

**BLENDED PEDAGOGY OF ARTIFICIAL INTELLIGENCE - HUMAN INSTRUCTIONAL INTEGRATION: EFFECT ON ACADEMIC ACHIEVEMENT AND MOTIVATION OF UNDERGRADUATE PHYSICS STUDENTS**

MOKUOLU, Adewunmi Olanrewaju (Ph.D)

Department of Physics, Federal College of Education, Abeokuta, Nigeria

Abstract

This study examines the effectiveness of blended pedagogy - an instructional approach that integrates human teaching with Artificial Intelligence (AI) tutoring tools, on students' academic achievement and motivation in undergraduate Physics and Chemistry classrooms. A quasi-experimental research design was adopted, with a study sample of 135 undergraduate science students, treated both as control groups (Physics control group, $n = 66$ and Chemistry control group, $n = 69$) and experimental groups (Physics experimental group, $n = 66$ and Chemistry experimental group, $n = 69$). The control groups were taught using the conventional teacher-led instruction, while the experimental groups were taught using the blended pedagogy. Data were collected using Science Achievement Test and Science Learning Motivation Scale which have reliability coefficients of 0.88 and 0.91 obtained using Kuder-Richardson and Cronbach's alpha, respectively. Collected data were analyzed using descriptive and inferential statistics at 0.05 significance level. Results showed significant differences in mean scores between the experimental and the control group (Experimental: $MS = 34.21$, $SD = 5.02$; Control: $MS = 26.83$, $SD = 6.18$; $t(130) = 7.53$, $p < 0.001$). Similarly, students in the experimental group reported significantly higher motivation levels ($n = 135$, $MS = 3.78$, $SD = 0.51$) compared to the control group ($n = 135$, $MS = 2.87$, $SD = 0.62$), $t(268) = 13.17$, $p < 0.001$. These results indicate a positive effect of blended pedagogy on students' academic achievement and motivation. It is therefore recommended that school authorities should organize training workshops for science lecturers on AI tools for teaching-learning and support them with necessary needed facilities.

Keywords: Artificial Intelligence, Academic Achievement, Motivation, Physics.

Introduction

Artificial Intelligence (AI) is a form of computer application that focuses on creating systems capable of performing tasks that normally require human intelligence. These tasks include learning, reasoning, problem-solving, perception, decision-making, and natural language understanding (Russell & Norvig, 2021). In simple terms, AI is a machine data-driven software that uses algorithms and models to "think" and "act" intelligently like humans usually in a faster and more efficient manner. AI tools used in education includes; (1) Intelligent Tutoring Systems, ITS - used to provide personalized instruction and feedback (e.g *Carnegie Learning* used for maths & science tutoring, *ALEKS* Adaptive learning for chemistry & maths, *Socratic by Google* - an AI-powered problem-solving support); (2) Virtual Laboratories & Simulations - an AI-driven platforms that allow students to conduct experiments virtually (e.g *Labster* used for virtual science



labs in biology, physics, chemistry, *PhET Interactive Simulations* used for physics and chemistry simulations, *MERLOT Virtual Labs*); (3) AI Chatbots and Virtual Assistants used to Support student engagement, Question and Answer, and personalized guidance (e.g *ChatGPT* used to supports problem-solving and tutoring, *IBM Watson Tutor*, *Duolingo's AI Tutor*) among others.

Artificial Intelligence (AI) has emerged as a promising tool to enhance teaching and learning by providing adaptive feedback, personalized learning pathways, and predictive analytics. It has the potential to revolutionize education (Holmes et al., 2019) and address the diverse needs of learners. AI plays a significant role in both general and higher education, influencing students' academic development by offering a mix of opportunities and challenges (Edtech, 2020). Artificial Intelligence (AI) enables personalized learning by adapting educational content to meet the unique needs of individual students (Hennekeuser et al., 2024). Research studies indicate that AI-based instruction can improve student performance, learning efficiency and motivation when designed properly (Kulik & Fletcher, 2016; Chen et al., 2020; Song & Song, 2023). Applications such as ChatGPT, intelligent tutoring systems, educational robots, learning analytics dashboards, adaptive learning platforms, and human-computer interactions have demonstrated significant potential for enhancing teaching and learning (Chen et al., 2020; Zawacki-Richter et al., 2019; Song & Song, 2023; Mallillin, 2024). Moreover, AI-powered tools have shown potential in identifying at-risk students and enabling early interventions that positively affect academic outcomes (Hamadneh et al., 2022; Contrino et al., 2024). Artificial Intelligence (AI) was observed to effectively targets the specific learning needs of students, facilitating comprehensive and improved learning experiences; identifies struggling learners and provides necessary interventions and support to enhance their academic performance; accurately measures and enhances students' attitudes toward learning, offering deeper insights into the learning process, and boosts students' motivation toward study habits and learning behavior (Mallillin, 2024).

AI application tool such as ChatGPT has been found to significantly improved students' learning performance, improved student perceptions of learning quality, increases learning and task motivation, with motivation influencing AI's effectiveness and is enhanced by AI's adaptive feedback but concerns about academic dishonesty and overdependence lowered motivation to use AI in some cases (Song & Song, 2023; Zheng & Pineda, 2023; Liu & Tsai, 2023; Qu & Wu, 2024; Hmoud et al., 2024; Wang et al., 2024). Fernández-García et al. (2025) in their study on generative chatbots in academic settings, observed that students were motivated to use generative chatbots mainly by curiosity, efficiency, and perceived academic support; and that some students used AI as a way to save time, while others valued it for developing skills; however, academic integrity concerns were noted, but overall motivational drivers outweighed deterrents. Contrino et al. (2024) in their study observed that implementing adaptive AI-based learning tools improved students' grades and satisfaction in both online and face-to-face courses; increased students' confidence and persistence in learning tasks; and strongest performance gains when the system offered personalized pathways tailored to students' needs. Several other studies have also shown that students who received AI-based personalized tutoring and feedback showed higher academic performance than those without it and AI analytics were particularly effective in blended learning environments; with AI increasing student persistence and success rates in remote settings, and performance gains were linked to content generation, personalized tutoring, and feedback tools, but highlighted the risk of surface learning if AI is overused for shortcuts (Ogunleye et al., 2024;



Hamadneh et al., 2022; Adewale et al., 2024). Even though, adaptive learning platforms leverage AI to tailor educational content to individual learners' needs, promoting more effective and efficient learning experiences (Holmes et al., 2019). However, positive educational outcomes are not guaranteed solely by the adoption of advanced AI technologies (Castaneda and Selwyn, 2018; Du Boulay, 2000; Selwyn, 2016).

Human instruction, by contrast, provides irreplaceable benefits such as mentorship, contextual guidance, empathy, emotional support and fosters motivation through interpersonal relationships — qualities difficult for AI to replicate. Studies suggest that motivation and deeper learning outcomes are more sustainable when learners feel supported by human instructors (Hmoud et al., 2024; Wang et al., 2024). However, the relationship between AI-based instruction and human instruction is complex. While some studies report that AI applications boost student performance, enhance engagement and reduce anxiety through instant support, other studies reveal concern about students' over-reliance on AI, undermining intrinsic motivation, self-directed learning, reduced self-regulation, and inconsistent effects on motivation (Hmoud et al., 2024; Wang et al., 2024; Zawacki-Richter et al., 2019; Ogunleye et al., 2024).

Statement of the Problem

Undergraduate education in Physics has long been characterized by challenges such as abstract nature of concept, high cognitive demands, and low levels of student motivation. Despite the dedication of some instructors and the use of conventional teaching strategies to provide structure, mentorship, and emotional support, many students still continue to struggle with conceptual understanding and sustained motivation due to their diverse learning needs leading directly to lower academic achievement, reduced interest and higher attrition rates in science disciplines.

Even though Artificial Intelligence (AI) provides personalized learning environments that can support diverse student needs and potentially enhance academic performance and motivation, still, the academic and motivational impact of AI is less conclusive, as interaction of AI and human instruction remains under-explored, especially in Physics, where mastery requires both conceptual understanding and motivation to persist and excel in the discipline.

This gap creates the need for this study with a view to investigating how blended approaches can maximize both achievement and motivation without sacrificing academic rigor. The findings from this research can help inform best practices in blended teaching models and ensure AI tools are applied responsibly while preserving the essential role of human instruction in higher education.

Purpose of the Study

The main purpose of this study is to investigate the impact of blended Artificial Intelligence and human instruction on students' academic achievement and motivation in physics at the undergraduate levels. It also aims to examine the extent to which AI tools enhance students' academic achievement and motivation in physics and chemistry classrooms.

Research Hypotheses

1. There is no significant difference in the Academic Achievement (AA) of students taught using AI-Human Blended Instruction, AI-HBI (experimental group) and those taught using the Traditional Lecture Instruction, TLI (control group).



2. There is no significant difference in the academic motivation of students taught using AI-Human Blended Instruction, AI-HBI (experimental group) and those taught using the traditional Lecture Instruction, TLI (control group). H_{01} :

Research Methodology

This study uses a quasi-experimental-descriptive research method. The target population for the study includes all science (100L - 300L) students in the school of Secondary Education (Sciences), Federal College of Education, Abeokuta, Ogun state, Nigeria. Through random sampling technique, 200L science students consisting of 135 students were selected as the sample size. The sample students were divided into Experimental Group (EPG, $N = 66$) and Control Group (CPG, $N = 69$) during the teaching-learning treatments.

Data were collected with the aid of *Science Achievement Test-Physics* (SAT-P), and *Science Learning Motivation Scale* (SLMS). The SAT-P is a physics assessment test consisting of parts I and II (called SAT-PI and SAT-P-II). Both SAT-PI and SAT-P-II contain 10 short structured questions each, selected from Physics courses - PHY 222 (Atomic and Quantum Physics I) and PHY 223 (Basic and Digital Electronics), respectively. Each SAT-P question has a maximum score of 5 marks, making a total of 50 marks for each part of the assessment test. The SLMS is a questionnaire, self-developed by the researchers consisting of 20-items designed to measure the students' learning motivation. Responses to the SLMS was based on five-point Likert scale of Strongly Agree (SA = 4), Agree (A = 3), Disagree (D = 2) and Strongly Disagree (SD = 1).

The SAT-P, and SLMS were validated by expert colleagues in measurement and evaluation. The reliabilities of the SAT-P was determined using Kuder-Richardson to yield reliability coefficient values of 0.88, while the reliability of SLMS was determined using Cronbach's Alpha statistic to yield a reliability coefficient value of 0.91. The teaching-learning activities covered four weeks with the Physics and Chemistry experimental groups taught using the AI-Human Blended Instruction (AI-HBI), while the Physics and Chemistry control groups was taught using the Traditional Lecture Instruction (TLI). At the completion of the teaching-learning activities, the SLMS was administered to all students (both experimental and control groups) under strict examination conditions. Similarly, the SAT-PI and SAT-P-II were administered to the Physics Experimental Group (PEG) and Physics Control Group (PCG) respectively, under strict examination conditions. The instruments were marked and scored adequately. Collected data were analyzed using descriptive and inferential statistics at 0.05 level of significance with the aid of SPSS statistical software.

Result and Discussion

H₀₁: There is no significant difference in the Academic Achievement (AA) of students taught using AI-Human Blended Instruction, AI-HBI (experimental group) and those taught using the Traditional Lecture Instruction, TLI (control group).

Table 1: t-test results for academic achievement analysis of science students taught using AI-HBI and those taught using TLI.

Group	N	MS	SD	MSD	df	t-value	p-value
Experimental (AA-Physics)	66	34.21	5.02				

Control (AA-Physics) 69 26.83 6.18 7.38 133 7.53* 0.001

MS = Mean Score , SD = Standard Deviation, MSD = Mean Score Difference, * = value is significant at 0.05 level, AA-Physics = Academic Achievement in Physics,

Table 1 results revealed that physics students taught using AI-HBI had a higher mean score (**MS = 34.21, SD = 5.02**) in their academic achievement than those taught using TLI (**MS = 26.83, SD = 6.18**), with a mean score difference, **MSD = 7.38**. The independent sample t-test analysis showed a t-test value, **t(130) = 7.53**, at $p < 0.001$ level of significance. Hence, the null hypothesis is rejected. This implies that there is statistically significant difference in the academic achievement of physics students taught using AI-HBI and those taught using the TLI.

These results indicate that blended pedagogy of AI-Human Based Instruction (AI-HBI) supported-classrooms have a stronger potential to enhance and boost students' academic achievement compared to the Traditional Lecture Instruction alone. These results are in line with previous research works of Vieriu and Petrea (2025), Hairunnisa et al. (2024), Wang & Fan (2025), Deng et al. (2025), among others. Vieriu and Petrea (2025) in their study found that AI offers significant benefits of improving including personalized learning, improved academic outcomes and enhanced student engagement. Hairunnisa et al. (2024) in their study show that AI usage for study purposes significantly influences student's engagement and academic performance. Wang and Fan (2025) in their study of AI tools like ChatGPT reported that ChatGPT has a large positive impact on improving learning performance ($g = 0.867$) and a moderately positive impact on enhancing learning perception ($g = 0.456$) and fostering higher-order thinking ($g = 0.457$). Deng et al. (2025) in their study review of AI tool - ChatGPT revealed that ChatGPT as an AI tool *improves* academic performance, affective-motivational states, and higher-order thinking propensities.

H₀₂: There is no significant difference in the academic motivation of students taught using AI-Human Blended Instruction, AI-HBI (experimental group) and those taught using the Traditional Lecture Instruction, TLI (control group).

Table 2: t-test results for academic motivation analysis of science students taught using AI-HBI and those taught using TLI

Group	N	MS	SD	MSD	df	t-value	p-value
Experimental (Motivation)	66	3.78	0.51				
Control (Motivation)	69	2.87	0.62	0.91	133	13.17*	0.001

MS = Mean Score , SD = Standard Deviation, MSD = Mean Score Difference, * = value is significant at 0.05 level.

Table 2 showed the motivation results of students under the influence of AI-HBI and TLI. The table showed that the students when taught using the AI-HBI had a higher motivation with a mean score, **MS = 3.78 (SD = 0.51)** than when taught using TLI (**MS = 2.87, SD = 0.62**), with a mean score difference, **MSD = 0.91**. The independent sample t-test analysis conducted showed a t-test value, **t (268) = 13.17**, at $p < 0.001$ level of significance. Hence, the null hypothesis is rejected. This implies that there is significant difference in the academic motivation of students when subjected to AI-HBI and when taught using the TLI.



These results indicate that the combined application of AI and Human Based Instruction (AI-HBI) in teaching-learning activities can increase students' motivation and desire to learn compared to the Traditional Lecture Instruction alone. These study findings thus supported previous research works of Qu & Wu (2024), Mallillin (2024), Ubabuiké & Nweke (2024), Melsiana (2025), among others. Qu & Wu (2024) in their study of *ChatGPT as an AI tool in language education*, found that ChatGPT as an AI tool motivated learners by making learning fun and interactive, leading to higher adoption intention. Mallillin (2024) in his study results indicate that AI improved learning experiences and boosts students' motivation toward study habits and learning behavior. Melsiana (2025) in his study revealed that AI-based learning media not only enhances students' engagement with academic content but also boosts their motivation to learn, showing a statistically significant positive relationship between AI usage and both learning patterns (coefficient = 0.4472, $p = 0.0008$) and interest in learning (coefficient = 0.5616, $p = 0.00001$). Ubabuiké and Nweke (2024) in their study of AI applications revealed that in schools where AI tools were in use, there was observable improvement in students' comprehension, retention, and critical thinking abilities as well as increased students' motivation and engagement with interactive and gamified AI tools.

Conclusion

The study concludes that Artificial Intelligence-Human Based Instruction (AI-HBI) positively supports students' motivation and academic achievement. The integration of AI tools like ChatGPT in teaching-learning processes provides students with personalized learning experiences and interactive activities, which helped them become more motivated and consequently enhance their academic performance.

Recommendation

Based on the findings obtained from this study, it is recommended that school authorities and other stakeholders in education systems should (i) organize training workshops and seminars for science teachers on the use of AI tools in teaching and learning processes of sciences, (ii) encourage and ensure science teachers responsibly integrate AI tools into their traditional human-based instruction to support their teaching-learning activities, (iii) and support science teachers with necessary needed AI tools and resources.

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