
Integrated Science Pre-Service Teachers' Perception and Utilization of AI-Driven Pedagogical Strategies in Nigerian Universities

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ABSTRACT

This study investigated Pre-service Integrated Science teachers' perception and utilization of AI-driven pedagogical strategies in Nigerian universities. Two research questions guided the study. A descriptive survey was adopted. The population comprised 643 pre-service Integrated Science teachers in government-owned universities in Akwa Ibom State. Two universities were purposively selected for the study and using an accidental sampling technique, a sample size of 120 respondents was obtained. The instrument for data collection was the Pre-service Teachers' Perception and Utilization of AI-Driven Pedagogical Strategies Questionnaire (PSTPUAIDPSQ). Cronbach Alpha statistics was used to determine the reliability of the instrument and a coefficient of 0.89 was obtained, indicating that the instrument was reliable for the study. The data collected were analyzed using mean and standard deviation to answer the research questions. The findings of this study showed that there is a great extent of Integrated Science Pre-service teachers' perception and utilization of AI-driven pedagogical strategies in Nigerian Universities. Based on the findings, it was concluded that, though there is a great extent of perception and utilization of AI-driven pedagogical strategies in Nigerian universities, recommendations were made, among others that university management should guarantee access to technology resources, so that more students can improve their knowledge, change perception and utilize artificial intelligence tools.

Keywords: *AI-driven, pedagogical strategies, technology, Pre-service, Universities*

INTRODUCTION

Modern learning is a complex, energetic and technology driven individual that needs to be challenged and inspired in his learning. John Dewey criticized academics of his days over a century ago on education's need to adopt new instructional approaches based on future societal needs (Umoetuk & Akpan, 2023). These words have come to pass as students need innovative instructional approaches that help facilitate activities where they are active participants, which in turn enhance students' interest, understanding and academic performance (Akpan, 2022; Akpan A. & Akpan I., 2017). Globally the pattern of teaching and learning is changing, technology is reshaping teaching, learning, assessment and classroom interaction and artificial intelligence (AI) is rapidly transforming educational practices.

In higher education, AI-driven pedagogical strategies such as intelligent tutoring systems, adaptive learning platforms, automated feedback systems, virtual laboratories, and generative AI tools are increasingly being integrated into instructional processes to enhance learning outcomes and teaching efficiency. This has the potential to improve access to quality education, personalize learning experiences, and support innovative teaching approaches in contemporary classrooms (Akpan et al., 2024). Similarly, Holmes et al (2019) emphasized that AI-driven instructional strategies can promote critical thinking, creativity, collaboration, and learner engagement when effectively implemented in educational settings. In the context of STEM education, the application of Artificial Intelligence in STEM classrooms offers numerous benefits, including personalized learning, improved instructional delivery, enhanced problem-solving opportunities, and greater learner engagement, although concerns relating to ethical issues, data privacy, and overdependence on technology remain significant (Akpan & Udo, 2025).

Recent studies have shown increasing interest in the perceptions and readiness of teachers toward AI integration. Positive perceptions among teachers are associated with higher acceptance, readiness, and willingness to adopt AI-driven pedagogical approaches. Wang and Liu (2021) further reported that teachers' acceptance of AI technology depends on perceived usefulness, ease of use, and confidence in applying such technologies in instructional practices. For instance, Adigun et al. (2025) found that Nigerian pre-service teachers demonstrated growing intention to adopt AI tools in classroom instruction, although challenges relating to infrastructure, competence, and ethical concerns remained significant. Similarly, Alejandro et al. (2024); Akpan et al (2025) showed that pre-service teachers generally exhibited favorable acceptance of AI applications in education, especially when they perceived AI as beneficial to teaching effectiveness and students' engagement. Ayanwale et al. (2024) and Guan et al. (2025) also highlighted the importance of AI literacy, digital competence, and institutional support in preparing future teachers for AI-integrated classrooms.

In science education, technology-driven pedagogical strategies possess enormous potential for improving concept visualization, inquiry learning, simulations, data analysis, and individualized instruction. Integrated science, being interdisciplinary and activity-oriented, requires innovative instructional approaches capable of enhancing students' scientific understanding and problem-solving skills (Abaka et al., 2026; Jimmy et al, 2025). AI technologies such as virtual simulations, intelligent assessment systems, and generative AI tools can support effective science teaching and learning in universities. Akpan (2026) observed that pre-service teachers recognized the benefits of generative AI in enhancing lesson planning, content generation, and personalized learning experiences, despite concerns about overdependence and ethical implications. Likewise, Markos et al. (2024) reported that many teacher trainees perceived ChatGPT and related AI tools as valuable resources for higher education instruction and academic support.

The growing global interest in AI integration notwithstanding, evidence suggests that the adoption and utilization of AI-driven pedagogical strategies in Nigerian universities remain limited. Studies conducted by Eden, Udo and Mbuk (2024); Akpan et al (2025); Uboh et al. (2025) indicated variations in the availability and usage of emerging technologies in science education across universities in Akwa Ibom State, and further report that teachers' perceptions of digital tools strongly influence their utilization in STEM education. Supporting this view, Akpan and Udo (2022) also reported limited competencies in the utilization of 21st-century skills among science teachers, while Etiubon and Akpan (2018) emphasized gaps in information and communication technology utilization for effective mastery learning in education. Consistent with these findings, Itighise et al (2023) reported varying levels of awareness and utilization of Web 2.0 technologies among science teacher trainees in Akwa Ibom State University, suggesting that digital technology adoption among prospective science teachers is still evolving. Akpan et al (2022) further observed uneven integration of digital technologies in STEM teaching across universities in Akwa Ibom State.

In addition, empirical evidence shows that digital innovations such as simulations and virtual laboratories are gradually improving STEM education by enhancing experiential learning and conceptual understanding (Atabang et al, 2024; Eno et al, 2023). Similarly, Akpan (2024) reported that pre-service science teachers possess varying levels of knowledge, utilization, and perception of emerging digital technologies in pedagogy, while, Akpan (2024) demonstrated the effectiveness of computer-based and innovative instructional strategies in improving students' academic achievement in science-related disciplines. Furthermore, Akpan and Udo (2025) confirmed the positive impact of AI tools such as ChatGPT on students' academic performance, reinforcing the relevance of AI in contemporary educational practice; while Zawacki-Richter et al. (2019) caution that educators are often underrepresented and not prepared to embrace AI processes, which may affect effective classroom implementation.

Although several studies have examined AI literacy, technology acceptance, and teacher readiness, limited attention has been given to comparing the perceptions of pre-service Integrated Science teachers regarding AI-driven pedagogical strategies in Nigerian universities. Understanding that perception is essential because they influence teachers' willingness to integrate AI tools into science instruction and determine the success of AI implementation in teacher education programs. Therefore, this study sought to examine Integrated Science pre-service teachers' perception and utilization of AI-driven pedagogical strategies in Nigerian universities with a view to providing empirical evidence that may guide policy formulation, teacher training, and effective integration of AI technologies in Science Education.

Statement of the Problem

Students are expected to develop competencies that align with emerging technological trends in education. However, it has been observed that many universities in Nigeria still rely heavily on conventional, lecture teaching methods, while the application of AI-driven pedagogical strategies remains limited. In most cases, inadequate technological infrastructure, insufficient training opportunities, poor digital literacy and lack of institutional support have negatively influence teachers' perceptions toward AI integration in teaching and learning. Although several studies have examined AI adoption in education, gaps still exist on the perceptions of Integrated Science teachers in their development programmes in the Nigerian universities. Consequently, there is insufficient evidence on how these categories of teachers perceive the usefulness, effectiveness, and challenges associated with AI-driven pedagogical strategies. It is against this background that this study sought to investigate Integrated Science Pre-service teachers' perception and utilization of AI-driven pedagogical strategies in Nigerian universities, Akwa Ibom State as a case study.

Purposes of the Study

The study was conducted to investigate Integrated Science Pre-service teachers' perception and utilization of AI-driven pedagogical strategies in Nigerian universities. Specifically, the study sought to:

1. Determine the extent of Integrated Science Pre-service teachers' perception of AI-driven pedagogical strategies in Nigerian universities.
2. Examine the extent of Integrated Science Pre-service teachers' utilization of AI-driven pedagogical strategies in Nigerian universities.

Research Questions

The following research questions guided the study:

1. What is the extent of Integrated Science Pre-service teachers' perception of AI-driven pedagogical strategies in Nigerian universities?

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2. What is the extent of Integrated Science Pre-service teachers' utilization AI-driven pedagogical strategies in Nigerian universities?

METHOD

A descriptive survey research design was adopted for the study. The population of the study comprised six hundred and forty three (643) Integrated Science pre-service in government owned universities in Akwa Ibom State. Two public universities (Akwa Ibom State University and University of Uyo) were purposively selected for the study because Integrated Science course is done in the schools, and accidental sampling technique was used to select a sample of 120 respondents (60 from each school) for the study. The instrument for data collection was the “*Pre-Service Teachers' Perception and Utilization of AI-Driven Pedagogical Strategies Questionnaire (PSTPUAIDPSQ)*”. The instrument consisted of two sections. Section A elicited demographic information of the respondents, like name of school, while Section B contained twelve items on respondents' perception and utilization of AI-driven pedagogical strategies in teaching and learning. The instrument was structured on a 4-point Likert scale of Very Great Extent (VGE), Great Extent (GE), Moderate Extent (ME) and Low Extent (LE). The instrument was validated by three experts in the Faculty of Education, Akwa Ibom State University. Their observations and corrections were incorporated into the instrument before the final administration. To establish the internal consistency of the instrument, the questionnaire was trial-tested on twenty (20) respondents who were not part of the main study. Data obtained from the trial test were analyzed using Cronbach Alpha reliability method and a reliability coefficient of 0.89 was obtained, which indicated that the instrument was reliable for the study. The instrument was administered to the respondents and retrieved immediately, which gave 100% return rate. Data collected were analyzed using mean and standard deviation to answer the research questions. In making decisions as regards the research questions, whenever the cluster mean score falls between: 1.00-1.49, 1.50-2.49, 2.50-3.49 and 3.50-4.00, it was taken to indicate: Low Extent (LE), Moderate Extent (ME), Great Extent (GE), and Very Great Extent (VGE).

RESULTS AND DISCUSSION

Table 1: Mean and Standard Deviation scores of Respondents on the Perceptions of Integrated Science Teachers on AI-Driven Pedagogical Strategies (N = 120)

S/N	Statements	Mean ($\bar{x}$)	SD	Decision
1	AI-driven pedagogical strategies can significantly improve the quality of instructional processes in Integrated Science.	3.09	0.96	GE
2	I feel AI tools effectively improve student engagement during instructional sessions.	3.16	0.92	GE
3	AI supports personalized learning experiences for students in Integrated Science.	3.29	0.85	GE
4	I am confident in my ability to integrate AI tools into my current instructional practices.	3.17	0.88	GE
5	AI technology will replace active teaching and learning in the future of Integrated Science education.	3.09	0.74	GE
6.	I am skeptical about the effectiveness of AI improving educational outcomes	2.49	1.02	ME
Grand Mean		3.05	0.90	

The result presented in Table 1 shows that respondents generally have a perception of AI-driven pedagogical strategies in Integrated Science instruction to a great extent. This is evidenced by the mean scores of items, which ranged from 2.49 to 3.29, and are all above the benchmark mean of 2.50. This means that AI-driven strategies enhance instructional quality, improve students' engagement, and support personalized learning, confidence in integrating AI into practice, AI technology replacing active teaching and learning, and effectiveness of AI in improving educational outcomes. The grand mean score of 3.05 further confirms that respondents hold a favorable perception of AI integration in teaching Integrated Science. In addition, the standard deviation values, which range from 0.74 to 1.02, indicate that the responses of the participants are closely clustered around the mean, showing a great extent of response among respondents.

Table 2: Mean and Standard Deviation scores of the extent of Integrated Science Pre-Service teachers' utilization of AI-Driven Pedagogical Strategies (N = 120)

S/N	Statements	Mean	SD	Decision
1	I use AI-driven tools to create personalized learning plans	3.10	0.95	Agree
2	I use AI-driven software to my teaching practices and experiences.	3.25	0.92	Agree
3	AI-driven tools are used for grading and feedback in my teaching practicum.	2.78	0.87	Agree
4	AI-driven interactive tools are used to support inquiry and research in Integrated Science.	2.61	1.06	Agree
5	I am experienced in using AI-driven technology for data analysis and interpretation.	2.43	0.74	Agree
6.	AI-driven technology is regularly used to enhance engagement and motivation in Integrated Science	2.70	1.11	
Grand Mean		2.81	0.94	

The result presented in Table 2 shows that to a great extent, Integrated Science Pre-service teachers in Nigerian universities have utilized AI-driven pedagogical strategies in education. The result revealed that all the mean scores of items are above the benchmark mean of 2.50, indicating to a great respondents use AI-driven pedagogical strategies to; create personalized learning, enhance teaching and learning experiences, grade and get feedback from practicum, support inquiry and research, analyze and interpret data and enhance engagement and motivation in Integrated Science. It is also noted that the standard deviation values, which range from 0.74 to 1.11, show that the responses are closely clustered around the mean values. Overall, the cluster or grand mean of 2.81 for all items indicates that there is a great extent of Pre-service teachers' utilization of AI-driven pedagogical strategies in Integrated Science education.

The result of analysis of the extent of Pre-service Integrated Science teachers' perception of AI-driven pedagogical strategies in Nigerian universities, reveal that there is a great extent of teachers' perception of AI-driven pedagogical strategies in Nigerian universities This finding aligns with Holmes et al. (2019) and Akpan & Udo (2025), who emphasize that AI enhances teaching effectiveness through adaptive learning and improved instructional support. It also corroborates Markos et al. (2024), that teachers view AI tools such as generative AI as useful for lesson development and learner engagement. Similarly, Alejandro et al. (2024); Akpan et al, (2024); Adigun et al. (2025) found that pre-service teachers generally demonstrate positive perceptions and attitudes toward AI adoption due to perceived usefulness and improved learning outcomes. However, the finding contrasts with Zawacki-Richter et al. (2019), who noted limited educator readiness and involvement in AI integration processes. And the potentials of AI

to simplify complex Integrated Science concepts and improve instructional efficiency. The great extent in perception observed may be attributed to increased exposure to digital technologies and growing awareness of AI's role in education.

The result of analysis of the extent of integrated science pre-service teachers' utilization of AI-driven pedagogical strategies in Nigerian universities, revealed that there is a great extent of Pre-service teachers' utilization of AI-driven pedagogical strategies in Nigerian universities. The finding is attributed to the fact that AI simplifies complex concepts, support inquiry and research and gives prompt feedback to information search. This finding is consistent with Wang and Liu (2021), who reported that teachers' acceptance of AI is largely influenced by perceived usefulness, likewise Eden et al. (2024), who reported utilization emergent technologies, based on availability.

CONCLUSION AND RECOMMENDATIONS

It was concluded that there is a great extent of Integrated Science Pre-service teachers' perception and utilization of AI-driven pedagogical strategies in Nigerian universities. Overall, the results indicate a growing readiness among Integrated Science teachers to embrace AI-driven instructional approaches, suggesting that effective integration of AI in Nigerian universities will depend more on training, infrastructure, and continuous professional development than on institutional ownership.

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

1. Teacher education programmes should be reviewed to include compulsory courses or modules on AI-driven pedagogical strategies to better prepare future teachers for technology-enhanced instruction.
2. Nigerian universities should strengthen the provision of digital infrastructure such as internet connectivity, smart classrooms, and access to AI-based educational tools to support effective classroom integration.
3. University management and educational stakeholders should organize regular training, workshops, and seminars to improve the AI literacy and pedagogical competence of both pre-service and in-service Integrated Science teachers.

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International Journal of Natural and Practical Sciences

Volume 8, Number 2, August 2026

ISSN(p): 2350-2150 ISSN(e): 2795-3076

Published By

International Centre for Integrated Development Research, Nigeria

In collaboration with

Copperstone University, Luanshya, Zambia

in Akwa Ibom State. *Inter-Disciplinary Journal of Science Education (IJ-SED)*, 5(1), 34-41.

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