EFFECT OF ARTIFICIAL INTELLIGENCE ON STUDENTS' ACADEMIC PERFORMANCE IN COMPUTER SCIENCE

BY

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Abstract
The purpose of this study was to investigate the effect of Artificial Intelligence (AI) on the academic performance of Senior Secondary School students in Computer Science. The objectives were to assess the influence of AI on students' performance and compare it with conventional teaching methods. A quasi-experimental design of pre-test, post-test, and control groups was employed. The population comprised 12,231 SS II students from 122 public secondary schools, with a sample of 160 students selected through multistage sampling procedure. Data were collected using a researcher-designed Computer Science Performance Test (CSPT). The instrument was validated by experts in Computer Science Education and Tests, Measurement and Evaluation, and found reliable with a coefficient of 0.83. The CSPT was administered at pre-test and post-test before and after a six-week instructional period. Data were analyzed using mean, standard deviation, and t-test at 0.05 significance. Findings revealed that students exposed to AI significantly outperformed those taught via conventional methods. It is recommended that schools adopt AI in teaching would provide technological resources, and train teachers in AI-based instruction to enhance student learning outcomes.

Keywords: Artificial Intelligence, Computer Science, Academic Performance, Secondary School Students, Instructional Strategies

Introduction
Education is widely recognized as a key driver of societal, moral, intellectual, cultural, and social development. It provides individuals with the knowledge, skills, and attitudes necessary to navigate and contribute meaningfully to society while fostering national development. The critical importance of education has prompted both individuals and governments to invest heavily in educational systems and infrastructure, ensuring that students are well-equipped to meet the challenges of modern life (Ekundayo, 2020). In Nigeria, education is prioritized at federal, state, and local government levels, reflecting a collective recognition of its transformative potential. Beyond personal advancement, education is seen as a cornerstone for national growth, promoting social cohesion, political engagement, technological innovation, and economic development. Secondary education, in particular, plays a pivotal role in equipping young people with skills for self-employment, vocational engagement, and advanced scientific knowledge, thereby enabling them to lead meaningful lives within their communities (Federal Government of Nigeria, 2014).

Science, as a discipline, is dedicated to explaining natural phenomena and establishing governing principles that regulate natural processes. Through

systematic observation, experimentation, and analysis, science enables predictable and accurate explanations of events in the natural world (Remi & Akujobi, 2019). In contemporary society, science remains profoundly relevant due to its applications in technological advancement and problem-solving. Its interactive and experiential approach relies on experimentation, validation, and critical analysis, which distinguishes it from other fields of knowledge and underscores the need for specialized teaching strategies (Sivakumar & Kirubanandhini, 2014). Nations, including Nigeria, have increasingly recognized that scientific progress is central to development, as breakthroughs in technology, medicine, and engineering directly shape the quality of life and the global competitiveness of a country.

Computers and digital technologies have become integral components of modern life, spanning industries, education, homes, offices, and business ventures. This widespread adoption underscores the importance of equipping individuals with foundational computer literacy and technical skills. Computer Science, as a field, encompasses computational thinking, programming, and the principles governing hardware and software systems (Ajayi & Ajayi, 2020). It involves a spectrum of topics, from coding and algorithm design to data structures, networking, cybersecurity, and software development. Teaching Computer Science in secondary schools, especially in Kwara State, requires embedding computational thinking, programming skills, and digital literacy into the curriculum. This aligns with the global focus on Science, Technology, Engineering, and Mathematics (STEM) education, aimed at preparing students for the demands of the 21st-century workforce.

The importance of Computer Science in national development cannot be overstated. It plays a crucial role in physical sciences, engineering, healthcare, governance, business, and security by providing technological solutions to societal challenges (Lim, Gottipati, & Cheong, 2024). Through interactive and experiential learning, students engage with both theoretical concepts and practical applications, developing the skills necessary to innovate and solve real-world problems. Computer Science education is therefore across all educational levels in Nigeria, starting from junior secondary school, and is compulsory due to its interdisciplinary applications. Despite these efforts, secondary school students' performance in Computer Science examinations remains a concern. Reports from the West African Examinations Council (WAEC) reveal a declining trend in student achievement over recent years, as illustrated in Table 1.

Table 1: WAEC Subject Performance Analysis of Candidates in Computer Studies, Kwara State (2019–2023)

Year	Candidates that Sat	% Pass (A1–C6)	% Fail (D7–F9)	% Absent
2019	1,542	82.03%	14.46%	2.83%
2020	1,764	59.80%	18.78%	2.86%
2021	1,433	63.85%	27.98%	5.47%
2022	1,740	78.90%	13.62%	2.84%
2023	1,750	78.40%	13.48%	3.47%

Source: The West African Examinations Council (WAEC), *Subject Performance Analysis of Candidates in Kwara State WASSCE (SC), 2019–2023.*

The data presented in Table 1 reveals that students' performance in Computer Studies in Kwara State between 2019 and 2023 fluctuated significantly. In 2019, students recorded the highest pass rate of 82.03%, reflecting a strong performance in the subject. However, there was a sharp decline in 2020, with the pass rate dropping to 59.80%, possibly due to disruptions in academic activities linked to the COVID-19 pandemic and the shift to remote learning, which may have affected students' preparedness. In 2021, performance slightly improved to 63.85%, indicating gradual recovery. By 2022 and 2023, the pass rates rose again to 78.90% and 78.40% respectively, showing a restoration of academic stability and improved instructional delivery. Throughout the five years, the failure rate ranged between 13.48% and 27.98%, while absenteeism remained relatively low, averaging around 3% to 5%, suggesting consistent participation but varying levels of academic achievement across the period.

Artificial Intelligence (AI) is being explored as a potential intervention to enhance teaching and learning outcomes. AI simulates human cognitive processes, including learning, adapting, problem-solving, and self-correction (Zhang & Lu, 2021; Fahimirad & Kotamjani, 2018). Machine learning, a subset of AI, enables systems to identify patterns, make predictions, and apply insights to new situations, thereby enhancing educational applications (Jordan & Mitchell, 2015). In education, AI facilitates personalized learning by analyzing students' strengths, weaknesses, and learning preferences, providing customized content, recommendations, and feedback (Gupta & Sakshi, 2021).

AI-powered educational platforms offer several advantages, including immediate feedback, real-time assessment, and interactive learning experiences. This approach encourages self-reflection and active participation, allowing students to correct errors and reinforce understanding promptly (Ahmadi, 2023). AI tools also enhance accessibility for learners with disabilities, support teachers in routine tasks, and allow educators to focus on mentoring and facilitating deeper engagement with students (Ikedinach et al., 2019). AI teaching and learning become more adaptive, interactive, and aligned with digital-native innovations, bridging gaps in traditional instruction.

Given the persistent poor performance in Computer Science in Kwara State, the use of AI presents a strategic approach to improving academic outcomes. By leveraging AI's capabilities for personalized learning, real-time feedback, and interactive engagement, education can transition from traditional analog methods to a digital knowledge-based framework. Such innovation has the potential to transform teaching and learning, enhance student achievement, and prepare Nigerian students for the technological demands of the 21st century. Hence, the need to investigate the effects of Artificial Intelligence (AI) on the academic performance of secondary schools students in Computer Science in Kwara State, Nigeria.

Purpose of the Study

The purpose of the study was to investigate the effects of Artificial Intelligence (AI) on the academic performance of secondary schools students in Computer Science.. It specifically:

i. assessed students' academic performance in Computer Science before and after being exposed to AI-based instructional strategies;
ii. compared the academic performance of students taught

using integrated AI strategies with those taught using conventional teaching methods;

Research Question

A research question was raised to guide the study:

1. Would Artificial Intelligence (AI) influence students' performance in Computer Science before and after exposure to Artificial Intelligence?

Research Hypotheses

The following null hypotheses were formulated for the study:

1. There is no significant difference in the academic performance of students in the experimental and control groups before the treatment in Computer Science.
2. There is no significant difference in the academic performance of students exposed to Artificial Intelligence (AI) and conventional teaching strategies in Computer Science.

Methodology

This study adopted a quasi-experimental design ofpre-test, post-test, and control groups to examine the effect of Artificial Intelligence (AI) on students' academic performance in Computer Science. The design was chosen to allow investigation of cause-and-effect relationships between the independent variable (AI) and the dependent variable (students' performance). The population consisted of 12,231 Senior Secondary School Two (SSS II) students from 122 public secondary schools across the sixteen Local Government Areas of Kwara State (Ministry of Education, 2024). A sample of 160 students was selected using a multistage sampling procedure, which involved random selection of two senatorial districts, one Local Government Area from each, and two public secondary schools from each LGA, ensuring representation of both urban and rural locations. The selected schools were assigned to experimental and control groups, and intact classes within these schools, comprising both male and female students, formed the study sample. Data were collected using a researcher-designed Computer Science Performance Test (CSPT), consisting of two sections: Section A elicited students' bio-data, while Section B contained 20 multiple-choice questions drawn from WAEC examinations conducted between 2021 and 2023. The instrument was validated for face and content validity by lecturers in Computer Science Education, Tests, Measurement and Evaluation experts, and experienced WAEC examiners. Reliability was established using the test-retest method on 20 students from schools outside the sample, yielding a coefficient of 0.83, indicating high reliability. AI instructional package for the experimental group included lesson plans, teaching materials, case studies, practical demonstrations, and assessment tools designed to guide teachers in integrating AI into classroom instruction. The control group was taught using conventional methods. The experimental procedure spanned eight weeks: the first week involved pre-test administration to determine group homogeneity and student baseline performance; six weeks were dedicated to treatment, during which the experimental group received AI-based instruction for forty minutes per period per week, while the control group continued with traditional teaching; and the final week involved administering the post-test using the CSPT, with items reshuffled to avoid test-wiseness. Data analysis employed descriptive statistics, including mean, standard deviation, and bar charts, to answer the research questions, while hypotheses were tested using t-tests at a 0.05 level of significance to determine the effect of AI on students' performance in Computer Science.

Results

Research Questions 1: Would Artificial Intelligence (AI) influence students' performance in Computer Science before and after exposure to Artificial Intelligence?

Table 1: Mean and Standard Deviation of students' performance in Computer Science before and after exposure to Artificial Intelligence

Group	N	Pre-test		Post-test		Mean Difference
		Mean	SD	Mean	SD	
Artificial Intelligence	77	55.20	10.30	70.50	8.70	15.30
Conventional Method	76	54.80	11.00	60.20	10.10	5.40

Table 1 shows the mean and standard deviation of students' performance in Computer Science before and after exposure to Artificial Intelligence (AI) compared with the conventional method. The results reveal that students in the AI group (N = 77) recorded a mean score of 55.20 before exposure, which increased significantly to 70.50 after exposure, with a mean difference of 15.30. In contrast, the conventional group (N = 76) had a mean score of 54.80 before exposure and 60.20 after exposure, with a smaller mean difference of 5.40. This indicates that while both groups improved, students exposed to AI experienced a greater enhancement in performance, implying that AI-based instruction had a stronger positive influence on learning outcomes than the conventional method.
This is also depicted in figure 1 below.

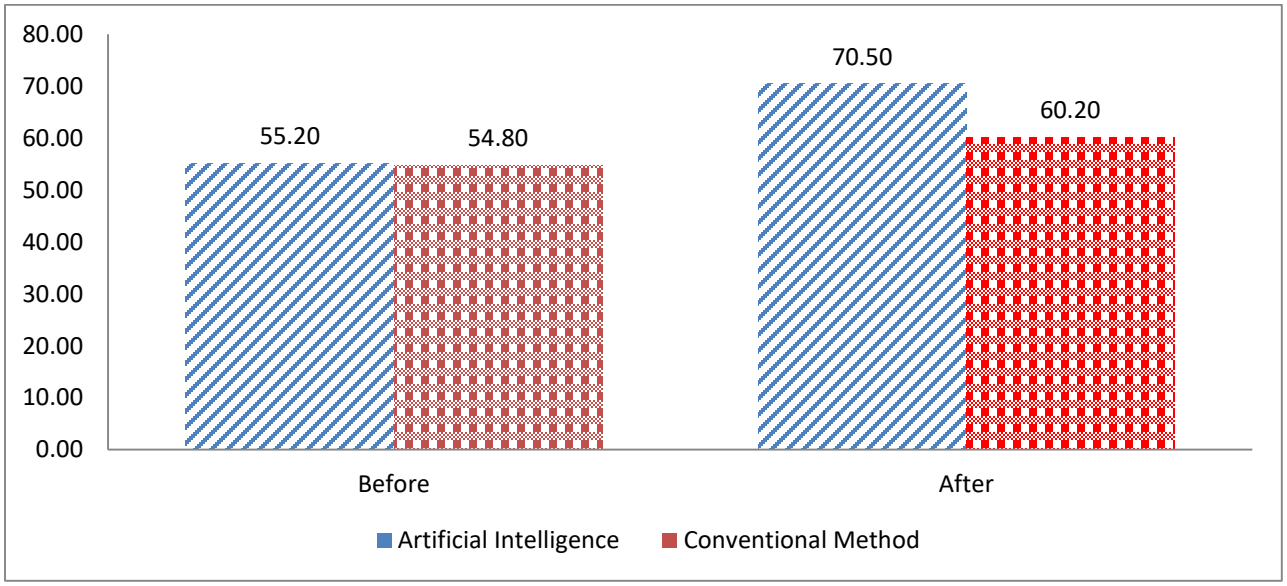

Figure 1: Bar Chart showing students' performance in Computer Science before and after exposure to Artificial Intelligence

Testing of Hypotheses

Hypothesis 1: There is no significant difference in the academic performance

of students in the experimental and control groups before the treatment in Computer Science

Table 2: t-test of the academic performance of students in the experimental and control groups before the treatment in Computer Science

Group	N	Mean	SD	df	t	p
AI Group	77	55.2	10.3	151	0.23	0.82
Conventional Group	76	54.8	11.0			

P<0.05

Table 2 presents the independent samples t-test comparing the academic performance of students in the AI group and the conventional group before treatment in Computer Science. The AI group (N = 77) had a mean score of 55.20 (SD = 10.30), while the conventional group (N = 76) recorded a mean of 54.80 (SD = 11.00). The analysis yielded a t-value of 0.23 with 151 degrees of freedom and a p-value of 0.82, which is greater than the 0.05 significance level. This result indicates that there was **no statistically significant difference** in the pre-treatment performance of the two groups, confirming the null hypothesis that both groups had comparable academic performance before the intervention.

Hypothesis 2: There is no significant difference in the academic performance of students exposed to Artificial Intelligence (AI) and conventional teaching strategies in Computer Science.

Table 3: t-test of the academic performance of students exposed to Artificial Intelligence (AI) and conventional teaching strategies in Computer Science.

Group	N	Mean	SD	df	t	p
AI Group	77	70.5	8.7	151	5.12	0.001
Conventional Method	76	60.2	10.1			

P<0.05

Table 3 presents the t-test analysis of students' academic performance in Computer Science after exposure to integrated Artificial Intelligence (AI) and conventional teaching strategies. The AI group (N = 77) obtained a higher mean score of 70.50 (SD = 8.70), compared to the conventional method group (N = 76), which had a mean score of 60.20 (SD = 10.10). The computed t-value was 5.12 with 151 degrees of freedom, and the associated p-value was 0.001, which is less than the 0.05 significance threshold. This result indicates a statistically significant difference in performance between the two groups, favoring students taught with AI. Therefore, the null hypothesis is rejected, confirming that the use of AI significantly enhanced students' academic performance in Computer Science compared to conventional teaching strategies.

Discussion

The finding of this study revealed that students exposed to Artificial Intelligence (AI) showed greater improvement in academic performance compared to those taught with the conventional method. This suggests that AI has the potential to transform teaching and learning by making instruction more interactive, personalized, and student-centered. Unlike conventional methods that often rely on teacher-led explanations and rote memorization, AI

provides adaptive feedback, tailors content to individual learning needs, and encourages active participation. These features make learning more engaging and effective, particularly in a practical and dynamic subject such as Computer Science. This result is in line with the finding of Sanusi, Adedoyin, and Olanrewaju (2024), who found that AI applications in Nigerian schools improve learning outcomes by supporting individualized learning and providing real-time feedback. It is also corroborated by Onuh and Charles (2023), who found that AI tools such as smart assessments and intelligent tutoring systems significantly enhance instructional effectiveness in secondary schools. Similarly, Okonkwo and Ade-Ibijola (2021) found that AI integration in Nigerian education has the potential to foster creativity, improve student motivation, and strengthen academic achievement by making learning more practical and accessible. The finding is further consistent with Eze and Nwosu (2022), who emphasized that AI-based learning platforms help students overcome barriers such as overcrowded classrooms and limited teaching resources, which are common challenges in Nigeria. This reveals that importance of adopting AI as a complementary instructional strategy to address gaps in the traditional classroom and to promote better performance in Computer Science and other subjects.

The finding of the study revealed that there was no significant difference in the academic performance of students in the AI and conventional groups before treatment, showing that both groups were academically comparable at baseline. This indicates that any observed differences in performance after the intervention can be attributed to the instructional strategies rather than pre-existing disparities in students' abilities. This finding is in line with the findings of Onu and Charles (2023), who reported that ensuring comparable groups before the introduction of new instructional approaches is essential for measuring the true effect of innovative teaching methods such as AI. It is also corroborated by Eze and Nwosu (2022), who found that baseline equivalence allows researchers to isolate the impact of emerging technologies on students' learning outcomes more accurately. Similarly, the finding is consistent with the work of Sanusi, Adedoyin, and Olanrewaju (2024), who found that pre-intervention equality between experimental and control groups strengthens the validity of educational experiments and enhances the credibility of their results. In the Nigerian, where differences in prior knowledge and access to resources can affect learning outcomes, establishing baseline comparability is particularly important. Thus, this result validates the reliability of the subsequent findings in this study by confirming that the groups were initially on equal footing before the AI intervention was introduced.

The finding of the study revealed that a significant difference was found between students exposed to AI and those taught with the conventional method, with the AI group performing better. This suggests that using AI in teaching enhances students' learning outcomes by making instruction more interactive, adaptive, and engaging. Unlike the conventional method, which often depends on rote learning and teacher-centered explanations, AI tailors content to individual learning needs, provides timely feedback, and supports active participation, which improves students' understanding and retention of knowledge. This finding is in line with the finding of Adeoye and Olanrewaju (2022), who reported that AI-based instruction significantly improved students' academic achievement in Computer

Science by fostering personalized and self-directed learning. It is also corroborated by Okonkwo and Nwafor (2023), who found that students exposed to AI-supported tools demonstrated higher performance and motivation compared to those taught with traditional approaches. Similarly, the finding is consistent with Adebayo and Yusuf (2021), who emphasized that AI integration enhances problem-solving skills and critical thinking, thereby improving academic outcomes. In Kwara State, where challenges such as large class sizes and limited teaching resources often hinder effective instruction, this result highlights the transformative potential of AI as a tool to bridge learning gaps and promote equitable access to quality education. Thus, the superiority of AI-based teaching over conventional methods underscores the need for its wider adoption in Computer Science and other subjects.

Conclusion

Based on the findings of this study, it is concluded that the use of Artificial Intelligence (AI) in teaching Computer Science significantly improves students' academic performance. The students exposed to AI demonstrated higher achievement compared to those taught using conventional methods, confirming the effectiveness of AI as an instructional strategy. The pre-test results established that the groups were initially comparable, indicating that the observed improvement was directly attributable to the AI intervention. Therefore, AI can be considered a valuable tool for enhancing teaching and learning in Computer Science, providing a more effective approach than traditional classroom methods.

Recommendations

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

1. Schools and educational authorities in Kwara State should integrate Artificial Intelligence (AI) into Computer Science instruction to enhance student engagement, understanding, and academic performance.
2. Teachers should be trained in the use of AI tools and platforms to effectively deliver personalized, interactive, and student-centered lessons. Professional development programs should include practical sessions on AI-assisted lesson planning, assessment, and classroom management.
3. Curriculum developers should incorporate AI-supported learning activities and resources into the Computer Science syllabus to ensure students are exposed to modern, technology-driven instructional approaches.
4. Schools should be equipped with the necessary technological infrastructure, including computers, internet access, and AI-enabled educational software, to facilitate effective AI-based teaching and learning.
5. Educational policymakers should create guidelines and incentives to encourage the adoption of AI in secondary schools, ensuring that both teachers and students benefit from technological innovations in education.

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