ARTIFICIAL INTELLIGENCE AMONG PRE-SERVICE SCIENCE TEACHERS: PREPAREDNESS, PEDAGOGICAL USAGE AND IMPLEMENTATION CHALLENGES

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Abstract
Pre-service science teachers are gradually adopting Artificial Intelligence (AI) as a transformative tool for effective teaching and learning. However, the issue of preparedness, pedagogical usage, and implementation challenges continue to be sources of concern. This study examined these concerns and their implications for teaching and learning. The study adopted a descriptive survey research design involving a proportionate stratified random sampling technique of 160 participants. Data were collected using a validated instrument titled "AI Integration Preparedness, Pedagogical Usage and Implementation Challenges (AI-PPUICQ). Preparedness (α = 0.93), Pedagogical Usage (α = 0.91) and challenges (α = 0.76), measured on a 4-point Likert scale and subjected to descriptive (percentages and means) and regression analysis. Results showed that respondents reported moderate levels

of AI preparedness, while their pedagogical usage was high. The most prevalent challenges were resources and infrastructure with a total mean score of 2.85; and institutional support was the least challenge they encounter with a mean score of 2.43. Furthermore, results showed that the influence of AI preparedness on pedagogical use was statistically significant ($\beta = .505$, $p < .001$). This paper highlights the importance of supporting pre-service science teachers' AI literacy through enhancing their capacity for pedagogical integration, minimizing obstacles, and encouraging responsible, creative classroom practice. These results underscore the importance of specific training, infrastructure, and supportive policies on the integration of AI in science education.

Keywords: Artificial Intelligence, Pedagogical usage, Preparedness, Implementation challenges

Introduction

Artificial Intelligence (AI) is increasingly becoming a necessity among pre-service teachers. The pressure of incorporating AI into pre-service teachers' programmes in order to equip them with knowledge, skills, and confidence to apply the tools into their own teaching and learning processes have drastically increased (Ayanwale et al., 2025). The rapid advent of AI tools which utilised Large Language Models, have increased global discussions which has called for structured AI literacy frameworks within teacher education (Aje & Olaguro, 2025; Daher, 2025; UNESCO, 2023). In science education, AI applications now support predictive modelling, virtual experimentation, adaptive simulations, automated feedback systems, and generative content creation, all of which have the capacity of transforming how scientific inquiry is conceptualized and taught (Kotsis, 2025). The relevant question is not whether AI will shape science classrooms, but whether future science teachers are adequately prepared to utilize its pedagogical potential (Park et al., 2023; Shi et al., 2024).

The history of AI integration in education has gone through the

development of early intelligent tutoring systems (ITS) that were meant to recreate the one-to-one human teaching to sophisticated generative and data-driven technologies integrated in regular educational practice (Zawacki-Richter et al., 2019). The recent trends in machine learning and Generative AI (GenAI) have broadened the core of AI to adaptive tutoring, knowledge co-creation, and automated reasoning (Quintanar & Rooney 2025). Nevertheless, the pace of spreading such technologies has been faster than the preparedness of most institutions of teacher education, particularly in developing countries (UNESCO, 2023).

Technology Acceptance Model (TAM) is one of the most popular theories that describes user's acceptance and adoption of new technologies in the field of information systems and technology adoption research. According to Davis (1989), perceived usefulness and ease of use are two construct that are central to users' acceptance of technology. Perceived usefulness refers to the extent to which a person thinks that using a specific technology will increase his or her performance. Perceived ease of use refers to the degree at which a person thinks that the technology will be easy to use and not demanding of effort. TAM provides an explanation on pre-service science teachers attitudes and behavioural intentions to integrate AI into the teaching and learning process. Davis (1989) claimed that if a person considers a technology useful and easy to use, then they will adopt and effectively use it. Perceived ease of use is specifically related to the perceived "ease of use" of AI by pre-service science teachers and can be correlated with the level of AI preparation these teachers have, due to the fact that having enough knowledge, skills, and confidence in AI instruments can make it easier for the users to perceive it as easy to use and manage. Likewise, the pedagogical application of AI is influenced by perceived usefulness, with pre-service science teachers more inclined to implement AI tools in instructional activities when they feel it will enhance the effectiveness of their teaching, lesson planning, assessments, and classroom interactions. The model also takes into account the impact of external variables on the adoption of technology (Venkatesh et al.,

2003). In this study, there are external factors that can affect the integration of AI by pre-service science teachers, including challenges related to digital infrastructure, unstable internet connection, lack of institutional support, lack of training opportunities, and lack of access to AI tools. UNESCO (2023) argued that the effective use of AI in education is contingent on individual skills as well as the capacity of the institutional environment to facilitate equitable and ethical use of technology. Similarly, OECD (2023) stated that the ability of teachers and infrastructural support are crucial factors in successful application of AI in the education system.

In addition, the validity of TAM for explaining the adoption of educational technology and integration of AI among teachers and students has been validated in prior works (Adigun, 2025; Venkatesh et al., 2003). Ayanwale et al. (2024) noted that teachers' confidence, the perceived value of AI in their instruction, and institutional environments that facilitate the use of AI technology can all negatively affect their willingness to use AI in their teaching. This suggests that pre-service science teachers' use of AI pedagogically is inevitably shaped by both preparedness and contextual challenges. Thus, TAM is used as a theoretical framework to analyse the relationship between AI preparedness, pedagogical use, and obstacles in implementing AI for pre-service science teachers. The framework highlights the importance of teachers' skills and attitudes, as well as the institutional environment for the effective integration of AI in science education.

Conceptualizing AI in Education

AI in education are computational technologies, such as machine learning, natural language processing, and data-driven algorithms, aimed at optimization of teaching, learning, and administration (Holmes et al., 2022; UNESCO, 2023). Unlike the traditional teaching technology, such as video cassette recorders and other media-based teaching technology that are mainly designed for delivering of content, AI tools possess the ability to learn, adapt,

reason, and provide personalized support to learners. The ability of AI systems to replicate the features of human intelligence that include reasoning, adapting, and decision making, characterizes these systems which allows more interactive learning conditions. The advent of AI has opened up new possibilities and instigated discussions as regards its feasible applications in education (Pedro et al., 2019; Okonkwo & Ade-Ibijola, 2021). One of the important topics in educational system is the persistent use of AI as a support tool. AI writing tools like Claude and ChatGPT are promising in providing feedback to assist students improve their writing skills (Mohamed, 2023). Generative models generate explanations, examples, and practice questions that best fit individual students (Shoaib et al., 2025). Okonkwo and Ade-Ibijola (2021) affirmed that timeliness, scalability, and the potential to provide real-time feedback and enhance student engagement are the key advantages of pedagogical chatbots.

According to Ossiannilsson (2025), all shareholders must play essential roles in the ethical and equitable use of AI, and teacher educators in particular must be at the forefront to steer the process correctly. This highlight the importance of preparing in-service and pre-service teachers with the knowledge, skills, and ethical awareness required for the effective integration of AI technologies in educational practice

AI use in Science Education

AI plays an important role in the modern era of Scientific Education vis a vis enhancing the process of teaching, learning, assessing, and engaging in education (Alkanaan, 2022; Yılmaz, 2023). ChatGPT, Gemini, and Claude are examples of AI tools that can help educators and students write explanations, solve scientific problems, develop educational materials, and provide customized learning experiences (Almuhanna, 2025; Nath & Yoon, 2024). The applications of AI in science education are crucial because of the abstract nature of science concepts which often demand interactive and adaptive learning (Kotsis, 2025). Research has shown that AI applications can

positively impact students' learning achievement and engagement in science classrooms (Gunsaldi et al., 2025; Huang et al., 2023). Intelligent tutoring systems and adaptive learning platforms enables learners with diverse skills to engage in personalized learning (Akyuz, 2020; Ibrahim et al., 2026; Kim, 2022). Similarly, Cooper (2023) has shown that ChatGPT has huge potentials for giving scientific answers to questions and helping in science lessons. AI can also help science educators create lesson plans, quizzes, lab exercises, and other educational resources in more efficient ways (Ishmuradova et al., 2025; Park, 2023).

According to Fasanya et al. (2025), AI enhances engagement, conceptual understanding and improve students' academic performance in physics and chemistry. However, there are issues of accuracy of AI-generated information, plagiarism, bias, and heavy reliance on AI tools (Ogwueleka, 2025). The issues identified necessitate the importance of teaching preparedness and responsible integration of AI in science education. While AI holds great promise for enhancing science education and learning, its effective implementation is highly dependent on educators' competence, preparedness, ethical and pedagogical usage.

The use of Al among Pre-service Teachers

Pre-service teachers in this era are the group of teachers entering the teaching profession at a time when the use of AI in education is growing. The question on the preparedness and use of AI tools has been gaining more attention between 2020 and 2025, but research in this field remains scarce. Numerous studies have demonstrated that many pre-service teachers know about the tools of AI like ChatGPT and are starting to utilize them for lesson design, content creation, and instructional support (Nyaaba et al., 2024; Tsakeni et al., 2025). The studies also found that pre-service teachers tend to see the use of AI as a valuable tool to enhance teaching and learning. Similarly, Ishmuradova et al. (2025) revealed that pre-service teachers are optimistic with utilisation of AI in learning science concepts. Yang and Chen (2023) indicated that perceived usefulness and ease of use

affected pre-service adoption intentions towards AI tools. Despite this, there are still a lot of pre-service teachers who have not fully understood the benefits of AI, and have only limited access to training (Alasadi & Baiz, 2023; Nyaaba & Zhai, 2024).

Statement of the Problem

Although pre-service teachers are becoming increasingly aware of AI tools as a result of the global digitalization trends (Lucas et al., 2025), their level of preparedness and meaningful pedagogical use remains minimal. Even though pre-service teachers have the general knowledge of AI technologies, their readiness was low, with minimal practical use in teaching and learning processes. Moreover, infrastructural inadequacies remain a challenge to AI literacy. Inadequate digital infrastructure and insufficient funding hinder the successful integration of AI and may affect the relationship between personal preparedness and classroom practice (Nwafor & Tsakeni, 2025; Muhammad et al., 2025). Although research investigating AI use in teacher education continues to grow, significant conceptual and methodological gaps remain. Most available literature focuses on awareness, perception, or intent to adopt AI rather than actual pedagogical application (Ibrahim et al., 2024; Bali et al., 2024). Most studies report levels of literacy or readiness without examining predictive relationships between competence-based and contextual factors and pedagogical behaviour. In Nigeria, research mostly assumes that pre-service teachers are a homogeneous population and gives limited attention to disciplinary differences in AI integration patterns (Akpan, 2024). There is also insufficient empirical knowledge regarding how AI preparedness and implementation challenges relate to the application of AI in pedagogy among pre-service science teachers in developing educational institutions.

Objectives of the Study

The following objectives were raised for the study:

a. examine the level of AI preparedness among pre-service science teachers;
b. assess the level of pedagogical usage of AI among pre-service

science teachers;

c. determine the influence of AI preparedness on the pedagogical usage of AI among pre-service science teachers
d. examine the implementation challenges that pre-service science teachers encounter in their integration of AI for instructional purposes.

Research Questions

This study seeks to provide answers to the following research questions:

1. What is the level of AI preparedness among pre-service science teachers?
2. What is the level of pedagogical usage of AI among pre-service science teachers?
3. What implementation challenges do pre-service science teachers encounter when integrating AI for instructional purposes?

Hypothesis

One hypothesis was formulated for this study:

H01: AI preparedness will not significantly influence pedagogical usage among pre-service science teachers.

Methodology

The study adopted a descriptive survey design. The use of descriptive research design will provide a comprehensive understanding on the preparedness, pedagogical usage, and implementation challenges of AI among pre-service science teachers. The target population for this study consisted of 228 (Biology= 126 Chemistry= 50 Physics= 35 Mathematics= 17) part III and IV pre-service science teachers in the Faculty of Education, Obafemi Awolowo University, Nigeria. The sample for the study was one hundred and sixty (Biology= 97, Chemistry= 29, Mathematics= 23 Physics= 11) pre-service science teachers obtained via proportionate stratified random sampling technique. The instruments employed for data collection in this study was a questionnaire titled AI Preparedness, Pedagogical Usage and

Implementation Challenges (AI-PPUICQ) which was adapted from (Celik, 2023), with a few modifications to suit the context of pre-service science teachers.

The instrument has four sections. Section A contains the demographic information such as gender, level of study, course of study and prior exposure to AI tools. Section B contained twelve items that address preparedness among pre-service science teachers while Section C, contained eleven items on pedagogical usage of AI. Section D also contained fifteen items that address implementation challenges that hinder pre-service science teachers from integrating AI in science instruction. A 4-point scale was used wherein "Strongly Agree" was 4; "Agree" 3; "Disagree" 2; and Strongly Disagree" 1. The responses were collated and summed to arrive at the total score for each respondent. The face and content validity of the questionnaire was done by experts. The instrument was piloted with twenty (20) students. Using Cronbach alfa coefficient the reliability for AI Preparedness ($\alpha = 0.93$), Pedagogical Usage ($\alpha = 0.91$) and challenges ($\alpha = 0.76$). The Quantitative data collected through questionnaire on AI-PPUICQ were coded and analysed descriptively (percentages and means) for research questions and inferentially (regression) for the hypothesis.

Results

Table 1. Demographic Profiles of Respondents

Variable		Frequency	Percentage (%)
Gender			
	Male	52	32.5
	Female	108	67.5
	Total	160	100.0

Variable		Frequency	Percentage (%)
Unit	Biology	97	60.6
	Chemistry	29	18.1
	Mathematics	23	14.4
	Physics	11	6.9
	Total	160	100.0
Level of Study	Part 3	68	42.5
	Part 4	92	57.5
	Total	160	100.0
Prior AI Exposure			
	Yes	143	89.4
	No	17	10.6
	Total	160	100.0

Table 1 shows a demographic study of the respondents for this study. In this study, the percentage of male accounted for 32.5% while female accounted for 67.5%. The units considered for this study were biology, chemistry, mathematics and physics with each unit accounting for 60.6%, 18.1%, 14.4% and 6.9% respectively. The study considered two level of study which are part 3 and part 4 with 42.5% and 57.5% respectively. Prior exposure to AI tools was also considered in two level with 89.4% agreeing to prior exposure to AI tools and 10.6% indicating no exposure to AI tools.

Research Question 1: What is the level of AI preparedness among pre-service science teachers?

To answer this question, items on the level of AI preparedness among pre-service science teachers were scored in such a way that "Strongly Agree" response was allotted a score of 4, "Agree" response was allotted a score of 3, "Disagree" response was allotted a score 2 and "Strongly Disagree" response was allotted a score 1. These were subjected to descriptive analysis and the results are presented in Tables 2 and 3.

The table below displays the descriptive analysis of the level of AI

preparedness among pre-service science teachers. The result indicated that majority of the respondents consented that they know how to interact with AI-based tools in their daily life, as evidenced by a mean of 3.19. Similarly, respondents show a high level of preparedness to execute some tasks with AI-based tools with a mean score of 3.11. Ability to initialize a task for AI- based technologies by text or speech has a mean score of 3.10, followed by item 7 with the mean score of 3.03, indicating that respondents know how to use different AI-based tools for personalized learning. Respondents with the mean score of 3.00 are familiar with AI-based tools and their technical capacities. Item 4 has a mean score of 2.94 which agreed to the fact that respondents have sufficient knowledge on how to use AI-based tools. Respondents' ability to teach a subject using AI-based tools with diverse teaching strategies and to appropriately combine my teaching content, AI-based tools and teaching strategies have a mean score of 2.92 respectively. Item 6 indicated that respondents who know how to use different AI-based tools for adaptive feedback has a mean of 2.90. However, there are areas where preparedness has a slightly low means. For instance, knowing how to use different AI-based tools for real-time feedback has a mean score of 2.87, and a mean score of 2.82 for respondents that can select various AI-based tools to monitor student's learning in their teaching. Conclusively, ability to take a leadership role among my colleagues in the integration of AI-based tools into my teaching field has the lowest mean of 2.82.

Table 2. Level of AI Preparedness of Respondents

Item	SA		A		D		SD		Mean
	f	%	F	%	f	%	f	%	
I know how to interact with AI-based tools in daily life.	43	26.9	106	66.3	9	5.6	2	1.3	3.19
I know how to execute some tasks with AI-based tools.	42	26.3	97	60.6	17	10.6	4	2.5	3.11
I know how to initialize a task for AIbased technologies by text or speech.	42	26.3	93	58.1	24	15.0	1	0.6	3.10

Item	SA		A		D		SD		
	f	%	F	%	f	%	f	%	Mean
I have sufficient knowledge to use AIbased tools.	30	18.8	92	57.5	37	23.1	1	0.6	2.94
I am familiar with AI-based tools andtheir technical capacities.	32	20.0	102	63.8	20	12.5	6	3.8	3.00
In teaching my field, I know how to use different AI-based tools for adaptive feedback.	21	13.1	107	66.9	27	16.9	5	3.1	2.90
In teaching my field, I know how to use different AI-based tools for personalized learning.	31	19.4	107	66.9	17	10.6	5	3.1	3.03
In teaching my field, I know how to use different AI-based tools for real-time feedback.	19	11.9	106	66.3	30	18.8	5	3.1	2.87
I can teach a subject using AI-based tools with diverse teaching strategies.	20	12.5	110	68.8	27	16.9	3	1.9	2.92
I can teach lessons that appropriately combine my teaching content, AI-based tools, and teaching strategies.	20	12.5	113	70.6	21	13.1	6	3.8	2.92
I can take a leadership role among my colleagues in the integration of AI-based tools into our teaching field.	20	12.5	87	54.4	48	30.0	5	3.1	2.76
I can select various AI-based tools to monitor student's learning in my teaching process.	18	11.3	99	61.9	39	24.4	4	2.5	2.82

Table 2 indicates that science pre-service teachers are moderately prepared, with stronger competence in basic usage and a relatively lower competence in the ability to take a leadership role among colleagues in the integration of AI-based tools into their teaching.

Table 3.Summary of level of preparedness of AI among pre-service science teachers

Level	Frequency	Percent
Low	20	12.5
Moderate	117	73.1
High	23	14.4
Total	160	100.0

Table 3 above categories the level of AI preparedness among pre-service science teachers into three (3) which are low, moderate and high. The result showed that 12.5% respondents have a low level of preparedness, 14.4% respondents have a high level of preparedness while 73.1% indicated that majority falls into the moderate level category. However, the above result indicated that pre-service science teachers generally exhibited a moderate level of AI preparedness, which implies that the respondents are familiar and competent with AI tools but still showed a low level of proficiency in advanced AI tools. This was visualized in Figure 1 below:

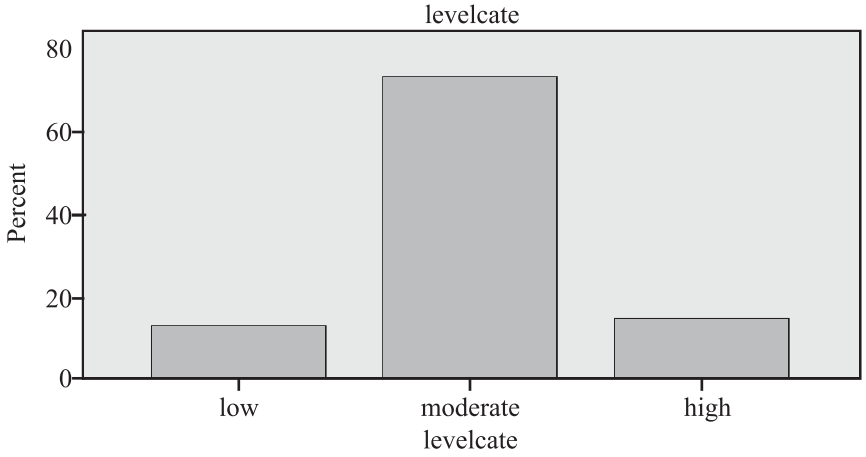

Figure 1: Level of Preparedness of Respondents.

As shown in Figure 1, most respondents have moderate levels of preparedness.

Research Question Two: What is the level of pedagogical usage of AI among pre-service science teachers?

Table 4. Level of AI Pedagogical Usage Among Respondents

Item	SA		A		D		SD		
	f	%	F	%	f	%	f	%	Mean
I can understand the pedagogical contribution of AI-based tools to my teaching field.	16	10.0	115	71.9	21	13.1	8	5.0	2.87
I can evaluate the usefulness of feedback from AI-based tools for teaching and learning	19	11.9	114	71.3	21	13.1	6	3.8	2.91
I can select AI-based tools for students to apply their knowledge.	21	13.1	108	67.5	26	16.3	5	3.1	2.91
I know how to use AI-based tools to monitor student's learning.	15	9.4	91	56.9	47	29.4	7	4.4	2.71
I can interpret messages from AI-based tools to give real-time feedback.	24	13.1	98	61.3	33	20.6	5	3.1	2.88
I can understand alerting (or notification) from AI-based tools to scaffold student's learning.	17	10.6	96	60.0	43	26.9	4	2.5	2.79
I have the knowledge to select AI-based tools to sustain student's motivation.	18	11.3	105	65.6	33	20.6	4	2.5	2.86
I can use the AI-based tools to search for education material in my teaching field.	38	23.8	103	64.4	16	10.0	3	1.9	3.10
I am aware of various AI-based tools which are used by professionals in my teaching field.	23	14.4	95	59.4	39	24.4	3	1.9	2.86
I can use AI-based tools to better understand the contents of my teaching field.	27	16.9	113	70.6	17	10.6	3	1.9	3.03
I know how to utilize my field-specific AI-based tools (e.g., intelligent tutor for Math).	23	14.4	89	55.6	43	26.9	5	3.1	2.81

Table 4 above shows the descriptive analysis of the level of pedagogical usage among pre-service science teachers. The result indicated that majority of the respondents agreed to know how to use the AI-based tools to search for education material in their teaching field as evidenced by a mean score of 3.10. Similarly, respondents agreed to know how to use AI-based tools to better understand the contents of their teaching field with a mean score of 3.03. Ability to evaluate the usefulness of feedback from AI-based tools for teaching and learning and to select AI-based tools for students to apply their knowledge have the of 2.91 respectively. Respondents with the mean score of 2.88 can interpret messages from AI-based tools to give real-time feedback, followed by item 1 with the mean score of 2.87 indicating the ability to understand the pedagogical contribution of AI-based tools to their teaching field. Respondents with the mean score of 2.86 have the knowledge to select AI-based tools to sustain student's motivation and are aware of various AI-based tools which are used by professionals in their teaching field. The mean score of 2.81 shows that respondents know how to utilize their fieldspecific AI-based tools (e.g., intelligent tutor for Math). Conclusively, the mean score of 2.79 indicated that respondents can understand alerting (or notification) from AI-based tools to scaffold student's learning and the mean score of 2.71 showed that respondents can use AIbased tools to monitor student's learning.

Table 5. Summary of level of pedagogical usage of AI among pre-service science teachers

Level	Frequency	Percent
Low	3	1.9
Moderate	73	45.6
High	84	52.5
Total	160	100.0

Table 5 shows the summary of level of pedagogical usage of AI among pre-service science teachers wherein they are categorized into three (3) levels which are low, moderate and high. The result showed that 1.9% respondents have a low pedagogical usage, 45.6% have a moderate pedagogical usage while 52.5% have a high level of pedagogical usage. However, the above result indicated that pre-service science teachers generally exhibited a high level of AI pedagogical usage, which implies that the respondents are familiar using AI for instructional purposes with stronger competence in basic applications than more advanced pedagogical practices.

Research Question three: Examine the implementation challenges that pre-service science teachers encounter in their integration of AI for instructional purposes.

Table 6. Level of Implementation Challenges of Respondents

Item	SA		A		D		SD		Mean
	f	%	F	%	f	%	f	%	
I have requisite knowledge of AI tools for teaching.	17	10.6	94	58.8	44	27.5	5	3.1	2.77
Selecting appropriate AI tools for science teaching come with ease for me.	22	13.8	91	56.9	44	27.5	3	1.9	2.83
It is easy for me to choose appropriate AI tools for science instruction.	22	13.8	93	58.1	43	26.9	2	1.3	2.84
Challenges related to access of internet subscription constraint my use of AI tools for instructional purposes.	27	16.9	96	60.0	30	18.8	7	4.4	2.89
Challenges related to cost of internet subscriptionconstraint my use of AI tools for instructionalpurposes.	30	18.8	90	56.3	35	21.9	5	3.1	2.91
My use of AI tools is constraint by epileptic power supply.	25	15.6	81	50.6	45	28.1	9	5.6	2.76
I believe I can successfully use AI tools teaching.	39	24.4	95	59.4	23	14.4	3	1.9	3.06
It takes a lot of time to learn the various AI toolsthat are used for teaching.	17	10.6	97	60.6	43	26.9	3	1.9	2.80
I find it difficult to evaluate students' learningwhen AI tools are used.	10	6.3	64	40.0	75	46.9	11	6.9	2.46
There is adequate opportunity to learn about the use of AI tools for instructional purposes throughworkshops and seminars in my institution.	16	10.0	82	51.3	49	30.6	13	8.1	2.63
Lecturers often demonstrate how AI tools can be used in teaching science.	12	7.5	59	36.9	63	39.4	26	16.3	2.36
My lecturers often encourage the use of AI for instructional purpose.	8	5.0	56	35.0	70	43.8	26	16.3	2.29
The ease at which one might commit academicand other unethical practices does not make me incline to use AI for pedagogical purpose.	8	5.0	75	46.9	61	38.1	16	10.0	2.47
I am concerned that students may become dependent on AI tools.	35	21.9	88	55.0	30	18.8	7	4.4	2.94
AI tools encourage academic dishonesty among students.	21	13.1	71	44.4	46	28.8	22	13.8	2.57

Table 6 above shows the descriptive analysis of implementation challenges that pre-service science teachers encounter in their integration of AI for instructional purposes. The result indicated that I believe I can successfully use AI tools for teaching has the highest mean of 3.06, followed by I am concerned that students may become overly dependent on AI tools with a mean score of 2.94. Respondents with mean score of 2.91 had challenges related to cost of internet subscription which constraint their use of AI tools for instructional purposes, Challenges related to access of internet subscription constraint my use of AI tools for instructional purposes has the mean of 2.89 while It is easy for me to choose appropriate AI tools for science instruction has the mean score of 2.84. Respondent with the mean score of 2.83 agreed that selecting appropriate AI tools for science teaching come with ease for me, It takes a lot of time to learn the various AI tools that are used for teaching has the mean of 2.80. I have requisite knowledge of AI tools for teaching has a mean score of 2.77. My use of AI tools is constrainted by epileptic power supply has a mean score of 2.76 while respondents with mean score of 2.63 agreed that there is adequate opportunity to learn about the use of AI tools for instructional purposes through workshops and seminars in my institution. AI tools encourage academic dishonesty among

students has the mean score of 2.57 while respondents with the mean score of 2.47 agreed that the ease at which one might commit academic and other unethical practices does not make me incline to use AI for pedagogical purpose. I find it difficult to evaluate students' learning when AI tools are used has a mean score of 2.46, while respondents with the mean score of 2.36 agreed that lecturers often demonstrate how AI tools can be used in teaching science and my lecturers often encourage the use of AI for instructional purposes has the mean score of 2.29.

Conclusively, knowledge and instructional challenges have an average mean of 2.81, resources and infrastructure challenges have an average mean of 2.85, pedagogical challenges have an average mean of 2.77, institutional support challenges have an average mean of 2.43 while ethical challenges have an average mean of 2.66. Hence, the most common challenge discovered was resources and infrastructure, with a total mean score of 2.85, and institutional support was the least challenge, with a mean score of 2.43.

Hypothesis

$H_0$1: AI preparedness will not significantly influence pedagogical usage among pre-service science teachers

Table 7. Model Summary for AI Preparedness and Pedagogical Usage

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.
			Std. Error	β	T	
1	(Constant)	.943	.085		11.087	.000
	Preparedness	.482	.066	.505	7.357	.000

It was revealed from Table 7 that the influence of AI preparedness and pedagogical usage was statistically significant (β = .505, p <.001). This implies that AI preparedness will significantly influence pedagogical usage among pre-service science teachers. Therefore, the null hypothesis was rejected.

Discussion of Findings

The findings of this study revealed that pre-service science teachers had moderate level of AI preparedness with ability to engage with AI-based tools, perform tasks with the help of AI technologies, and use AI tools in personalized learning and instruction. But lower competencies were seen in higher levels of proficiency like AI monitoring of student learning, giving students feedback in real-time, and leading initiatives for AI integration. This suggests that, while the respondents have basic AI literacy, their higher-order pedagogical abilities and skills in the integration of AI are still in the process of development. The result is in agreement with the findings of Ambode et al (2025) who reported that despite AI technologies such as automated grading systems, intelligent tutoring patforms and adaptive learning tools being increasingly integrated into education globally, many pre-service teachers are not confident to implement them effectively.

The study also found that the pre-service science teachers had a relatively high pedagogical use of AI tools. Participants reported that they could access educational resources and find information, comprehend educational material, review feedback, and assist in classroom instruction and learning using AI. Respondents, however, seemed more skilled in the use of basic instructional applications but less so in advanced pedagogical uses such as employing AI to scaffold students' learning and to track academic progress. The result is in tandem with the study of Nyaaba et al. (2024) that pre-service teachers are increasingly turning to generative AI tools (such as ChatGPT) for lesson planning, learning support and content creation. Similarly, other researchers, like Adigun et al. (2025) noted that AI tools were regarded as beneficial by Nigerian teachers for enhancing teaching efficacy, lesson preparation, and student participation in classroom activities. Similarly, Okunade (2024) observed that the application of AI-based instructional systems in science education facilitates personalized learning and boosts learner engagement in

the learning process. It can be concluded that although there are some challenges in incorporating AI in advanced pedagogic ways, pre-service science teachers are increasingly adopting AI technologies to enhance their teaching.

The results on the challenges in implementing the integration of AI indicated that pre-service science teachers' infrastructural and resource-related challenges were the most dominant in the process of integrating AI. In particular, high cost of internet subscription, poor internet connection and epileptic power supply were cited as major challenges that limit the use of AI tools for instructional purposes by respondents. The result shows that infrastructure is still a key challenge to the successful integration of AI into Nigerian teacher education institutions. The study by Tsakeni and Nwafor (2025) revealed that one of the significant issues with AI literacy and application among pre-service teachers is the lack of sufficient digital infrastructure and internet connectivity. Similarly, Oshowole (2024) noted that the lack of technological infrastructure and poor digital facilities has negative impacts on technology integration practices in schools in Nigeria. This is also corroborated with the findings of Ojo (2024) which revealed unstable electricity supply and poor internet connectivity as major challenges to AI preparedness among pre-service teachers in Nigeria.

The study also showed that the level of institutional support for the incorporation of AI is relatively low. There was a lack of agreement on lecturers using AI in science classes often, or promoting the use of AI as tools in pedagogical practice. This indicates that there is still a lack of institutional and lecturer support for the use of AI in the study context. This finding aligns with that of Ogunbodede et al. (2023) who is of the opinion that digital competence of teacher educators in Nigerian universities has a negative influence on the use and implementation of educational technologies. Similarly, Guan et al. (2025) suggested that the adoption of AI in teacher education programs is necessary because pre-service teachers are not well exposed to AI concepts within their institutions and do not receive

formal training in AI. It can be inferred that the framework of institutional support to embed AI into teacher education remains insufficient, and needs further enhancement.

Findings also revealed that respondents pointed to the potential for students to become too reliant on AI tools and for AI technologies to promote academic dishonesty among students. The concerns suggest that, while AI tools offer instructional advantages, there is a concern about the potential misuse and plagiarism among students. The findings corroborate with Ogwueleka (2025) who found plagiarism, misinformation, overdependence, and unethical use of generative AI to be challenging issues in the learning environment. In the same way, Nyaaba and Zhai (2024) noted that while pre-service teachers were positive about the use of AI, they also continued to express concerns about the misuse of AI and over-reliance on AI technologies among the respondents.

Finally, it was found that there was a significant relationship between preparedness and pedagogical use of AI among pre-service science teachers which implies that those who are more AI-ready are more likely to successfully implement AI tools into their teaching. This result is consistent with Adigun et al. (2025) findings that teacher competence and readiness are crucial factors that affect their behaviour in the use of AI technologies in education. Similarly, Ibrahim et al. (2025) found a positive relationship between pre-service teachers' digital literacy and AI competence in technology integration in tertiary education institutions in Nigeria.

Conclusion

The study revealed that pre-service science teachers demonstrated a moderate level of AI preparedness while exhibiting a relatively high level of pedagogical usage for instructional and learning-related purposes. More so, AI preparedness significantly predicted pedagogical usage, indicating that increased competence and familiarity with AI tools enhance effective application in educational practice. However, the integration of AI into science teaching has its

own challenges such as infrastructural constraints like the high cost of internet, poor internet connectivity, and epileptic power supply which have continued to limit effective utilization of AI tools. There are also concerns related to overreliance on AI tools, academic integrity, and inadequate institutional support. These findings are of significance to teacher training institutions, policymakers, and other stakeholders in education. Broadly, it highlights the importance of adopting a supportive measure to AI integration among pre-service science teachers in order to strengthen it pedagogical use. For teachers' training institutions, the study highlights the need to review teacher education curricula to incorporate AI literacy, ethical and practical use of AI for instructional purposes. It also emphasizes the need for the government to invest in reliable internet connectivity, stable electricity and digital infrastructure in schools. For education stakeholders, the study could inform institutional planning, curriculum innovation, AI-based educational solutions and future studies on AI in teacher education. Evidence from the study had revealed that by aligning teacher education programmes with emerging AI competencies, institutions can better create enabling learning environments, thereby equipping pre-service science teachers to leverage AI efficiently for teaching and learning. This will in turn enhance innovative pedagogical application and also contribute to the development of a technologically savvy teaching workforce capable of meeting the evolving demands of twenty-first-century education.

Recommendations

Based on the results of this study the following recommendations were made:

1. Courses on AI literacy and pedagogical usage should be integrated into teacher education programmes in Nigerian Universities to enhance pre-service teachers' competence of it use.
2. Faculties of Education should conduct frequent workshops, seminars and practical training programs on AI integration.
3. Government and educational stakeholders need to provide digital infrastructures including stable internet connectivity, affordable internet subscription and reliable electricity supply in tertiary institutions.
4. Lecturers should actively demonstrate the pedagogical application of AI during lecture to make pre-service teachers have some experience with AI application.
5. Educational policies and guidelines should be established to ensure that AI tools are used in an ethical and responsible way to reduce academic dishonesty and reliance on AI tools during learning and teaching.
6. Educational institutions should offer ongoing support mechanisms and professional development programs to improve the skills of teachers and students in using AI.
7. Future research should also explore the implementation of AI integration in various disciplines and other contextual factors that affect the adoption of AI in pre-service teachers in Nigeria.

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