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The Role of Artificial Intelligence in Vocational and Technical Education on Youth Empowerment and Socioeconomic Development in Sokoto State

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ABSTRACT

Artificial intelligence (AI) is increasingly shaping education, employment, and skills development, yet its integration in technical and vocational education and training (TVET) remains limited in low-resource contexts. This study assessed AI readiness for digital and vocational learning in TVET institutions in Sokoto State, Nigeria, using a quantitative cross-sectional survey of 200 students, educators, and administrators. Measures covered AI awareness, infrastructure readiness, teacher and learner capacity, curriculum and policy readiness, perceived employability benefits, and barriers to AI integration. Descriptive statistics, ANOVA, correlation, and regression analyses were applied. Results showed moderate AI awareness ($M = 3.02$), low infrastructure readiness ($M = 2.34$), low curriculum and policy readiness ($M = 2.25$), and low-to-moderate overall AI readiness ($M = 2.59$). In contrast, perceived employability benefits of AI were high ($M = 4.06$), indicating strong recognition of AI's labour-market relevance. The main barrier was the lack of trained educators ($M = 4.22$), followed by poor electricity supply and weak policy or curriculum guidance. Significant group differences were found in awareness, teacher/learner capacity, and overall readiness. The findings suggest that while AI integration in Sokoto State TVET is promising, progress requires a staged strategy prioritising teacher training, foundational AI literacy, low-cost digital tools, and curriculum reform.

Keywords: artificial intelligence, TVET, digital learning, vocational education, youth empowerment

1. INTRODUCTION

Artificial intelligence (AI) is increasingly influencing how knowledge is produced, accessed, taught, assessed, and applied in work-related contexts. In education, AI is commonly associated with adaptive learning systems, intelligent tutoring, automated assessment, learning analytics, and generative tools that support teaching and learning (Chen et al., 2020; Crompton & Burke, 2023; Wang et al., 2024). These developments offer opportunities for personalised learning and skills development but also raise concerns about equity, teacher preparedness, data governance, and the capacity of education systems to adopt AI responsibly (Miao et al., 2021; Zawacki-Richter et al., 2019).

AI is particularly relevant for technical and vocational education and training (TVET), which equips learners with practical skills for employment, self-employment, and entrepreneurship. As automation and AI reshape job tasks and labour-market expectations, TVET institutions are under pressure to prepare

learners for emerging forms of work (World Economic Forum, 2023). AI literacy is no longer relevant only to computer science students; it is increasingly relevant to agriculture, engineering, business, construction, and technical trades.

In Nigeria, TVET has long been viewed as a pathway for improving youth employability. However, empirical studies on Nigerian technical colleges show persistent constraints, including inadequate equipment, limited funding, weak workshop management, and gaps in career guidance and labour-market alignment (Okolie et al., 2019, 2020). AI integration requires more than curriculum ambition: it requires trained educators, functional digital infrastructure, reliable electricity, internet access, institutional policy support, and practical industry links.

Sokoto State provides a relevant context for examining AI readiness in TVET because youth empowerment and vocational skill development remain pressing development priorities, while many low-resource settings face infrastructural and institutional limitations that may restrict their ability to benefit from emerging technologies. The World Bank Group (2019) identifies digital infrastructure, platforms, financial services, entrepreneurship, and skills as foundational pillars of Nigeria's digital economy. If these foundations are weak in TVET institutions, AI adoption may remain rhetorical rather than practical. Although research on AI in education has grown rapidly, much of the literature focuses on higher education, intelligent tutoring, learning analytics, or AI-supported personalisation (Crompton & Burke, 2023; Wang et al., 2024; Zawacki-Richter et al., 2019). Less empirical attention has been given to AI readiness in TVET institutions in low-resource African contexts. Readiness includes human readiness (awareness, confidence, teacher capacity); institutional readiness (infrastructure, technical support); and curriculum readiness (the formal inclusion of AI literacy and emerging technologies in training programmes) (Dai et al., 2020; Miao et al., 2021).

This study examines AI readiness for digital and vocational learning in TVET institutions in Sokoto State. It does not assume that AI automatically improves youth empowerment; instead, it investigates whether the necessary readiness conditions exist and whether stakeholders perceive AI-related skills as relevant to employability and entrepreneurship.

1.1 Aim and Objectives

The aim is to assess the readiness of TVET institutions in Sokoto State to integrate AI into digital and vocational learning. Specific objectives are to: (1) assess AI awareness among students, educators, and administrators; (2) examine institutional readiness (electricity, internet, computing facilities, technical support); (3) assess teacher and learner capacity; (4) examine curriculum and policy preparedness; (5) investigate perceptions of AI's contribution to employability and entrepreneurship; (6) identify key barriers; and (7) propose practical strategies for integrating AI literacy into TVET curricula.

1.2 Contribution of the Study

This study contributes to the literature in four ways. First, it provides empirical evidence on AI readiness in TVET institutions in a low-resource Nigerian context. Second, it shifts the discussion from the general promise of AI to measurable readiness conditions. Third, it links AI readiness to youth empowerment without making unsupported causal claims about employment or income outcomes. Fourth, it provides a practical framework for policymakers, educators, and TVET administrators seeking to introduce AI literacy and digital skills into vocational education.

2. LITERATURE REVIEW

2.1 Artificial Intelligence in Education

AI in education refers to computational systems that support tasks such as prediction, classification, recommendation, feedback generation, language processing, and personalised learning. Common applications include intelligent tutoring systems, adaptive learning environments, automated assessment, learning analytics, and generative AI tools (Chen et al., 2020; Holmes et al., 2019; Wang et al., 2024). Systematic reviews show rapid expansion: Zawacki-Richter et al. (2019) found that AI research in higher education has focused on student profiling, prediction, and assessment, with limited attention to

educators. Crompton and Burke (2023) and Wang et al. (2024) confirm intelligent tutoring, assessment, and learning analytics as dominant themes.

Researchers caution against treating AI as an automatic solution. Selwyn (2019) and Williamson and Eynon (2020) argue that data-driven education can reproduce inequality if governance, ethics, and institutional capacity are not addressed. UNESCO emphasises that AI in education should be human-centred, inclusive, transparent, and ethically governed (Miao et al., 2021). For TVET, this is particularly important: vocational education is practical and skills-oriented, and AI tools require trained educators, reliable infrastructure, and curriculum integration to be effective.

2.2 AI Readiness and Educational Implementation

AI readiness refers to the extent to which individuals, institutions, and systems are prepared to adopt AI meaningfully, ethically, and sustainably. It includes awareness, perceived relevance, teacher capacity, infrastructure, curriculum preparedness, and policy support. Dai et al. (2020) propose that readiness involves knowledge, ability, evaluation, ethics, and future-oriented perception. Teacher readiness is equally important: Ayanwale et al. (2022) showed Nigerian teachers' readiness to teach AI is influenced by behavioural intention, perceived usefulness, self-efficacy, and facilitating conditions. Without confident, trained, and supported teachers, AI integration is unlikely to succeed.

Technology acceptance theories support this. The Technology Acceptance Model (Davis, 1989) emphasises perceived usefulness and ease of use, while UTAUT (Venkatesh et al., 2003) adds performance expectancy, effort expectancy, social influence, and facilitating conditions. In low-resource settings, facilitating conditions are especially critical: positive attitudes alone cannot compensate for missing electricity, connectivity, computers, or trained personnel. This study, therefore treats AI readiness as a multidimensional construct.

2.3 TVET, Youth Empowerment, and Employability

TVET is widely recognised as a pathway for developing practical skills, improving employability, supporting entrepreneurship, and promoting socioeconomic participation (Billett, 2011; McGrath et al., 2020). UNESCO's TVET strategy emphasises that vocational education must respond to technological change, digitalisation, and shifting labour-market demands (UNESCO, 2022; UNESCO-UNEVOC, 2025). In Nigeria, Okolie et al. (2019, 2020) identified persistent challenges in workshop management, equipment, funding, and career guidance, suggesting that employability outcomes depend on institutional support and labour-market alignment in addition to curriculum content.

AI-related skills may strengthen TVET by exposing learners to digital tools, automation, and data-driven decision-making. AI can support agriculture, engineering and technical trades (simulation, predictive maintenance, computer-aided design), and business and entrepreneurship. However, AI readiness does not automatically produce employment or income gains. A defensible argument is that AI-related skills may improve perceived employability, digital confidence, and preparedness for technology-mediated work.

2.4 Digital Infrastructure and the Nigerian Context

Digital infrastructure is foundational for AI-enabled learning. The World Bank Group (2019) identifies digital infrastructure, skills, platforms, financial services, and entrepreneurship as the key pillars of Nigeria's digital economy. The digital divide remains serious: Van Dijk (2020) and Warschauer (2004) argue that digital inequality is not limited to physical access but includes differences in skills, usage, and outcomes. For TVET institutions in low-resource settings, this implies that AI adoption should be staged. Expensive AI laboratories or advanced robotics may not be feasible as initial interventions; more appropriate starting points include basic AI literacy, mobile-based learning, offline resources, AI-assisted lesson planning, and vocationally relevant data literacy.

2.5 AI, Labour-Market Change, and Vocational Relevance

AI is reshaping labour markets by changing tasks and skills employers demand. The World Economic Forum (2023) identifies technological change, automation, and AI as major drivers of job transformation. Workers increasingly need digital adaptability, problem-solving ability, data awareness, and the capacity

to use AI-supported tools in their fields. The OECD (2021) argues that AI has broad implications for skills systems, work organisation, and education policy, and Luckin et al. (2016) argue that AI supports learning when designed around human intelligence, pedagogy, and meaningful goals.

2.6 Curriculum and Policy Readiness for AI in TVET

Without formal curriculum support, AI-related learning depends on individual teachers or short-term projects, producing inconsistent implementation. UNESCO recommends coherent policy frameworks addressing inclusion, teacher development, curriculum design, ethics, and data governance (Miao et al., 2021; UNESCO-UNEVOC, 2025). Curriculum readiness involves formal inclusion of AI literacy, digital skills, data literacy, ethical AI use, and practical applications, with assessment methods that evaluate applied understanding. Policy readiness involves institutional rules, funding priorities, teacher training plans, partnerships, and ethical guidelines. Floridi et al. (2018) propose ethical principles beneficence, non-maleficence, autonomy, justice, and explicability, that are directly relevant to educational settings where AI influences access, assessment, and feedback.

2.7 Barriers to AI Integration in TVET

Barriers can be grouped into human, institutional, infrastructural, ethical, and policy-related factors. Human barriers include low awareness, lack of teacher training, low confidence, and limited pedagogical understanding (Ayanwale et al., 2022; Zawacki-Richter et al., 2019). Institutional barriers include weak leadership, lack of funding, and absence of implementation strategy (Miao et al., 2021; UNESCO-UNEVOC, 2025). Infrastructural barriers include unreliable electricity, poor internet access, and lack of devices (World Bank Group, 2019). Ethical and governance barriers include data privacy, surveillance, bias, and academic integrity (Floridi et al., 2018; Williamson & Eynon, 2020). For TVET, vocational learning often requires workshops and hands-on demonstrations, so AI must complement rather than replace practical learning.

3. METHODOLOGY

3.1 Research Design and Study Area

The study adopted a quantitative cross-sectional survey design to measure AI awareness, perceptions, institutional readiness, curriculum preparedness, perceived employability benefits, and barriers at a single point in time. The design supports comparison across respondent groups (students, educators, administrators) and statistical analysis of readiness constructs. The study was conducted in Sokoto State, located in northwestern Nigeria, focusing on three TVET-related institutions: Umaru Ali Shinkafi Polytechnic, Usmanu Danfodiyo University, and Shehu Shagari College of Education. These institutions offer programmes relevant to vocational education, technical training, digital learning, entrepreneurship, agriculture, engineering, and social development.

3.2 Population, Sample, and Sampling

The target population comprised students, educators, and administrators in TVET-related programmes. A total of 200 valid respondents participated: 140 students, 45 educators, and 15 administrators. The study used a stratified sampling approach to ensure representation across the main respondent categories; within each stratum, respondents were selected based on accessibility and relevance to TVET-related programmes. The sample size was adequate for descriptive statistics, reliability analysis, group comparison tests, correlation analysis, and regression modelling.

3.3 Research Instrument

Data were collected using a structured questionnaire developed from the study objectives and the AI-TVET readiness framework. The questionnaire was organised into seven sections: (A) Demographic information; (B) AI awareness, awareness of AI concepts, tools, and applications in education and vocational fields; (C) Infrastructure readiness, electricity supply, internet access, computers, digital learning facilities, technical support; (D) Teacher and learner capacity, digital skills, confidence, training, ability to use technology for teaching and learning; (E) Curriculum and policy readiness, inclusion of AI,

digital skills, data literacy, automation, and emerging technologies in curricula and policy; (F) Perceived employability benefit perceptions of AI's contribution to employability, entrepreneurship, innovation, productivity, and income opportunities; and (G) Barriers, lack of trained educators, poor electricity, poor internet, cost of devices, low awareness, and lack of policy guidance. Most items used a five-point Likert scale (1 = strongly disagree; 5 = strongly agree).

3.4 Validity and Reliability

Content validity was established by ensuring that each section corresponded directly to one or more research objectives and by reviewing items for clarity, relevance, and appropriateness to the TVET context. Internal consistency was assessed using Cronbach's alpha; coefficients ranged from 0.609 to 0.751. AI awareness, infrastructure readiness, perceived employability benefit, and barriers exceeded 0.70. Teacher/learner capacity (0.673) and curriculum/policy readiness (0.609) were slightly below 0.70 but acceptable for exploratory research with context-specific constructs.

3.5 Data Collection, Measurement, and Analysis

Respondents participated voluntarily after being informed of the purpose. Completed questionnaires were screened for completeness; responses with substantial missing data were excluded, leaving 200 valid responses. Six composite scores were computed by averaging items: AI awareness, infrastructure readiness, teacher/learner capacity, curriculum and policy readiness, perceived employability benefit, and barrier score. An overall AI readiness score was computed as the mean of the four readiness components (excluding employability benefit and barriers).

Data were analysed using R. Analysis included data cleaning, descriptive statistics (means, SDs, medians, ranges), Cronbach's alpha, one-way ANOVA with post-hoc comparisons, correlation analysis, and regression. Regression results were interpreted cautiously because the overall readiness score was derived from component constructs.

4. RESULTS

4.1 Respondent Characteristics

A total of 200 valid responses were analysed: 140 students (70.0%), 45 educators (22.5%), and 15 administrators (7.5%). Male respondents accounted for 63.0% and female for 37.0%. The largest age group was 20–24 years (36.5%), followed by below 20 (21.5%), 25–29 (16.0%), 30–39 (13.5%), and 40 and above (12.5%). Respondents were drawn from Umaru Ali Shinkafi Polytechnic (48.5%), Usmanu Danfodiyo University (28.0%), and Shehu Shagari College of Education (23.5%).

Table 1. Demographic characteristics of respondents

| Variable | Category | Frequency | % |
|------------------|------------------------------------|-----------|------|
| Respondent group | Student | 140 | 70.0 |
| | Educator | 45 | 22.5 |
| | Administrator | 15 | 7.5 |
| Gender | Male | 126 | 63.0 |
| | Female | 74 | 37.0 |
| Age group | Below 20 | 43 | 21.5 |
| | 20–24 | 73 | 36.5 |
| | 25–29 | 32 | 16.0 |
| | 30–39 | 27 | 13.5 |
| | 40 and above | 25 | 12.5 |
| Institution | Umaru Ali Shinkafi Polytechnic | 97 | 48.5 |
| | Usmanu Danfodiyo University | 56 | 28.0 |
| | Shehu Shagari College of Education | 47 | 23.5 |

4.2 Reliability Analysis

Cronbach's alpha coefficients ranged from 0.609 to 0.751. AI awareness (0.710), infrastructure readiness (0.732), perceived employability benefit (0.704), and barriers to AI integration (0.751) exceeded 0.70. Teacher/learner capacity (0.673) and curriculum and policy readiness (0.609) fell below the conventional threshold but were retained for this exploratory, context-specific study.

Table 2. Reliability analysis of constructs

| Construct | Number of items | Cronbach's alpha |
|---------------------------------|-----------------|------------------|
| AI awareness | 4 | 0.710 |
| Infrastructure readiness | 5 | 0.732 |
| Teacher/learner capacity | 4 | 0.673 |
| Curriculum and policy readiness | 4 | 0.609 |
| Perceived employability benefit | 4 | 0.704 |
| Barriers to AI integration | 6 | 0.751 |

4.3 Descriptive Statistics of AI-TVET Readiness Constructs

Mean AI awareness was 3.02 (moderate). Infrastructure readiness was low ($M = 2.34$), and curriculum and policy readiness was the lowest ($M = 2.25$). Teacher/learner capacity was below the moderate level ($M = 2.74$). Overall AI readiness was 2.59, suggesting low-to-moderate readiness for AI integration. In contrast, perceived employability benefit was high ($M = 4.06$), indicating that respondents strongly perceived AI-related skills as relevant to employability, entrepreneurship, and youth empowerment. The mean barrier score was 4.13. Overall, the descriptive results reveal a gap between strong perceived employability value and weak institutional readiness.

Table 3. Descriptive statistics of main constructs

| Construct | N | Mean | SD | Median | Min | Max |
|---------------------------------|-----|------|------|--------|------|------|
| AI awareness | 200 | 3.02 | 0.64 | 3.00 | 1.25 | 4.50 |
| Infrastructure readiness | 200 | 2.34 | 0.58 | 2.40 | 1.20 | 3.80 |
| Teacher/learner capacity | 200 | 2.74 | 0.61 | 2.75 | 1.00 | 4.25 |
| Curriculum and policy readiness | 200 | 2.25 | 0.54 | 2.25 | 1.00 | 3.50 |
| Perceived employability benefit | 200 | 4.06 | 0.51 | 4.00 | 2.75 | 5.00 |
| Barriers to AI integration | 200 | 4.13 | 0.44 | 4.17 | 3.00 | 5.00 |
| Overall AI readiness | 200 | 2.59 | 0.27 | 2.59 | 1.80 | 3.39 |

4.4 Construct Scores by Respondent Group

Educators reported the highest AI awareness ($M = 3.23$, $SD = 0.73$), followed by administrators ($M = 3.00$, $SD = 0.66$) and students ($M = 2.95$, $SD = 0.59$). Administrators reported the highest teacher/learner capacity ($M = 3.10$, $SD = 0.41$), followed by educators ($M = 2.84$) and students ($M = 2.66$). Overall AI readiness was highest among administrators ($M = 2.73$), followed by educators ($M = 2.65$) and students ($M = 2.55$). However, no group reached a high-readiness range.

Table 4. Construct scores by respondent group

| Group | N | Awareness | Infra | Capacity | Curriculum | Employ. | Barrier | Overall |
|---------------|-----|-----------|-------|----------|------------|---------|---------|---------|
| Administrator | 15 | 3.00 | 2.53 | 3.10 | 2.28 | 4.05 | 4.07 | 2.73 |
| Educator | 45 | 3.23 | 2.24 | 2.84 | 2.31 | 4.11 | 4.26 | 2.65 |
| Student | 140 | 2.95 | 2.36 | 2.66 | 2.22 | 4.04 | 4.09 | 2.55 |

4.5 Barriers to AI Integration

The highest-ranked barrier was lack of trained educators ($M = 4.22$, $SD = 0.63$), followed by poor electricity supply ($M = 4.16$), lack of clear policy or curriculum guidance ($M = 4.14$), low AI awareness ($M = 4.13$), cost of computers and digital devices ($M = 4.09$), and poor internet access ($M = 4.03$). AI integration is therefore constrained by a combination of human-capacity, infrastructure, policy, and affordability barriers, with educator training the most urgent.

Table 5. Ranking of barriers to AI integration

| Rank | Barrier | Mean | SD |
|------|---|------|------|
| 1 | Lack of trained educators | 4.22 | 0.63 |
| 2 | Poor electricity supply | 4.16 | 0.64 |
| 3 | Lack of clear policy or curriculum guidance | 4.14 | 0.68 |
| 4 | Low AI awareness among students and educators | 4.13 | 0.66 |
| 5 | Cost of computers and digital devices | 4.09 | 0.67 |
| 6 | Poor internet access | 4.03 | 0.65 |

4.6 Group Differences in AI Readiness

One-way ANOVA showed significant group differences in AI awareness, $F(2, 197) = 3.47$, $p = 0.033$; teacher/learner capacity, $F(2, 197) = 4.54$, $p = 0.012$; and overall AI readiness, $F(2, 197) = 5.19$, $p = 0.006$. Differences were not significant for infrastructure readiness, curriculum and policy readiness, perceived employability benefit, or barriers (the barrier score approached significance, $p = 0.053$).

Table 6. ANOVA results by respondent group

| Outcome | F | p-value | Interpretation |
|---------------------------------|------|---------|-----------------------|
| AI awareness | 3.47 | 0.033 | Significant |
| Infrastructure readiness | 1.65 | 0.195 | Not significant |
| Teacher/learner capacity | 4.54 | 0.012 | Significant |
| Curriculum and policy readiness | 0.45 | 0.636 | Not significant |
| Perceived employability benefit | 0.34 | 0.713 | Not significant |
| Barriers to AI integration | 2.98 | 0.053 | Not significant at 5% |
| Overall AI readiness | 5.19 | 0.006 | Significant |

Post-hoc comparisons indicated educators reported significantly higher AI awareness than students, students reported significantly lower teacher/learner capacity than administrators, and overall readiness was significantly lower for students than administrators.

5. DISCUSSION

The study highlights a significant gap between stakeholders' strong perception of the value of AI skills and the low institutional readiness to integrate AI in TVET. While respondents widely recognise AI's relevance to employability, institutions lack the necessary policy frameworks, curriculum alignment, infrastructure, and technical support to operationalise AI integration. Curriculum and policy readiness, along with infrastructure (electricity, internet, devices), were identified as the weakest areas.

Although respondents demonstrated moderate AI awareness, this did not translate into adequate teacher or learner capacity. The most critical barrier was the shortage of trained educators, followed by infrastructural deficiencies and weak policy guidance. This indicates that AI integration challenges are primarily human and institutional, not merely technological, making teacher training the most logical starting point for reform.

Group comparisons showed that educators and administrators had higher awareness and readiness than students, but no group reached a high readiness level, confirming that the problem is systemic. Perceived employability benefits of AI were high regardless of readiness levels, suggesting that stakeholders value AI even though institutions are not yet prepared to deliver meaningful AI-enabled training.

The findings support a staged, context-sensitive strategy focused on foundational AI literacy, educator development, basic digital infrastructure, and vocationally relevant applications, rather than costly advanced technologies. The central policy concern is the clear mismatch between the perceived importance of AI skills and the current institutional capacity to support them.

6. CONCLUSION

Respondents perceived AI-related skills as highly relevant to employability, entrepreneurship, and youth empowerment, but the institutions studied were only at a low-to-moderate level of AI readiness. The main weaknesses were curriculum and policy readiness, infrastructure readiness, and teacher/learner capacity. AI awareness was moderate but not supported by adequate institutional conditions. The highest-ranked barrier was lack of trained educators, followed by poor electricity, weak policy guidance, low awareness, cost of devices, and poor internet.

AI integration in TVET institutions in Sokoto State is promising but not yet institutionally mature. AI should not be introduced as a superficial slogan or isolated intervention but through a staged, practical, context-sensitive strategy beginning with teacher training, basic AI literacy, digital infrastructure, and curriculum reform. AI-related skills may support youth empowerment by improving perceived employability and entrepreneurship readiness, but the evidence supports only perceived relevance, not actual employment, income, or entrepreneurship outcomes. Future studies should examine whether AI-enhanced TVET programmes lead to measurable labour-market outcomes.

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