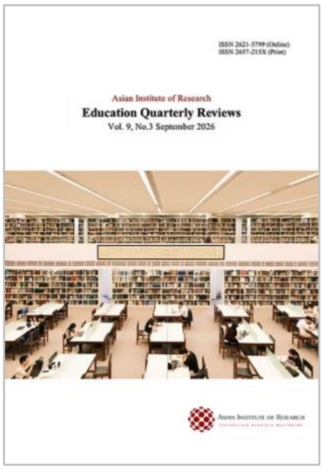

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Perceptions And Acceptance of Artificial Intelligence in Science Education Programmes: Voices of Pre-Service Science Teachers

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Abstract
This study examined pre-service science teachers' perceptions, acceptance, and use of artificial intelligence (AI) in science education programmes in Ghana. Guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Theory of Planned Behaviour (TPB), the study explored the AI tools frequently used by pre-service science teachers, the purposes for which these tools are employed, and their perceptions, behavioural intentions, and actual use of AI in science teaching and learning. A quantitative cross-sectional survey design was adopted, involving 380 pre-service science teachers selected from science education programmes. Data were collected using a structured questionnaire and analysed using descriptive and inferential statistics. The findings revealed generally positive perceptions of AI, with participants recognising its potential to improve teaching quality, instructional effectiveness, and student learning outcomes. ChatGPT emerged as the most frequently used AI tool, while research, content explanation, and lesson planning were the primary purposes for its use. Although

participants demonstrated positive attitudes, favourable effort expectancy, and strong behavioural intentions toward AI adoption, actual classroom use remained moderate. The study concludes that effective AI integration requires enhanced digital infrastructure, targeted professional development, and supportive institutional policies to bridge the gap between intention and practice.

Keywords: Artificial Intelligence, Science Education, Pre-Service Science Teachers, Technology Acceptance, Behavioural Intention, AI integration, Ghana

1. Introduction

The rapid expansion of artificial intelligence (AI) is profoundly transforming education, offering significant opportunities and challenges for teaching and learning. AI systems, characterised by their capacity to learn, adapt, synthesise information, and self-correct, have become central to educational discussions. This transformation is especially evident in science education, where AI technologies—including generative models like ChatGPT, adaptive tutoring systems, and automated assessment tools—are poised to revolutionise the delivery of scientific concepts, facilitate inquiry-based learning, and increase student engagement with complex subject matter (Mustafa, 2024; T Kotsis, 2025). Previous research in science education has demonstrated that technology-supported and collaborative instructional approaches can significantly improve students' conceptual understanding of difficult scientific concepts, highlighting the potential of innovative technologies to enhance science learning outcomes (Amponsah & Ochonogor, 2018). Educators' perceptions—encompassing cognitive and emotional evaluations of AI's benefits, risks, and suitability—along with their acceptance, reflected in intentions and actual usage, critically influence the meaningful integration of AI in classrooms. This observation is consistent with findings from Ghanaian secondary schools, where teachers' perceptions of technology initiatives significantly influenced their instructional practices and willingness to integrate digital tools into teaching and learning processes (Asoma et al., 2024). The issue is pressing, as AI advancements outpace pedagogical adaptations and regulatory measures, potentially exacerbating disparities in preparedness and equity (Cabero-Almenara et al., 2024; J. Kim, 2025).

Current research consistently identifies performance expectancy and effort expectancy as key determinants of teachers' intentions to adopt AI. Investigations involving science and STEM educators reveal recognition of AI's capacity to enhance the delivery of complex content and alleviate routine tasks. Factors such as AI familiarity, teaching experience, academic self-efficacy, and instructional beliefs further shape readiness for AI integration (Roshan et al., 2024; Sova et al., 2024). However, the literature reveals tensions: while quantitative surveys often show generally favourable attitudes toward AI, qualitative and mixed-methods studies emphasise concerns about data privacy, algorithmic transparency, the potential dehumanisation of education, and fears that AI will replace teachers (Alghamdy, 2023; Dignum, 2023). Furthermore, scholars argue that traditional acceptance frameworks may inadequately address the ethical and epistemological complexities unique to AI. A significant research gap persists: most studies focus on general educator populations in Western and Asian contexts, with limited quantitative inquiry into pre-service science teachers' perspectives in Ghana (Akanzire et al., 2025; Eusebio et al., 2025) (Ishmuradova et al., 2025; Awofala et al., 2025; Adelana et al., 2024).

This study addresses this void through a quantitative analysis of pre-service science teachers' perceptions and acceptance of AI in Ghana. Guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Theory of Planned Behaviour (TPB), this study examined performance expectancy, attitude, perceived behavioural control, behavioural intention, and actual use. This research explores the scope and patterns of AI engagement among this population.

1.1. Statement of the Problem

Although AI tools such as ChatGPT and Microsoft Copilot are becoming increasingly accessible, little is known about how pre-service science teachers in Ghana perceive their pedagogical value, ethical implications, and applicability for lesson planning, instruction, assessment, and student engagement. Furthermore, much of the existing research on AI adoption in education has focused on general teaching contexts, with inadequate emphasis on science education, where inquiry-based learning and conceptual mastery are fundamental (Agormedah et al., 2022; Agyei & Voogt, 2010; Akyeampong, 2017). This gap is compounded by contextual challenges such as infrastructural limitations, limited professional development opportunities, and concerns related to academic integrity and ethical AI use. Similar challenges have been reported in studies examining technology integration in Ghanaian schools, where teacher readiness and perceptions were found to influence the successful implementation of educational technologies (Asoma et al., 2024). As a result, these may shape teachers' readiness and acceptance of AI. Therefore, there is a clear need for an empirical investigation into pre-service science teachers' perceptions and acceptance of AI in science education programmes in Ghana to inform teacher preparation, policy, and pedagogical practice. In line with the above, this study aims to:

i. Identify AI tools frequently used by pre-service science teachers in Ghana for teaching and lesson preparation.
ii. Explore the primary purposes for which pre-service science teachers use AI in science education programmes.
iii. Assess pre-service science teachers' perceptions, intentions, and actual use of AI in science education.

1.2. Research Questions

1. Which AI tools are frequently used by pre-service science teachers in Ghana?
2. For what purposes do pre-service science teachers use AI in science education programmes?
3. What are pre-service science teachers' perceptions, behavioural intentions, and actual use of AI in science education?

2. Literature Review

2.1. Theoretical Framework

Implementing artificial intelligence (AI) in science teaching is both a technological advancement and a cognitive activity that involves teachers' beliefs, judgments, and sense of agency. While most studies have focused on whether teachers view AI as beneficial and whether it is uncomplicated to integrate, fewer have examined the cognitive processes that inform such teaching behaviours. To bridge the gap between AI teaching perception and practice, this study adapts the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003) and the Theory of Planned Behaviour (TPB) by Ajzen (1991), which has been expanded in subsequent work. The UTAUT framework offers a basic understanding of how people assess new technologies. Unlike previous acceptance models, such as the technology acceptance model (Davis, 1989), UTAUT draws on all eight major theories to explain technology acceptance and use (Venkatesh et al., 2003). In this model, performance expectancy reflects teachers' views of AI's ability to improve their effectiveness and students' thinking skills in learning science. Evidence from science education research suggests that instructional innovations that enhance collaboration and active engagement can significantly improve students' conceptual understanding and learning outcomes, thereby strengthening teachers' perceptions of their usefulness (Amponsah & Ochonogor, 2018). Recent studies in educational technology and AI have consistently shown that performance expectancy is a major factor influencing teachers' willingness to work with AI (Kim et al., 2024; Teo & Noyes, 2012; Tram, 2024). Teachers' willingness to use AI technologies has also been influenced by their perceived effort expectancy, with AI and technical training falling short of expectations (Fang et al., 2025). Recent improvements to UTAUT have highlighted the importance of the above factors in assessing teachers' responses to advanced technologies with data (AI) (Venkatesh & Thong, 2016). By contrast, many researchers believe that UTAUT is good at predicting a person's intention but weak at explaining the behaviour that the intention is materialised. This limitation has prompted the need for integrative frameworks that focus on behavioural mechanisms rather than direct-effect explanations.

The theory of planned behaviour (TPB), introduced by Ajzen (1991) and later expanded (Ajzen & Schmidt, 2020), attempts to address this by putting a model to the thought processes that lead to that behaviour. Key to the TPB is the claim that a cognitive commitment to the action is the strongest predictor of its occurrence. In educational technology, the TPB has been cited to explain the divergence among teachers in their adoption of digital and AI-driven technologies (Bosnjak et al., 2020). With the TPB, attitudes toward AI refer to teachers' positive or negative evaluations of using AI in science teaching, including its perceived value, relevance, and instructional efficiency. In the TPB, PBC is a construct introduced by Ajzen (1991) to explain the influence of non-volitional factors on behaviour, and it refers to the extent to which a teacher believes they can utilise AI to teach effectively, given the available resources, skills, and supportive structures within the institution. Recent studies on TPB and technology adoption have focused on the other impact of behavioural intention and have found that attitudes and PBC do not directly impact technology use but influence other factors that determine it (Naskar & Lindahl, 2025). This applies to the context of science education, where teachers may have a positive conceptual attitude toward AI but lack the external factors to translate that attitude into practice.

2.2 Conceptual Framework

Behavioural intention (BI) refers to the conscious effort one exerts to perform a specific behaviour and is one of the strongest predictors of future occurrences of similar behaviours in the fields of health and technology (Ajzen, 1991; Venkatesh et al., 2003). Between the Theory of Planned Behaviour and the Unified Theory of Acceptance and Use of Technology, behavioural intention is placed closest to the behaviours in question, and the influences of attitudes, norms, perceived behavioural control, and the performance and effort expected are channelled primarily through behavioural intention. *Venkatesh* et al. (2003) built upon previous research to separate the concepts of BI and behavioural expectation through the lens of social influence and facilitating conditions, which they posit are more essential to expectations in technology contexts. There is considerable evidence supporting the intention–behavior link. Budu et al. (2018) demonstrated this phenomenon in Ghanaian tertiary institutions, where BI was identified as the mediating factor in the relationship between self-efficacy and the actual use of e-learning.

Performance expectancy (PE) reflects the extent to which someone views a given system as a contributor to improved job performance. It utilises foundational constructs, such as perceived usefulness from the technology acceptance model, extrinsic motivation, and relative advantage from innovation diffusion theory (Venkatesh et al., 2003). It is the primary driver of perceived efficiency and effectiveness of technology and is widely cited as the most influential factor in behavioural intention. Recent empirical studies have continued to extend this role across various contexts. Most notably, PE was the strongest predictor (among all constructs studied) of mobile learning among postgraduate students in Nigeria (Oyewole, 2018).

Effort expectancy (EE) denotes the perceived ease of utilising a given system. It indicates the levels of complexity and usability hypothesised in the technology acceptance model (TAM) and in the UTAUT (Venkatesh et al., 2003). Systems perceived as complex and difficult to use may impose cognitive and physical costs that discourage use, even when the value is clear; in contrast, a system considered easy to use may reduce the psychological costs associated with it and increase the intention to adopt it. While there is a general context that supports the relevance of EE, there are outliers within it. Oyewole (2018) acknowledged a notable positive correlation between EE and smartphone use, specifically in mobile learning ($r = 0.724$), highlighting the value of ease of use in a population with a low level of digital literacy. In contrast, Bayaga and du Plessis (2024) found no significant positive correlation between EE and behavioural intention among university students in South Africa, suggesting that control may be moderated by the context's hierarchy, structure, or culture.

Perceived behavioural control (PBC) is defined as the ease with which an individual believes they can perform a behaviour. PBC captures both internal barriers and facilitators (e.g., skills and abilities) and external barriers and facilitators (e.g., resources, opportunities, and organisational backing) (Ajzen, 1991). PBC is conceptually similar to Bandura's notion of self-efficacy, except that it considers external environmental barriers. There is an extensive body of literature that illustrates the predictive power of PBC. Research involving Ghanaian pre-service teachers has also shown that individual cognitive attributes and learner characteristics influence confidence, competence, and educational performance, factors that are conceptually linked to perceptions of behavioural control and technology adoption readiness (Budu et al., 2022).

Attitude (AT) indicates a person's general positive or negative assessment of a behaviour; in this case, how positive or negative a user evaluates a system. This evaluation emerges from a system user's cognitive assessments of potential consequences and emotional responses (Ajzen, 1991). Such evaluations relate to salient behavioural beliefs. Positive attitudes toward educational innovations have similarly been observed among Ghanaian teachers participating in game-based learning initiatives, with favourable perceptions contributing to a greater willingness to adopt learner-centred pedagogical approaches (Yeboah et al., 2025). These beliefs are outcome expectations, such as time savings and improvements in the quality or efficacy of technological advancements, and are positively associated with the perceived importance of these improvements. According to Budu and Mireku (2018), participants' positive attitudes influenced their willingness to engage the public.

3. Methodology

3.1 Research Design and Selection of Participants

This study utilised a quantitative cross-sectional research design. This design allows for a detailed description of pre-service science teachers' perceptions, acceptance, and use of artificial intelligence in science education. The design allows for the collection of data at one point in time and provides a strong framework for comparisons between groups (Creswell & Creswell, 2023).

3.2 Population and Participant Selection

A purposive sampling technique was employed to select 380 pre-service science teachers out of a total population of 450 who were actively engaged in science education programmes. This sampling approach ensured that participants were well-positioned to provide informed insights into the integration of artificial intelligence (AI) in science education programmes, thereby capturing a broad range of experiences and perceptions (Creswell & Creswell, 2023).

3.3 Data Collection and Instrument

Data were collected using a self-developed, structured questionnaire comprising seven sections designed to examine pre-service science teachers' perceptions, acceptance, and use of artificial intelligence (AI) in science education. The first section captured respondents' demographic characteristics. Sections 2 to 6 measured key AI adoption constructs, including performance expectancy (e.g., using AI will improve the quality of my science lessons), effort expectancy (e.g., AI applications are easy to learn and use), attitude towards AI (e.g., I feel positive about using AI in my science lessons), perceived behavioral control (e.g., confidence in using AI for science teaching), and behavioral intention (e.g., intention to use AI in future science lessons). The final section assessed actual use of AI, focusing on respondents' self-reported use of AI tools in science lessons during the past semester. All construct-related items were measured using a five-point Likert-type scale to capture respondents' levels of agreement.

3.4 Data Analysis Method

Data were analysed using both descriptive and inferential statistical techniques. Descriptive statistics (means and standard deviations) and inferential statistics (one-sample t-tests and associated p-values) were used to summarise teachers' AI usage patterns, perceptions, and behavioural intentions. To test whether the mean responses differed significantly from the neutral midpoint, one-sample t-tests were conducted. Additionally, the measurement model was assessed through reliability and validity analyses, including Cronbach's alpha, composite reliability, and average variance extracted (AVE), to confirm the internal consistency and convergent validity of the constructs. All analyses were performed using the Statistical Package for the Social Sciences (SPSS).

3.5 Ethical Consideration

Informed consent was obtained from all participants, who were made aware of the study's purpose, their right to withdraw, and how their data would be utilised. Confidentiality was maintained by anonymising participant information and securely storing data.

3.6 Validity and Reliability

Table 1: Reliability and Validity of Study Constructs

	Cronbach's Alpha	Composite Reliability (rho_C)	Composite Reliability (rho_A)	AVE
Actual Use of AI	.876	.909	.885	.668
Attitude Towards AI	.934	.948	.936	.752
Behavioural Intentions	.918	.936	.923	.709
Effort Expectancy	.854	.892	.870	.581
Perceived Behavioural Control	.926	.942	.929	.730
Performance Expectancy	.907	.928	.913	.682

Source: Author (2026)

The measurement model demonstrated strong internal consistency and adequate convergent validity. All constructs recorded Cronbach's alpha and composite reliability values above the recommended threshold of 0.70, indicating high reliability. Additionally, the average variance extracted (AVE) values exceeded 0.50 for all constructs, indicating that each construct explained a sufficient proportion of the variance in its indicators. The results confirmed that the measurement model was reliable and valid, providing evidence that the study constructs were suitable for subsequent statistical analyses of pre-service science teachers' perceptions and acceptance of artificial intelligence in science education programmes.

4. Results and Discussion

4.1 Results

Identify AI tools frequently used by pre-service science teachers in Ghana for teaching and lesson preparation.

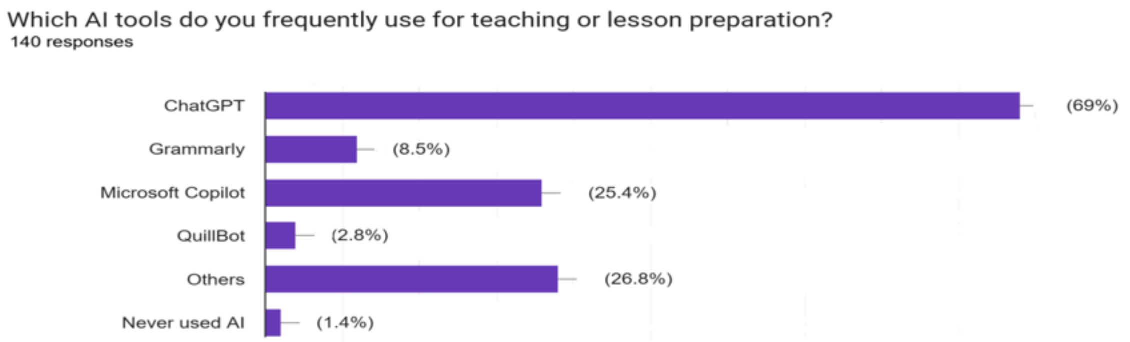

Figure 1: AI Tools Frequently Used by Pre-Service Science Teachers

Source: Author (2026)

The results indicate a high level of AI adoption among pre-service science teachers for teaching and lesson preparation. ChatGPT emerged as the most widely used tool, with 69% of respondents reporting frequent use, underscoring its central role in instructional planning and content development. Microsoft Copilot (25.4%) and other AI tools (26.8%) also recorded moderate usage, suggesting a growing openness to multiple AI platforms. In contrast, Grammarly (8.5%) and QuillBot (2.8%) were used by relatively few teachers, implying that AI applications focused on language editing are less integral to science teaching. Importantly, only 1.4% of respondents reported never having used AI, reflecting widespread exposure to and engagement with AI technologies in science education programs.

Explore the primary purposes for which pre-service science teachers use AI in science education programmes.

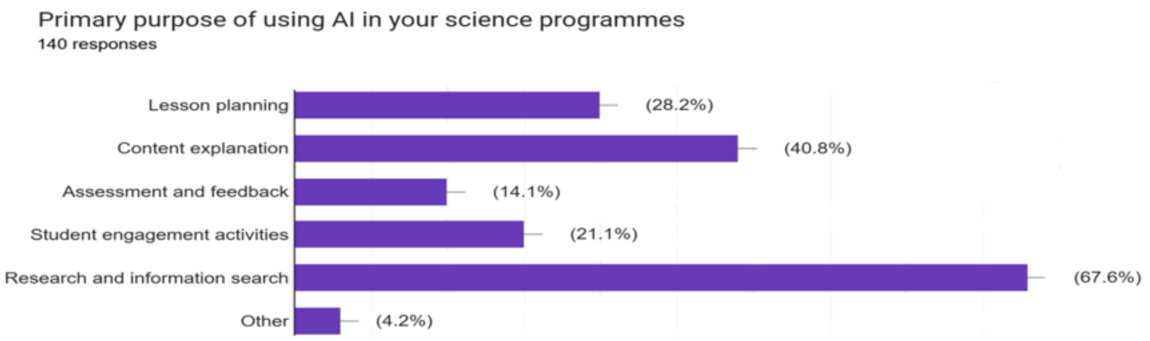

Figure 2: Primary Purpose of Using AI by Pre-Service Science Teachers

Source: Author (2026)

The chart shows that the majority of teachers use AI primarily for research and information searching (67.6%). The second most common use is content explanation (40.8%), followed by lesson planning (28.2%). Student engagement activities accounted for 21.1%, while assessment and feedback were the least selected among the main categories (14.1%). Only 4.2% indicated other purposes for using AI. These results suggest that teachers are mainly using AI as a support tool for research and content delivery, rather than for assessment or student interaction.

Assess pre-service science teachers' perceptions, intentions, and actual use of AI in science education.

Table 2: Descriptive Statistics on Performance Expectancy

	Mean	**SD**	**T-value**	**P-value**
I believe using AI in science teaching will improve the quality	4.04	.933	36.525	< .001
AI tools will make my teaching more efficient	4.04	1.048	32.502	< .001
Using AI in the classroom will help students understand science	3.93	.961	34.455	< .001
AI can help me achieve better learning outcomes for my students	4.01	.886	38.163	< .001
Incorporating AI into teaching will make my work more effective	4.13	.955	36.406	< .001
AI adoption is likely to improve my overall teaching performance	3.80	1.154	27.764	< .001

Source: Author (2026)

The results indicate that teachers generally have positive perceptions of the integration of artificial intelligence (AI) in science teaching. All items received mean scores above the midpoint of 3.0, reflecting favourable attitudes toward AI adoption. Specifically, teachers agreed that AI could improve the quality of science teaching ($M = 4.04$, $SD = .933$) and make teaching more efficient ($M = 4.04$, $SD = 1.048$). They also believed that the use of AI in the classroom would enhance students' understanding of science ($M = 3.93$, $SD = .961$) and improve learning outcomes ($M = 4.01$, $SD = .886$). Additionally, participants agreed that incorporating AI into teaching would make their work more effective ($M = 4.13$, $SD = .955$) and that AI adoption is likely to improve their overall teaching performance ($M = 3.80$, $SD = 1.154$). One-sample t-test results revealed that all these mean scores were significantly higher than the neutral midpoint, as indicated by statistically significant t-values ($p < .001$), suggesting that teachers' positive perceptions of AI are not due to chance but represent a meaningful trend in the sample.

Table 3: Descriptive Statistics on Effort Expectancy

	Mean	SD	T-value	P-value
I find AI applications easy to learn and use in science teaching.	3.89	.994	32.968	< .001
Interaction with AI tools in the classroom is clear and understandable.	3.90	.848	38.777	< .001
Using AI in science lessons requires little effort.	3.52	1.094	27.130	< .001
AI tools can be used without extensive technical knowledge.	3.69	1.141	27.244	< .001
AI software and applications are user-friendly for teaching purposes	3.89	.871	37.609	< .001
Integrating AI into my existing lesson plans is easy for me.	3.80	.965	33.192	< .001

Source: Author (2026)

The results for effort expectancy indicate that teachers generally perceive AI applications as easy to use and integrate into science teaching. All six items had mean scores above the neutral midpoint of 3.0, suggesting that participants found the AI tools relatively user-friendly. Specifically, teachers agreed that AI applications are easy to learn and use (M = 3.89, SD = 0.994) and that interacting with AI tools in the classroom is clear and understandable (M = 3.90, SD = 0.848). They also reported that AI software and applications are user-friendly for teaching purposes (M = 3.89, SD = 0.871) and easy to integrate into existing lesson plans (M = 3.80, SD = 0.965). While participants generally perceived AI as not requiring extensive effort, the item "Using AI in science lessons does not require a lot of effort" had a slightly lower mean score (M = 3.52, SD = 1.094), indicating some reservations about the effort involved. Similarly, teachers believed that they could use AI tools without needing extensive technical knowledge (M = 3.69, SD = 1.141). The one-sample t-test results showed that all mean scores were significantly higher than the midpoint, as indicated by statistically significant t-values ($p < .001$), suggesting that teachers' perceptions of AI's ease of use are meaningfully positive.

Table 4: Descriptive Statistics on Attitude Toward AI (AT)

	Mean	SD	T-value	P-value
I am optimistic about using AI in science lessons.	3.92	.890	37.055	< .001
Using AI in science teaching is enjoyable.	4.10	.949	35.657	< .001
I believe that AI is a valuable tool for improving science education.	3.85	1.009	32.103	< .001
I am enthusiastic about incorporating AI into my teaching practice.	3.83	1.014	31.835	< .001
I have a favourable opinion on AI applications in science classrooms.	3.83	1.000	32.287	< .001
Using AI enhances my motivation to teach science effectively.	3.86	1.046	31.087	< .001

Source: Author (2026)

The findings show that teachers generally have a positive attitude toward the use of AI in science teaching. All six items recorded mean scores above the neutral midpoint of 3.0, indicating favourable perceptions. Specifically, teachers reported positive feelings about using AI in their science lessons (M = 3.92, SD = 0.890) and found it enjoyable to use in teaching (M = 4.10, SD = 0.949). They also believed that AI was a valuable tool for improving science education (M = 3.85, SD = 1.009) and expressed enthusiasm for incorporating AI into their teaching practice (M = 3.83, SD = 1.014). Additionally, participants held favourable views of AI applications in science classrooms (M = 3.83, SD = 1.000) and agreed that AI enhanced their motivation to teach science effectively (M = 3.86, SD = 1.046). One-sample t-test results indicated that all mean scores were significantly higher than the midpoint, with all p-values < .001, suggesting that positive attitudes toward AI were statistically significant rather than due to chance.

Table 5: Descriptive Statistics on Perceived Behavioural Control (PBC)

	Mean	**SD**	**T-value**	**P-value**
I am confident in my ability to use AI in science teaching.	3.83	1.000	32.287	< .001
I can overcome the technical challenges of using AI in lessons.	3.82	1.019	31.576	< .001
I have sufficient skills to use AI tools effectively in teaching.	3.76	1.021	31.044	< .001
I can integrate AI into my lesson plan.	3.79	.99	31.963	< .001
I can use AI independently without external assistance.	3.73	1.207	26.064	< .001
I can manage classroom activities effectively using AI.	3.70	1.074	29.054	< .001

Source: Author (2026)

The results for perceived behavioural control indicate that teachers generally feel capable of using AI in science teaching. All items scored above the neutral midpoint of 3.0, suggesting that participants perceived they had sufficient control and competence to integrate AI tools into their teaching. Teachers reported confidence in their ability to use AI in science teaching (M = 3.83, SD = 1.000) and believed they could overcome technical challenges when using AI in lessons (M = 3.82, SD = 1.019). Participants also indicated that they possessed sufficient skills to use AI tools effectively (M = 3.76, SD = 1.021) and felt capable of integrating AI into lesson plans (M = 3.79, SD = 0.999). However, slightly lower mean scores were observed for items related to independent use and classroom management while using AI, with participants indicating moderate confidence in using AI without external assistance (M = 3.73, SD = 1.207) and managing classroom activities effectively while using AI (M = 3.70, SD = 1.074). One-sample t-test results showed that all mean scores were significantly higher than the midpoint ($p < .001$), indicating that teachers' perceived behavioural control regarding AI integration was significantly positive.

Table 6: Descriptive Statistics on Behavioural Intention (BI)

	Mean	**SD**	**T-value**	**P-value**
I intend to use AI in science lessons soon.	3.80	1.023	31.326	< .001
I plan to integrate AI tools into my teaching practice regularly.	3.92	1.052	31.357	< .001
I will use AI to enhance student learning.	3.94	1.040	31.939	< .001
I am determined to adopt AI in my teaching practice.	3.72	1.209	25.909	< .001
I intend to explore new AI applications for teaching science.	3.77	1.085	29.316	< .001
I encourage other teachers to use AI in science education.	3.66	1.09	28.187	< .001

Source: Author (2026)

The findings indicate that teachers generally intend to use AI in their science teaching soon. All six items recorded mean scores above the neutral midpoint of 3.0, suggesting positive behavioural intentions toward AI adoption. Participants expressed intentions to regularly integrate AI tools into their teaching practice (M = 3.92, SD = 1.052) and try to use AI to enhance student learning (M = 3.94, SD = 1.040). They also indicated that they intend to use AI in their science lessons in the near future (M = 3.80, SD = 1.023) and plan to explore new AI applications for teaching science (M = 3.77, SD = 1.085). However, slightly lower mean scores were observed for the determination to adopt AI (M = 3.72, SD = 1.209) and the intention to encourage other teachers to use AI (M = 3.66, SD = 1.095), indicating some hesitation in fully advocating AI use among peers. One-sample t-test results revealed that all mean scores were significantly higher than the midpoint ($p < .001$), indicating that teachers' behavioural intentions to adopt AI are statistically significant and not due to chance.

Table 7: Descriptive Statistics on Actual Use (AU)

	Mean	**SD**	**T-value**	**P-value**
I used AI tools in my science lessons during the past semester.	3.70	1.188	26.274	< .001
I used AI applications to prepare teaching materials for science lessons.	3.75	.952	33.161	< .001
I have applied AI-based activities in classroom teaching.	3.63	1.137	26.932	< .001

I used AI tools to assess and monitor student learning outcomes.	3.52	1.119	26.504	< .001
I frequently use AI to enhance my students' engagement and understanding.	3.48	1.286	22.799	< .001

Source: Author (2026)

The results on the actual use of AI in science teaching indicate that teachers have been moderately engaged with AI tools in their instructional practice. All items had scores above the midpoint of 3.0, indicating that participants have used AI to some extent. Teachers reported using AI tools in their science lessons during the past semester ($M = 3.70$, $SD = 1.188$) and utilising AI applications to prepare teaching materials ($M = 3.75$, $SD = 0.952$). They also indicated that they have applied AI-based activities during classroom teaching ($M = 3.63$, $SD = 1.137$) and used AI tools to assess or monitor student learning outcomes ($M = 3.52$, $SD = 1.119$). However, the lowest mean score was observed for the frequency of AI use to enhance student engagement and understanding ($M = 3.48$, $SD = 1.286$), suggesting that consistent or frequent use of AI in classroom instruction may still be limited. One-sample t-test results showed that all mean scores were significantly higher than the midpoint ($p < .001$), indicating that teachers' actual use of AI is significantly positive, although not very high.

4.2. Discussion

This study explored how Ghanaian pre-service science teachers perceive and utilise artificial intelligence (AI) tools in their teaching and lesson preparation, focusing on key constructs such as performance expectancy, effort expectancy, attitude, perceived behavioural control, behavioural intention, and actual use. The findings reveal a generally positive orientation toward AI, with widespread adoption primarily for research, content explanation, and lesson planning rather than assessment or student engagement. These findings align with previous Ghanaian studies indicating that teachers are generally receptive to innovative educational technologies when they perceive clear instructional benefits and opportunities to enhance teaching effectiveness (Asoma et al., 2024; Yeboah et al., 2025). Teachers held favourable views of AI's potential to enhance teaching quality, instructional efficiency, and student learning outcomes, and demonstrated moderate confidence in their ability to use AI effectively. These findings align with the Unified Theory of Acceptance and Use of Technology (UTAUT), which posits that performance expectancy and effort expectancy are among the strongest predictors of technology adoption intentions (Venkatesh et al., 2003). The positive perceptions observed in this study suggest that pre-service science teachers recognise the pedagogical value of AI and believe that it can improve teaching effectiveness. Similar findings have been reported among Ghanaian teachers, where positive perceptions of technology initiatives significantly influenced classroom technology integration (Asoma et al., 2024). The findings also align with evidence from broader African contexts, where educators increasingly view AI as a tool to improve instructional delivery, learner engagement, and access to educational resources (Adigun et al., 2025; Akanzire et al., 2025). However, despite strong behavioural intentions to use AI, actual classroom integration remained moderate, suggesting that AI adoption among Ghanaian pre-service science teachers is still in its developmental stage.

The interpretation of these results suggests that while pre-service teachers recognise the instrumental value of AI as a cognitive and preparatory aid, its transformative pedagogical potential has yet to be fully realised. The predominance of ChatGPT and other generative AI tools for research and content development aligns with an instrumentalist view of technology, in which AI serves to augment teachers' efficiency rather than fundamentally reshape instructional methods. This pattern is consistent with the Unified Theory of Acceptance and Use of Technology (UTAUT), in which performance expectancy strongly predicts adoption intentions (Venkatesh et al., 2003).

The positive effort expectancy scores indicate that respondents generally perceived AI tools as accessible, understandable, and relatively easy to integrate into science teaching. Within the UTAUT framework, effort expectancy influences behavioural intention by reducing the cognitive burden associated with learning and applying new technologies (Venkatesh et al., 2003). The findings suggest that the increasing availability of user-friendly AI applications, such as ChatGPT, has lowered the barriers to technology adoption among pre-service teachers. Similar observations have been reported among educators in Ghana and other developing countries, where ease of use significantly enhances willingness to adopt emerging technologies (Agyei & Voogt, 2010; Naatu et al., 2024). Nevertheless, the slightly lower ratings regarding independent use and technical competence indicate that some participants may still require additional training and institutional support to maximise the pedagogical benefits of AI. This finding is consistent with evidence suggesting that personal dispositions and affective competencies influence educational decision-making and engagement with innovative practices among pre-service teachers (Mintah et al., 2020; Budu et al., 2022). The favourable attitudes toward AI and the positive levels of perceived behavioural control observed among participants provide further support for the Theory of Planned Behaviour (TPB) (Ajzen, 1991). According to the TPB, behavioural intention is shaped by individuals' attitudes toward a behaviour and their perceived capacity to perform it successfully. The positive attitudes recorded in this study suggest that pre-service science teachers perceive AI as a valuable instructional resource that can enhance science teaching and learning. Likewise, their confidence in overcoming technical challenges and integrating AI into lesson planning reflects relatively high perceived behavioural control. These findings imply that participants possess both the motivation and self-belief necessary for AI adoption. Similar patterns have been reported among Ghanaian pre-service teachers, where confidence, emotional competence, and personal dispositions significantly influenced engagement with innovative educational practices (Mintah et al., 2020; Budu et al., 2022). Consequently, the findings reinforce TPB assumptions that favourable attitudes and strong perceptions of control are important precursors to behavioural intentions to adopt technology. However, the intention–behavior gap evident in actual use highlights systemic and infrastructural constraints (Kim, 2025). These may include limited access to reliable digital infrastructure, insufficient professional development, and unclear institutional policies, which collectively impede the translation of positive dispositions into sustained classroom practice (Hakimi & Shahidzay, 2024; Kim & Wargo, 2025).

These findings resonate with the broader international literature documenting early-stage AI adoption in education as predominantly preparatory and supportive rather than transformative. Similar studies have identified performance expectancy and ease of use as pivotal predictors of AI acceptance among educators, reinforcing the external validity of these models within the Ghanaian context (Geddam et al., 2024).

The relatively lower use of AI for assessment and student engagement highlights an important contextual dimension of technology adoption in developing countries. While educators recognised the benefits of AI for lesson preparation, research, and content explanation, they appeared less confident in employing AI for more sophisticated pedagogical functions. This finding reflects broader patterns reported across Sub-Saharan Africa, where limitations in digital infrastructure, institutional support, and professional development often constrain the depth of technology integration (Hakimi & Shahidzay, 2024; Naatu et al., 2024). In Ghana specifically, previous studies have shown that positive perceptions alone do not guarantee effective classroom implementation unless accompanied by adequate technological resources, training opportunities, and supportive educational policies (Abedi et al., 2023; Asoma et al., 2024). Consequently, the gap between intention and actual use observed in this study may be explained not only by individual factors but also by systemic and contextual barriers that shape technology adoption behaviour.

The implications of these findings are significant for Ghana's science education system, which appears to be at a critical juncture. The widespread positive perceptions and intentions indicate that pre-service teachers are ready to embrace AI, suggesting fertile ground for targeted interventions to deepen AI integration (Abedi et al., 2023; Agyei & Voogt, 2010; Blonder et al., 2024). Addressing systemic barriers could facilitate the transition from instrumental use toward more transformative pedagogical practices. Similar transformations have been observed in science classrooms where collaborative and learner-centred instructional strategies promoted deeper conceptual understanding and more meaningful student engagement (Amponsah & Ochonogor, 2018). These unlock AI's full potential to enhance inquiry-based learning and student engagement in science education.

Theoretically, this study reinforces integrative adoption frameworks that combine expectancy-based constructs with behavioural and contextual factors, confirming that perceptual drivers are necessary but not sufficient for educational innovation. Practically, it signals to policymakers and educational leaders that investments in digital infrastructure, curriculum alignment, and sustained teacher training are essential to capitalise on the current momentum and ensure equitable and effective AI adoption (Mustofa et al., 2025). In summary, this research contributes to the growing body of knowledge on AI in education by providing empirical evidence from a Sub-

Saharan African context and emphasising the interplay between individual perceptions and systemic enablers in shaping AI integration trajectories.

The findings suggest that an interplay of expectancy beliefs, behavioural dispositions, and contextual conditions influences AI adoption among Ghanaian pre-service science teachers. Consistent with UTAUT, perceptions of usefulness and ease of use contributed to positive intentions toward AI adoption. At the same time, TPB constructs demonstrated the importance of attitudes and perceived behavioural control in shaping behavioural intentions. However, the persistence of an intention–practice gap indicates that psychological readiness alone is insufficient to ensure sustained AI integration. The findings therefore support contemporary African scholarship that advocates a holistic approach to educational technology adoption, combining individual capacity building with institutional investment, policy support, and improved digital infrastructure to facilitate meaningful and sustainable AI integration in teaching and learning.

5. Conclusion

This study demonstrates that Ghanaian pre-service science teachers generally hold positive perceptions of artificial intelligence, recognise its usefulness, and are motivated to integrate it into teaching, particularly for research, lesson planning, and content explanation; yet, actual classroom use remains moderate. These findings indicate a transitional phase in science education, in which cognitive and attitudinal readiness is high but systemic and contextual factors, such as technological infrastructure, professional development, and curriculum alignment, moderate full integration. The study suggests that policies and interventions should prioritise capacity building, practical training, and supportive structures to bridge the gap between intention and practice, thereby enabling AI to move from a supportive tool to a transformative educational resource. Future research should investigate longitudinal adoption, pedagogical impacts on student outcomes, and regional variations, highlighting that realising AI's potential in Ghanaian science classrooms depends on both teacher readiness and systemic facilitation.

5.1 Limitation of the Study

A key limitation of this study is its reliance on self-reported data from pre-service science teachers, which may be influenced by social desirability bias or overestimation of AI use and competence. Additionally, the cross-sectional design captures perceptions and behaviours at a single point in time, limiting the ability to infer causal relationships or track changes in AI adoption over time. The study also focused primarily on teachers' perspectives without incorporating insights from students or school administrators, which may influence AI integration. Finally, the findings are specific to the Ghanaian context. While they provide valuable insights for similar educational settings, generalisation to other countries with different infrastructural and policy conditions should be approached with caution.

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