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Teachers' Artificial Intelligence Capability and Usage in Secondary School Science Teaching: A Case Study in Abeokuta Metropolis, Ogun State, Nigeria

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Abstract: The application of Artificial Intelligence (AI) technologies into education has emerged as a significant strategy for enhancing teaching effectiveness. However, the successful implementation of AI in science education depends largely on teachers' AI capability and it usage. This study investigated teachers' level of AI capability, and the extent of its usage in science instruction. The study adopted a descriptive survey design, with a sample of 300 secondary school science teachers, selected using a multistage sampling procedure. Data were collected using Teachers' Artificial Intelligence Capability and Usage Scale, which was validated by experts, and Cronbach's Alpha reliability coefficient of 0.81 was obtained. Data were analyzed using descriptive and inferential statistics at 0.05 significance level. The findings revealed that science teachers possessed moderate level of AI capability (Grand Mean = 2.88, SD = 0.71), and moderate AI usage for science instruction (Grand Mean = 2.76, SD = 0.73). Findings also showed: (i) a significantly positive relationship between teachers' AI capability and AI usage ($r = 0.684$, $p < 0.05$), (ii) teachers' AI capability significantly predicted their AI usage for science instruction ($R = 0.683$, $R^2 = 0.466$, $\beta = 0.683$, $t = 13.474$, $p < 0.05$). This study also indicated that AI knowledge, digital competence, self-efficacy, and institutional support are important determinants of AI usage among science teachers. It was recommended that educational stakeholders provide continuous AI-related training, and improve access to digital resources towards sustainable science education.

Keywords: *Artificial Intelligence, Teachers' Readiness, Technology adoption, Science Education.*

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I. INTRODUCTION

The increasingly spread of Artificial Intelligence (AI) technologies across several sectors of human life, including education, is reshaping human operational functioning and effectiveness. In education, students have increasingly integrated AI into their teaching-learning, often faster than schools and curricula features can (Amoozadeh et al., 2024; Malik et al., 2023). For teachers, artificial intelligence (AI) present them with challenges and opportunities to revolutionize instructional strategies, enhance operational efficiency, and provide personalized learning experiences (Braaten & Farnsworth, 2024; Klopfer et al., 2024; Hazzan-Bishara, 2025). Artificial Intelligence basically refers to computer algorithm systems capable of performing tasks that typically require human intelligence, such as learning, reasoning, problem-solving, decision-making, and natural language processing. According to Grájeda et al. (2024) AI are computer systems capable of human-like processes, such as self correction, adaptation, learning, synthesis, and using data for complex tasks. On a general note, Artificial Intelligence (AI) refers to the simulation of human intelligence by machines, enabling interaction with humans to influence behavior and assist in accomplishing tasks beyond individual capabilities (Chintalapati & Pandey, 2022; Holmes & Tuomi, 2022; Uzir et al., 2023). In essence, AI through its technologies such as intelligent tutoring systems, adaptive learning platforms, automated assessment systems, virtual laboratories, and generative AI applications, has emerged as a transformative force in education,

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presenting science education the opportunities of personalized learning experiences, improve learner engagement, immediate feedback provision, scientific information analysis, responsive and adaptive learning environments, optimizing language acquisition and and enhance educational outcomes (Luckin et al., 2016; Holmes et al., 2019; Mello et al., 2023; Malik et al., 2023; Yılmaz, 2024).

Recent studies have shown that AI-supported learning environments can enhance students' scientific reasoning, engagement, and academic achievement when effectively implemented (Zawacki-Richter et al., 2019). Artificial Intelligence applied in teaching-learning systems has been found capable of enhancing and improving teachers' skills and productivity, offering support, and resolving issues (Bai et al., 2021; Cukurova et al., 2023; Wang et al., 2021; Holmes & Tuomi, 2022). Mello et al. (2023) and Velander et al. (2024) also found AI with the ability to streamline assessment processes, apply predictive analytics and personalized students' learning experiences. Other studies further revealed AI's ability to manage student records, track attendance, evaluate assignments, and identify learning difficulties through automated analysis, thus giving teachers room to focus on other responsibilities (Tuomi, 2018; Feuerriegel et al., 2024; Kyrpa et al., 2024; Velander et al., 2024). Consequently, educational systems worldwide are increasingly exploring AI-driven innovations as a means of improving the quality and sustainability of science education.

Teachers' use of AI in science classrooms depends substantially on teachers' competencies, attitudes, beliefs, and preparedness. Hazzan-Bishara, (2025) stated that successful implementation of AI in education depends on teachers' awareness and willingness to adopt it. Application of AI in education has often focus on teacher preparedness (Galindo-Domínguez et al., 2024; Lozano & Blanco Fontao, 2023) and ethical concerns (Cukurova & Miao, 2024; Grassini, 2023). Studies have also indicated that a positive attitude towards AI can enhances teachers' acceptance and willingness to adopt AI tools, while negative perceptions can hinder effective integration (Papadakis & Kalogiannakis, 2020; Pokrivcakova, 2023). Similarly, integration of AI has been found to be challenging for teachers, especially those with less experience in the technology, thus creating a barrier to AI implementation in education (Limna et al., 2022; Sanusi et al., 2021b). Research has consistently demonstrated that teachers who possess higher levels of technological competence and confidence are more likely to adopt emerging educational technologies effectively (Tondeur et al., 2017; Scherer et al., 2019). Amandoron (2025) in his study found that technological and pedagogical competencies significantly influenced pre-service science teachers' readiness to integrate AI into science instruction. Iddrisu & Iddrisu (2025) in their research study identified self-efficacy, institutional support, and AI familiarity as major determinants of AI readiness and adoption among teachers.

Ayanwale et al. (2025) in a study of teachers' readiness for artificial intelligence in education showed that readiness is shaped by technological competence, awareness, attitude, access to tools, and support systems. Alshorman et al. (2024) found that science teachers generally recognized the educational potential of AI but reported significant concerns regarding insufficient training, limited technical expertise, and inadequate institutional support. Kim (2025) reported that many K–12 educators expressed uncertainty regarding their preparedness to adopt generative AI tools and highlighted the need for targeted professional development initiatives. Ma et al. (2024) emphasized the critical role of AI literacy in shaping educators' intentions to adopt AI technologies, while Cabero-Almenara et al. (2024) reported that teachers' pedagogical beliefs significantly influenced their acceptance of AI in educational settings. Likewise, Hazzan-Bishara et al. (2025) found that institutional support, intrinsic motivation, and self-efficacy were among the strongest predictors of teachers' intentions to adopt generative AI technologies. Chiu and Chai (2020) in their study emphasized that teachers need technological, pedagogical, and ethical competencies to integrate AI meaningfully. Celik (2023) investigated the role of teacher professional knowledge in AI-supported education and showed that teachers require not only technical knowledge but also pedagogical and ethical understanding of AI tools. Almasri (2024) in a systematic review study found that AI tools could improve science learning through simulations, adaptive learning, feedback, and inquiry-based activities., but successful implementation depends on teacher competence, infrastructure, and instructional design. Ng et al. (2023) reviewed AI literacy in education and showed that teachers need AI literacy before they can guide students responsibly in AI-supported learning environments. Despite the growing interest of AI applications in education, evidence suggests that many teachers are not adequately capable and prepared to use AI technologies into their teaching practices.

In this study, teachers' AI capability for science teaching application comprised of collectivity of teachers' AI knowledge, digital competence, AI self-efficacy, access to AI resources, and institutional support; while teachers' AI usage in science teaching consist of teachers' application of AI technologies for lesson planning, assessment, feedback provision, content generation, personalized instruction, and student engagement.

- *Statement of the Problem*

Despite the possible benefits of AI technologies, evidence from recent studies suggests that their usage in educational settings remains relatively limited. Many teachers continue to experience challenges related to inadequate AI knowledge, insufficient digital competence, lack of professional training, limited technological infrastructure, and uncertainty regarding the pedagogical application of AI tools. These challenges are particularly pronounced in science education, where teachers are expected to integrate emerging technologies into inquiry-based and learner-centered instructional practices. Consequently, many science teachers are unable to fully

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apply AI technologies to enhance teaching effectiveness and support sustainable learning outcomes.

Empirical evidence has also revealed limited information regarding the extent of science teachers' AI capability and usage, as well as factors that facilitate or hinder such capability and usage, particularly in developing country like Nigeria where infrastructural and professional development challenges remain significant. It is based on this background that this study is being conducted in a bid to provide empirical evidence that can guide policymakers, educational administrators, and teacher educators in developing strategies for effective AI integration toward achieving sustainable science education.

➢ *Research Objectives*

The main objective of this study is to examined teachers' capability and usage of Artificial Intelligence technologies in science education. Specifically, the study seeks to:

- Determine the level of science teachers' capability to apply Artificial Intelligence technologies in science teaching.
- Examine the extent of science teachers' usage of Artificial Intelligence technologies for science teaching.
- Determine the relationship between science teachers' capability and usage of Artificial Intelligence technologies for science teaching.

➢ *Research Questions*

The following research questions will guide the study:

- What is the level of science teachers' capability to apply Artificial Intelligence technologies for science teaching?
- To what extent do science teachers use Artificial Intelligence technologies for science instruction?

➢ *Research Hypotheses*

The following null hypotheses will be tested at the 0.05 level of significance:

- $H0_1$: There is no significant relationship between science teachers' AI capability and usage for science teaching.
- $H0_2$: Science teachers' AI capability does not significantly predict their AI usage for science teaching.

II. METHODOLOGY

➢ *Research Design, Population of the Study, Sample and Sampling Technique*

This study adopted a descriptive survey research design. The population for the study comprised all Science teachers teaching Physics, Chemistry, and Biology in public and private secondary schools within Abeokuta metropolis (comprising Odeda, Abeokuta-South and Abeokuta-North Local Government Areas).

A sample of 300 science teachers was selected from the target population using a multistage sampling procedure. In the first stage, secondary schools were selected using simple random sampling. In the second stage, proportionate stratified sampling was used to ensure adequate representation of Physics, Chemistry, and Biology teachers. Finally, simple random sampling was employed to select the respondents from the participating schools.

➢ *Study Instrument*

Data were collected using a self-developed questionnaire titled "Teachers' Artificial Intelligence Capability and Usage Scale (TAICUS)". The TAICUS is a questionnaire consisting of sections A, B, C. Section A elicited on demographic information such as gender, Age, teaching experience, educational qualification, school type and science specialization. Section B obtains information on teachers' AI capability, and contained items that measure teachers' AI knowledge, digital competence, AI self-efficacy, access to AI resources, and institutional support. Section C obtains information on teachers' AI usage, and contained items that measures the extent to which teachers use AI technologies for: Lesson planning, Assessment, Feedback provision, Content generation, Personalized instruction, and Student engagement. Responses were rated on a four-point Likert scale of Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1.

➢ *Validity and Reliability of the Instrument*

The instrument was subjected to face and content validation by experts in science education, educational technology, and measurement and evaluation. The experts examined the instrument for clarity, relevance, appropriateness of language, and adequacy of item coverage in relation to the study objectives. Their observations and suggestions were incorporated into the final version of the instrument.

A pilot study was conducted using 30 science teachers from schools outside the study area. The reliability of the instrument was determined using Cronbach's Alpha reliability coefficient with an overall value of 0.81 ($\alpha = 0.82$ for teachers' AI capability, $\alpha = 0.80$ for teachers' AI usage). Based on this value, the instrument is adjudged to possessed adequate internal consistency since the reliability coefficients exceeded the acceptable threshold of 0.70.

➢ *Data Collection and Method of Data Analysis*

Copies of the data collection instrument (TAICUS) were distributed personally to the respondents by the researchers with the assistance of the sampled school teachers. Participants were informed of the purpose of the study and assured of confidentiality and anonymity. Completed questionnaires were retrieved immediately where possible and within one weeks in cases where respondents required additional time.

Collected data were coded and analyzed using the Statistical Package for Social Sciences (SPSS) version 29. The research questions were answered using descriptive statistics, while the hypotheses were tested at the 0.05 level

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of significance using inferential statistics (Pearson Product-Moment Correlation, Simple Linear Regression).

The decision on teachers' level and extent of AI capability and usage for science instruction were determined from the response mean score based the criterion below:

Mean Score (MS) = 1.00 – 2.49 = Low level of teachers' AI capability/usage;

Mean Score (MS) = 2.50 – 2.99 = Moderate level of teachers' AI capability/usage;

Mean Score (MS) = 3.00 – 3.99 = High level of teachers' AI capability/usage.

III. RESULTS AND DISCUSSION

➢ *Research Question One:*

What is the level of science teachers' capability to apply Artificial Intelligence technologies for science teaching?

Table 1 Mean and Standard Deviation of Science Teachers' AI Capability for Science Teaching

S/N	Variable	N	Mean Score	SD	Decision
1.	AI Knowledge	300	3.11	0.64	High
2.	Digital Competence	300	3.08	0.58	High
3.	AI Self-Efficacy	300	3.05	0.71	High
4.	Access to AI Resources	300	2.64	0.82	Moderate
5.	Institutional Support	300	2.52	0.79	Moderate
	Grand Mean	**300**	**2.88**	**0.71**	**Moderate Capability**

Source: Fieldwork, 2025

Table 1 shows teachers' responses to AI capability for science teaching. As revealed by table 1, the science teachers demonstrated a moderate level of capability for AI integration in science teaching (Grand Mean = 2.88, SD = 0.71). Teachers' AI knowledge has the highest mean score (MS = 3.11), while institutional support and access to AI resources recorded the lowest mean score (MS = 2.52, 2.64). This finding suggests that although many teachers are aware of AI technologies and possesses reasonable AI knowledge, as well as basic digital competencies regarding AI technologies. However, the moderate ratings for institutional support and access to AI resources indicate that infrastructural challenges remain barriers to effective teachers' capability to integrate AI in science teaching.

This finding agrees with Alshorman (2024), who reported that science teachers generally showed willingness to use AI and recognized the value of AI, but their readiness was limited by inadequate training opportunities, limited technical resources, and insufficient institutional support. Similarly, the finding agrees with Kim (2025) who found that many teachers were interested in adopting AI technologies but lacked adequate preparation and guidance for effective classroom implementation. The finding is also in line with Viberg et al. (2025) who in their work found that teachers with higher AI understanding and AI self-efficacy perceived more benefits and fewer concerns about AI educational technologies. This supports the present study's result that AI knowledge and self-efficacy are important components of teachers' capability for AI integration.

➢ *Research Question Two:*

To what extent do science teachers use Artificial Intelligence technologies for science instruction?

Table 2 Mean and Standard Deviation of Science Teachers' use of AI for Science Instruction

S/N	Variable	N	Mean Score	SD	Decision
1.	Lesson Planning	300	3.01	0.67	High
2.	Content Development	300	3.02	0.73	High
3.	Assessment and Feedback	300	2.56	0.76	Moderate
4.	Personalized Learning	300	2.52	0.79	Moderate
5.	Student Engagement Activities	300	2.69	0.72	Moderate
	Grand Mean	**300**	**2.76**	**0.73**	**Moderate Usage**

Source: Fieldwork, 2025

The results in Table 2 reveal that science teachers moderately use Artificial Intelligence technologies for science instruction (Grand Mean = 2.76, SD = 0.73). AI technologies were most frequently utilized for lesson planning and content development, while personalized learning recorded the lowest level of adoption.

This finding suggests that teachers are more comfortable employing AI for administrative and preparatory tasks than for sophisticated pedagogical applications. The result corroborates the findings of Cabero-Almenara et al. (2024), who observed that teachers often begin AI adoption with lesson planning and content generation before progressing to more advanced

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instructional uses. This finding is also consistent with the work of Alwaqdani (2025), who reported that teachers perceived AI technologies as useful for reducing workload and improving instructional efficiency. The finding is consistent with Zawacki-Richter et al. (2019), who reviewed AI applications in education and found that AI tools were increasingly used for assessment, adaptive learning, prediction, and tutoring, but teacher-centered classroom adoption remained limited. This supports the present finding that AI usage in science education exists but is still developing.

➢ *Research Hypothesis One:*

There is no significant relationship between science teachers' AI capability and usage for science teaching.

Table 3 Pearson Correlation Between Teachers' Readiness and AI Adoption

Variables	N	r	p-value	Remarks
Teachers' AI capability	300	0.684	0.001	Correlation is significant
Teachers' AI usage	300			

Source: Fieldwork, 2025

The results show a strong positive relationship between teachers' AI capability and AI usage ($r = 0.684$, $p < .05$). This therefore implies that as teachers' AI capability increases, their usage of AI technologies for science instruction also increases. The strong correlation obtained ($r = 0.684$) indicates that AI capability plays a critical role in determining whether teachers use and integrate AI into science instruction. Teachers who possess higher levels of AI knowledge, digital competence, self-efficacy, and access to support systems are more likely to use and adopt AI technologies in their classrooms.

The finding aligns with the studies of Ma et al. (2024), who reported that AI literacy significantly predicts teachers' intentions to adopt AI technologies, and Granström & Oppi (2025), who found that teacher readiness and perceived usefulness were significant determinants of AI utilization. This finding is also align with Scherer et al. (2019) studies who found that teachers' technology adoption is significantly influenced by perceived usefulness, perceived ease of use, self-efficacy, and readiness, thus supporting the present result that teachers who have more AI capabilities are more likely to use and adopt AI technologies. The result is also in agreement with Celik (2023) study, who found that teachers with higher levels of AI-related knowledge and pedagogical competence demonstrated stronger intentions and capabilities to utilize AI tools in classroom instruction. In addition, the result also agrees with recent evidence from Eke (2024) who showed that Nigerian teacher educators who demonstrated higher readiness and positive attitudes toward AI were more willing to adopt AI technologies in educational settings, thus emphasizing that readiness, competence, and confidence significantly influence teachers' acceptance and utilization of AI innovations.

➢ *Research Hypothesis Two:*

Science teachers' AI capability does not significantly predict their AI usage for science teaching.

Table 4a Model Summary of Simple Linear Regression Analysis Showing Prediction of Science Teachers' AI Usage by Science Teachers' AI Capability

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.683	0.466	0.462	0.518

Source: Fieldwork, 2025

- Predictors (Independent Variable): (Constant), Science teachers' AI capability
- Dependent Variable: Science teachers' AI usage for science Instruction

Table 4a revealed that science teachers' AI capability explained 46.6% ($R = 0.683$, $R^2 = 0.466$) of the variance in science teachers' AI usage. This shows that science teachers' AI capability is a significant predictor of science teachers' AI usage for science instruction.

Table 4b ANOVA Table of Simple Linear Regression Analysis Showing Prediction of Science Teachers' AI Usage by Science Teachers' AI Capability

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	48.721	1	48.721	181.564	0.000
Residual	55.795	208	0.268		
Total	104.516	209			

Source: Fieldwork, 2025

- Predictors (Independent Variable): (Constant), Science teachers' AI capability
- Dependent Variable: Science teachers' AI usage for science Instruction

Table 4b indicates that science teachers' AI capability significantly predicts their AI usage [$F(1,208) = 181.564$, $p < 0.05$], which further implies that science teachers' AI capability contributes significantly to explaining variations in teachers' AI usage for science instruction.

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Table 4c Coefficients of Simple Linear Regression Analysis Showing Prediction of Science Teachers' AI Usage by Science Teachers' AI Capability

	Unstandardized Coefficients		Standardized Coefficients		
Model	**B**	**Std. Error**	**Beta**	**T**	**sig**
(Constant)	0.842	0.217	—	3.880	0.000
science teachers' AI capability	0.709	0.053	0.683	13.474	0.000

Source: Fieldwork, 2025

- Predictors (Independent Variable): (Constant), Science teachers' AI capability
- Dependent Variable: Science teachers' AI usage for science Instruction

The results in Tables 4c revealed that science teachers' AI capability significantly predicted their AI usage for science instruction ($\beta = 0.683$, $t = 13.474$, $p < 0.05$). The standardized beta coefficient ($\beta = 0.683$) indicates a strong positive predictive relationship between science teachers' AI capability and their AI usage for science instruction. This implies that science teachers, who possess higher levels of AI capability such as AI knowledge, digital competence, AI self-efficacy, access to AI resources and institutional support, are more likely to use AI technologies in their science instructional activities.

This finding is supported by previous studies such as that of Amandoron (2025), Cukurova et al. (2023), Deshen et al. (2026), Kim (2025), Unal & Hobe (2025). Amandoron (2025) in a research study reported that pre-service science teachers' readiness for AI integration significantly influenced their preparedness to adopt AI technologies in science education. Using Structural Equation Modelling, the study found that AI readiness positively predicted AI adoption intentions and integration practices among science teachers. Cukurova et al. (2023) in their study revealed that teachers' knowledge, confidence, preparedness, trust, and support mechanisms significantly predicted engagement with AI technologies; therefore concluded that readiness-related factors remain essential determinants of successful AI adoption in schools. Deshen et al. (2026) revealed that teachers' AI literacy was positively associated with AI acceptance and willingness to use AI technologies in education, therefore suggesting that teachers who possess greater AI knowledge and confidence are more likely to integrate AI technologies into teaching and learning activities. Kim (2025) in a study found that K–12 educators' preparedness and familiarity with AI significantly influenced their willingness to adopt AI tools for instructional purposes, thus concluding that teacher readiness is a critical prerequisite for successful AI adoption in educational settings. Unal & Hobe (2025) likewise reported that positive attitudes, familiarity with AI technologies, and readiness to integrate AI significantly influenced intentions to adopt AI-supported instructional practices; and then concluded that increasing teachers' readiness through training and professional development enhances the likelihood of AI adoption in educational environments.

IV. CONCLUSION

Findings from study indicate that although science teachers are increasingly embracing AI technologies, but there is a need to improved infrastructure, professional development, and institutional support to facilitate its sustainable usage in science education. Such efforts would enhance teachers' AI capability, increase AI usage, and ultimately contribute to achieving the goals of sustainable and quality science education. Overall, this study has shown that teachers' AI capability significantly predicted their AI usage for science instruction. In essence, teachers with higher levels of AI capability such as AI knowledge, digital competence, AI self-efficacy, access to AI resources and institutional support, are more likely to use AI technologies in their teaching-learning activities.

RECOMMENDATIONS

➢ *Based on the Findings and Conclusions of this Study, the Following Recommendations are Made:*

- Educational authorities and school administrators should organize regular workshops, seminars, conferences, and professional development programmes aimed at enhancing science teachers' knowledge and competencies in the use of Artificial Intelligence technologies for science teaching.

- Education teacher-training institutions should incorporate Artificial Intelligence literacy, AI pedagogy, and AI ethics into pre-service teacher education curricula to adequately prepare future science teachers for AI-enabled classrooms.

- Governments and educational stakeholders should provide schools with adequate technological facilities, including reliable internet connectivity, digital devices, AI software, and other necessary resources required for effective AI integration in science education.

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