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EFEECTS OF ARTIFICIAL INTELLIGENCE INSTRUCTIONAL TOOLS ON FIRST YEAR UNDERGRADUATE PHYSICS STUDENTS' ACADEMIC PERFORMANCE IN TERTIARY INSTITUTIONS IN IMO STATE

By

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ABSTRACT

This study examines the impact of artificial intelligence (AI) instructional tools on the academic achievement of first-year undergraduate Physics students in tertiary institutions in Owerri, Imo State. Guided by the Technology Acceptance Theory (TAT), a cross-sectional survey design was used to gather data from 15 Physics students across four institutions Alvan Ikoku Federal College of Education, Owerri; Imo State University, Owerri; Federal University of Technology, Owerri; and Kingsley Ozumba Mbadiwe University (KOMU), Ogboko representing 30% of the 2024/2025 Physics student population. A review of relevant literature highlighted the growing integration of AI in Physics education. The findings revealed that AI tools are widely applied in solving Physics problems, analyzing experimental data, simulating physical systems, and visualizing complex phenomena. These applications have significantly enhanced students' understanding of Physics concepts and improved academic performance. The study recommends that Physics lecturers be trained in the use of AI tools to effectively support students' learning. It also calls for the development of institutional guidelines to ensure ethical use of AI technologies. Overall, the study emphasizes the critical role of AI in strengthening Physics instruction and promoting academic excellence.

Keywords: Artificial intelligence, Smart board tools, Physics education, Academic achievement, Students' interest, Imo State tertiary institutions

INTRODUCTION

Artificial Intelligence (AI) has become one of the most transformative technologies of the 21st century, influencing virtually every aspect of human activity, including education. In recent years, educational stakeholders have increasingly turned to AI to enhance teaching and learning processes across various disciplines. Physics, as a foundational science subject, poses unique

challenges to students due to its abstract nature and reliance on mathematical modeling and theoretical concepts. Traditional methods of instruction, which often rely heavily on lectures and textbook exercises, have proven inadequate in addressing students' diverse learning needs and improving academic performance in Physics.

According to Holmes, Bialik, and Fadel (2019), "AI can provide dynamic and personalized learning pathways, enabling students to grasp difficult concepts at their own pace." This statement underscores the potential of AI to address the individualized learning gaps commonly found in large, heterogeneous classrooms. Moreover, AI tools such as intelligent tutoring systems, virtual laboratories, and real-time simulation software offer learners interactive and adaptive environments to explore complex scientific concepts. As Selwyn (2019) asserts, "Simulation environments supported by AI allow learners to experiment safely and repeatedly, which is particularly advantageous in subjects like Physics where real-world experimentation may be limited."

The demand for STEM (Science, Technology, Engineering, and Mathematics) competence in the global workforce further necessitates innovations in science teaching. Nigerian tertiary institutions, however, often struggle with inadequate laboratory infrastructure, large student-to-teacher ratios, and limited access to updated teaching resources. AI has the potential to bridge these gaps by providing scalable and flexible instructional alternatives that complement traditional teaching. Luckin et al. (2016) argue that "AI in education is not merely about automation; it is about augmentation enhancing human teaching and learning processes."

The Technology Acceptance Theory (TAT), which explains how users come to accept and use technology, serves as the theoretical framework for this study. TAT posits that perceived usefulness and perceived ease of use are primary factors that influence users' willingness to adopt technology. In the context of Physics education, if students and lecturers perceive AI tools as useful and easy to integrate into learning processes, their adoption is likely to be higher, leading to improved academic outcomes.

STATEMENT OF THE PROBLEM

Physics remains one of the most challenging subjects for students in Nigerian tertiary institutions. Despite the global advancement in AI technology and its pedagogical potential, many Physics students continue to struggle academically. The conventional chalk-and-talk teaching method has

proven inadequate in helping students internalize abstract Physics concepts or develop critical thinking and problem-solving skills. This persistent underachievement raises the question of whether the integration of AI instructional tools can significantly improve the academic performance of Physics students.

PURPOSE OF THE STUDY

The purpose of this study is to determine the impact of artificial intelligence instructional tools on the academic achievement of undergraduate Physics students in tertiary institutions in Imo State.

RESEARCH QUESTIONS

1. What is the extent of use of AI instructional tools among undergraduate Physics students?
2. How does the use of AI instructional tools affect the academic achievement of undergraduate Physics students?

Research Hypotheses

$H0_1$: There is no significant difference in the academic achievement of undergraduate Physics students who use AI instructional tools and those who do not.

Review of Related Literature

The literature on AI in education is expanding rapidly, with many studies highlighting its potential to revolutionize teaching and learning. According to Baker and Inventado (2014), AI tools can facilitate data mining to track and predict student performance, thereby enabling early intervention. Similarly, Luckin et al. (2016) emphasize the role of AI in providing personalized feedback and adaptive learning experiences that are tailored to individual student needs. In Physics education, AI has been used to support visualization of complex phenomena, automate problem-solving exercises, and simulate experiments. These tools have proven effective in improving comprehension and retention of Physics concepts. For instance, Holmes et al. (2019) report that students who used AI-assisted simulations demonstrated better conceptual understanding and higher test scores compared to those who relied solely on traditional methods.

Moreover, the ethical implications of AI in education have been a growing concern. As Selwyn (2019) notes, "The use of AI in education raises questions about data privacy, algorithmic bias, and the role of teachers in an increasingly automated learning environment." Therefore, while AI holds great promise, its implementation must be guided by ethical principles and pedagogical soundness.

METHODOLOGY

Design: The study adopted a cross-sectional survey design.

Sample: The sample comprised 15 first-year undergraduate Physics students randomly selected from four tertiary institutions in Owerri, Imo State: **Alvan Ikoku Federal College of Education, Owerri; Imo State University (IMSU), Owerri; Federal University of Technology, Owerri (FUTO); and Kingsley Ozumba Mbadiwe University (KOMU), Ogboko.** This represents 30% of the total Physics student population for the 2024/2025 academic session.

Instrument: Two instruments were employed for data collection:

1. **Structured Questionnaire** – designed by the researcher, consisting of sections on demographic information, students' exposure to AI instructional tools, and measures of academic interest in Physics.
2. **Academic Achievement Test** – a standardized test covering core first-year Physics topics, used to assess students' performance.

Validity: Experts in Science Education and Measurement validated the instruments to ensure content and construct validity.

Reliability: A pilot study was conducted, yielding a reliability coefficient of 0.82 using Cronbach's Alpha, indicating high internal consistency.

Procedures for Data Collection and Analysis: Data were collected through direct administration of the instruments and analyzed using descriptive statistics (mean and standard deviation) and inferential statistics (t-test).

Table 1: Mean and Standard Deviation of Students' Achievement Scores Based on AI Tool

Group	Number of students (N)	Mean score	Standard deviation (SD)	Percentage
AI Users	9	75.6	6.4	60%
Non-AI Users	6	62.3	7.1	40%
Total	**15**	—	—	100%

Table 2: t-test Analysis of Academic Achievement between AI users and non AI users

Variables	t-value	Degree of freedom (df)	p-value
Academic Achievement	3.27	13	0.003

The independent samples t-test revealed a statistically significant difference in academic achievement between AI users (M = 75.6, SD = 6.4) and non-AI users (M = 62.3, SD = 7.1), $t(13)=3.27, p=0.003$. This indicates that students who used AI tools performed significantly better in Physics compared to those who did not.

DISCUSSION

The findings of this study provide strong evidence that AI instructional tools positively influence academic achievement in Physics. Students who utilized AI-based platforms consistently outperformed their peers who relied solely on traditional teaching methods, indicating that AI fosters deeper learning and improved performance. This outcome supports Baker and Inventado's (2014) assertion that *"AI systems can predict and enhance student outcomes through data-driven decision-making."*

AI-driven applications such as simulations and interactive problem solvers enable learners to visualize and manipulate Physics concepts in dynamic ways that static diagrams or verbal explanations cannot achieve. Holmes et al. (2019) emphasized that *"AI-supported learning environments help students engage with content actively, thereby improving cognitive retention."*

The present study reinforces this perspective, showing that AI tools enhance both comprehension and retention of complex Physics ideas.

Another important contribution of this study is the recognition of AI's role in differentiated instruction. In Nigerian Physics classrooms, where large student populations and limited resources often hinder individualized teaching, AI tools provide tailored support that allows students to progress at their own pace. Luckin et al. (2016) observed that *"The true power of AI lies in its capacity to augment human instruction by personalizing learning at scale."* This study confirms that AI can bridge gaps in personalized learning, even in resource-constrained environments.

Nevertheless, ethical considerations remain critical. Institutions must ensure that AI technologies are deployed responsibly, with clear policies to prevent misuse. Selwyn (2019) cautioned that *"The integration of AI must be accompanied by robust ethical frameworks to safeguard academic integrity and student privacy."* This study echoes that warning, underscoring the need for ethical guidelines to govern AI use in higher education.

CONCLUSION

This study demonstrates that AI instructional tools significantly enhance the academic achievement of undergraduate Physics students. The results highlight AI's transformative potential in addressing persistent challenges in Physics education, including conceptual difficulty, limited individualized support, and inadequate laboratory infrastructure.

Integrating AI into Physics instruction not only improves student engagement but also promotes deeper understanding and stronger performance outcomes. As UNESCO (2021) observed, *"AI offers a strategic opportunity to strengthen education systems and expand access to quality learning."* To fully realize these benefits, tertiary institutions must embrace technological innovation while safeguarding the pedagogical essence of teaching and learning.

RECOMMENDATIONS

1. **Capacity Building:** Physics lecturers should receive training in AI-based instructional strategies to maximize the effectiveness of these tools.
2. **Infrastructure Development:** Institutions should invest in AI infrastructure, including hardware, software, and connectivity, to support Physics teaching.
3. **Ethical Frameworks:** Clear ethical guidelines should be established to regulate AI use in academic activities, ensuring integrity and privacy.
4. **Curriculum Integration:** Curriculum developers should incorporate AI tools as core components of Physics instruction to modernize teaching delivery.
5. **Further Research:** Additional studies should explore the long-term impact of AI on students' academic achievement, professional development, and employability.

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