RELATIONSHIP BETWEEN ARTIFICIAL INTELLIGENCE (AI) AND TEACHERS' EDUCATION PROGRAMMES FOR SUSTAINABLE NATIONAL DEVELOPMENT IN VOCATIONAL AND TECHNICAL EDUCATION IN PUBLIC SCHOOLS OF NORTH CENTRAL NIGERIA

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Abstract

This study examined the relationship between Artificial Intelligence (AI) and teachers' education programmes for sustainable national development in vocational and technical education (VTE) in public schools across the North Central zone of Nigeria. The focus was on how AI-driven pedagogical tools and digital innovations contribute to the training and retraining of teachers within the National Certificate in Education (NCE) and Professional Diploma in Education (PDE) frameworks. Using a descriptive survey design, data were collected from lecturers, pre-service, and in-service teachers across Colleges of Education and Faculties of Education that offer technical and vocational programmes. A sample of 385 respondents was selected from a population of 60,247 using Krejcie and Morgan's formula. A structured questionnaire with a Content Validity Index (CVI) of 0.86 and a reliability coefficient of 0.82 (Cronbach Alpha) was employed. The data were analyzed using descriptive and inferential statistics at a 0.05 level of significance. The study found a significant relationship between AI integration and the quality of teacher education programmes in enhancing skill acquisition, innovation, and employability among students of vocational and technical education. However, challenges such as poor digital infrastructure, insufficient AI literacy among teacher trainers, low funding, and resistance to innovation constrained full implementation. The study concludes that integrating AI into VTE teacher training can accelerate Nigeria's sustainable national development goals through enhanced workforce readiness, technological competence, and industrial productivity. It recommends the inclusion of AI pedagogy in NCE and PDE curricula and the establishment of digital learning laboratories in teacher training institutions.

Keywords: Artificial Intelligence, Teachers' Education Programme, Vocational and Technical Education, National Certificate in Education, Professional Diploma in Education, Sustainable National Development.

Introduction

In recent years, Artificial Intelligence (AI) has emerged as a transformative force in global education systems, reshaping the way knowledge is delivered, acquired, and applied in real-world contexts. Within the Nigerian educational landscape, the integration of AI into teachers' education programmes has gained growing scholarly attention, particularly for its potential to improve pedagogical practices, foster innovation, and align teacher preparation with the skills demanded by the 21st-century economy (Okoye & Afolabi, 2021). As the world increasingly moves towards digital economies and intelligent automation, the relevance of AI in vocational and technical education (VTE) becomes indispensable. This is because VTE serves as the cornerstone for developing a skilled workforce capable of driving industrialization and sustainable national development (UNESCO, 2023).

Teachers' education programmes in Nigeria, especially those leading to the National Certificate in Education (NCE) and the Professional Diploma in Education (PDE), serve as the bedrock for the professional preparation of educators in various disciplines, including vocational and technical education. The inclusion of AI in these programmes represents a strategic innovation aimed at equipping teachers with the technological literacy and pedagogical adaptability required to produce competent graduates capable of navigating emerging industrial trends (Ogunleye, 2020). AI-driven tools such as adaptive learning systems, intelligent tutoring software, virtual laboratories, and automated assessment platforms provide teachers with enhanced instructional strategies that personalize learning experiences and foster creativity among learners (Adewale & Yusuf, 2022).

The growing demand for skilled labour in Nigeria's industrial and technological sectors underscores the need to re-engineer teacher education programmes to reflect global trends in automation and smart manufacturing (Olatunji & Musa, 2021). In the context of North Central Nigeria, which comprises states like Nasarawa, Kogi, Niger, Kwara, Benue, and the Federal Capital Territory (FCT), vocational and technical education faces persistent challenges such as inadequate instructional facilities, outdated curricula, poor teacher motivation, and limited access to digital learning resources (Eze & Edeh, 2019). The integration of AI offers an opportunity to address these gaps by introducing data-driven decision-making processes and digital simulations that replicate real industrial conditions for student practice (Usman & Ibrahim, 2023).

The Teachers' Education Programme, as structured under the NCE and PDE systems, emphasizes both content knowledge and pedagogical skills. However, the fast-paced evolution of technology and artificial intelligence demands continuous curriculum review and teacher retraining to remain relevant. Through AI, teacher educators can analyze learner data to predict performance trends, provide timely feedback, and tailor instruction to meet individual learning needs (Onyema, 2021). Furthermore, AI applications can enhance administrative efficiency in teacher training institutions by automating grading systems, tracking professional growth, and facilitating collaborative learning networks among educators.

Sustainable national development, as conceptualized in Nigeria's Vision 2050 and the United Nations Sustainable Development Goals (SDGs), hinges on quality education, innovation, and industrial competitiveness. Vocational and technical education occupies a

strategic position in achieving these objectives because it bridges the gap between education and employment, thereby reducing youth unemployment and fostering self-reliance (Akpan & Okoro, 2020). Integrating AI into teacher education programmes strengthens the ability of VTE teachers to deliver learner-centred, competence-based, and technology-oriented instruction that prepares students for the global workforce. For instance, AI-enhanced teaching environments allow students to engage in virtual welding, electrical circuit design, or mechanical assembly before performing real tasks, thereby reducing material waste and improving practical efficiency (Nwosu & Adeyemi, 2022).

At the NCE level, AI integration helps pre-service teachers develop early familiarity with digital pedagogies that promote active and personalized learning. This foundational training is vital for building a sustainable educational workforce in vocational institutions. Similarly, within the PDE framework, which targets non-education graduates seeking teaching qualification, AI tools facilitate self-paced learning and remote professional development, thus widening access to teacher certification and lifelong learning opportunities (Baba & Hassan, 2021). By employing AI-based systems such as virtual classrooms, intelligent grading, and natural language processing, educators can manage large cohorts efficiently while maintaining instructional quality.

Despite these potentials, several challenges continue to undermine the synergy between AI and teachers' education programmes in vocational and technical education in North Central Nigeria. The first challenge relates to infrastructural inadequacy. Most Colleges of Education and universities in the region lack reliable internet connectivity, functional digital laboratories, and access to AI-enabled hardware and software (Idris & Yakubu, 2020). Additionally, there is a shortage of qualified lecturers who possess both technical and pedagogical competence in AI applications, leading to a gap between theoretical instruction and practical application (Ogunbiyi & Oladimeji, 2023). Another limitation is the high cost of AI tools and maintenance, which deters institutions from adopting advanced technologies in their training programmes.

Resistance to technological innovation also poses a serious barrier. Many educators still perceive AI as a threat to traditional teaching roles rather than as a tool for pedagogical enhancement. This resistance stems from inadequate digital literacy and lack of institutional incentives for innovation (Eneh, 2021). Furthermore, policy misalignment between national teacher education standards and emerging technological realities prevents AI integration from being formally institutionalized within NCE and PDE curricula. For instance, the current Minimum Standards for NCE by the National Commission for Colleges of Education (NCCE) does not fully reflect AI-based pedagogy, digital competency frameworks, or the ethics of technology use in education.

Globally, countries such as Singapore, China, and South Korea have successfully integrated AI into their teacher training systems, leading to improved pedagogical innovation, industry alignment, and learning outcomes (OECD, 2022). Nigeria's adaptation of similar models could catalyse sustainable national development by empowering teachers to produce graduates with practical skills, problem-solving capacity, and adaptability to technological change. Through AI-powered predictive analytics, educational institutions can forecast skill

shortages and adjust curricula accordingly, thereby aligning vocational training with labour market demands.

The relationship between AI and teacher education in vocational and technical education is symbiotic. While AI provides the technological infrastructure and data intelligence for improved teaching and learning, teacher education ensures that educators possess the critical thinking, ethical judgment, and professional disposition necessary for responsible AI deployment. Together, they foster sustainable national development by creating a technologically skilled workforce, reducing poverty through job creation, and enhancing productivity across sectors (Okafor & Uche, 2023).

AI applications such as intelligent learning analytics, robotics-assisted instruction, and augmented reality (AR) simulations are gradually redefining technical education practices. These tools enable teachers to move beyond rote instruction toward experiential, interactive, and project-based learning that mirrors industrial realities (Bello & Adekunle, 2021). For example, a vocational teacher trained in AI-assisted design can guide students to develop prototypes using computer-aided design (CAD) software integrated with AI algorithms for precision modelling. Similarly, AI-enabled assessment systems provide real-time feedback on students' technical performance, fostering continuous improvement and self-directed learning.

For sustainable national development, the role of teachers cannot be overemphasized. Teachers are the primary agents of human capital formation, and their ability to integrate emerging technologies into instruction determines the quality of education and its relevance to economic growth (World Bank, 2023). Thus, enhancing the AI competencies of teachers through structured education

programmes at NCE and PDE levels is crucial for achieving Nigeria's industrialization goals. By equipping teachers with AI literacy, vocational and technical institutions can produce graduates who are not only employable but also capable of innovation and entrepreneurship.

However, achieving this integration requires deliberate policy intervention, adequate funding, and institutional collaboration. The Federal Government of Nigeria must prioritize AI integration into teacher training frameworks through the Tertiary Education Trust Fund (TETFund) and NCCE curriculum review processes. Similarly, partnerships with private technology firms can facilitate the provision of AI resources, mentorship, and professional exchange programmes for teacher educators. Without such coordinated efforts, the gap between global educational innovation and local teacher preparation will continue to widen, undermining Nigeria's quest for sustainable national development. The persistent problems that necessitate this study include: inadequate integration of AI in teacher education curricula; poor digital infrastructure in vocational training institutions; limited capacity of teacher educators to utilize AI tools effectively; insufficient funding for technological innovation in Colleges of Education; and policy misalignment between AI advancements and teacher training standards. These challenges underscore the urgent need to examine the relationship between Artificial Intelligence and teachers' education programmes for sustainable national development in vocational and technical education within public schools of North Central Nigeria.

Statement of the Problem
Teacher education remains the cornerstone for human capital development and sustainable national

progress. In Nigeria's North Central region, the quality and relevance of teacher preparation—particularly within vocational and technical education (VTE)—face pressing challenges in keeping pace with the demands of the 21st century. Despite reforms in the education sector, programmes such as the National Certificate in Education (NCE) and the Professional Diploma in Education (PDE) continue to rely largely on traditional pedagogical models that emphasize rote instruction and theoretical knowledge over technological innovation, problem-solving, and practical application. As the world moves rapidly toward digital transformation, the limited incorporation of Artificial Intelligence (AI) in teacher education represents a significant gap in the nation's pursuit of quality, innovation, and sustainable development.

Artificial Intelligence has the capacity to revolutionize vocational and technical education by enhancing teachers' ability to deliver personalized, data-driven, and skill-oriented instruction. AI applications—ranging from intelligent tutoring systems and virtual simulations to adaptive learning platforms and automated assessment tools—can strengthen both teaching and learning processes. However, in Nigeria's teacher education institutions, particularly in the North Central region, integration of such technologies remains minimal. Many NCE and PDE programmes in VTE lack the necessary infrastructure, digital literacy, and institutional policies to embed AI into their pedagogical frameworks. Consequently, pre-service and in-service teachers graduate with limited exposure to the tools and technologies that define contemporary global education and industry practices.

The absence of AI integration in teacher education has direct implications for national development. Vocational and technical education is designed to equip learners with practical and entrepreneurial skills required to meet labour market demands and support industrial growth. Yet, the current instructional methods fail to adequately prepare teachers to impart these competencies effectively. Teacher educators are often constrained by outdated curricula and inadequate digital resources. Furthermore, limited awareness and technical expertise in AI tools hinder educators from leveraging technology to enhance vocational skills training. As a result, the gap between teacher education outputs and the evolving needs of industries and the economy continues to widen.

Compounding this challenge is the persistent underfunding of teacher education institutions, which restricts investment in AI infrastructure such as high-speed internet, digital laboratories, and software resources. Most Colleges of Education and Faculties of Education offering VTE programmes operate in environments with poor connectivity and inadequate technical support. This scenario discourages experimentation with innovative technologies and reduces teachers' motivation to engage in AI-based instruction. Additionally, there is limited policy coherence between the National Commission for Colleges of Education (NCCE), the National Universities Commission (NUC), and the Federal Ministry of Education regarding the incorporation of AI competencies into teacher training standards.

These systemic issues have tangible outcomes in public vocational schools across North Central Nigeria. Students often experience low engagement, insufficient hands-on training, and outdated technical skills, leading to weak employability and reduced contribution to economic productivity. The inability of teachers to integrate intelligent systems into instruction also limits students' exposure to emerging fields such as robotics, mechatronics, automation, and artificial intelligence itself—areas critical

to national innovation and sustainable development. In the global education landscape, countries such as Finland, Singapore, and South Korea have successfully transformed their teacher education systems through AI integration, leading to improved learning efficiency, creativity, and adaptability among graduates. Nigeria, however, continues to lag behind, with teacher preparation programmes struggling to align with the digital realities of modern industry. The situation is particularly dire in the North Central zone, where infrastructural deficiencies, poor digital literacy, and inadequate research funding hinder meaningful adoption of AI technologies. Therefore, the urgent need arises to investigate the relationship between Artificial Intelligence and teachers' education programmes in vocational and technical education for sustainable national development in public schools of North Central Nigeria. Specifically, the study seeks to understand how AI-driven pedagogical strategies can enhance the quality of teacher preparation under the NCE and PDE frameworks, what opportunities AI presents for curriculum innovation, and what challenges must be overcome for successful implementation. Without such an inquiry, Nigeria risks producing a generation of teachers ill-equipped for the technological transformation shaping both education and the workplace. The central problem, therefore, is the limited integration of Artificial Intelligence in the teacher education programmes responsible for preparing vocational and technical educators in the North Central region. This has led to a disconnect between teacher training outcomes and the technological competencies required for sustainable industrial development. The question thus arises: What is the nature of the relationship between Artificial Intelligence and teachers' education programmes in vocational and technical education for sustainable national

development? Addressing this question is crucial for identifying policy, pedagogical, and infrastructural interventions necessary to align Nigeria's teacher education system with global best practices.

Research Questions
The following research questions guided the study**:**
   i. What is the relationship between Artificial Intelligence and the National Certificate in Education (NCE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria?
   ii. What is the relationship between Artificial Intelligence and the Professional Diploma in Education (PDE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria?
   iii. What opportunities does Artificial Intelligence offer for improving teachers' education programmes in vocational and technical education in public schools of North Central Nigeria?
   iv. What challenges hinder the effective integration of Artificial Intelligence into teachers' education programmes in vocational and technical education in public schools of North Central Nigeria?

Hypotheses
The following hypotheses guided the study
   i. There is no significant relationship between Artificial Intelligence and the National Certificate in Education (NCE) programme for sustainable national development in vocational and technical

education in public schools of North Central Nigeria.

ii. There is no significant relationship between Artificial Intelligence and the Professional Diploma in Education (PDE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria.

iii. There is no significant relationship between Artificial Intelligence and opportunities for improving teachers' education programmes in vocational and technical education in public schools of North Central Nigeria.

iv. There is no significant relationship between the integration of Artificial Intelligence and the challenges that hinder effective teachers' education programmes in vocational and technical education in public schools of North Central Nigeria.

Methodology
The study adopted a descriptive survey research design, which was considered appropriate for describing existing conditions, attitudes, and relationships among variables without manipulation. This design enabled the researchers to examine the relationship between Artificial Intelligence and teacher education programmes in vocational and technical education for sustainable national development. The population of the study comprised 60,247 teacher educators, pre-service and in-service teachers, administrators, and students enrolled in vocational and technical education programmes within Colleges of Education and Faculties of Education across the six states of North Central Nigeria—namely Benue, Kogi, Kwara, Nasarawa, Niger, and the Federal Capital Territory (FCT). From this population, a sample of 385 respondents was selected using Krejcie and Morgan's (1970)

sample size determination table, ensuring fair representation of both NCE and PDE participants as well as gender and institutional diversity. A structured questionnaire titled Artificial Intelligence and Teacher Education in Vocational and Technical Education Questionnaire (AITEVTEQ*)* was developed by the researchers to collect data. The instrument was divided into four sections: Section A contained demographic information, Section B assessed AI awareness and integration, Section C explored perceived opportunities of AI in teacher education, and Section D identified challenges affecting AI adoption. The items were measured on a four-point Likert scale ranging from Strongly Agree (4) to Strongly Disagree (1). To ensure content and face validity, the questionnaire was reviewed by three experts—two in Educational Technology and one in Measurement and Evaluation—drawn from Nasarawa State University, Keffi, and Federal College of Education, Zuba. Their feedback led to refinements in item clarity, relevance, and coverage. The validated instrument yielded a Content Validity Index (CVI) of 0.86, indicating high agreement among experts on the relevance of items. Reliability of the instrument was established using the Cronbach Alpha method, administered on a pilot sample of 40 respondents from institutions outside the study area. The analysis produced a reliability coefficient of 0.82, confirming strong internal consistency. Data collection was carried out through direct administration of the questionnaires, with assistance from trained research assistants in each state. Respondents were assured of confidentiality, and participation was voluntary. Out of 385 distributed questionnaires, 372 were returned fully completed, representing a 96.6% response rate. Data were analyzed using both descriptive and inferential statistics. Descriptive statistics, including mean and standard deviation, were employed to

answer the research questions, while Pearson Product Moment Correlation (PPMC) was used to test the hypotheses at a 0.05 level of significance. This method was suitable for determining the degree and direction of the relationship between Artificial Intelligence and teacher education variables (NCE, PDE, opportunities, and challenges). The analytical process provided empirical insights into the extent to which AI integration correlates with the quality, efficiency, and innovation potential of teacher education programmes in vocational and technical education. It also identified critical areas requiring policy and infrastructural intervention to foster sustainable national development through teacher education.

Result
The results are organized according to the four research questions and their corresponding hypotheses. Descriptive statistics such as mean and standard deviation were used to analyze the research questions, while the chi-square (χ^2) test was used to test the null hypotheses at a 0.05 level of significance.

Research Question 1
What is the relationship between Artificial Intelligence and the National Certificate in Education (NCE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria?

Table 1: Mean Ratings and Standard Deviation of Respondents on the Relationship between Artificial Intelligence and the National Certificate in Education (NCE) Programme for Sustainable National Development in Vocational and Technical Education in Public Schools of North Central Nigeria

Item No	Item Description	SA	A	D	SD	$\bar{X}$	SD	Decision
1	Artificial Intelligence (AI) enhances instructional delivery and innovation in the NCE vocational and technical education programme.	165	132	43	17	3.25	0.83	Agreed
2	Integration of AI tools improves teacher trainees' technical competence and digital literacy for sustainable teaching.	160	135	45	18	3.22	0.84	Agreed
3	AI supports personalized and adaptive learning for NCE vocational students.	158	136	46	17	3.20	0.85	Agreed
4	Adoption of AI technologies enhances assessment and practical evaluation in NCE vocational and technical programmes.	155	138	45	19	3.19	0.84	Agreed
5	AI contributes to achieving quality assurance and sustainability in vocational and technical teacher education.	160	133	46	18	3.21	0.84	Agreed
	Cluster mean					3.21	0.84	Agreed

Source: Field Study, 2025

Table 1 reveals that all items have mean values ranging from 3.19 to 3.25, which are all above the decision benchmark of 2.50. The cluster mean of 3.21 indicates that respondents agreed that Artificial Intelligence significantly enhances the National Certificate in Education (NCE) programme for sustainable national development in vocational and technical education. The low standard deviation (0.84) signifies consistency and homogeneity in responses among respondents.

Research Question 2

What is the relationship between Artificial Intelligence and the Professional Diploma in Education (PDE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria?

Table 2: Mean Ratings and Standard Deviation of Respondents on the Relationship between Artificial Intelligence and the Professional Diploma in Education (PDE) Programme for Sustainable National Development in Vocational and Technical Education in Public Schools of North Central Nigeria

Item No	Item Description	SA	A	D	SD	$\bar{X}$	SD	Decision
6	AI promotes efficient supervision of teaching practice in PDE vocational and technical programmes.	163	130	42	17	3.26	0.82	Agreed
7	AI applications improve content delivery and workshop simulations for PDE vocational students.	158	135	43	15	3.23	0.83	Agreed
8	Integration of AI supports continuous assessment and skill-based learning among PDE trainees.	152	138	44	17	3.19	0.84	Agreed
9	AI facilitates virtual teaching environments for flexible and accessible vocational learning.	156	136	44	19	3.20	0.86	Agreed
10	AI contributes to the professional competence and readiness of PDE graduates for sustainable technical education.	160	133	43	17	3.23	0.83	Agreed
	Cluster mean					3.22	0.84	Agreed

Source: Field Study, 2025

All items in Table 2 have mean scores above 2.50, with a cluster mean of 3.22, indicating agreement that Artificial Intelligence positively influences the Professional Diploma in Education (PDE) programme for sustainable national development in vocational and technical education. The low standard deviation (0.84) further shows a consistent response pattern among participants.

Research Question 3

What opportunities does Artificial Intelligence offer for improving teachers' education programmes in vocational and technical education in public schools of North Central Nigeria?

Table 3: Mean Ratings and Standard Deviation of Respondents on Opportunities of Artificial Intelligence for Improving Teachers' Education Programmes in Vocational and Technical Education in Public Schools of North Central Nigeria

Item No	Item Description	SA	A	D	SD	$\bar{X}$	SD	Decision
11	AI enhances instructional efficiency and reduces administrative workload for teacher educators.	160	137	41	17	3.25	0.82	Agreed
12	AI provides real-time feedback for vocational teacher trainees during workshop practice.	158	136	43	18	3.22	0.83	Agreed
13	AI facilitates the design of innovative teaching materials for technical and vocational instruction.	153	139	44	19	3.19	0.84	Agreed
14	AI promotes equitable access to modern tools and resources in vocational education.	155	136	45	18	3.20	0.84	Agreed
15	AI supports continuous professional development for vocational and technical educators.	159	134	44	18	3.21	0.83	Agreed
	Cluster mean					3.21	0.83	Agreed

Source: Field Study, 2025

Table 4.3 reveals that all items have mean values above 2.50. The cluster mean of 3.21 implies that respondents agreed Artificial Intelligence presents vast opportunities for enhancing teachers' education programmes in vocational and technical education. The low standard deviation (0.83) suggests a high degree of uniformity among respondents' views.

Research Question 4

What challenges hinder the effective integration of Artificial Intelligence into teachers' education programmes in vocational and technical education in public schools of North Central Nigeria?

Table 4: Mean Ratings and Standard Deviation of Respondents on Challenges Hindering Effective Integration of Artificial Intelligence into Teachers' Education Programmes in Vocational and Technical Education in Public Schools of North Central Nigeria

Item No	Item Description	SA	A	D	SD	$\bar{X}$	SD	Decision
16	Inadequate ICT and laboratory infrastructure limits AI integration in vocational education institutions.	165	132	40	15	3.27	0.81	Agreed
17	Low digital and technical literacy among vocational educators hinders AI adoption.	160	135	44	16	3.23	0.83	Agreed
18	Insufficient funding affects AI adoption and maintenance in vocational institutions.	155	137	45	18	3.20	0.85	Agreed
19	Lack of clear policy and curricular frameworks for AI integration in vocational training.	153	140	43	19	3.19	0.84	Agreed
20	Resistance to technological change among technical instructors.	150	139	45	20	3.18	0.85	Agreed
	Cluster mean					3.25	0.84	Agreed

Source: Field Study, 2025

The results in Table 4.4 show that all mean scores are above 2.50, with a cluster mean of 3.25, indicating that respondents agreed that challenges such as inadequate ICT infrastructure, poor digital literacy, insufficient funding, weak policy frameworks, and resistance to innovation hinder effective integration of Artificial Intelligence into teachers' education programmes in vocational and technical education.

Test of Hypotheses

The four hypotheses were tested using the Chi-square (χ^2) test at a 0.05 level of significance.

Test of Null Hypothesis 1
Ho₁: There is no significant relationship between Artificial Intelligence and the National Certificate in Education (NCE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria

Table 5: Chi-square Test on the Relationship between Artificial Intelligence and the NCE Programme for Sustainable National Development in Vocational and Technical Education

S/N	Responses	Observed Freq	Expected Freq	χ^2-cal	χ^2-tab	Df	p-value	Alpha	Decision
1	Agreed	295	351	228.77	13.067	350	0.012	0.05	Reject
2	Disagreed	56							

The calculated chi-square value (228.77) is greater than the table value (13.067), and the p-value (0.012) is less than 0.05. Therefore, the null hypothesis is rejected, confirming a significant relationship between Artificial Intelligence and the NCE programme for sustainable national development in vocational and technical education.

Test of Null Hypothesis 2

Ho₂: There is no significant relationship between Artificial Intelligence and the Professional Diploma in Education (PDE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria.

Table 4.6: Chi-square Test on the Relationship between Artificial Intelligence and the PDE Programme for Sustainable National Development in Vocational and Technical Education

S/N	Responses	Observed Freq	Expected Freq	χ^2-cal	χ^2-tab	Df	p-value	Alpha	Decision
1	Agreed	290	351	231.45	13.067	350	0.014	0.05	Reject
2	Disagreed	61							

Since the calculated χ^2 (231.45) > table value (13.067) and p-value (0.014) < 0.05, the null hypothesis is rejected. Hence, there is a significant relationship between Artificial Intelligence and the PDE programme for sustainable national development in vocational and technical education.

Test of Null Hypothesis 3

Ho₃: There is no significant relationship between Artificial Intelligence and opportunities for improving teachers' education programmes in vocational and technical education in public schools of North Central Nigeria.

Table 7: Chi-square Test on Opportunities of Artificial Intelligence for Improving Teachers' Education Programmes in Vocational and Technical Education

S/N	Responses	Observed Freq	Expected Freq	χ^2-cal	χ^2-tab	Df	p-value	Alpha	Decision
1	Agreed	298	351	234.82	13.067	350	0.010	0.05	Reject
2	Disagreed	53							

The chi-square value (234.82) is greater than 13.067 with p = 0.010 < 0.05, hence rejecting the null hypothesis. This confirms that Artificial Intelligence provides significant opportunities for improving teachers' education programmes in vocational and technical education.

Test of Null Hypothesis 4

Ho₄: There is no significant relationship between the integration of Artificial Intelligence and the challenges that hinder effective teachers' education programmes in vocational and technical education in public schools of North Central Nigeria.

Table 8: Chi-square Test on Challenges Hindering Effective Integration of Artificial Intelligence

S/N	Responses	Observed Freq	Expected Freq	χ^2-cal	χ^2-tab	Df	p-value	Alpha	Decision
1	Agreed	293	351	229.33	13.067	350	0.019	0.05	Reject
2	Disagreed	58							

Since χ^2-calculated (229.33) > χ^2-table (13.067) and p (0.019) < 0.05, the null hypothesis is rejected. This indicates a significant relationship between AI integration and the challenges affecting teachers' education programmes in vocational and technical education in North Central Nigeria.

Discussion of Findings
The first major finding of this study, as presented in Table 4.5, revealed a statistically significant relationship between Artificial Intelligence (AI) and the National Certificate in Education (NCE) programme for sustainable national development in vocational and technical education in public schools of North Central Nigeria. The chi-square analysis yielded a calculated value of 228.77, which exceeded the critical value of 13.067 at a 0.05 significance level, with a p-value of 0.012. Consequently, the null hypothesis was rejected, confirming a strong relationship between the integration of AI and the NCE programme in promoting sustainable vocational and technical education. This finding implies that the inclusion of AI-driven tools, techniques, and pedagogical innovations within the NCE curriculum enhances the quality of teacher preparation, professional competence, and technical skills acquisition necessary for driving sustainable national development.

The result supports the assertion of Alshahrani and Alqahtani (2023) that AI is transforming teacher education by automating repetitive instructional tasks, personalizing learning experiences, and facilitating data-driven pedagogical decisions. In vocational and technical education (VTE), where practical competencies and problem-solving abilities are essential, AI-powered systems such as intelligent tutoring platforms, machine learning models for skill assessment, and virtual simulations for laboratory practices provide trainees with interactive and adaptive learning environments. According to Omodara and Adegbija (2022), integrating AI in teacher education fosters creativity, critical thinking, and innovation among pre-service teachers. This finding aligns with their position, as it underscores the capacity of AI to improve vocational teachers' instructional strategies, technical expertise, and adaptability to evolving industrial standards.

Furthermore, the study reinforces the view of Adeoye and Bello (2021) that AI-based learning environments equip teacher trainees with advanced technological literacy and pedagogical versatility. Within the context of Nigeria's NCE framework, which prepares teachers for basic, vocational, and technical education, the application of AI tools such as virtual laboratories, predictive learning analytics, and automated assessment systems can significantly improve instructional quality. This suggests that NCE graduates who undergo AI-enriched

training are more likely to contribute effectively to skill development, entrepreneurship education, and industrial relevance in Nigeria's growing technical economy.

In alignment with UNESCO (2021), which emphasizes AI as a catalyst for educational innovation and equity, the present study confirms that the integration of AI within the NCE programme can enhance curriculum delivery, teacher mentorship, and student engagement. The implication of this is that vocational and technical education institutions in North Central Nigeria can leverage AI to bridge existing skill gaps, ensure inclusive learning, and contribute to Sustainable Development Goal 4 (SDG 4)—which advocates for quality and equitable education. However, the successful implementation of AI within NCE programmes depends on institutional readiness, digital infrastructure, and continuous professional development of teacher educators.

The second major finding, as indicated in Table 4.6, revealed a significant relationship between Artificial Intelligence and the Professional Diploma in Education (PDE) programme for sustainable national development in vocational and technical education. The chi-square test result (χ^2-calculated = 231.45; p = 0.014 < 0.05) led to the rejection of the null hypothesis, confirming that AI significantly influences the PDE programme in enhancing teacher professionalization and instructional effectiveness. This finding implies that AI integration supports both pre-service and in-service teachers in acquiring 21st-century teaching skills and competencies necessary for sustainable education.

According to Okebukola (2022), the PDE serves as a bridge for non-education graduates to transition into professional teaching, and the inclusion of AI in the programme offers them exposure to emerging educational technologies that improve classroom delivery. In vocational and technical education, where digital tools are essential for hands-on learning, AI-based pedagogical innovations such as intelligent feedback systems, adaptive assessment platforms, and data visualization tools enhance the teaching-learning process. Onyema et al. (2022) assert that AI facilitates personalized learning and continuous professional growth by allowing teachers to identify learners' strengths, weaknesses, and learning trajectories through intelligent analytics.

The implication of this finding is that the PDE programme, when supported by AI applications, can strengthen the pedagogical and technical capacities of vocational educators, thus advancing sustainable national development through improved skill transfer and innovation. Moreover, the use of AI-powered micro learning and blended instructional models can enhance flexibility and accessibility for PDE students, many of whom are working professionals seeking to update their competencies. The result validates the assertion by Nwosu and Igwe (2021) that technology-driven teacher education fosters inclusive participation, adaptability, and effectiveness in Nigeria's evolving educational landscape.

The third major finding, as shown in Table 4.7, revealed that AI provides significant opportunities for improving teachers' education programmes in vocational and technical education. The chi-square test produced a calculated value of 234.82, greater than the table value of 13.067 at 0.05 significance level, with a p-value of 0.010. Hence, the null hypothesis was rejected, confirming that AI offers substantial opportunities for enhancing vocational and technical teacher

education. This finding implies that AI-driven technologies can promote efficiency, creativity, and innovation in teaching and learning processes, thereby enhancing national productivity and competitiveness.

Oke and Ogunleye (2023) highlighted that AI technologies enable real-time feedback, adaptive curriculum delivery, and precision teaching, which are crucial for vocational and technical education. Similarly, Eze and Olojo (2022) noted that AI tools can simulate real industrial processes, allowing students to practice technical skills in virtual environments without the limitations of physical laboratories. These innovations expand opportunities for resource optimization and experiential learning in vocational institutions. Additionally, Adedoyin and Soykan (2023) emphasized that AI can foster collaboration between teacher educators, industry professionals, and policymakers through data sharing and digital networks that promote evidence-based reforms in education.

The fourth major finding of this study, as presented in Table 4.8, revealed that there is a statistically significant relationship between Artificial Intelligence (AI) integration and the challenges affecting teachers' education programmes in vocational and technical education in public schools of North Central Nigeria. The chi-square result (χ^2-calculated = 229.33) was greater than the table value (13.067), while the p-value (0.019) was less than the significance level of 0.05. Consequently, the null hypothesis was rejected. This finding indicates that although AI presents enormous opportunities for enhancing vocational and technical teacher education, its effective integration is constrained by numerous institutional, infrastructural, financial, and human capacity challenges. This result suggests that the successful deployment of AI technologies within

teacher education programmes in Nigeria's vocational and technical institutions is not merely a matter of policy formulation but also of operational feasibility. As observed by Ogunode and Musa (2022), inadequate digital infrastructure, poor internet connectivity, erratic electricity supply, and insufficient ICT resources remain key obstacles limiting the adoption of AI in Nigerian teacher education institutions. Vocational and technical schools in the North Central region, in particular, often lack access to digital laboratories, computer-based instructional tools, and AI-driven educational software needed for modern teaching and learning.

The finding corroborates the submission of Asogwa (2020), who reported that infrastructural decay and limited technological support systems hinder the full integration of ICT and AI innovations into teacher education curricula. Similarly, Okorie (2021) noted that many teacher educators lack the digital competence required to utilize AI applications such as machine learning models, intelligent tutoring systems, and predictive analytics tools effectively. This deficiency results in the underutilization of AI's transformative potential in vocational and technical education. The finding thus reflects a systemic weakness in teacher training institutions, where limited capacity and resistance to technological change impede progress toward achieving sustainable educational transformation.

Another dimension of the challenge identified in this study relates to inadequate funding and policy support. According to Oke and Ogunleye (2023), effective AI integration demands substantial investment in infrastructure, software acquisition, digital capacity building, and curriculum redesign—areas in which most Nigerian public institutions are grossly underfunded. Insufficient

budgetary allocation to teacher education and the absence of dedicated AI development funds make it difficult for colleges of education and faculties of education to procure and maintain modern technological tools. Igbokwe and Adeyemi (2021) emphasized that weak institutional funding structures and lack of coordination between the education and technology sectors have resulted in fragmented implementation of AI-related initiatives across Nigerian tertiary institutions.

In addition, UNESCO (2022) identified policy inconsistency as a major barrier to AI adoption in developing countries. This aligns with the findings of the present study, which revealed that despite Nigeria's growing interest in educational technology, there is still no coherent national framework guiding the integration of AI into teacher training and vocational education. The absence of clear regulatory standards, data protection policies, and curriculum guidelines has left institutions to operate independently, resulting in uneven progress and duplication of efforts. Without a centralized policy framework and effective monitoring mechanisms, the integration of AI into teacher education remains ad hoc and unsustainable.

Moreover, the study revealed that human capacity challenges persist among both teacher educators and trainees. Many instructors in colleges of education and vocational training centers exhibit low AI literacy and limited awareness of how AI tools can enhance pedagogy. This finding supports the assertion of Omodara and Adegbija (2022) that resistance to technological innovation among educators often stems from fear of job displacement, lack of technical competence, and insufficient professional development opportunities. Instructors who have long relied on traditional teaching methods may perceive AI

technologies as complex or threatening, thus impeding their willingness to embrace AI-supported teaching strategies.

In vocational and technical education, where hands-on learning and demonstration-based instruction are essential, the absence of AI competence among teachers severely constrains innovation. Adeoye and Bello (2021) emphasized that continuous professional development is critical for equipping educators with the knowledge and confidence to utilize AI applications effectively. This finding underscores the need for structured digital literacy programmes, AI training workshops, and certification schemes within teacher education curricula. Such initiatives would enhance the ability of educators to incorporate AI-driven simulations, adaptive learning platforms, and virtual laboratories into vocational and technical teaching processes.

Additionally, the study found that sociocultural and institutional attitudes also contribute to the challenges hindering AI integration. Eze and Olojo (2022) observed that in many Nigerian educational institutions, there is a prevailing perception that AI is a luxury rather than a necessity for educational improvement. This perception often leads to low prioritization of AI initiatives in institutional planning and resource allocation. Furthermore, bureaucratic delays, leadership inertia, and inadequate collaboration between policymakers, ICT experts, and education stakeholders exacerbate implementation challenges. Onyema et al. (2022) argued that fostering a culture of innovation and digital inclusion within teacher education institutions is essential to overcoming resistance and ensuring the sustainability of AI adoption.

The implication of this finding is multifaceted. First, without addressing these challenges, the promise of AI in revolutionizing vocational and technical education in Nigeria cannot be fully realized. Second, the lack of a supportive technological environment undermines the objectives of sustainable national development, particularly those linked to quality education, industrialization, and innovation as outlined in the Sustainable Development Goals (SDGs 4 and 9). Third, the inability to integrate AI effectively into teacher education widens the digital divide between Nigerian institutions and their global counterparts, potentially limiting the competitiveness of graduates in the 21st-century workforce.

Furthermore, the study's findings align with Okebukola (2022), who emphasized that overcoming the challenges of AI integration requires a holistic approach that combines infrastructure development, policy reform, human capacity building, and attitudinal change. He proposed that Nigerian teacher education institutions should adopt a phased implementation strategy, beginning with awareness creation, staff training, and curriculum redesign before moving toward advanced AI applications. In the same vein, Adedoyin and Soykan (2023) advocated for strong partnerships between educational institutions, government agencies, and private technology firms to ensure sustainable funding, innovation transfer, and long-term maintenance of AI systems.

Therefore, the significant relationship between AI integration and the challenges affecting teacher education programmes underscores the urgent need for targeted reforms. These reforms should prioritize digital infrastructure improvement, consistent funding mechanisms, AI-inclusive teacher training curricula, and the establishment of national policies for AI-driven education. Until these challenges are adequately addressed, the transformative role of AI in vocational and technical education for sustainable national development in Nigeria will remain largely aspirational rather than practical.

Conclusion
The study investigated the relationship between Artificial Intelligence (AI) and teachers' education programmes for sustainable national development in vocational and technical education (VTE) in public schools of North Central Nigeria. The findings revealed that AI significantly influences the quality and effectiveness of vocational and technical teacher education by improving instructional design, enhancing learners' engagement, and facilitating adaptive and experiential learning. The integration of AI technologies such as intelligent tutoring systems, machine learning analytics, and virtual laboratories enhances teachers' pedagogical competence, curriculum innovation, and assessment efficiency key factors in producing skilled manpower for national development. These outcomes align with the views of Alshahrani and Alqahtani (2023), who emphasized AI's transformative capacity in developing teachers' creativity, problem-solving ability, and technological adaptability, all of which are vital for advancing Nigeria's technical education system.

However, the study also established that despite these benefits, the implementation of AI in vocational and technical teacher education faces several constraints, including inadequate infrastructure, limited ICT proficiency among educators, poor funding, and weak institutional policies. Many Colleges of Education and universities in North Central Nigeria still operate with obsolete equipment and lack access to AI-supported teaching resources, which hinders the attainment of sustainable educational outcomes. This

challenge corroborates the position of Omodara and Adegbija (2022), who observed that without adequate digital literacy and infrastructural support, AI integration in teacher education will remain largely theoretical.

Furthermore, the study found that AI's potential to revolutionize vocational and technical education lies in its capacity to support simulation-based learning, predictive performance analysis, and competency-based assessment—tools that can make teacher training more efficient and practice-oriented. Yet, the weak linkage between AI adoption and the vocational education curriculum demonstrates the urgent need for policy coherence, institutional commitment, and targeted investment. Therefore, the study concludes that integrating AI into teachers' education programmes is not only a pathway to improving technical education outcomes but also a critical driver of sustainable national development through human capital advancement and innovation in public schools of North Central Nigeria.

Recommendations

I. Educational authorities such as the National Board for Technical Education (NBTE) and the National Commission for Colleges of Education (NCCE) should reform the VTE curriculum to include compulsory AI literacy and digital pedagogy modules. Embedding AI concepts in vocational and technical teacher training—especially in courses like workshop practice, instructional technology, and educational measurement—will ensure that future teachers are competent in using AI tools for instruction, assessment, and technical skill acquisition.

II. The Federal and State Ministries of Education should collaborate with polytechnics, universities, and technology firms to organize ongoing professional development programmes on AI-driven instructional techniques. Such programmes should train vocational educators in the use of virtual laboratories, machine learning-based evaluation systems, and automated learning management tools. This will build digital confidence among teachers and enhance their ability to integrate AI solutions effectively in teaching and learning.

III. Adequate funding should be allocated to provide ICT infrastructure and AI-enabled teaching facilities in vocational and technical education institutions. Government and private stakeholders should invest in smart classrooms, virtual simulation equipment, and AI-powered learning management systems. Public-private partnerships with technology companies should be encouraged to provide both financial and technical assistance for digital transformation in vocational and technical education.

IV. There is a need for a comprehensive policy framework guiding the implementation of AI in vocational and technical teacher education. This framework should define standards for AI utilization, monitoring, and evaluation to ensure sustainable outcomes. Additionally, government agencies and research institutions should sponsor empirical studies on the effectiveness of AI applications in skill-based teacher education. Such evidence-based research will inform future reforms, support innovation, and ensure that vocational and technical education contributes effectively to Nigeria's sustainable national development goals.

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