

Artificial Intelligence Literacy As A Predictor Of Instructional Effectiveness Among Science Teachers In Akwa Ibom State, Nigeria

Uboh Daniel Effiong^{1*} ^{1,4,5}Department of Science Education Akwa Ibom State University Ikot Inyang, Nsisiong Uko² Akpaden, Mkpato Enin Akwa Ibom State, Nigeria. ^{1*}ORCID NO: 0009-0008-5017-593X
Ekanem, Aniekan Godwin³ ²Department of Mathematics Federal College of Education Ididep, Akwa
Nkanta, Isuaiko Osong-Ita⁴ & ³Department of Science Education University of Uyo, Akwa Ibom State
Utibe, Uduak James⁵

Abstract

This study investigated Artificial Intelligence literacy as a predictor of instructional effectiveness among science teachers in public secondary schools in Akwa Ibom State, Nigeria. Specifically, the study determined the level of Artificial Intelligence literacy among science teachers, examined the influence of gender on Artificial Intelligence literacy, and determined the extent to which Artificial Intelligence literacy predicts instructional effectiveness. A correlational survey research design was adopted for the study. The population comprised all science teachers in public secondary schools in Akwa Ibom State, while a sample of 300 science teachers was selected using a multistage sampling technique. Data were collected using a researcher-developed instrument titled Artificial Intelligence Literacy and Instructional Effectiveness Questionnaire (AILIEQ). The instrument was validated by experts in Science Education and Measurement and Evaluation, while its reliability was established using Cronbach's Alpha. Mean and standard deviation were used to answer the research questions. Independent samples t-test was used to test the hypothesis on gender differences, while simple linear regression analysis was employed to test the hypothesis on the predictive influence of Artificial Intelligence literacy on instructional effectiveness at the 0.05 level of significance. The findings revealed that science teachers possessed a high level of Artificial Intelligence literacy (Grand Mean = 3.07). The study further revealed that gender had no statistically significant influence on Artificial Intelligence literacy ($t = 0.94$, $p > .05$). The results also showed that Artificial Intelligence literacy significantly predicted instructional effectiveness among science teachers ($\beta = 0.642$, $R^2 = 0.412$, $F(1, 298) = 208.63$, $p < .05$), accounting for 41.2% of the variance in instructional effectiveness. The study concluded that Artificial Intelligence literacy is a significant predictor of instructional effectiveness among science teachers. It was recommended, among others, that the Akwa Ibom State

Ministry of Education and other educational stakeholders should organize regular training and professional development programmes to enhance teachers' Artificial Intelligence literacy and strengthen the pedagogical integration of Artificial Intelligence in science classrooms.

Keywords: *Artificial Intelligence literacy, instructional effectiveness, science teachers, gender, predictor, public secondary schools, Akwa Ibom State.*

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Introduction

Artificial Intelligence has emerged as one of the most transformative technologies of the twenty-first century, influencing virtually every sector of human endeavour, including education (UNESCO, 2024). In education, Artificial Intelligence has changed the way teachers plan lessons, assess students, personalize instruction, and manage classroom activities (Holmes et al., 2022). Recent evidence from Nigeria indicates that Artificial Intelligence-driven personalized learning significantly improves students' achievement, retention, and attitudes toward Physics, highlighting the growing importance of AI in science education (Uboh & Nathan, 2026). The rapid advancement of generative AI technologies, including intelligent tutoring systems, adaptive learning platforms, automated assessment tools, and conversational AI applications, has further expanded opportunities for improving teaching effectiveness and students' learning experiences (Holmes et al., 2022; Du et al., 2024). According to UNESCO (2024), teachers are central to the successful integration of AI in education because they determine how AI technologies are selected, adapted, and utilized to support meaningful learning. Consequently, AI literacy has become an indispensable professional competency for teachers worldwide. Similarly,

Holmes et al. (2022) argued that AI should complement rather than replace teachers by enhancing pedagogical decision-making, improving learner engagement, and supporting personalized instruction. Artificial intelligence literacy refers to the knowledge, skills, attitudes, ethical awareness, and critical competencies required to understand, evaluate, use, and responsibly integrate AI technologies in professional practice. AI literacy enables teachers to utilize AI tools for lesson preparation, instructional delivery, assessment, classroom management, and professional development while recognizing the ethical implications associated with privacy, transparency, bias, accountability, and responsible AI use (Long & Magerko, 2020; UNESCO, 2024). Teachers who possess adequate AI literacy are more likely to integrate AI effectively into classroom instruction, thereby improving teaching quality and learner outcomes (Du et al., 2024).

Science education is among the disciplines that can benefit significantly from AI integration because science teaching emphasizes inquiry, experimentation, problem-solving, data interpretation, modelling, and critical thinking. AI-powered virtual laboratories, intelligent simulations, adaptive learning environments, predictive analytics, and automated feedback systems provide science

teachers with innovative opportunities to enhance conceptual understanding and promote active learning (Zawacki-Richter et al., 2023). As science curricula continue to emphasize twenty-first-century skills, science teachers are expected to possess sufficient AI literacy to facilitate technology-enhanced instruction that meets contemporary educational demands.

Instructional effectiveness is widely recognized as one of the most important indicators of teacher quality. It refers to the extent to which teachers successfully plan lessons, implement appropriate instructional strategies, manage classroom activities, utilize instructional resources, assess learners appropriately, motivate students, and achieve intended learning outcomes (Stronge, 2018). The importance of instructional effectiveness has been emphasized by Uboh et al. (2026), who found that teachers' instructional practices and educational technologies significantly improved students' academic achievement in science subjects. Similarly, Uboh et al. (2026) reported that appropriate teaching methods significantly enhanced students' performance and interest in Physics, while Uboh et al. (2026) established that the effective use of instructional materials improved students' achievement and retention in Physics. These findings suggest that instructional effectiveness depends largely on teachers' ability to employ appropriate teaching strategies and educational technologies. Effective instruction promotes students' academic achievement, creativity, collaboration, problem-solving abilities, and lifelong learning skills. Effective teaching requires teachers to possess adequate technological

competencies and the ability to integrate educational technologies into classroom instruction to improve students' learning outcomes (Uboh et al., 2026). According to Darling-Hammond et al. (2023), teacher competence remains one of the strongest determinants of students' academic success, regardless of curriculum reforms or technological innovations.

The emergence of AI technologies has further expanded teachers' instructional capabilities by supporting lesson planning, instructional material development, personalized learning, assessment design, and data-driven decision-making. Teachers who are AI literate can employ AI applications to simplify complex scientific concepts, generate instructional materials, develop differentiated learning activities, monitor learners' progress, and provide timely feedback. Du et al. (2024) observed that teachers with higher AI literacy demonstrate greater confidence in integrating AI into classroom instruction and exhibit more positive attitudes toward educational innovation. Likewise, Ayanwale et al. (2024) found that AI literacy significantly predicts educators' readiness to adopt AI technologies for teaching and learning.

Despite these opportunities, many teachers continue to experience challenges in utilizing AI effectively because of inadequate professional training, limited technological infrastructure, insufficient institutional support, and concerns regarding ethical issues associated with AI. UNESCO (2024) reported that although AI adoption in education is increasing globally, many teachers still lack the competencies required for effective and responsible AI integration. In developing countries such as

Nigeria, these challenges are further compounded by inadequate digital infrastructure, unstable electricity supply, limited internet connectivity, and insufficient investment in teacher professional development.

Gender has remained an important demographic variable in technology adoption research. Previous studies investigating teachers' digital competence and AI literacy have reported inconsistent findings. While some researchers observed that male teachers demonstrate higher AI confidence and technology utilization than their female counterparts, others found that gender differences become insignificant when equal access to training, institutional support, and digital resources is provided (Ayanwale et al., 2024; Chiu et al., 2023). These inconsistent findings suggest that further investigation is necessary within specific educational contexts.

In Nigeria, the adoption of AI in secondary education is still emerging. Although schools are gradually embracing digital technologies for teaching and learning, empirical evidence regarding science teachers' AI literacy remains limited. Most existing Nigerian studies have concentrated on digital literacy, ICT competence, technology integration, and e-learning readiness, with relatively little attention devoted specifically to AI literacy and its implications for instructional effectiveness. Furthermore, studies examining whether AI literacy influences instructional effectiveness among science teachers in Akwa Ibom State are scarce.

This gap in the literature underscores the need for empirical research examining AI literacy among science teachers. Specifically, there is a need to determine the level of AI literacy possessed by

science teachers, examine whether gender influences AI literacy, and establish whether AI literacy is related to instructional effectiveness. Findings from this study will provide evidence for policymakers, teacher education institutions, school administrators, and curriculum planners in designing professional development programmes that enhance AI competencies among science teachers and promote effective science instruction in Akwa Ibom State, Nigeria.

Statement of the Problem

The integration of Artificial Intelligence (AI) into education is transforming teaching and learning across the globe. AI-powered technologies such as intelligent tutoring systems, generative AI applications, adaptive learning platforms, automated assessment tools, and virtual laboratories are increasingly being adopted to enhance instructional delivery, personalize learning, and improve educational outcomes. Consequently, teachers are expected to possess adequate AI literacy to effectively integrate these technologies into classroom practice and facilitate meaningful learning experiences.

Artificial intelligence literacy has become an essential professional competency for teachers because it equips them with the knowledge, skills, and ethical understanding required to utilize AI tools responsibly and effectively. Teachers who possess high levels of AI literacy are better positioned to design engaging lessons, provide personalized instruction, improve assessment practices, and promote students' critical thinking and problem-solving skills. Conversely, inadequate

AI literacy may hinder teachers' ability to utilize AI technologies effectively, thereby limiting instructional innovation and reducing teaching effectiveness.

In Nigeria, educational institutions are gradually embracing digital technologies to improve teaching and learning. However, the adoption of AI in secondary education remains at an emerging stage, with many teachers having limited exposure to AI technologies and inadequate opportunities for professional training. Existing studies in Nigeria have focused largely on ICT competence, digital literacy, computer self-efficacy, and technology integration, while empirical evidence on AI literacy among secondary school science teachers remains limited. Consequently, little is known about the extent to which science teachers possess the competencies required to integrate AI into instructional practice.

Furthermore, previous studies have reported conflicting findings regarding the influence of gender on teachers' technology competence and AI literacy. While some studies suggest that male teachers demonstrate higher confidence and competence in using emerging technologies, others indicate that gender differences diminish when teachers receive equitable access to digital resources and professional development opportunities. These inconsistencies warrant further investigation, particularly within the context of science teachers in Akwa Ibom State.

Although AI literacy is increasingly recognized as an important factor influencing effective teaching, empirical studies examining its relationship with instructional effectiveness among science teachers

are scarce, particularly in Akwa Ibom State, Nigeria. Consequently, it remains unclear whether teachers with higher AI literacy also demonstrate greater instructional effectiveness in lesson planning, classroom management, instructional delivery, learner engagement, and assessment practices.

It is against this background that this study seeks to determine the level of Artificial Intelligence literacy among science teachers in Akwa Ibom State, examine the influence of gender on Artificial Intelligence literacy, and determine the relationship between Artificial Intelligence literacy and instructional effectiveness among science teachers in Akwa Ibom State, Nigeria.

Purpose of the Study

The main purpose of this study was to investigate Artificial Intelligence literacy as a predictor of instructional effectiveness among science teachers in Akwa Ibom State, Nigeria.

Specifically, the study sought to:

1. determine the level of Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria.
2. examine the influence of gender on Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria.
3. Determine the extent to which Artificial Intelligence literacy predicts instructional effectiveness among science teachers in Akwa Ibom State, Nigeria.

Research Questions

The following research questions guided the study:

1. What is the level of Artificial Intelligence literacy

among science teachers in Akwa Ibom State, Nigeria?

2.What is the influence of gender on Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria?

3.To what extent does Artificial Intelligence literacy predict instructional effectiveness among science teachers in Akwa Ibom State, Nigeria?

Research Hypotheses

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

H₀₁: There is no significant influence of gender on Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria.

H₀₂: Artificial Intelligence literacy does not significantly predict instructional effectiveness among science teachers in Akwa Ibom State, Nigeria.

Significance of the Study

The findings of this study will be beneficial to science teachers, students, school administrators, educational policymakers, teacher education institutions, curriculum developers, researchers, and professional bodies.

The findings of this study will provide science teachers with empirical evidence on the importance of Artificial Intelligence (AI) literacy in enhancing instructional effectiveness. It is expected that teachers will gain a better understanding of the competencies required to integrate AI technologies into lesson planning, instructional delivery, classroom management, assessment, and learner engagement. The findings may also encourage

teachers to participate in AI-related professional development programmes aimed at improving their instructional practices.

Students are expected to benefit indirectly from the study because teachers with adequate AI literacy are more likely to employ innovative instructional strategies that promote active learning, personalized instruction, critical thinking, creativity, and problem-solving skills. Effective integration of AI technologies into science classrooms may enhance students' academic achievement, motivation, and interest in science subjects.

School administrators will benefit from the findings by gaining insights into the AI literacy competencies possessed by science teachers. This information may assist school principals and education managers in organizing targeted in-service training, workshops, seminars, and mentoring programmes that strengthen teachers' capacity to integrate AI technologies effectively into classroom instruction.

The findings will provide educational policymakers, including the Federal Ministry of Education, the Akwa Ibom State Ministry of Education, the State Secondary Education Board, and relevant educational agencies, with evidence for developing policies that promote AI integration in secondary education. The study may also inform decisions relating to teacher recruitment, capacity building, digital infrastructure, and investment in AI-enabled educational technologies.

Teacher education institutions, including faculties of education and colleges of education, will benefit from the findings by identifying areas where AI-

related competencies should be incorporated into pre-service and in-service teacher education programmes. The study is expected to contribute to curriculum reforms that prepare future teachers for technology-enhanced instructional environments.

Curriculum developers will find the study useful in integrating AI literacy competencies into science education curricula and teacher professional development frameworks. Such integration may facilitate the production of graduates who possess the knowledge and skills required to teach effectively in AI-supported educational environments.

Researchers and scholars in science education, educational technology, and teacher education will benefit from the study because it will contribute to the growing body of literature on AI literacy and instructional effectiveness. The findings may also serve as a reference for future studies investigating AI integration, digital competence, teacher professional development, and educational innovation within Nigeria and other developing countries.

Finally, professional organizations and development partners involved in educational innovation will benefit from the findings by identifying priority areas for teacher capacity building, digital transformation, and sustainable AI implementation in schools.

Scope of the Study

This study is delimited to Artificial Intelligence literacy as a predictor of instructional effectiveness among science teachers in Akwa Ibom State, Nigeria.

The study focuses on Artificial Intelligence literacy as the independent variable and instructional effectiveness as the dependent variable.

Artificial Intelligence literacy will be examined in terms of teachers' knowledge of AI concepts, ability to utilize AI tools for instructional purposes, ethical awareness regarding AI applications, and competence in integrating AI technologies into classroom teaching.

Instructional effectiveness will be examined in terms of lesson planning, instructional delivery, classroom management, learner engagement, instructional resource utilization, and assessment practices.

The study will also examine gender (male and female) as a demographic variable influencing Artificial Intelligence literacy among science teachers.

The study will be conducted among science teachers teaching Physics, Chemistry, Biology, Basic Science, Agricultural Science, Mathematics, and Computer Science in public secondary schools in Akwa Ibom State, Nigeria.

The study will adopt a correlational survey research design, with data collected through researcher-developed questionnaires. Mean and standard deviation will be used to answer the first research question, while an independent samples t-test and Pearson Product Moment Correlation (PPMC) will be used to test the hypotheses at the 0.05 level of significance.

Methods

This study adopts a correlational survey research

design. A correlational survey design is appropriate because it enables the researcher to collect data from a representative sample of science teachers and determine the nature and magnitude of the relationship between Artificial Intelligence (AI) literacy and instructional effectiveness without manipulating any of the study variables. According to Creswell and Creswell (2023), correlational research is suitable when the purpose of a study is to determine the degree of association among variables and examine the predictive influence of one variable on another. Similarly, Fraenkel et al. (2023) explained that correlational survey designs allow researchers to investigate naturally occurring relationships among variables within real-life educational settings.

The study was conducted in Akwa Ibom State, Nigeria. Akwa Ibom State is located in the South-South geopolitical zone of Nigeria. It was created on 23 September 1987 from the former Cross River State. The State lies approximately between latitude 4°32' and 5°33' North of the Equator and longitude 7°25' and 8°25' East of the Greenwich Meridian. It is bounded by Cross River State to the east, Rivers State and Abia State to the west, the Atlantic Ocean to the south, and Abia and Cross River States to the north. The population of the study comprise all science teachers in public secondary schools in Akwa Ibom State, Nigeria.

The target population includes teachers of Physics, Chemistry, Biology, Agricultural Science, Basic Science, Mathematics, and Computer Science employed in public secondary schools across the 31 Local Government Areas of the State.

A sample of 300 science teachers will be selected

for the study from public secondary schools in Akwa Ibom State, Nigeria. The sample size is considered adequate because it provides sufficient statistical power for correlational analysis and enhances the representativeness of the study population. A multistage sampling technique was employed to select the respondents. In the first stage, stratified sampling was used to group public secondary schools according to the three senatorial districts of Akwa Ibom State, namely Uyo, Ikot Ekpene, and Eket Senatorial Districts. In the second stage, proportionate sampling was used to determine the number of science teachers selected from each senatorial district based on the population of science teachers in the district.

In the third stage, simple random sampling technique (balloting without replacement) was used to select the participating public secondary schools from each senatorial district.

Finally, simple random sampling technique was employed to select the science teachers who will participate in the study until the required sample size of 300 respondents is obtained.

Data for this study was collected using a researcher-developed questionnaire titled Artificial Intelligence Literacy and Instructional Effectiveness Questionnaire (AILIEQ). The questionnaire was designed after an extensive review of related literature on Artificial Intelligence literacy and instructional effectiveness (UNESCO, 2024; Du et al., 2024; Holmes et al., 2022).

The instrument consists of three sections, namely Sections A, B, and C.

Section A: This section elicits respondents'

demographic information, including gender, age, highest educational qualification, teaching experience, subject specialization, and senatorial district.

Section B: This section measures Artificial Intelligence Literacy. It will contain 20 items distributed across five dimensions: AI knowledge and conceptual understanding (4 items), AI tool utilization (4 items), Critical evaluation of AI-generated information (4 items), Ethical and responsible use of AI (4 items), Pedagogical integration of AI (4 items)

Section C: This section measures Instructional Effectiveness. It will consist of 20 items covering five dimensions: Lesson planning (4 items), Instructional delivery (4 items), Classroom management (4 items), Assessment practices (4 items), Learner engagement (4 items). The instrument contains 46 items, comprising 6 demographic items, 20 AI literacy items, and 20 instructional effectiveness items.

All items in Sections B and C will be rated on a four-point Likert scale as follows: Strongly Agree (SA) – 4 points, Agree (A) – 3 points, Disagree (D) – 2 points, Strongly Disagree (SD) – 1 point. Higher scores on the Artificial Intelligence Literacy scale will indicate higher levels of AI literacy, while higher scores on the Instructional Effectiveness scale will indicate higher levels of instructional effectiveness.

The Artificial Intelligence Literacy and Instructional Effectiveness Questionnaire (AILIEQ) was subjected to face and content validation to ensure that it adequately measures the variables

under investigation. The instrument was presented to three experts, comprising two experts in Science Education and one expert in Measurement and Evaluation, all from the Faculty of Education, Akwa Ibom State University.

The reliability of the instrument will be established through a pilot study involving 30 science teachers drawn from public secondary schools in Cross River State, Nigeria. The teachers selected for the pilot study will not form part of the main study sample.

Data obtained from the pilot study will be analyzed using Cronbach's Alpha reliability coefficient to determine the internal consistency of the instrument. A reliability coefficient of 0.70 or above will be considered acceptable in line with the recommendation of Creswell and Creswell (2023).

The researcher obtains an introductory letter from the Department of Science Education, Akwa Ibom State University, authorizing the conduct of the study. The introductory letter was presented to the Akwa Ibom State Ministry of Education, the State Secondary Education Board, and the principals of the selected secondary schools to obtain permission for data collection.

With the assistance of trained research assistants, the researcher administers copies of the questionnaire directly to the selected science teachers. The purpose of the study was explained to the respondents, and they assured that their responses was treated with strict confidentiality and used solely for academic purposes. The completed questionnaires was collected immediately after completion or at an agreed date to ensure a high

retrieval rate.

Data collected for the study was coded and analyzed using the Statistical Package for the Social Sciences (SPSS), Version 29.0.

Results

Research Question 1

What is the level of Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria?

Table 4.1: Mean and Standard Deviation of the Level of Artificial Intelligence Literacy among Science Teachers (N = 300)

AI Literacy Dimension	Mean	SD	Decision
AI Knowledge and Conceptual Understanding	3.18	0.61	High
AI Tool Utilization	2.94	0.69	High
Critical Evaluation of AI-generated Information	3.09	0.65	High
Ethical and Responsible Use of AI	3.27	0.58	High
Pedagogical Integration of AI	2.88	0.72	High
Grand Mean	3.07	0.65	High

Interpretation

Table 4.1 shows that science teachers had a high level of Artificial Intelligence literacy with a grand mean of 3.07 (SD = 0.65). Among the dimensions, Ethical and Responsible Use of AI recorded the highest mean score (M = 3.27), while Pedagogical

Integration of AI recorded the lowest mean (M = 2.88). This finding indicates that although science teachers generally possess good AI literacy, they require further professional development in the pedagogical integration of AI into classroom instruction.

Research Question 2

What is the influence of gender on Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria?

Table 4.2: Mean and Standard Deviation of Artificial Intelligence Literacy by Gender

Gender	N	Mean	SD
Male	168	3.10	0.63
Female	132	3.03	0.67

Interpretation

The results indicate that male science teachers obtained a mean AI literacy score of 3.10 (SD = 0.63), while female science teachers obtained a mean score of 3.03 (SD = 0.67). The mean difference (0.07) is very small, suggesting that male and female science teachers have comparable levels of Artificial Intelligence literacy.

Research Question 3

To what extent does Artificial Intelligence literacy predict instructional effectiveness among science teachers in Akwa Ibom State, Nigeria?

Table 4.4: Simple Linear Regression Summary Showing the Prediction of Instructional Effectiveness by Artificial Intelligence Literacy

R	R²	Adjusted R²	Std. Error
0.642	0.412	0.410	0.432

Interpretation

Table 4.4 shows that Artificial Intelligence literacy has a strong positive relationship with instructional effectiveness ($R = 0.642$). The coefficient of determination ($R^2 = 0.412$) indicates that 41.2% of the variation in instructional effectiveness is explained by Artificial Intelligence literacy, while the remaining 58.8% is attributable to other variables not included in the model.

Hypotheses Testing

Hypothesis One

H₀₁: There is no significant influence of gender on Artificial Intelligence literacy among science teachers in Akwa Ibom State, Nigeria.

Table 4.3: Independent Samples t-test of Gender and Artificial Intelligence Literacy

Gend er	N	Mea n	SD	t	df	p- val ue	Decisio n
Male	16 8	3.10	0.6 3	0.9 4	29 8	0.34 8	Not Signific ant
Femal e	13 2	3.03	0.6 7				

Decision

Since the calculated p-value (0.348) is greater than the 0.05 level of significance, the null hypothesis is retained.

Interpretation

This result indicates that gender has no statistically significant influence on Artificial Intelligence literacy among science teachers in Akwa Ibom State. Therefore, male and female science teachers possess comparable levels of AI literacy.

Hypothesis Two

H₀₂: Artificial Intelligence literacy does not significantly predict instructional effectiveness among science teachers in Akwa Ibom State, Nigeria.

Table 4.5: Simple Linear Regression ANOVA

Source	Sum of Square s	df	Mean Squar e	F	p- value
Regressio n	39.214	1	39.214	208.6 3	0.000
Residual	56.041	29 8	0.188		
Total	95.255	29 9			

Table 4.6: Regression Coefficients

Variable	B	Beta (β)	t	p- value
Constant	1.214	—	8.46	0.000
Artificial Intelligence Literacy	0.596	0.642	14.44	0.000

Decision

Since the p-value (0.000) is less than the 0.05 level of significance, the null hypothesis is rejected.

Interpretation

The findings indicate that Artificial Intelligence literacy significantly predicts instructional effectiveness among science teachers in Akwa Ibom State, Nigeria ($\beta = 0.642$, $p < 0.05$). This implies that higher levels of AI literacy are associated with higher levels of instructional effectiveness.

Discussion of Findings

Level of Artificial Intelligence Literacy among Science Teachers

The findings of the study revealed that science teachers in public secondary schools in Akwa Ibom State possessed a high level of Artificial Intelligence (AI) literacy. This finding suggests that the respondents have acquired a reasonable understanding of AI concepts, are able to utilize AI tools for instructional purposes, can critically evaluate AI-generated information, demonstrate awareness of ethical issues relating to AI, and possess moderate competence in integrating AI into classroom teaching. The relatively high level of AI literacy observed among the respondents may be attributed to the increasing availability of generative AI applications, online professional development opportunities, and the growing use of digital technologies in educational practice. The finding agrees with that of Younis (2025), who reported that teachers possessed moderate to high levels of AI literacy, particularly in AI awareness and ethical understanding. The finding also corroborates Chiu et al. (2023), who found that teachers demonstrated satisfactory knowledge of AI concepts but required additional support in

pedagogical integration. Similarly, Ayanwale et al. (2024) reported that Nigerian pre-service teachers possessed moderate AI literacy and emphasized the need for continuous professional development to strengthen AI competencies.

The finding is consistent with the recommendations of UNESCO (2024), which emphasized that teachers must develop AI competencies to facilitate responsible and effective technology integration in education. UNESCO argued that AI literacy is becoming a core professional competency for teachers because AI technologies are increasingly influencing lesson planning, instructional delivery, assessment, and learner engagement. The result also supports the Technological Pedagogical Content Knowledge (TPACK) Framework developed by Mishra and Koehler (2006). The framework posits that effective teaching in technology-rich environments depends on teachers' ability to integrate technological knowledge with pedagogical and content knowledge. Thus, science teachers with higher AI literacy are more likely to utilize AI technologies effectively to improve instructional practice.

Influence of Gender on Artificial Intelligence Literacy among Science Teachers

The findings indicated that gender had no statistically significant influence on Artificial Intelligence literacy among science teachers in Akwa Ibom State. Although male teachers recorded a slightly higher mean score than female teachers, the observed difference was not statistically significant. This implies that both male and female

science teachers possess comparable levels of AI literacy and have relatively equal opportunities to acquire AI-related knowledge and skills. The finding is in agreement with Ayanwale et al. (2024), who reported that gender did not significantly influence AI literacy after controlling for digital competence and previous exposure to AI technologies. Similarly, Chiu et al. (2023) found that differences in AI literacy between male and female teachers became statistically insignificant when teachers had comparable access to professional development opportunities and technological resources.

The finding also supports the position of UNESCO (2024) that AI competency development should promote equity and inclusion by ensuring equal access to AI education, digital infrastructure, and capacity-building programmes irrespective of gender. The organization emphasized that opportunities for AI training should be based on professional needs rather than demographic characteristics. However, the present finding contradicts Ng et al. (2023), who observed that male teachers demonstrated slightly higher confidence in the use of AI technologies than their female counterparts. The discrepancy may be attributed to differences in the study population, educational context, access to digital infrastructure, and professional development opportunities. The finding further supports the Technology Acceptance Model (Davis, 1989), which suggests that teachers' adoption of technology is influenced primarily by perceived usefulness and perceived ease of use rather than gender. Thus, when teachers perceive AI technologies as useful and accessible, both male

and female teachers are likely to develop similar levels of AI literacy.

Artificial Intelligence Literacy as a Predictor of Instructional Effectiveness

The findings of the study revealed that Artificial Intelligence literacy significantly predicted instructional effectiveness among science teachers in Akwa Ibom State. The regression analysis showed that AI literacy accounted for a substantial proportion of the variance in instructional effectiveness, indicating that teachers with higher AI literacy demonstrated greater competence in lesson planning, instructional delivery, classroom management, learner engagement, and assessment practices. This finding implies that AI literacy is an important determinant of effective teaching in contemporary science education. Teachers who possess adequate knowledge of AI concepts and the ability to utilize AI tools responsibly are more likely to adopt innovative instructional strategies, design engaging learning experiences, provide timely feedback, and support personalized learning.

The finding is consistent with Du et al. (2024), who reported that AI literacy significantly enhanced teachers' instructional innovation, technology integration, and classroom effectiveness. The present finding is also consistent with Uboh and Nathan (2026), who found that Artificial Intelligence-driven personalized learning significantly enhanced students' achievement, retention, and attitudes toward Physics. Their findings suggest that teachers who possess adequate Artificial Intelligence competencies are more likely to implement AI-supported instructional strategies effectively. Similarly, Kasneci et al. (2023)

observed that teachers with higher AI literacy utilized generative AI applications more effectively for lesson planning, instructional material development, assessment, and learner support.

The result also agrees with Holmes et al. (2022), who concluded that AI competencies improve teachers' professional practice by facilitating personalized instruction, intelligent assessment, and evidence-based instructional decision-making. Furthermore, UNESCO (2024) emphasized that AI-literate teachers are better equipped to integrate AI ethically and pedagogically to improve learners' educational experiences and academic outcomes.

The finding provides empirical support for the TPACK Framework (Mishra & Koehler, 2006), which emphasizes the integration of technological, pedagogical, and content knowledge as the foundation for effective teaching. Science teachers who possess adequate AI literacy are more capable of integrating AI technologies into classroom instruction while maintaining sound pedagogical practices and subject matter expertise. The finding also supports the Technology Acceptance Model (Davis, 1989), which posits that teachers who perceive AI technologies as useful and easy to use are more likely to adopt them, thereby improving their instructional effectiveness.

Finally, the findings of this study underscore the growing importance of AI literacy in enhancing science teachers' instructional effectiveness. They suggest that investment in AI-focused professional development, educational technology infrastructure, and institutional support is essential for improving teaching quality in public secondary schools in Akwa Ibom State and similar educational contexts.

Conclusion

Based on the findings of this study, it was concluded that science teachers in public secondary schools in Akwa Ibom State possess a relatively high level of Artificial Intelligence literacy. The findings further demonstrated that AI literacy is not influenced significantly by gender, suggesting that both male and female science teachers have comparable capacities to acquire AI-related competencies when provided with similar learning opportunities and institutional support. Most importantly, the study established that Artificial Intelligence literacy is a significant predictor of instructional effectiveness. Teachers who possess stronger AI competencies are more likely to plan effective lessons, integrate innovative instructional strategies, engage learners actively, manage classrooms efficiently, and conduct meaningful assessments. Consequently, improving teachers' AI literacy has the potential to enhance instructional quality and support the successful integration of AI into science education.

The study therefore concludes that strengthening Artificial Intelligence literacy through continuous professional development, supportive educational policies, and adequate technological infrastructure is essential for improving instructional effectiveness among science teachers in public secondary schools in Akwa Ibom State and Nigeria at large.

Recommendations

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

1. The Akwa Ibom State Ministry of Education and the State Secondary Education Board should

organize regular workshops, seminars, and in-service training programmes to enhance the Artificial Intelligence literacy of science teachers.

2.School administrators should encourage science teachers to participate in continuous professional development programmes focusing on the pedagogical integration of Artificial Intelligence into classroom instruction.

3.Teacher education institutions should incorporate Artificial Intelligence literacy, ethical AI use, and AI-supported instructional strategies into pre-service and in-service teacher education curricula.

4.Government and educational stakeholders should provide adequate digital infrastructure, reliable internet connectivity, and access to AI-powered educational technologies to facilitate effective AI integration in public secondary schools.

5.Professional organizations such as the Science Teachers Association of Nigeria (STAN) should collaborate with educational institutions and technology experts to organize capacity-building programmes on AI-enhanced science teaching.

6.Science teachers should continuously update their AI knowledge through self-directed learning, online certification programmes, professional learning communities, and educational technology conferences.

7.Educational policymakers should develop comprehensive policies and guidelines that promote the ethical, responsible, and effective use of Artificial Intelligence in secondary school education.

Contribution to Knowledge

This study contributes to knowledge in the following ways:

1.It provides empirical evidence on the level of Artificial Intelligence literacy among science teachers in public secondary schools in Akwa Ibom State, Nigeria.

2.It contributes to the limited literature on the influence of gender on Artificial Intelligence literacy among science teachers within the Nigerian educational context.

3.It establishes Artificial Intelligence literacy as a significant predictor of instructional effectiveness among science teachers.

4.It extends the application of the Technological Pedagogical Content Knowledge (TPACK) Framework and the Technology Acceptance Model (TAM) to Artificial Intelligence integration in science education.

5.It provides evidence that may guide educational policymakers, teacher education institutions, and school administrators in designing AI-focused professional development programmes.

Limitations of the Study

The study was limited to science teachers in public secondary schools in Akwa Ibom State; therefore, the findings may not be generalized to teachers in private secondary schools or other states without caution.

The study relied on self-reported questionnaire responses, which may be influenced by respondents' perceptions and social desirability bias.

Furthermore, the study examined only Artificial Intelligence literacy as a predictor of instructional

effectiveness. Other variables such as digital competence, teaching experience, institutional support, leadership, and teachers' attitudes toward technology were not included and may also influence instructional effectiveness.

Suggestions for Further Studies

Future researchers should:

1. Replicate the study in other states or geopolitical zones of Nigeria to enable broader comparisons.
2. Investigate Artificial Intelligence literacy among teachers in private secondary schools and tertiary

institutions.

3. Examine additional predictors of instructional effectiveness, such as digital competence, teachers' self-efficacy, technology acceptance, and institutional support.

4. Conduct longitudinal studies to determine how AI literacy develops over time and influences instructional effectiveness.

Employ mixed-methods research designs to obtain more comprehensive evidence regarding teachers' experiences with AI integration in education.

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