

**ARTIFICIAL INTELLIGENCE AWARENESS, DIGITAL
COMPETENCE AND TECHNOLOGICAL PEDAGOGICAL
CONTENT KNOWLEDGE OF PRE-SERVICE SCIENCE
TEACHERS IN FEDERAL UNIVERSITIES IN
SOUTHWESTERN NIGERIA**

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Abstract

Artificial Intelligence (AI) as well as digital competence have been revealed to be one of the forces driving the education sector around the world. The study determined the influence of AI awareness and digital competence on the technological pedagogical content knowledge of final year pre-service science teachers in the Southwestern, Nigeria. The study adopted descriptive survey research design. Population for the study comprised all final year pre-service science teachers in federal universities in southwestern, Nigeria. Sample size consisted of 150 respondents which were selected from three federal universities in the region. A structured questionnaire was used as the instrument for data collection for the study. The instrument was validated by experts, trial tested and the reliability was tested using Cronbach Alpha. The instrument had three sections of Technological Pedagogical Content Knowledge questionnaire; awareness of AI specifically for education purpose and Digital competence scale with reliability index of 0.72, 0.81 and 0.76 respectively. The findings of the study showed that there was a moderate level of awareness of AI among the respondents ($\bar{x}$ = 3.53).

The level of Digital competence of the teachers was high ($\bar{x}$ = 3.94). The study further revealed that there is a significant influence of AI awareness and digital competence on the Technological Pedagogical Content Knowledge of preservice final year science teachers in federal universities in southwestern Nigeria (F = 14.281, p < 0.05). The study concluded that pre-service science teachers need AI awareness and digital competence to build their Technological Pedagogical Content Knowledge.

Keywords: Artificial Intelligence, Education, TPCK, Digital Competence, Pre-Service Teachers

Introduction

With the rapid progress of digital technologies, the education sector is also witnessing a significant transformation in all aspects of society. Artificial Intelligence (AI) is one of the most significant technological breakthroughs of recent times, changing how teaching, learning, assessment, and educational management are performed. AI is a way of computer systems or machines learning, reasoning, problem-solving, processing language, making decisions and recognising patterns, which are normally the capabilities of human intelligence (Jackson, 2019; Nwosu et al., 2024). New opportunities have arisen with the growing availability of AI-powered educational tools, including ChatGPT, Gemini, DeepSeek, Kahoot, Quizizz, Curipod, Eduaide, and Magic School, and several other AI tools some of which have been made to solve specific educational problems (ElSayary et al., 2025; Younas et al., 2025). These AI tools are expected to aid in improving instructional delivery, enhancing learner engagement, personalizing learning experiences, and supporting teachers to undertake their professional duties more effectively.

AI has emerged as a transformative force in global education systems, particularly in the delivery of science instruction (Okunade, 2024). Contemporary research demonstrates that AI-driven tools such as intelligent tutoring systems (e.g., DreamBox), adaptive

learning platforms (e.g., Khan Academy), and automated assessment technologies can enhance learning outcomes (Liu et al., 2026; Patel & Thompson, 2023; Roschelle, 2017). According to Mohammed et al. (2025), the growth and spread of digital technologies have transformed how modern society works. One major part of this change is AI, which is becoming very important because of its ability to improve teaching and learning methods. Presently, AI is no longer just an idea; it is already being used in schools and classrooms (Okunade, 2024). AI technologies are applied through different tools that help improve teaching. For example, intelligent tutoring systems can give students personalized support by adjusting to their learning needs. Automated assessment tools such as Quizizz also make grading easier by providing quick feedback and reducing teachers' workload. In addition, learning analytics help teachers understand students' learning patterns, while adaptive learning systems adjust lesson content to suit each learner. All these AI tools help to make education more effective, inclusive, and suitable for today's digital world (Adigun & Ojomo, 2025). Nwafor et al. (2023) however, noted that a 21st century teacher needs digital technology AI's role in education is part of the greater digital transformation of education. Digital technologies are widely used to support the process of teaching, learning, communication, collaboration, assessment and content production in educational institutions (Okunade, 2024). Teachers are therefore expected to have good knowledge of the subject area, to have pedagogical skills, and to learn technological skills that enable them to work well in a technology-laden learning environment. The ability of teachers to understand, embrace, and apply new technologies to enhance learning is a major factor in the successful implementation of technology in the school (Ajani, 2024).

Digital competence is one of the competencies needed for the effective use of technology. According to Kiryakova and Kozhvarova (2024), digital competence relates to the knowledge, skills, attitudes and confidence needed to use digital technologies safely, critically, creatively and effectively to learn, to teach, to communicate and to develop professionally. Digital competence according to

Ogunbodede et al., (2023) is defined as the set of skills, understanding and outlooks required to effectively use digital tools and resources for communication, problem-solving and information management. Digital competent teachers are more likely to use digital tools effectively, embrace technological innovations and engage students in meaningful learning (Aliyu & Muhammad, 2025). Digital competence has become a basic competency for teachers in the 21st century, especially in science education, where science teaching and learning increasingly rely on technological tools for simulations, virtual laboratories, data processing/comparison, content generation and collaborative learning. Science education in the context of this study refers to the learning of science education courses in universities. That is, the studying of courses like Physics, Chemistry and Biology education courses, preparing teachers to teach these subjects in secondary schools.

Technological Pedagogical Content Knowledge (TPCK) is closely related to digital competence, and it was developed based on the model of Technological Pedagogical Content Knowledge (TPC-K) proposed by Mishra and Koehler (2006). TPCK is the teacher's ability to use technology, pedagogy and content knowledge in an integrated way for facilitating learning (Olori & Saka, 2024). The framework acknowledges that technological expertise is not enough for effective technology integration; teachers need to be aware of how technology can be used in conjunction with the right pedagogical practices and content knowledge, to enhance student learning outcomes. Teachers with good TPCK are better equipped to make decisions about technology use, to create learning experiences that make sense in technology-enhanced classrooms, and to meet the learning needs of students in the varying contexts of technology-enhanced classrooms (Priyanda et al. 2025).

As AI technologies become more prevalent in the field of education, teachers' competencies continue to increase (Okunade, 2024). In addition to general digital skills, teachers are now expected to have a

grasp of the capabilities and limitations of AI tools, as well as how and when they can be used in the classroom. The awareness of AI has, therefore, emerged as a crucial part of the digital age teacher preparation. AI awareness is defined as the awareness, understanding, familiarity and recognition of AI technology and its applications in the education context (Olugbuyi et al., 2026). Teachers who know about AI technologies are more likely to brainstorm new ways to use them in instruction, consider whether they can be used in the classroom, and effectively leverage AI tools in instruction (Kim, 2024).

Addressing the challenge of effectively incorporating AI-powered technologies into educational settings, research has focused on examining how well prospective educators are equipped to do so (Eke, 2024; Okunade, 2024). Given the significance of AI in education, there has been an interest in understanding the readiness of future teachers for the effective use of these AI-powered tools (Eke, 2024). Many students and educators know about AI tools like ChatGPT, Gemini, DeepSeek, and other general-purpose tools (Younas et al., 2025), but not as many know about specialized education AI tools. This creates a significant challenge as the effectiveness of the use of AI in education relies heavily on teachers' knowledge, engagement and ability to utilize such technologies. If pre-service teachers lack the awareness and understanding, they might not be able to make the most of the possibilities that AI brings to improve teaching and learning. In recent years, the drive for digital transformation in education has picked up momentum in Nigeria (Agidani, 2021). In recent years, the introduction of Information and Communication Technologies (ICTs) in the academic programmes of the universities and teacher education institutions has been growing in number, and the intention is to equip students for the new educational context. While pre-service teachers have a certain level of basic digital skills (Onanuga & Saka, 2025; Akpan, 2024), there are several questions concerning their knowledge of educational AI tools, their digital competence and preparedness to use new technologies in teaching profession. These concerns are especially

relevant to science education, as technology is an important enabler for inquiry-based learning, experimentation, visualization of abstract concepts and scientific problem-solving. A few empirical studies have focused on various facets of the awareness of AI, digital competence, and technology integration among teachers and students (Madu & Musa, 2024; Anaso & Anaso, 2025; Egere et al., 2025; Onanuga & Saka, 2025; Akpan, 2024) with more emphasis placed on students at secondary school level and also teachers at this level with little targeting awareness of pre-service teachers to the efficacy of AI technology to the teaching profession. Also, there are dearth of literatures to address the AI awareness for educational purpose and their digital competence as predictors the TPCK of pre-service science teachers in universities in Nigeria. Addressing these gaps is particularly important due to the perceived increase in the integration of AI technologies. Teacher education programmes must be equipped with empirical evidence that can guide curriculum development, professional training initiatives, and policy decisions aimed at preparing future educators for technology-rich teaching environments. Without such evidence, efforts to integrate AI into education may fail to achieve their intended outcomes.

It is against this background that this study investigated AI awareness, digital competence, and TPCK among pre-service final-year science teachers in federal universities in Southwestern Nigeria. Specifically, the study sought to assess the level of AI awareness for educational purposes among pre-service science teachers, determine their level of digital competence, and examine the influence of AI awareness and digital competence on their TPCK. By addressing these objectives, the study contributes to the growing body of knowledge on teacher preparedness for AI-enabled education and provides valuable insights for teacher educators, curriculum planners, policymakers, and educational stakeholders seeking to enhance the quality of science teacher education in Nigeria.

Purpose of the Study

The general aim of the study was to determine the influence of AI

awareness and digital competence on the TPCK of final year pre-service science teachers in federal universities in Southwestern, Nigeria. Specifically, the study:

- a. accessed the level of AI awareness for education among pre-service final year science teachers in federal universities in southwestern Nigeria;
- b. investigated the level of digital competence of preservice final year science teachers in the study area; and
- c. determined the influence of AI awareness and digital competence on the TPCK of pre-service science teachers in the study area.

Methodology

The study adopted the descriptive survey research design. The population for the study was all pre-service science teachers in federal universities in Southwestern, Nigeria. Specifically, final year students of science (Physics, Chemistry and Biology for 2024/2025 academic session) education students were the targeted population for the study. This is because these are students that have passed through different pedagogical training and processes and should be ready to move to the in-service status.

The sample for this study comprised 150 pre-service science teachers which were selected using multi-stage sampling procedure. There are only six federal universities in Southwestern, Nigeria offering education courses from which only five of them offer science education courses (2024/2025). From the five universities, three universities were selected using simple random sampling technique. From the three selected institutions, 50 final year students studying science education courses (Physics, Chemistry and Biology) were selected using the convenience sampling technique making a total of 150 respondents selected as the sample for this study. This is because of the low number of science education students in federal universities in Nigeria. However, only 126 copies of questionnaire were retrieved making 84% retrieval rate.

A well-structured questionnaire was used as the instrument of data collection for the study. The questionnaire had four Sections. Section A collected data on the demographic characteristics of the respondents. The demographic characteristics that were assessed included sex, age and name of school. Section B contained questionnaire items on TPCK. The items of the section were adapted from Schimdt et al. (2009). It contained 15 questionnaire items that were designed on a four point-Likert scale of Strongly Agree, Agree, Disagree and Strongly Disagree. Section C contained questionnaire on the awareness of AI tools which are used for education purpose. In this section, eight AI tools were listed, and the respondents were asked to pick the extent to which they are aware of the AI tools which were developed for education purpose. The section was on five-point Likert-Scale of 5 = To a very large extent 4 = To a large extent 3 = Moderately 2 = Not sure I can use it 1 = Not at all. Section D was designed to collect data on digital competence of the respondents. This section contained questionnaire items that collected data on the extent to which teachers can make use of digital technology for teaching and learning process. Respondents were required to indicate the extent to which they could make used of these digital technologies for teaching and learning process. The questionnaire items were on five-point Likert-scale of 5 = To a very large extent 4 = To a large extent 3 = Moderately 2 = Not sure I can use it 1 = Not at all.

The items of the questionnaire were validated by experts in curriculum studies/science education and also experts in test and measurement. The instrument was pilot tested and reliability was carried out using Cronbach Alpha. The section B had a reliability index of 0.72, Section C had a reliability index of 0.81 while section D had a reliability index of 0.76. This indicates that the research instrument was reliable to collect data for the study.

Data were collected from the respondents through both face-to-face and online. The use of both modes was intended to maximize participation, improve coverage, and accommodate students with varying levels of access to internet-enabled devices. After the

purpose of the study was explained and informed consent was obtained, printed copies of the questionnaire were distributed to students who agreed to participate. Respondents completed the questionnaires immediately. For the online survey, the questionnaire was created using an online survey platform (Google Form). The survey link was shared through students' WhatsApp groups commonly used by the students. Participants were encouraged to complete the questionnaire voluntarily and to share the survey link with their peers within the target population. To minimize duplicate responses, respondents were instructed to complete the questionnaire only once, regardless of the mode of administration. Responses from both the online and physical questionnaires were screened, coded, merged into a single dataset, and checked for completeness and consistency before data analysis. Participation was entirely voluntary, and respondents were assured of the confidentiality and anonymity of the information they provided.

Data collected were analysed using appropriate statistics. Specifically, frequency, percentage, mean, standard deviation, regression analysis and were used to analyse the data collected using Statistical Package for Social Science (SPSS) version 27.

Results

Research Question One: What is the level of AI awareness for education among pre-service final year science teachers in federal universities in southwestern Nigeria?

To answer this research question, responses of the respondents to the section B of the research instrument was ranked based on the mean and standard deviation of each items of the section. The result is presented in Table 1.

Table 1: Pre-service Teacher awareness of education AI

AI	To a very large extent	To a large extent	Moderately	Not sure I can use it	Not at all	Std. Deviation	Mean
ChatGPT	92 73.0%	26 20.6%	4 3.2%	4 3.2%	0 0.0%	0.709	4.65
DeepSeek	66 52.4%	35 27.8%	13 10.3%	0 0.0%	12 9.5%	1.241	4.16
Kahoot	38 30.2%	24 19.0%	29 23.0%	14 11.1%	21 16.7%	1.455	3.42
Quizizz	23 18.3%	24 19.0%	29 23.0%	20 15.9%	30 23.8%	1.438	3.00
Magic School	16 12.7%	32 25.4%	31 24.6%	17 13.5%	30 23.8%	1.365	2.94
Eduaide	12 9.5%	31 24.6%	39 31.0%	17 13.5%	27 21.4%	1.263	2.94
Curipod	8 6.3%	26 20.6%	48 38.1%	15 11.9%	29 23.0%	1.223	2.81
Gemini	82 65.1%	18 14.3%	13 10.3%	9 7.1%	4 3.2%	1.112	4.35
Grand Mean							3.53

Decision Rule- 1.00-2.33 = Low, 2.34-3.67 = Moderate, 3.68-5.00 = High

The awareness of pre-service science teachers in federal universities in southwestern, Nigeria is presented in Table 1. The table shows that ChatGPT is the AI that the pre-service teachers are aware about the most (mean = 4.65). This is followed by Gemini (mean = 4.35). DeepSeek was third (mean = 4.16). Furthermore, Kahoot was ranked as fourth most popular AI among the respondents (mean = 3.42). Quizizz came fifth (mean = 3.00). Both Magic school and Eduaide had the same mean (mean = 2.94). Curipod was the AI technology with the least awareness among the respondents. The grand mean of 3.53 shows that the level of awareness of AI was moderate.

Research Question Two: What is the level of digital competence of preservice science teachers?

The research question was answered with the section C of the questionnaire. The responses of the respondents to this section were ranked using mean and standard deviation. The result is presented in Table 2

Table 2: Digital Competence of Respondents

	To a very large extent	To a large extent	Moderately	Not sure I can use it	Not at all	Mean	Std. Deviation
Tube	92 73.0%	20 15.9%	9 7.1%	2 1.6%	3 2.4%	0.881	4.56
Social media outlets	50 39.7%	35 27.8%	32 25.4%	9 7.1%		0.972	4.00
Blended Learning	28 22.2%	40 31.7%	32 25.4%	14 11.1%	12 9.5%	1.224	3.46
PowerPoint	48 38.1%	37 29.4%	23 18.3%	14 11.1%	4 3.2%	1.136	3.88
Online Note	41 32.5%	33 26.2%	39 31.0%	9 7.1%	4 3.2%	1.080	3.78
Education contents Creation	57 45.2%	28 22.2%	20 15.9%	21 16.7%		1.134	3.96
Grand Mean							3.94

Decision Rule- 1.00-2.33 = Low, 2.34-3.67 = Moderate, 3.68-5.00 = High

Table 4 presents the responses of the respondents to the list of digital tools. They were asked to respond to the extent to which they can make use of the digital outlets for teaching and learning process. The table shows that the digital tool that they make use of mostly is YouTube (mean = 4.56). this is followed by social media outlets (such as Facebook, Instagram etc.) (mean = 4.00). educational content creation was ranked as the 3rd (Mean = 3.96). use of PowerPoint for teaching was ranked 4th (mean = 3.88). this is followed closely with the use of online notes (mean = 3.78) use of blended learning was ranked the least according to the response of the students (mean = 3.46). The grand mean of 3.94 shows that there is a high level of digital competence among final year pre-service

science teachers in federal universities in Southwestern, Nigeria was high

Hypothesis Ho:

There is no significant influence of AI awareness and digital competence on the technological pedagogical content knowledge of preservice science teachers in universities in southwestern, Nigeria.

Multiple linear regression was used to address the hypothesis. The AI awareness and digital competence of the respondents were used as the independent variables while the pedagogical content knowledge was the dependent variable. The result of the analysis is presented in Table 3.

Table 3: Multiple Regression analysis of influence of AI awareness and digital competence on TPCK

Model		Unstandardized Coefficients		Standardized Coefficients	
		B	Std. Error	Beta	t
R = 0.434	(Constant)	7.514	1.464		5.133
R ² = 0.188	AI Awareness	.080	.039	.186	2.060
Adj R ² = 0.175	Digital Competence	.232	.066	.318	3.520
F = 14.281					
p = 0.000					

a. Dependent Variable: Technological Pedagogical Content Knowledge

Table 5 presents the result of the regression analysis. The table shows F = 14.281 and p < 0.05. this shows that there is a significant influence of the independent variables on the dependent variables. We therefore reject the null hypothesis that was earlier stated. That is the analysis shows that there is a significant influence of AI awareness and digital competence on the technological pedagogical content knowledge of preservice teachers in universities in southwestern, Nigeria. Furthermore, statistical values of t = 2.060, p = 0.041 and t = 3.520, p = 0.01 shows tat both AI awareness and Digital competence significantly influence the TPCK of the respondents. Furthermore, R = 0.434 shows that both AI awareness and digital competence account for 43.4% variance in the TPCK of the respondents. In

addition, R^2 and Adjusted R^2 of 0.188 and 0.175 respectively suggest that the independent variables have 17.5% to 18.8% influence on the dependent variable.

Discussion of Findings

The first objective of the study showed that there is a moderate level of AI awareness among respondents. The study accessed the awareness of the respondents on various AI which are used for teaching and learning processes. The study revealed that the respondents are only aware of the general Artificial Intelligence. ChatGPT, DeepSeek and Gemini were the most popular AI among the respondents whereas AI such as Kahoot, Quiziz, Magic School, Eduaide, and Curipod which are meant specifically for education purposes were still oblivion to the respondents. This imply that majority of the respondents do not have adequate information about Artificial Intelligence for teaching and learning purposes. Also, this suggest that the respondents are only aware of AI which are meant for general purposes and are not aware of AI which are meant specifically for education purposes. A similar result was discovered by Agbo et al. (2022) when they found moderate level of awareness of pre-service teachers in Ebonyi state. An opposing finding by Alkanaa (2022) revealed that pre-service science teachers have low level of AI awareness. This finding agrees with the findings of Guneyli et al., (2024) who revealed that the level of awareness of teachers for education purpose is just above the average level. Which indicates an average level of awareness about AI for teaching and learning. The findings of Madu et al., (2024) further strengthens the finding when they revealed a moderate level of awareness of lecturers on use of AI. The findings of Ekwevugbe (2025) showed that there is a high level of awareness about AI tools among pre-service teachers while they noted that the level of usage was only moderate. The study by Adeniran et al., (2024) revealed a growing level of awareness about integration of AI into the teaching learning process among university lecturers and students.

The study further revealed that the level of digital competence of the respondents was high. From the study, many of the respondents that

they can use YouTube contents, social media outlets, blended learning, PowerPoint, online notes, education contents creation and many other digital tools. The implication of this is that many of the respondents have the necessary skill and awareness to make use of digital tools and platforms for teaching and learning process, however, the question remains their commitment towards applying digital tools to teaching and learning process where necessary. A similar report was recorded by Galindo-Dominguez and Bezanilla when they found a medium level of digital competence among future teachers with content creation being the area of lowest weakness. This finding is opposing to a study by Tomczyk (2024) whose finding showed that preservice teachers are lacking in some areas of digital competence which included creating, retrieving and managing digital content; integrating ICT into subject content and so on. The study by Dias-Trindade and Moreira (2020) found a similar finding in quantitative research. They found that the level of digital competence of teachers was moderate. Misbah et al., (2022) however found that teachers are not competent enough to make use of digital technological tools especially when it comes to use of online platforms.

The findings of the study showed that there is a significant influence of AI awareness and digital competence on the Technological Pedagogical content knowledge of the preservice Science Teachers. The findings showed that the higher the AI awareness and digital competence of the respondents, the higher the TPCK of the respondents. The findings of Madu et al. (2024) showed that there is a significant positive relationship between awareness of AI, digital competence and other related variables among lecturers. This finding agrees with the findings of Yue (2025) whose findings revealed that there is a serious and significant relationship between technological pedagogical content knowledge and the awareness and attitude of teachers towards the use of AI among teachers. However, the finding of Anaso and Anaso (2025) revealed that there is no significant relationship between pedagogical competence related to AI usage among Chemistry teachers. Also, the findings of Egere et al. (2025)

shows that AI integration and digital competence contribute significantly to the technological pedagogical content knowledge of both preservice and in-service teachers.

Conclusion

The study examined the level of AI awareness, digital competence and technological pedagogical content knowledge of pre-service final year science teachers in federal universities in southwestern region of Nigeria. From the findings of the study, it can be concluded that level of awareness of pre-service science teachers about education AI is insufficient as they are only aware about general AI technological tools while the level of awareness about education AI tools. The study concluded that the final year pre-service science teacher has inadequate level of AI awareness and digital competence as awareness of educational AI tools specifically designed to support teaching and learning, including Kahoot, Quizizz, Magic School, Eduaide, and Curipod, remains relatively low. This suggests that although respondents are familiar with the concept of AI, their knowledge of specialized AI tools for educational purposes is limited. The study Further concludes that AI awareness and digital competence contribute significantly to the technological pedagogical content knowledge of preservice science teachers in federal universities. The findings indicate that increased awareness of AI technologies and higher levels of digital competence contributes positively to the development of TPCK. Therefore, enhancing AI awareness and strengthening digital competence among pre-service teachers can improve their ability to integrate technology effectively into teaching and learning processes.

Recommendations

- The study recommends that teacher education institutions should incorporate AI education into their training programmes.
- Courses, conferences, workshops and seminars should be organised to expose pre-service teachers to different AI tools which are particularly designed for education purposes.

- Continuous digital skills development programmes should be encouraged among pre-service teachers and also in-service teachers. This is to ensure that teachers are up to date with evolving digital technologies and teaching innovations.
- Teacher education programmes should emphasise practical integration of AI and digital tools and technology into classroom instructions which in turn should improve the technological pedagogical skills of teachers in training.
- Researchers should therefore carry out studies on barriers and challenges associated with the adoption of AI tools and technologies in teaching and learning among both in-service and pre-service teachers.

References

- Adeniran, T. A. Daranijo, S. B. & Lawal, Z. O. (2024). Assessment of student-teachers' awareness and utilization of artificial intelligence (ai) at Ekiti State University. *International Journal of Innovative Technology Integration in Education*, 7(2), 54-63.
- Adigun, O. T., & Ojomo, O. T. (2025). Application of Artificial Intelligence for Inclusive Education. In *Enablers, Barriers, and Challenges for Inclusive Curriculum* (pp. 147-166). IGI Global Scientific Publishing.
- Agbo, J. N., Nmadu, J., Nduibisi, M. C., Yero, S., Gwoza, M. L., & Egah, G. O. (2022). Awareness, willingness and readiness of pre-service teachers to deploy artificial intelligence in education in Ebonyi State. *African Journal of Science, Technology and Mathematics Education*, 8(1), 25-31.
- Agidani, J. (2021). The need for digital transformation in the education sector in Nigeria. *Current Journal of Applied Science and Technology*. 40(47): 41-47
- Ajani, O. A. (2024). The role of educational technology in enhancing professional development and teaching competence among secondary school teachers. *International Journal of Development and Sustainability*, 13(7), 588-606.
- Akpan, A. O. (2024). Knowledge, utilization and perception of

emergent digital technologies in pedagogy by pre-service science teachers in Nigeria. *Journal of Institutional Research, Big Data Analytics and Innovation*, 1(1). 55-67

Aliyu, A., & Muhammad, Y. (2025). Educational Technology as a Catalyst for Collaborative and Transformative Teacher Education in Nigeria. *Abuja International Journal of Education*, 12(1). 568-588

AlKanaan, H. M. N. (2022). Awareness Regarding the Implication of Artificial Intelligence in Science Education among Pre-Service Science Teachers. *International Journal of Instruction*, 15(3), 895-912.

Anaso, J. N., & Anaso, C. P. (2025). Assessment on Integrating Artificial Intelligence Technological and Pedagogical Competencies among Secondary School Chemistry Teachers in Kaduna State, Nigeria. *Federal University Gusau Faculty of Education Journal*, 5(3), 300-306. <https://doi.org/10.64348/zije.202571>

Dias-Trindade, S., Moreira, J. A., & Ferreira, A. G. (2020). *Assessment of university teachers on their digital competences. Qwerty – Open and Interdisciplinary Journal of Technology, Culture and Education*, 15(1), 50–69. <https://doi.org/10.30557/QW000025>

Egere, A. N., Nwokocha, A. I., & Ariwa, R. N. (2025). From reform to reality: Assessing teacher and institutional readiness for cybersecurity, ai, and programming in Nigeria's 2025/2026 digital curriculum. *International Journal of Library Science and Educational Research*. 9(8), 79-94

Eke, E. O. (2024). Assessing the readiness and attitudes of Nigerian teacher educators towards adoption of artificial intelligence in educational settings. *Journal of Educational Technology and Online Learning*, 7(4-ICETOL 2024 Special Issue), 473-487.

Ekwevugbe, A. O. (2025). Use Of Artificial Intelligence Technology For Revolutionizing Teaching And Learning Practices In Teacher Education Programmes In Nigeria. *International*

Journal of Innovative Information Systems & Technology Research, 13(4), 33-39.

Elsayary, A., Kuhail, M. A., & Hojeij, Z. (2025). Examining the Role of Prompt Engineering in Utilizing Generative AI Tools for Lesson Planning: Insights From Teachers' Experiences and Perceptions. *Human Behavior and Emerging Technologies*. <https://doi.org/10.1155/hbe2/9986139>

Galindo-Domínguez, H., & Bezanilla, M. J. (2021). Digital competence in the training of pre-service teachers: Perceptions of students in the degrees of early childhood education and primary education. *Journal of Digital Learning in Teacher Education*, 37(4), 262-278.

Güneyli, A., Burgul, N. S., Dericioğlu, S., Cenkova, N., Becan, S., Şimşek, Ş. E., & Güneralp, H. (2024). Exploring teacher awareness of artificial intelligence in education: A case study from Northern Cyprus. *European Journal of Investigation in Health, Psychology and Education*, 14(8), 2358-2376. <https://doi.org/10.3390/ejihpe14080156>

Jackson, P. C. (2019). *Introduction to artificial intelligence*. Courier Dover Publications.

Kim, J. (2024). Leading teachers' perspective on teacher-AI collaboration in education. *Education and information technologies*, 29(7), 8693-8724.

Kiryakova, G., & Kozhuharova, D. (2024). The digital competences necessary for the successful pedagogical practice of teachers in the digital age. *Education Sciences*, 14(5), 507.

Liu, B., Zhang, W., & Wang, F. (2026). Can Generative Artificial Intelligence Effectively Enhance Students' Mathematics Learning Outcomes?—A Meta-Analysis of Empirical Studies from 2023 to 2025. *Education Sciences*. <https://doi.org/10.3390/educsci16010140>

Madu, C. O., & Musa, A. (2024). Lecturers' level of awareness of artificial intelligence as correlate of their digital competence at Federal University Wukari, Nigeria. *Journal of Educational Research in Developing Areas*, 5 (1), 59-67.

<https://doi.org/10.47434/JEREDA.5.1.2024.59>.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, 108(6), 1017–1054. <https://doi.org/10.1111/j.14679620.2006.00684.x>

Mohammed, I. Abdulazeez, F. & Abdulkarim, S. K. (2025). Examining pre-service teachers AI competency for future classroom. *Gombe Journal of Education (GOMJE)*, 8(1), 167-190

Nwafor, P. I., Ejoh, A. O., Chukwurah, M. U., & Okeke, S. U. (2023). Assessment of teachers' competence in utilization of digital instructional tools in upper basic schools in Cross River State, Nigeria. *Global journal of educational research*, 22(2), 165-175.

Nwosu, C. C., Obalum, D. C., & Ananti, M. O. (2024). Artificial intelligence in public service and governance in Nigeria. *Journal of Governance and Accountability Studies*, 4(2), 109-120.

Ogunbodede, K. F., Ewata, T. O., Kumar, A., & Okediji, O. G. (2023). Digital competencies and the 21st century skills of university teachers in Nigeria. *European Journal of Interactive Multimedia and Education*, 4(2), e02305.

Okunade, A. I. (2024). The role of artificial intelligence in teaching of science education in secondary schools in Nigeria. *European Journal of Computer Science and Information Technology*, 12(1), 57-67.

Olori, A., & Saka, A. O. (2024). Differences in Technological Pedagogical Content Knowledge Between Experienced and Less Experienced Computer Teachers in Ogun State, Nigeria. *IIUM Journal of Educational Studies*, 12(2), 21-32.

Olugbuyi, P. O., Ahmed, M. A., & Olorundare, A. S. (2026). Institutional differences in awareness, attitude, utilization, and competence in artificial intelligence tools among chemistry lecturers and undergraduates in South-West Nigeria. *Discover Education*.

Onanuga, P. A., & Saka, A. O. (2025). Emerging Digital Technologies: Building Competencies of STEM Pre-Service Teachers. *Journal of Teaching and Learning*, 19(1), 155-169.

Priyanda, R., Herman, T., Amalia, R., & Ihsan, I. R. (2025). Exploring teachers' pedagogical reasoning in mathematics education using the TPACK framework. *Frontiers in Education*. <https://doi.org/10.3389/educ.2025.1552760>

Tomczyk, Ł. (2024). Digital competence among pre-service teachers: A global perspective on curriculum change as viewed by experts from 33 countries. *Evaluation and Program Planning*, 105, 102449.

Younas, M., El-Dakhs, D., & Noor, U. (2025). The impact of artificial intelligence-based learning tools in academic innovation: a review of Deep seek, GPT, and Gemini (2020–2025). *Frontiers in Education*. <https://doi.org/10.3389/educ.2025.1689205>

Yue, M., Jong, M. S. Y., & Ng, D. T. K. (2024). Understanding K–12 teachers' technological pedagogical content knowledge readiness and attitudes toward artificial intelligence education. *Education and Information Technologies*, 29(15), 19505-19536. <https://doi.org/10.1007/s10639-024-12621-2>