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Artificial Intelligence Literacy and Its Integration into Curriculum and Pedagogical Practices of TVET Lecturers in South-South Nigeria: The Mediating Role of Pedagogical Competence

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Abstract

This study examined the relationships between artificial intelligence (AI) literacy and AI integration in Technical and Vocational Education and Training (TVET) curriculum and pedagogical practices among university-based educators in South-South Nigeria, and investigated the mediating role of AI pedagogical competence. A correlational survey design was adopted. A proportionate stratified sample of 243 academic staff was drawn from a population of 617 academic staff in TVET-related disciplines across 12 universities; 221 questionnaires were returned (90.9%). Data were collected using a researcher-developed questionnaire containing 32 measurement items. Descriptive statistics, Pearson correlations and Partial Least Squares Structural Equation Modelling (PLS-SEM) were used. The study found positive correlations between AI literacy and curriculum integration ($r = 0.553$, $p < .001$) and between AI literacy and AI-enabled pedagogical practices ($r = 0.448$, $p < .001$). The structural paths were positive: AI literacy to AI pedagogical competence ($\beta = 0.447$), AI literacy to curriculum integration ($\beta = 0.408$), AI pedagogical competence to curriculum integration ($\beta = 0.334$), AI literacy to pedagogical practices ($\beta = 0.255$), and AI pedagogical competence to pedagogical practices ($\beta = 0.443$). The indirect effects through AI pedagogical competence were 0.149 for curriculum integration and 0.198 for pedagogical practices; both 95% confidence intervals excluded zero. The study has acceptable measurement statistics, including composite reliability values from 0.922 to 0.938 and AVE values from 0.625 to 0.655. The study concludes that AI literacy and AI pedagogical competence are associated with educators' reported curriculum and instructional integration of AI. It was recommended, among others, that university management institutionalise continuous AI literacy training for TVET educators through workshops, seminars, and practical sessions on AI concepts, applications, evaluation of AI-generated information, bias detection, data protection, and responsible AI use. Educators should also be encouraged to participate in relevant online professional development programmes.

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Keywords: AI literacy; AI pedagogical competence; TVET; curriculum integration; pedagogical practices

Background of the Study

Artificial Intelligence (AI) is increasingly shaping how knowledge is generated, processed, communicated and applied across sectors of society. Its growing use in healthcare, manufacturing, finance, transport and education has created opportunities to improve productivity, decision-making and service delivery (Celik et al., 2022). In education, AI technologies are transforming conventional approaches to teaching and learning through applications that support content development, personalised instruction, automated assessment, intelligent tutoring and feedback. These developments provide educators with additional resources to address instructional needs and manage teaching activities (Celik et al., 2022). Miao and Cukurova (2024) observed that the growing influence of AI in education requires reconsidering teachers' professional roles and the competencies needed to use AI appropriately. Beyond classroom instruction, AI also calls for a reconsideration of curriculum content, learning objectives and assessment approaches to ensure that educational programmes remain responsive to technological and occupational changes. Consequently, educators' capacity to understand and apply AI has become an important consideration in contemporary education.

The educational application of AI, however, involves more than the availability of digital tools or the ability to operate technological applications. It requires an understanding of how AI systems function, their possible applications, limitations and implications. Ng et al. (2021) conceptualised AI literacy around four dimensions: knowing and understanding AI, using and applying AI, evaluating and creating with AI, and addressing ethical issues associated with AI. This suggests that AI literacy extends beyond familiarity with AI applications to include the ability to assess their outputs and make informed decisions about their use. Similarly, Miao and Cukurova (2024) identified human-centred thinking, AI ethics, AI foundations and applications, AI pedagogy, and AI for professional learning as important dimensions of teachers' competence in the AI era. These perspectives indicate that educators require the literacy to understand, evaluate and use AI responsibly, particularly when making decisions about curriculum content and instructional activities. This requirement is especially relevant in educational settings concerned with developing occupational knowledge and practical competencies, such as Technical and Vocational Education and Training.

Technical and Vocational Education and Training (TVET) plays an important role in preparing individuals with the knowledge, practical skills, attitudes and competencies required for employment, entrepreneurship and participation in economic activities. The Federal Republic of Nigeria (2013) describes TVET as encompassing educational processes that involve studying technologies and related sciences, alongside acquiring practical skills, attitudes, understanding, and occupational knowledge. Similarly, UNESCO (2022) emphasised that TVET connects education with the world of work and must respond to changing occupational requirements and technological developments. Its relevance therefore depends partly on the extent to which curricula reflect contemporary workplace demands and provide learners with opportunities to acquire appropriate occupational competencies. In the context of AI, this requires attention to curriculum content, instructional resources and learning experiences that expose learners to emerging technologies and their applications. Yang et al. (2026) stressed that AI integration in TVET should extend across programme and curriculum development, pedagogy, training delivery, assessment and competency development. This broader perspective indicates that AI integration should not be restricted to classroom technology use but should also address the curriculum through which occupational knowledge and skills are developed.

The importance of curriculum in TVET becomes more apparent given changing workplace demands. A curriculum provides an organised framework for determining the knowledge, skills, values, learning experiences and assessment activities through which educational objectives are pursued. In vocational education, its relevance is particularly important because learners are expected to acquire competencies that correspond with changing occupational practices and technological requirements. The increasing application of AI in industrial processes, production systems and service delivery therefore raises questions about the extent to which TVET curricula reflect the competencies required in AI-influenced occupations. Yang et al. (2026) identified programme and curriculum development as a central area requiring attention in institutional AI integration. Similarly, Dawodu et al. (2025), in their study of curriculum innovation and

TVET students' preparation for AI-driven workforce transformation in technical colleges in Lagos State, Nigeria, reported that existing curriculum innovations were insufficient to equip students with essential AI and digital skills. Their findings highlight the need for curriculum responsiveness in preparing vocational learners for technological changes. However, curriculum responsiveness also requires educators who can interpret curriculum expectations and translate them into relevant learning content, instructional activities and assessment experiences. This highlights the role of TVET educators in connecting curriculum requirements with teaching and learning processes.

The integration of AI into TVET curriculum and pedagogical practices is particularly significant because of the practical and competency-based orientation of vocational education. Pedagogical practices refer to the instructional approaches, strategies, and activities educators use to facilitate learning, guide learners' participation, and assess learning outcomes. TVET involves developing occupational competencies through theoretical instruction, demonstrations, practical exercises, problem-solving activities and performance assessment. AI applications may support these processes through intelligent tutoring systems, adaptive learning resources, automated feedback, instructional content generation, virtual simulations and assessment support (Celik et al., 2022). Celik (2023) further showed that effectively integrating AI-based tools requires teachers to combine technological, pedagogical, and content-related knowledge with the ability to assess ethical implications. At the curriculum level, AI integration may involve incorporating relevant AI concepts, applications, ethical considerations and occupational uses into programme content and learning experiences. At the instructional level, it may involve using AI to prepare learning materials, explain technical concepts, develop practical learning scenarios, provide feedback and support assessment. Yang et al. (2026) similarly emphasised the need for coordinated attention to curriculum development, pedagogy, training delivery and assessment. Meaningful integration therefore depends on educators' ability to connect AI applications with curriculum requirements and instructional objectives.

The distinction between curriculum integration and pedagogical practices matters because including AI-related content in a programme does not automatically mean educators use AI effectively in teaching. Similarly, an educator may use AI to prepare instructional materials or provide feedback without incorporating AI-related knowledge and competencies into programme content. Although related, the two represent different aspects of educational integration. Yang et al. (2026) recognise this distinction by treating programme and curriculum development, pedagogy, training delivery, assessment and competency development as connected but identifiable areas of AI integration in TVET. Examining these outcomes separately can therefore provide a more comprehensive understanding of how AI is incorporated into vocational education. However, educators' contributions to both outcomes may depend partly on their knowledge and understanding of AI, making AI literacy a relevant explanatory variable.

AI literacy refers to the knowledge, understanding, skills and evaluative abilities that enable individuals to interact meaningfully and responsibly with AI technologies (Ng et al., 2021). Among educators, it involves understanding the capabilities of AI applications, recognising their educational uses, evaluating the accuracy of generated information and identifying ethical concerns associated with their application. For TVET educators, this may include identifying suitable AI applications for preparing curriculum-related materials, developing occupationally relevant learning resources, explaining technical concepts and supporting assessment. It also requires recognising that AI-generated information may contain inaccuracies or unsuitable recommendations, particularly in specialised technical subjects. Miao and Cukurova (2024) emphasised the need for teachers to understand AI applications, apply ethical principles and make informed pedagogical decisions. Similarly, Celik (2023), through the Intelligent Technological Pedagogical Content Knowledge (Intelligent-TPACK) perspective, highlighted the importance of integrating technological, pedagogical and content knowledge with ethical considerations in AI-supported instruction. The ability to translate AI knowledge into appropriate curriculum-related and instructional decisions therefore highlights AI pedagogical competence.

AI pedagogical competence concerns educators' capacity to select, adapt and integrate AI technologies in ways that align with curriculum objectives, subject content, teaching strategies, learners' needs and assessment requirements. Miao

and Cukurova (2024) identified AI pedagogy as one of the five dimensions of their AI Competency Framework for Teachers, emphasising AI-assisted teaching and the integration of AI into pedagogical practice. Similarly, Celik (2023) explained that integrating AI into education requires teachers to combine technological knowledge with pedagogical and content-related knowledge while considering ethical implications. In TVET, this competence may be reflected in educators' ability to select AI applications appropriate for vocational subjects, adapt AI-generated materials to curriculum content, develop AI-supported learning activities and use AI-assisted feedback and assessment appropriately. Setiyawan et al. (2025), in developing and validating an AI-integrated Technological Pedagogical Content Knowledge instrument for vocational education, demonstrated the importance of examining AI-related technological, pedagogical and content knowledge as interconnected dimensions of vocational teachers' professional competence. Thus, while AI literacy enables educators to understand and critically engage with AI technologies, AI pedagogical competence enables them to translate that understanding into curriculum-responsive and instructionally appropriate decisions. This makes AI pedagogical competence a possible link between educators' AI literacy and their integration of AI into curriculum and pedagogical practices.

AI integration in TVET curriculum and pedagogical practices involves the purposeful incorporation of AI-related knowledge, applications, and resources into curriculum-related activities, as well as the use of AI technologies to support instruction. Curriculum integration involves educators reviewing and adapting curriculum content, incorporating relevant AI concepts and applications into learning experiences, aligning instructional resources with occupational requirements, and considering AI-related competencies in assessment. Pedagogical integration, in contrast, involves using AI applications in instructional planning, content development, teaching delivery, learner support, feedback and assessment. Celik et al. (2022) identified instructional planning, implementation and assessment as areas in which AI can support teachers' work, while Yang et al. (2026) highlighted curriculum development, pedagogy, training delivery and assessment as interconnected areas of AI integration in TVET. For educators, these practices may include developing curriculum-related materials, preparing technical illustrations, generating vocational learning scenarios and supporting assessment activities with AI applications. However, their educational value depends on educators' ability to evaluate AI-generated outputs and determine their suitability for curriculum content, occupational requirements and learning objectives. AI integration therefore involves more than the frequency of technology use; it requires purposeful application aligned with educational and vocational learning outcomes.

The relationship among AI literacy, AI pedagogical competence, and AI integration in TVET curriculum and pedagogical practices is important for understanding how educators translate AI knowledge into educational practice. AI literacy may provide the understanding required to recognise the capabilities, limitations and educational uses of AI technologies, while AI pedagogical competence enables educators to connect this understanding with curriculum objectives, subject content, teaching strategies and assessment requirements. The two outcomes represent the application of these capabilities in curriculum-related activities and instructional processes. This proposed relationship aligns with Celik's (2023) emphasis on integrating technological, pedagogical, and content knowledge in AI-supported teaching, as well as the AI pedagogy dimension of the framework developed by Miao and Cukurova (2024). It also reflects Yang et al.'s (2026) position that meaningful AI integration in TVET requires attention to both curriculum development and pedagogical implementation. It is therefore important to examine whether AI pedagogical competence mediates the relationships between AI literacy and each outcome.

In Nigeria, these issues are relevant to the need for TVET programmes to remain responsive to technological developments and changing occupational requirements. AI integration raises questions about the extent to which university-based educators understand AI, possess the pedagogical competence required to apply it and contribute to incorporating relevant AI knowledge and competencies into their programmes. Evidence from Nigeria has begun to address aspects of this concern. Dawodu et al. (2025), for instance, investigated curriculum innovation and TVET students' preparation for AI-driven workforce transformation in technical colleges in Lagos State. Their study involved 150 technical college teachers and examined curriculum-related issues associated with preparing learners for an AI-driven workforce. Although this provides empirical evidence on the relationship

between TVET curriculum and technological change in Nigeria, it focused on technical colleges in Lagos State and curriculum innovation for workforce preparation. It did not examine the relationships among university-based TVET educators' AI literacy, AI pedagogical competence, curriculum integration and AI-enabled pedagogical practices. These differences in institutional setting, geographical context and explanatory focus provide a basis for further investigation.

The South-South geopolitical zone provides a relevant setting for examining these relationships among educators in federal and state universities offering TVET-related programmes. Universities in the zone provide training in areas such as vocational and technical education, business education, agricultural education and home economics education. Educators in these programmes participate in teaching, curriculum interpretation, instructional planning and assessment, and may contribute to curriculum review and development. Their responsibilities make their understanding and application of AI relevant to preparing learners for changing occupational environments. Nevertheless, the extent to which these educators possess AI literacy, demonstrate AI pedagogical competence and contribute to AI integration in curriculum and pedagogical practices requires empirical examination. Focusing on university-based educators in the South-South also provides a different institutional and geographical context from the technical college setting investigated by Dawodu et al. (2025).

Although existing studies have examined AI literacy, teachers' professional knowledge for AI integration, AI-related competencies in vocational education and curriculum innovation for AI-driven workforce transformation, these areas have not necessarily been examined together within a single explanatory model. Ng et al. (2021) provided a conceptual foundation for understanding AI literacy, while Celik (2023) examined the professional knowledge required for ethical and pedagogically appropriate AI integration. Setiyawan et al. (2025) extended this line of inquiry to vocational education by developing and validating an AI-TPACK instrument. In Nigeria, Dawodu et al. (2025) examined curriculum innovation in relation to AI-driven workforce transformation among technical colleges in Lagos State. However, research still needs to examine how AI literacy relates separately to AI integration in TVET curricula and AI-enabled pedagogical practices among university-based TVET educators, and whether AI pedagogical competence explains these relationships. The present study therefore addresses a contextual and explanatory gap rather than assuming that previous research has not considered AI and TVET curriculum or pedagogy.

Against this background, the study examines the relationships among AI literacy, AI pedagogical competence, AI integration in TVET curriculum and AI-enabled pedagogical practices among university-based educators in South-South Nigeria. Specifically, it examines the direct relationships between AI literacy and AI pedagogical competence and each outcome, the relationships between AI pedagogical competence and both outcomes, and the indirect relationships between AI literacy and each outcome through AI pedagogical competence. Curriculum integration and pedagogical practices are treated as distinct but related outcomes.

Statement of the Problem

Technical and Vocational Education and Training (TVET) programmes are expected to equip learners with competencies relevant to changing workplaces. As AI applications become more visible in occupational and educational settings, TVET curricula and teaching practices face pressure to address relevant AI knowledge, applications and ethical considerations (UNESCO, 2022; Yang et al., 2026). Educators have an important role in interpreting curriculum expectations and translating them into subject content, learning activities and assessment practices.

However, the availability of AI technologies does not guarantee their meaningful integration into TVET. AI-supported teaching requires educators to understand the capabilities and limitations of AI systems and to make informed decisions about their pedagogical use (Celik et al., 2022; Celik, 2023). Evidence from Nigerian technical colleges also points to concerns about whether curriculum innovation adequately prepares learners for AI-related workplace changes (Dawodu et al., 2025). These concerns make educators' AI literacy and AI pedagogical competence relevant to curriculum development and instructional practice.

Although existing studies have examined AI literacy, teachers' knowledge of AI integration, and curriculum innovation in vocational education, the

literature does not establish how these constructs jointly relate among university-based TVET educators in South-South Nigeria. In particular, the mediating role of AI pedagogical competence between AI literacy and curriculum integration, and between AI literacy and AI-enabled pedagogical practices, requires examination in this context. The present study addresses this contextual and explanatory question without assuming that earlier research has ignored AI in TVET.

Purpose of the Study

This study examines the relationships among AI literacy, AI pedagogical competence, AI integration in TVET curriculum and AI-enabled pedagogical practices among university-based educators in South-South Nigeria. Specifically, it seeks to determine the:

1. relationship between AI literacy and AI pedagogical competence;
2. relationship between AI literacy and AI integration in TVET curriculum;
3. relationship between AI pedagogical competence and AI integration in TVET curriculum;
4. relationship between AI literacy and AI-enabled pedagogical practices;
5. relationship between AI pedagogical competence and AI-enabled pedagogical practices; and
6. mediating role of AI pedagogical competence in the relationships between AI literacy and (a) AI integration in TVET curriculum and (b) AI-enabled pedagogical practices.

Research Questions

The following research questions guided the study:

1. What is the relationship between AI literacy and AI pedagogical competence among university-based educators in South-South Nigeria?
2. What is the relationship between AI literacy and AI integration in TVET curriculum?
3. What is the relationship between AI pedagogical competence and AI integration in TVET curriculum?
4. What is the relationship between AI literacy and AI-enabled pedagogical practices?
5. What is the relationship between AI pedagogical competence and AI-enabled pedagogical practices?
6. To what extent does AI pedagogical competence mediate the relationships between AI literacy and the two outcome variables?

Hypotheses

The following null hypotheses were tested at the .05 level of significance:

1. AI literacy has no significant relationship with AI pedagogical competence.
2. AI literacy has no significant relationship with AI integration in TVET curriculum.
3. AI pedagogical competence has no significant relationship with AI integration in TVET curriculum.
4. AI literacy has no significant relationship with AI-enabled pedagogical practices.
5. AI pedagogical competence has no significant relationship with AI-enabled pedagogical practices.
6. AI pedagogical competence does not significantly mediate the relationships between AI literacy and the two outcome variables.

Theoretical Framework

Mishra and Koehler (2006) proposed the TPACK framework as an extension of Shulman's Pedagogical Content Knowledge. The framework explains that effective technology integration requires educators to combine three forms of knowledge: technological knowledge, pedagogical knowledge and content knowledge. It emphasises that educators should not introduce technology in isolation but select and apply it in ways that complement subject content and appropriate teaching methods. In this study, the framework provides a basis for understanding AI

pedagogical competence as the ability of TVET educators to connect their knowledge of AI with vocational content, curriculum requirements and instructional practices. It also explains how educators' AI literacy can be translated into meaningful AI integration in TVET curriculum and AI-enabled pedagogical practices. However, the TPACK framework focuses mainly on the knowledge required for effective technology integration and does not sufficiently explain how new technologies are adopted and become established within an educational system. This limitation makes it necessary to draw on a complementary theory such as Diffusion of Innovations Theory that addresses the adoption and implementation of innovations.

Rogers (2003) proposed the Diffusion of Innovations Theory to explain how new ideas, technologies and practices spread among members of a social system through communication channels over time. The theory identifies four major elements of diffusion: the innovation, communication channels, time and the social system. It also explains that adoption is influenced by how individuals perceive an innovation's relative advantage, compatibility, complexity, trialability, and observability. In this study, the theory helps explain how AI technologies may be adopted and incorporated into TVET curricula and pedagogical practices within universities. It highlights that educators' willingness and ability to integrate AI may be influenced not only by their knowledge and competence but also by the compatibility of AI applications with existing curricula, institutional practices, and teaching requirements.

Methodology

The study adopted a correlational survey research design. The design was considered appropriate because the study examined the relationships among artificial intelligence literacy, AI pedagogical competence, AI integration in TVET curriculum and AI-enabled pedagogical practices without manipulating any of the variables. It also enabled the researcher to examine the mediating role of AI pedagogical competence in the relationships between AI literacy and the two outcome variables. Data were collected from TVET educators through a structured questionnaire.

The study was conducted in South-South Nigeria, comprising Akwa Ibom, Bayelsa, Cross River, Delta, Edo and Rivers States. The area was selected because it has universities offering programmes in TVET-related disciplines, including vocational, technical, business, agricultural and home economics education. These disciplines provide the institutional context for examining educators' AI literacy, pedagogical competence and the integration of AI into curriculum and teaching practices.

The study population comprised 617 academic staff in TVET-related disciplines across 12 universities in the six states of South-South Nigeria. The distribution of the population by institution is presented in Table 1.

A sample of 243 respondents was selected for the study. The sample size was determined using Yamane's formula for finite populations. A proportionate stratified sampling technique was adopted to ensure that the 12 universities were represented in accordance with their respective population sizes. Each university constituted a stratum, and the number of respondents selected from each institution was determined proportionately. Simple random sampling was then used to select respondents within each stratum.

Table 1: Distribution of the Population of the Study & Proportionate Allocation of the Sample

S/N	State	University	Areas	Population	Sample
1	Akwa Ibom	University of Uyo	Vocational, Technical, Business, Agricultural and Home Economics Education	102	40
2	Bayelsa	Niger Delta University	Business Education, Technical Education, Vocational and Industrial Education	47	19
3	Bayelsa	Federal University Otuoke	Business Education	13	5
4	Cross River	University of Calabar	Vocational, Business, Agricultural and Home Economics Education	95	37

5	Cross River	Cross River University of Education and Entrepreneurship	Business Education and Technical Education	33	13
6	Edo	University of Benin	Vocational, Technical, Business and Computer Education	56	22
7	Edo	Ambrose Alli University	Business, Agricultural and Home Economics Education, Technical Education and Vocational and Technical Education	79	31
8	Delta	Delta State University, Abraka	Agricultural Science, Home Economics, Fine Arts Education, Business and Technical Education	88	35
9	Delta	University of Delta, Agbor	Agricultural, Business, Home Economics Education	41	16
10	Rivers	Rivers State University	Business Education	9	4
11	Rivers	Ignatius Ajuru University of Education	Business, Computer, Home Economics and Technical Education	37	14
12	Rivers	University of Port Harcourt	Business Education	17	7
	Total	**12 Universities**		**617**	**243**

Data were collected using a researcher-developed questionnaire titled Artificial Intelligence Literacy and AI Integration in TVET Curriculum and Pedagogical Practices among University-Based Educators in South-South Nigeria: The Mediating Role of AI Pedagogical Competence (AILAITCPPQ). The instrument contained five sections: Section A collected respondent background information, while Sections B–E measured AI literacy, AI pedagogical competence, AI integration in TVET curriculum, and AI-enabled pedagogical practices.

Section B contained eight AI literacy items; Section C contained eight AI pedagogical competence items; Section D contained seven AI curriculum integration items; and Section E contained nine AI-enabled pedagogical practice items. Sections B–D used a four-point agreement scale (Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1). Section E used a five-point frequency scale (Very Often = 5, Often = 4, Sometimes = 3, Rarely = 2, Never = 1).

The questionnaire underwent face validation by three experts from the University of Nigeria, Nsukka. The experts comprised one specialist in Computer and Robotics Education, one in Business Education and one in Industrial Technical Education. They examined the instrument for the relevance of the items to the study variables, clarity of expression, adequacy of construct coverage, appropriateness of the response options, and possible overlap among items. Their observations and recommendations were used to revise the questionnaire before pilot testing.

The revised questionnaire was pilot-tested among 30 TVET educators from the University of Nigeria, Nsukka. Reliability coefficients of 0.813, 0.766, 0.922, and 0.780 were obtained for AI literacy, AI pedagogical competence, AI integration in the TVET curriculum, and AI-enabled pedagogical practices, respectively.

The researcher administered the questionnaire to the sampled TVET educators in the 12 participating universities. The administration was carried out with the help of 4 research assistants. Respondents were informed of the purpose of the study and assured that participation was voluntary and that the information provided would be treated confidentially. A total of 221 questionnaires were retrieved, indicating a return rate of 90.9%.

Data were analysed using descriptive statistics, Pearson correlation and Partial Least Squares Structural Equation Modelling (PLS-SEM).

The analysis was conducted using SmartPLS 4. The measurement model was assessed using indicator loadings, Cronbach's alpha, composite reliability (CR), average variance extracted (AVE) and the heterotrait–monotrait ratio (HTMT). The structural model was assessed using path coefficients, coefficient of determination (R^2), effect sizes (f^2), variance inflation factors (VIF) and the standardised root mean square residual (SRMR). The SRMR value was 0.065, indicating good model fit. Indirect effects were bootstrapped using 2,000 resamples.

The indirect relationships were assessed using bootstrap estimates and 95% confidence intervals. An indirect effect was treated as statistically significant where its confidence interval did not include zero.

The study observed relevant ethical principles throughout the research process. Participation was voluntary, and respondents were informed about the purpose of the study before completing the questionnaire. Their identities were not required in the instrument, and the information obtained was used strictly for research purposes. The researcher also obtained the necessary institutional permissions before administering the questionnaire in the participating universities.

Results

Table 2: Mean and Standard Deviation of the Study Variables (N = 221)

Study variables	Number of items	Mean	SD
Artificial Intelligence Literacy	8	2.55	0.89
AI Pedagogical Competence	8	2.50	0.88
AI Integration in TVET Curriculum	7	2.52	0.86
AI-Enabled Pedagogical Practices	9	3.01	1.08

Table 2 shows that AI literacy had a mean score of 2.55 and a standard deviation of 0.89. AI pedagogical competence recorded a mean of 2.50 and a standard deviation of 0.88, while AI integration in TVET curriculum had a mean of 2.52 and a standard deviation of 0.86. These results indicate that respondents' ratings of the three constructs measured on the four-point agreement scale were close to the scale midpoint of 2.50, indicating borderline agreement. AI-enabled pedagogical practices recorded a mean of 3.01 and a standard deviation of 1.08 on the five-point frequency scale. This indicates a moderate reported frequency of AI-enabled pedagogical practices among the respondents.

Table 3: Pearson Correlation between AI Literacy and AI Integration in TVET Curriculum

Variables	r	p-value	Decision
AI Literacy and AI Integration in TVET Curriculum	0.553	< .001	Significant positive relationship

Table 3 shows a positive and statistically significant relationship between AI literacy and AI integration in TVET curriculum ($r = 0.553$, $p < .001$). This indicates that higher levels of AI literacy were associated with greater reported integration of AI-related concepts, applications and activities into TVET curriculum among the educators. Consequently, the null hypothesis that AI literacy has no significant relationship with AI integration in TVET curriculum (Hypothesis 2) was rejected.

Table 4: Pearson Correlation between AI Literacy and AI-Enabled Pedagogical Practices

Variables	r	p-value	Decision
AI Literacy and AI-Enabled Pedagogical Practices	0.448	< .001	Significant positive relationship

Table 4 indicates a positive and statistically significant relationship between AI literacy and AI-enabled pedagogical practices ($r = 0.448$, $p < .001$). This suggests that educators with higher AI literacy tended to report more frequent use of AI applications in their teaching activities. Therefore, the null hypothesis that AI literacy has no significant relationship with AI-enabled pedagogical practices (Hypothesis 4) was rejected.

Table 5: Measurement Model Assessment

Construct	Items	Outer loading range	Cronbach's alpha	Composite reliability (CR)	AVE
AIL	8	0.711–0.869	0.924	0.938	0.655
AIPC	8	0.761–0.848	0.920	0.935	0.641
AIIC	7	0.750–0.819	0.901	0.922	0.628
AIEPP	9	0.753–0.850	0.925	0.937	0.625

Table 5 shows that the outer loadings ranged from 0.711 to 0.869, indicating that the measurement items met the commonly applied loading criterion of approximately 0.70. Composite reliability values ranged from 0.922 to 0.938, exceeding the recommended minimum of 0.70. Similarly, the AVE values ranged from 0.625 to 0.655, exceeding the minimum criterion of 0.50. These results provide evidence of satisfactory indicator reliability, internal consistency reliability and convergent validity for the four constructs.

Table 6: Discriminant Validity Assessment

Construct	AIL	AIPC	AIIC	AIEPP
AIL	—	0.478	0.606	0.485
AIPC	0.478	—	0.563	0.598
AIIC	0.606	0.563	—	0.396
AIEPP	0.485	0.598	0.396	—

The HTMT values ranged from 0.396 to 0.606, which were below the commonly applied threshold of 0.85. This indicates that the constructs were empirically distinguishable from one another. Thus, the results provide evidence of satisfactory discriminant validity.

Table 7: Structural Model Path Coefficients

Relationship	β	Bootstrap SE	Approx. t	Approx. p	95% CI
AIL → AIPC	0.447	0.054	8.297	< .001	[0.340, 0.555]
AIL → AIIC	0.408	0.059	6.904	< .001	[0.291, 0.523]
AIPC → AIIC	0.334	0.062	5.414	< .001	[0.213, 0.451]
AIL → AIEPP	0.255	0.062	4.113	< .001	[0.134, 0.375]
AIPC → AIEPP	0.443	0.058	7.699	< .001	[0.325, 0.556]

Table 7 shows that AI literacy was positively related to AI pedagogical competence ($\beta = 0.447$, $p < .001$). This suggests that educators with higher AI literacy tended to demonstrate higher AI pedagogical competence. AI literacy was also positively related to AI integration in the TVET curriculum ($\beta = 0.408$, $p < .001$), indicating that greater AI literacy was associated with increased curriculum integration. Furthermore, AI pedagogical competence had a positive relationship with AI integration in the TVET curriculum ($\beta = 0.334$, $p < .001$). Similarly, AI literacy ($\beta = 0.255$, $p < .001$) and AI pedagogical competence ($\beta = 0.443$, $p < .001$) were positively associated with AI-enabled pedagogical practices. These findings indicate that both AI literacy and the ability to apply AI knowledge to instructional decisions were associated with educators' reported AI-enabled teaching practices. Accordingly, the null hypotheses that AI literacy has no significant relationship with AI pedagogical competence (Hypothesis 1), that AI pedagogical competence has no significant relationship with AI integration in TVET curriculum (Hypothesis 3) and that AI pedagogical competence

has no significant relationship with AI-enabled pedagogical practices (Hypothesis 5) were rejected.

Table 8: Coefficient of Determination

Endogenous construct	R^2	Variance explained
AIPC	0.199	19.9%
AIIC	0.399	39.9%
AIEPP	0.362	36.2%

The R^2 values indicate that the model explained 19.9% of the variance in AI pedagogical competence, 39.9% in AI integration in TVET curriculum and 36.2% in AI-enabled pedagogical practices. These values indicate modest explanatory power for AI pedagogical competence and moderate explanatory power for the two outcome constructs under commonly used PLS-SEM interpretive guidance.

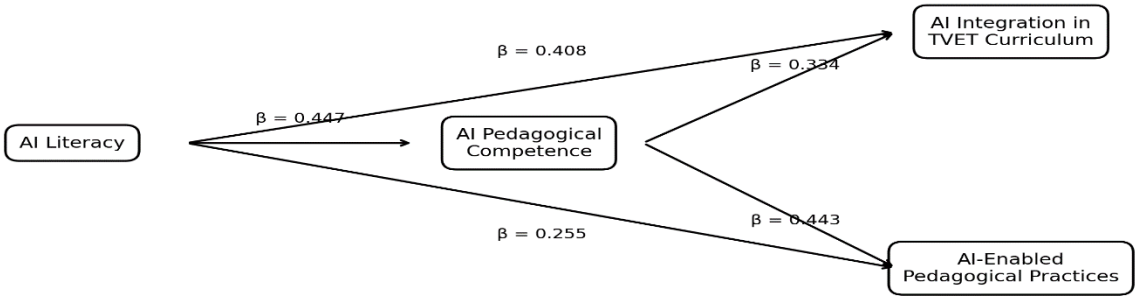
Table 9: Specific Indirect Effects of AI Literacy through AI Pedagogical Competence

Indirect relationship	Indirect effect (β)	Bootstrap SE	95% CI	Resamples
AIL → AIPC → AIIC	0.149	0.034	[0.089, 0.223]	2000
AIL → AIPC → AIEPP	0.198	0.036	[0.135, 0.276]	2000

Table 9 shows that the indirect relationship between AI literacy and AI integration in TVET curriculum through AI pedagogical competence was positive ($\beta = 0.149$), with a 95% confidence interval of 0.089 to 0.223. Since the confidence interval did not include zero, the result indicates a statistically significant indirect relationship. Similarly, the indirect relationship between AI literacy and AI-enabled pedagogical practices through AI pedagogical competence was positive ($\beta = 0.198$), with a 95% confidence interval of 0.135 to 0.276. The confidence interval also excluded zero, indicating a statistically significant indirect relationship. Consequently, the null hypothesis that AI pedagogical competence does not significantly mediate the relationships between AI literacy and AI integration in TVET curriculum and between AI literacy and AI-enabled pedagogical practices (Hypothesis 6) was rejected.

The direct relationships between AI literacy and both outcome variables remained positive and statistically significant after accounting for AI pedagogical competence. This pattern is consistent with complementary partial mediation. It suggests that AI literacy was associated with curriculum integration and pedagogical practices both directly and indirectly through AI pedagogical competence.

Figure 1. Structural model of the study constructs



Discussion of Findings

The study revealed a positive and statistically significant relationship between AI literacy and AI integration in TVET curriculum ($r = 0.553$, $p < .001$). The structural model also showed a positive relationship between AI literacy and curriculum integration ($\beta = 0.408$, $p < .001$). This finding suggests that educators with a greater understanding of AI concepts, applications, limitations, and ethical implications tend to report greater incorporation of AI-related content and activities into the courses they teach. This finding is consistent with Ng et al. (2021), who conceptualised AI literacy as involving the ability to understand AI, use and apply AI, evaluate AI outputs, and recognise ethical issues associated with its application. These dimensions are relevant to curriculum integration because educators need more than basic familiarity with AI tools to identify appropriate AI concepts, occupational applications, and learning activities to include in their subject areas. Similarly, the AI Competency Framework for Teachers (Miao & Cukurova, 2024) identifies AI foundations and applications, AI pedagogy and AI ethics as important areas of teacher competence. These areas reinforce the importance of educators possessing adequate AI knowledge when considering how AI-related competencies can be reflected in teaching content and learning activities.

In the context of TVET, the finding is particularly relevant because curriculum integration requires educators to connect AI applications with the knowledge, practical activities and occupational competencies relevant to their areas of specialisation. For example, an educator's understanding of AI may help identify relevant AI applications in business operations, technical processes, vocational problem-solving, and other occupational activities. However, the moderate mean recorded for AI integration in TVET curriculum ($M = 2.52$) suggests that the reported level of integration may not yet be extensive. Thus, although AI literacy is positively associated with curriculum integration, strengthening educators' knowledge and providing institutional support may be necessary to better incorporate AI-related competencies into TVET course content and activities.

The findings further revealed a positive and statistically significant relationship between AI literacy and AI-enabled pedagogical practices ($r = 0.448$, $p < .001$). The structural model also indicated a positive relationship between AI literacy and AI-enabled pedagogical practices ($\beta = 0.255$, $p < .001$). This suggests that educators who understand AI and its applications are more likely to report using AI tools for instructional planning, preparing learning resources, explaining vocational concepts, student support, and feedback and assessment-related activities. The finding supports Ng et al. (2021), who argued that AI literacy extends beyond knowing that AI exists to understanding how it works, applying it appropriately and evaluating its outputs. In teaching, such knowledge is important because educators must determine when an AI application is suitable for a particular instructional task and assess whether its outputs are accurate and relevant. The finding also agrees with Celik (2023), whose study on teachers' professional knowledge for integrating AI-based tools found that technological-pedagogical knowledge is

important for the pedagogical integration of AI. This indicates that using AI in teaching requires educators to connect their knowledge of technology with appropriate instructional purposes.

The result also reflects Miao and Cukurova's (2024) position that teachers require competencies that enable them to apply AI appropriately in teaching while maintaining human agency and ethical responsibility. Nevertheless, the mean score of 3.01 for AI-enabled pedagogical practices, measured on a five-point frequency scale, suggests a moderate reported frequency of use. This indicates that awareness and understanding of AI do not necessarily translate into frequent classroom application. Educators may understand AI applications but still require opportunities, institutional guidance and practical experience to incorporate them consistently into their teaching activities. Therefore, professional development should move beyond introducing educators to AI tools and provide practical opportunities to apply them to authentic TVET teaching tasks.

The structural model revealed a positive relationship between AI literacy and AI pedagogical competence ($\beta = 0.447$, $p < .001$). This finding suggests that educators' understanding of AI concepts, applications and ethical considerations is associated with their ability to make informed instructional decisions about the use of AI. In other words, knowledge of AI provides an important foundation for determining how AI applications can be selected, adapted and used to achieve specific teaching and learning objectives. This finding is supported by Chiu et al. (2024), who distinguished AI literacy from AI competency by explaining that literacy concerns knowledge and understanding, whereas competency involves applying that knowledge effectively. This distinction matters to the present study because knowing how AI works is not necessarily the same as knowing how to use it to design instructional activities, respond to learners' needs, or evaluate AI-generated learning materials. Similarly, Celik (2023) demonstrated the importance of technological and pedagogical knowledge in teachers' integration of AI-based tools. The present finding therefore reinforces the view that AI literacy is an important foundation for developing the pedagogical competence required for meaningful AI integration. The implication is that professional development for TVET educators should not be limited to introducing them to AI applications. It should also develop their capacity to translate AI knowledge into appropriate instructional decisions that reflect the practical and occupational orientation of TVET programmes.

The study found that AI pedagogical competence was positively related to AI integration in the TVET curriculum ($\beta = 0.334$, $p < .001$). This suggests that educators who are better able to select AI applications, align them with learning objectives, design AI-supported activities and establish appropriate guidelines for their use tend to report greater integration of AI-related content and activities into the courses they teach. This finding is consistent with Celik (2023), whose study identified technological-pedagogical knowledge as important for integrating AI-based tools into education. It also reflects the Miao and Cukurova (2024) framework, which recognises AI pedagogy as a key dimension of teacher AI competence. These perspectives suggest that curriculum integration requires more than awareness of available AI technologies; educators must also understand how to connect the technologies with subject content, instructional objectives and appropriate learning experiences.

The finding is particularly significant for TVET because curriculum integration involves linking AI applications to occupational knowledge and practical competencies. An educator may understand the principles of AI but still need pedagogical competence to determine which AI-related concepts, examples and practical activities are relevant to the courses taught. The result therefore suggests that developing AI pedagogical competence may help educators move from general awareness of AI towards its purposeful incorporation into course content, learning outcomes and practical learning activities.

The findings further showed that AI pedagogical competence was positively related to AI-enabled pedagogical practices ($\beta = 0.443$, $p < .001$). Among the two reported direct predictors of AI-enabled pedagogical practices, AI pedagogical competence had the larger path coefficient. This suggests that educators' ability to make instructional decisions about AI applications is particularly relevant to their reported use of AI in teaching activities. This finding supports Celik's (2023) argument that technological-pedagogical knowledge is important for the effective integration of AI-based tools into teaching. It also aligns with the Miao and Cukurova (2024) framework, which identifies AI pedagogy as a distinct area of teacher competence. These

perspectives emphasise that the educational value of AI depends not merely on access to tools but also on teachers' capacity to use them in ways that support learning.

This matters because AI-enabled pedagogical practices involve instructional activities such as preparing learning materials, explaining difficult concepts, supporting student inquiry, providing feedback, and developing assessment resources. These activities require educators to decide on the suitability, accuracy, and educational value of AI-generated outputs. Consequently, AI pedagogical competence appears to be an important factor in translating AI knowledge into reported teaching practices. The finding further suggests that training programmes for TVET educators should include practical, subject-specific activities through which educators can develop and demonstrate AI-supported instructional skills.

The mediation analysis indicated a positive indirect relationship between AI literacy and AI integration in TVET curriculum through AI pedagogical competence ($\beta = 0.149$; reported confidence interval = 0.089–0.223). Since the reported confidence interval did not include zero, the result indicates a statistically significant indirect relationship. The direct relationship between AI literacy and curriculum integration also remained positive and statistically significant. This pattern is consistent with complementary partial mediation.

The finding suggests that AI literacy may be associated with curriculum integration through two related pathways. First, educators' knowledge and understanding of AI may be directly associated with their ability to identify relevant AI concepts and applications for inclusion in their courses. Second, AI literacy may be associated with stronger AI pedagogical competence, which in turn is associated with greater curriculum integration. Thus, the ability to translate AI knowledge into instructional decisions provides an important link between knowing about AI and incorporating AI-related content and activities into TVET courses. This interpretation is consistent with Chiu et al. (2024), who distinguished knowledge about AI from the competence to apply that knowledge effectively. It also reflects the findings of Celik (2023), which highlight the importance of pedagogical knowledge in integrating AI-based technologies. The present study extends this line of reasoning by examining AI pedagogical competence as an intervening construct between AI literacy and curriculum integration among university TVET educators.

The finding implies that initiatives aimed at improving AI integration in TVET curriculum should address both educators' understanding of AI and their ability to apply that understanding when making curriculum-related instructional decisions. Providing general AI awareness training alone may not be sufficient to support the integration of relevant AI applications into course content, learning outcomes and practical activities.

The study also revealed a positive indirect relationship between AI literacy and AI-enabled pedagogical practices through AI pedagogical competence ($\beta = 0.198$; reported confidence interval = 0.135–0.276). The reported confidence interval did not include zero, indicating a statistically significant indirect relationship. The direct relationship between AI literacy and AI-enabled pedagogical practices also remained positive and statistically significant. This pattern is likewise consistent with complementary partial mediation. This finding suggests that AI literacy is associated with educators' use of AI in teaching not only through their direct knowledge of AI but also through their ability to apply that knowledge to instructional activities. Educators may understand AI applications and their possible uses, but their ability to select appropriate tools, align them with learning objectives, adapt activities to learners' needs and evaluate AI-generated outputs may determine how effectively they translate that knowledge into teaching practices.

This finding is supported conceptually by the distinction Chiu et al. (2024) make between AI literacy and AI competency. It also agrees with Celik (2023), who emphasised the importance of technological-pedagogical knowledge in AI-supported instruction. In addition, Al-Abdullatif (2024), in a study of university teachers' acceptance of generative AI, examined AI literacy alongside Intelligent-TPACK and perceived trust, thereby highlighting the relevance of both AI knowledge and pedagogical-technological knowledge to teachers' engagement with generative AI. This finding contributes to the discussion by showing that AI pedagogical competence provides an important indirect pathway linking AI literacy with AI-enabled pedagogical practices among TVET educators. It therefore suggests that efforts to promote AI use in TVET teaching should combine AI literacy

development with practical pedagogical training. Such training should enable educators to apply AI tools to authentic teaching activities while retaining professional judgement and responsibility for instructional decisions. The Diffusion of Innovations perspective also provides a contextual explanation: adoption may depend on perceived compatibility with existing courses, the complexity of available tools and opportunities to try them. These institutional adoption conditions were not directly measured in the present study and should therefore be treated as explanatory context rather than tested findings.

Limitations of the Study

Several limitations should be considered when interpreting the findings. First, the cross-sectional correlational design does not establish causal relationships. Second, all constructs were measured through self-report at one point in time, creating possible social desirability and common-method bias. No dedicated full-collinearity assessment or Harman single-factor test was conducted, so common-method bias cannot be ruled out. Third, the researcher-developed instrument was subjected to face validation, pilot testing and measurement-model assessment, but independent validation with a new sample remains advisable.

Suggestions for Further Research

Future studies could use longitudinal or mixed-methods designs to examine whether changes in AI literacy precede changes in pedagogical competence and practice. Self-report data could be complemented with classroom observation, analysis of course outlines and lesson plans, and performance-based assessments of AI literacy. Further studies should specify clear inclusion criteria for TVET-related disciplines, examine differences across demographic groups, and report predictive relevance statistics together with a dedicated common-method-bias assessment.

Conclusion

The study examined the relationships among AI literacy, AI pedagogical competence, AI integration in TVET curriculum and AI-enabled pedagogical practices among educators in South-South Nigeria. The findings showed that AI literacy had positive, statistically significant relationships with both AI integration in the TVET curriculum and AI-enabled pedagogical practices. The structural model further showed that AI literacy was positively associated with AI pedagogical competence, while AI pedagogical competence was positively associated with both curriculum integration and AI-enabled pedagogical practices. A key finding was the mediating role of AI pedagogical competence in the relationships between AI literacy and the two outcome variables. The reported indirect effects suggest that educators' ability to translate AI knowledge into instructional decisions provides an important pathway through which AI literacy is associated with curriculum integration and pedagogical practices. The persistence of the positive direct relationships also suggests that AI pedagogical competence complements, rather than entirely replaces, the direct contribution of AI literacy.

The study therefore concludes that meaningful AI integration in TVET education requires more than educators' awareness or understanding of artificial intelligence. It also requires the pedagogical competence to connect AI applications with relevant curriculum content, occupational learning activities and instructional objectives. Strengthening both AI literacy and AI pedagogical competence is consequently important for supporting the integration of AI into TVET curriculum and teaching practices.

Recommendations

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

1. University management should institutionalise continuous AI literacy training for TVET educators. The training programmes should be incorporated into staff development activities and organised through workshops, seminars and practical training sessions. The sessions should cover fundamental AI concepts, applications in occupational fields, evaluating AI-generated information, identifying biased outputs, data protection, and responsible AI use. Departments should also encourage educators to participate in relevant online professional development programmes to sustain their AI knowledge.

2. Faculties and departments offering TVET programmes should organise practical AI pedagogical competence development for their educators. These programmes should involve demonstrations and hands-on exercises in which educators practise selecting AI applications for specific learning

objectives, developing AI-supported instructional activities, adapting learning resources to students' needs and evaluating AI-generated materials. Educators should also be required to develop sample lesson plans and teaching activities that demonstrate appropriate AI use in their respective subject areas.

3. Heads of TVET departments should coordinate periodic reviews of course content to identify opportunities for integrating relevant AI competencies. During departmental curriculum review meetings, course lecturers and curriculum committees should examine existing course outlines, identify relevant AI concepts and occupational applications, and incorporate appropriate AI-related learning outcomes, examples and practical activities. The review should also address ethical considerations and responsible AI use in the relevant occupational fields.

4. TVET educators should incorporate appropriate AI applications into their regular instructional activities. Lecturers should identify suitable AI tools for lesson preparation, developing instructional resources, explaining difficult vocational concepts, supporting student inquiry, and preparing feedback and assessments. They should also verify AI-generated information against reliable sources and subject knowledge before using it for instruction, while ensuring that students continue to develop the practical skills and independent judgement required in their disciplines.

5. University management should establish institutional guidelines governing the responsible use of AI in teaching, learning and curriculum-related activities. The guidelines should specify acceptable and unacceptable uses of AI, procedures for protecting students' and staff members' data, expectations for acknowledging AI-generated contributions, methods for checking the accuracy of AI outputs and measures for maintaining academic integrity. Departments should communicate these guidelines to educators and students and incorporate them into relevant course instructions.

6. University management should promote collaboration between TVET educators, curriculum specialists and educational technology experts. Faculties should establish departmental or interdepartmental working groups to identify emerging AI applications relevant to different occupational areas. These groups should develop and share sample teaching resources, practical learning activities and assessment materials that demonstrate how AI can be meaningfully integrated into TVET courses. Such collaboration would also encourage the exchange of experiences and effective practices among educators.

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