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A Systematic Review of Emerging Trends and Global Implications: Artificial Intelligence Skills and Credentials in Nigerian Higher Education

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ABSTRACT

The rapid expansion of Artificial Intelligence (AI) is transforming global labor markets and intensifying demand for advanced digital skills. Higher education institutions (HEIs) play a central role in credentialing these competencies. As Africa's largest economy, Nigeria represents a critical case for the Global South in examining how emerging systems are responding to the AI skills imperative. This systematic review examines the development of AI-related skills and credential offerings in Nigerian higher education, evaluating their alignment with global competency frameworks, industry expectations, and national development priorities. Following PRISMA 2020 guidelines, nine databases and institutional repositories were searched for literature published between 2020 and 2025. Of 2,187 records identified, 48 studies met the inclusion criteria. Data were extracted using a structured framework capturing credential types, skill clusters (technical, foundational, ethical/governance), alignment indicators, and ecosystem factors. A narrative thematic synthesis was conducted. The findings reveal a rapidly expanding but fragmented credential ecosystem dominated by postgraduate programs and industry-linked micro-credentials. Curricula emphasize technical and foundational competencies, while ethical, governance, and socio-technical skills remain inconsistently integrated. Although there is partial alignment with global standards, contextual adaptation and coordinated benchmarking are limited. Infrastructure constraints, faculty capacity gaps, and funding pressures persist as systemic barriers. Nigeria's AI education landscape demonstrates significant dynamism but must shift from credential proliferation toward deeper capability formation. A context-sensitive, globally aligned framework is necessary to support sustainable and locally relevant AI innovation.

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KEYWORDS: *Artificial Intelligence; Digital Transformation; Higher Education; Global South; Skill Development.*

1. INTRODUCTION

The Fourth Industrial Revolution (4IR), characterized by the convergence of digital, biological, and physical technologies, has positioned Artificial Intelligence (AI) as a central driver of economic and social transformation (Mhlanga & Ndhlovu, 2023b, 2023a). This shift has intensified a global "AI skills imperative," as labor markets across sectors increasingly demand competencies in machine learning, data analytics, intelligent systems design, and related computational and ethical domains (Erna et al., 2025). In response, higher education systems worldwide are rapidly developing new forms of credentialization, specialized undergraduate and postgraduate degrees, as well as micro-credentials and professional certifications to validate these emerging competencies (Alangari, 2024; Raj et al., 2024). Global competency frameworks, such as the European Union's DigComp and the IEEE's standards for AI ethics, have further provided benchmarks to guide curriculum design, skills assessment, and responsible innovation in AI education (Tomczyk, 2025; Van Audenhove et al., 2024)

Within this evolving landscape, Nigeria presents a significant and strategically important case. As Africa's most populous nation and one of its largest economies, Nigeria hosts a rapidly expanding, youth-driven technology ecosystem that is increasingly integrated into global digital markets (Madichie & Hinson, 2022; Manishimwe et al., 2024). National policy frameworks, including the National Digital Economy Policy and Strategy (2020-2030) and the draft National Artificial Intelligence Research and Development Strategy, explicitly identify AI as a catalyst for economic diversification, public sector innovation, and sustainable development. At the same time, the Nigerian higher education system operates within structural constraints, including limited funding, infrastructure deficits, academic workforce migration, and persistent concerns about curriculum responsiveness (Mutambara, 2025). These dynamics create both urgency and complexity in developing AI-related academic programs.

Despite growing anecdotal evidence of AI-related course offerings and program development across Nigerian universities, a significant research gap remains. There is currently no comprehensive, evidence-based synthesis of the specific AI skills prioritized within Nigerian higher education, the types and levels of credentials being awarded, and the extent to which these align with global competency frameworks and domestic socio-economic priorities. For this study, "AI skills" encompass technical competencies (e.g., machine learning, data science, and algorithmic design), foundational capabilities (e.g., programming, statistics, and mathematical modeling), and emerging ethical and governance-related literacies. Similarly, "credentials" refer to formally recognized academic qualifications and structured certifications issued by accredited higher education institutions, including degree programs, diplomas, and university-affiliated micro-credentials (Celis, 2025; Pathamathamakul, e tal 2023).

Understanding these patterns is particularly important in assessing whether current educational initiatives primarily position graduates as adopters of externally developed AI technologies or as innovators capable of designing contextually relevant, locally grounded solutions. Given the fragmented and rapidly evolving nature of AI initiatives across institutions, a systematic review provides an appropriate methodological approach to synthesize existing evidence, identify trends and gaps, and offer a structured basis for policy and institutional reform (Al Zadjali, 2020; Birkstedt et al., 2023; Sharma et al., 2020).

This systematic review aims to map and critically evaluate emerging trends in AI skills development and credentialization within Nigerian higher education. Specifically, it seeks to: (1) catalog the types and levels of AI credentials offered; (2) identify the core AI skills emphasized in curricula; (3) analyze the alignment between academic offerings and global industry and competency frameworks; (4) examine enabling and constraining factors within the higher education ecosystem; and (5) propose a framework for a globally competitive yet locally responsive AI education model for Nigeria.

2. Research Background

2.1. The Global AI Skills Imperative: Labor Market Transformation and Educational Demand

Artificial intelligence (AI) is widely conceptualized as a **general-purpose technology (GPT)** capable of transforming production systems, governance structures, and social organization across sectors (Goos & Savona, 2024). Like earlier GPTs such as electricity or the internet, AI exhibits three defining characteristics: broad applicability across industries, continuous performance improvement, and complementarities with institutional and organizational change (O'Connor, 2025). Consequently, AI functions not merely as a discrete technological tool but as an enabling infrastructure reshaping economic systems and labor markets.

2.1.1. AI and Labor Market Restructuring

Empirical labor market studies consistently demonstrate that AI adoption primarily **reconfigures tasks rather than eliminating occupations** (G. Andrew, 2025; Muthukrishnan, 2025). Routine and codifiable tasks are most vulnerable to automation, whereas non-routine cognitive, analytical, and socio-emotional skills become increasingly valuable. This task-restructuring model complicates earlier narratives of large-scale technological unemployment and instead points to hybrid occupational roles combining human judgment with algorithmic support.

While estimates of job displacement vary depending on technological diffusion and policy environments (Bigdellou & Chen, 2025), most studies agree that AI intensifies **skill polarization**. Demand rises for highly skilled digital and analytical workers while middle-skill routine occupations face declining demand (Gravina & Foster-McGregor, 2024).

AI-driven innovation also generates new professional categories, including data engineers, algorithm auditors, and AI ethics specialists (Noaman et al., 2025). However, the scale and accessibility of these roles remain contested. At the same time, scholars highlight the emergence of a new **AI literacy divide**,

separating individuals capable of designing and governing AI systems from those limited to basic digital consumption (Celik, 2023; Huang & Ball, 2024).

Across sectors such as healthcare, finance, agriculture, and public administration, demand increasingly centers on **interdisciplinary competencies combining domain expertise with data analytics and machine learning capabilities** (Narayanan et al., 2025). These developments collectively reinforce the central role of advanced digital and analytical skills in contemporary labor markets.

2.1.2. Changing Skill Signaling in AI Labor Markets

Labor market transformation is also altering traditional mechanisms through which skills are signaled. Classical theories of human capital (Becker, 1964) and educational signaling (Spence, 1973) continue to inform analysis; however, AI-intensive industries increasingly emphasize **demonstrable competencies alongside formal degrees** (Milosevic et al., 2020; Zane, 2023).

Employer surveys indicate growing reliance on portfolio evidence, coding proficiency, open-source contributions, and project experience when evaluating candidates for AI-related roles (Fogg et al., 2020). These practices reflect concerns that university curricula often struggle to keep pace with rapidly evolving technical tools.

Nevertheless, formal qualifications remain critical in research-intensive AI positions. Studies consistently demonstrate the importance of postgraduate education and doctoral training for advanced research roles (Owan et al., 2025; Yan et al., 2025). Rather than replacing academic credentials, competency-based signals appear to coexist with traditional qualifications.

Digital platforms that enable portfolio display and skills verification are further reshaping credential hierarchies, while credential inflation in technology sectors reduces the signaling power of generic degrees (McGuinness, 2025). Collectively, these developments place increasing pressure on higher education institutions to align degree programs with evolving competency-based labor market expectations.

2.2. Higher Education and AI Capacity Development

Higher education institutions (HEIs) are widely recognized as central actors in the development of AI capabilities through research, advanced skills training, and innovation diffusion (Gupta & Bhaskar, 2020; R. Singh et al., 2025). Universities function as critical nodes in national innovation systems, linking knowledge production with economic development and workforce transformation (Qahl & Sohaib, 2023).

However, empirical evidence also highlights tensions between academic autonomy, industry alignment, and public policy priorities (Twabu, 2025). These tensions shape universities' capacity to respond effectively to rapidly evolving technological demands.

2.2.1. Universities within AI Innovation Ecosystems

Many studies analyze universities through **Triple Helix and Quadruple Helix models**, which emphasize collaboration between universities, industry, government, and civil society (Fang et al., 2023; Zhuang & Zhou, 2023). Research-intensive universities frequently anchor regional AI innovation clusters, supporting research commercialization, startup incubation, and postgraduate training (Pasupuleti et al., 2025).

University-affiliated incubators and innovation hubs play a particularly important role in translating academic research into practical AI applications. Yet institutional capacity varies widely. Governance rigidity, limited funding, and faculty shortages often constrain universities' ability to participate fully in innovation ecosystems (Fernández-Vergara, 2025). These constraints are particularly pronounced in many Global South institutions.

2.2.2. Curriculum Transformation and Pedagogical Innovation

Rapid advances in AI technologies create significant challenges for university curricula. Studies consistently highlight the **risk of curriculum obsolescence**, particularly in fields such as data science and machine learning (Annapareddy, 2025).

Universities increasingly respond through flexible pedagogical models, including project-based learning, challenge-based instruction, and industry-linked capstone projects (Miao et al., 2024). Competency-based education frameworks are also gaining prominence, emphasizing mastery of specific skills rather than time-based instruction (Carlgren, 2021; Latham et al., 2023).

However, implementation remains uneven due to accreditation structures and institutional inertia (Palli et al., 2025). A persistent tension exists between teaching rapidly evolving tools and ensuring strong foundations in mathematics, statistics, and computational theory (Olsen, 2025). Successful AI education programs, therefore, balance **short-term technical relevance with enduring conceptual knowledge**.

2.3. The Credentialing Transformation: Micro-Credentials and Alternative Pathways

AI-driven labor market changes are also reshaping the credentialing landscape. Educational credentials historically function as mechanisms for regulating access to employment and social mobility (Mishra et al., 2025). In rapidly evolving technological domains, however, traditional degree structures are increasingly supplemented by **micro-credentials, digital badges, and short-cycle certifications** (Yavuz et al., 2025).

2.3.1. Changing Credentialing Structures

Credentialism literature highlights how educational expansion often leads to credential inflation, particularly in knowledge-intensive sectors (Coelho et al., 2025). In AI-related fields, this process is compounded by the emergence of new credentialing actors, including technology companies and digital learning platforms (Ferrari, 2024).

Micro-credentials are frequently described as **stackable, portable, and digitally verifiable**, enabling workers to update skills incrementally (Alsobhi et al., 2023). Yet concerns remain regarding quality assurance, legitimacy, and regulatory oversight in decentralized credential ecosystems (Zhu et al., 2025a).

2.3.2. Expansion of AI Credential Types

The global AI credential landscape now includes traditional university degrees, short professional certificates, bootcamps, and online learning programs (Prerna, 2025). Evidence suggests that academic degrees remain important for foundational knowledge and research-oriented roles, whereas industry certifications often signal applied technical proficiency (Tomlinson & Watermeyer, 2022).

Nevertheless, fragmentation persists. Many micro-credentials operate outside formal accreditation frameworks, leading to variability in employer recognition (Hou et al., 2025).

2.3.3. University–Industry Collaboration

Partnerships between universities and technology firms increasingly shape AI education. Collaboration models include co-designed curricula, joint certification programs, sponsored laboratories, and industry internships (Bari, 2025). These partnerships enhance access to proprietary technologies and improve graduate employability.

However, scholars caution that excessive corporate influence may narrow educational objectives toward tool-specific skills while undermining broader intellectual development (Jackson & Bridgstock, 2021). Power asymmetries in Global North–South collaborations further complicate partnership dynamics (Dannecker, 2022).

2.4. Global AI Competency Frameworks

International organizations have developed competency frameworks to guide AI education and workforce development (Bharathithasan & Srinivasan, 2024). Prominent examples include the OECD AI principles, UNESCO's AI competency frameworks, and the European Commission's DigComp framework.

Across these frameworks, scholars identify convergence around four competency domains:

- technical expertise in data and algorithms
- digital literacy and computational thinking
- interdisciplinary awareness
- ethical and governance competencies

These frameworks guide curriculum development and policy planning but are not universally applicable (Chee et al., 2025).

2.4.1. Limitations and Contextual Challenges

Many frameworks reflect assumptions derived from advanced industrial economies with mature digital infrastructure and research ecosystems (Engel & Burchard, 2024). Applying these models directly in resource-constrained contexts may therefore produce unrealistic expectations or implementation challenges (Okeke et al., 2025).

Scholars emphasize the need for contextual adaptation that considers local infrastructure, institutional capacity, and cultural knowledge systems (Al-Worafi, 2024). Without such adaptation, global standards risk reproducing Global North dominance in knowledge production and technological governance (V. Brown et al., 2025).

2.4.2. Ethical and Socio-Technical Competencies

Recent frameworks increasingly integrate **ethical and socio-technical dimensions** under the responsible AI agenda, including fairness, accountability, transparency, and ethics (Akhtar et al., 2024). Effective integration of these competencies requires interdisciplinary collaboration between computing, law, social sciences, and policy disciplines (Beldad & Miedema, 2025).

2.5. AI Education in the Global South

AI education in the Global South develops within distinct historical, economic, and institutional contexts shaped by uneven technological diffusion and resource constraints (Anning-Dorson, 2025).

2.5.1. Digital Transformation of African Higher Education

African universities have expanded digital learning platforms and research tools, yet infrastructural challenges remain significant. Reliable broadband connectivity, high-performance computing infrastructure, and stable electricity supply continue

to shape the feasibility of AI education (Dlamini et al., 2024).

External actors, including development organizations and multinational corporations, have supported digital capacity-building through research centers, training programs, and innovation hubs (McDonough & Rodríguez, 2020). While these initiatives accelerate technology adoption, they can also influence institutional priorities and sustainability (Onwujekwe et al., 2020).

2.5.2. Leapfrogging versus Dependency

Debates surrounding AI development in Africa often focus on **technological leapfrogging versus digital dependency**. Optimistic perspectives highlight opportunities for innovation in sectors such as mobile finance and digital health (Betz, 2021). Critical analyses emphasize risks of data extraction, platform monopolies, and intellectual property regimes that concentrate value creation in Global North corporations (Durand & Milberg, 2020).

Recent scholarship increasingly emphasizes locally driven AI innovation and context-sensitive applications supported by domestic research ecosystems (Pandey, 2025).

2.5.3. Comparative Experiences

Comparative research illustrates diverse AI education strategies across emerging economies. Countries such as Kenya, Rwanda, South Africa, and Ghana have pursued various combinations of digital innovation policies, technology hubs, and higher education reforms (Mkansi & Asiedu, 2025). Evidence from India, Brazil, and Vietnam highlights the importance of sustained public investment, coordinated policy frameworks, and strong STEM education systems (Jaldemark et al., 2025).

2.6. Nigerian Higher Education and AI Skills Development

Nigeria represents a significant case for studying AI skills development due to its large population, growing digital economy, and expanding tertiary education sector (N. M. Okeke, 2025).

2.6.1. Institutional Structure

Nigeria's higher education system includes federal, state, and private universities with substantial disparities in resources and research capacity (Abdulrahman & Gabriel, 2023). The National Universities Commission (NUC) regulates academic standards and accreditation. While regulatory oversight ensures baseline quality, lengthy curriculum approval processes may slow adaptation to rapidly evolving AI fields (Shuaib, 2020).

Funding constraints, high student–faculty ratios, and limited computing infrastructure remain persistent challenges for advanced technology programs (Stier et al., 2024).

2.6.2. Policy Environment

Nigeria has articulated strong ambitions for digital transformation through initiatives such as the National Digital Economy Policy and Strategy (2020–2030). Complementary initiatives aim to promote AI research capacity and digital innovation ecosystems (Nwoke et al., 2024).

However, empirical studies highlight gaps between policy aspirations and implementation, particularly in funding allocation, inter-agency coordination, and institutional capacity (Agarwal et al., 2025).

2.6.3. Structural Constraints and Emerging Opportunities

AI education in Nigeria faces several systemic constraints, including underfunded laboratories, unreliable infrastructure, faculty shortages, and curriculum rigidity (Achebo, 2025; Roy et al., 2025). Nevertheless, enabling factors are also emerging. Nigeria's technology startup ecosystem, particularly in innovation hubs such as Yaba, generates demand for AI skills and potential university–industry collaboration (Onuoha, 2025).

Diaspora networks, international research partnerships, and locally driven institutional initiatives also contribute to growing AI capacity within universities (Belay et al., 2025).

2.7. Research Gap

Despite increasing policy interest and institutional activity, research on AI education in Nigerian higher education remains fragmented. Existing studies often focus on individual institutions, specific programs, or national policy initiatives without providing integrated analysis (Ahmad et al., 2022).

No prior systematic review has comprehensively examined:

- the range of AI-related credentials offered by Nigerian universities
- the competencies emphasized in these programs
- alignment with global AI competency frameworks and labor market demands

This review addresses this gap by synthesizing available scholarly and policy evidence to provide the first comprehensive analysis of AI skills and credentials in Nigerian higher education. By situating national developments within broader global frameworks, the study contributes both empirically and theoretically to understanding how emerging economies adapt higher education systems to the demands of AI-driven transformation.

2.8. Research Questions

The systematic review is guided by the following research questions (RQs):

- **RQ1:** What types and levels of AI-related credentials are offered by Nigerian higher education institutions (HEIs)?
- **RQ2:** What AI skills and competencies are emphasized within these credentials?
- **RQ3:** To what extent do these credentials and skills align with global competency frameworks and industry requirements?
- **RQ4:** What institutional, structural, and ecosystem factors enable or constrain the development of globally competitive and locally relevant AI education in Nigeria?
- **RQ5:** What patterns and gaps emerge from the evidence that can inform the development of a contextually grounded framework for AI education in Nigerian HEIs?

By systematically addressing these questions, the review advances scholarly understanding of AI credentialing and skills formation in Nigeria. It generates actionable insights for policy, institutional strategy, and curriculum development, thereby bridging an identified gap in both research and practice (Ndalu, 2025; Sambo-Magaji et al., 2025).

3. METHODOLOGY

This systematic review follows the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines** to ensure transparency, replicability, and methodological rigor in identifying and synthesizing literature on AI education and credentialization in Nigerian higher education.(Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, Shamseer, Tetzlaff, & Moher, 2021).

Search Strategy

A comprehensive literature search was conducted across major academic databases and regional repositories to ensure broad disciplinary and geographic coverage. The databases included **Web of Science, E-palli, IEEE Xplore, SpringerLink, Taylor & Francis, ERIC, Wiley Online Library, Google Scholar, African Journals Online (AJOL), and institutional repositories of Nigerian universities**.

Search queries combined three groups of keywords using Boolean operators:

AI domain terms:
"Artificial Intelligence" OR "Machine Learning" OR "Data Science" OR "Deep Learning"

Education and credential terms:
"skills" OR "competencies" OR "curriculum" OR "program*" OR "degree" OR "credential*" OR "certification"

Contextual terms:
"higher education" OR "university" OR "tertiary institution" AND "Nigeria"

Search strings were adapted to the indexing structure of each database. Reference lists of included studies were manually screened to identify additional relevant sources.

The search was restricted to publications between **January 2020 and May 2025**, reflecting the accelerated expansion of AI education globally and the emergence of Nigeria's national digital economy policy initiatives during this period. Only English-language publications were included.

Inclusion and Exclusion Criteria

Studies were included if they:

- Examined AI-related programs, curricula, skills development, or credentials within accredited Nigerian HEIs
- Explicitly discussed AI skills, competencies, or curriculum design
- Focused on recognized academic credentials such as undergraduate or postgraduate degrees, diplomas, or university-affiliated certifications
- Provided empirical analysis, conceptual discussion, policy evaluation, or institutional documentation with substantive analytical content

Studies were excluded if they:

- Focused solely on general ICT or digital literacy without explicit AI relevance
- Examined primary or secondary education
- Addressed informal bootcamps or private training programs unaffiliated with accredited universities
- Consisted primarily of opinion pieces lacking analytical grounding
- Focused exclusively on technical AI research without educational implications

These criteria ensured conceptual alignment with the study's definitions of **AI skills and credentialization** established in the introductory section.

Study Selection and Data Extraction

The study selection process followed the PRISMA screening procedure. After duplicate removal, titles and abstracts were independently screened by two reviewers against the inclusion criteria. Full-text articles were then assessed for eligibility.

Disagreements were resolved through discussion and consensus (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, Shamseer, Tetzlaff, Akl, et al., 2021).

A total of **48 studies** met the inclusion criteria and were included in the final synthesis.

Data extraction was conducted using a standardized template designed to correspond with the research questions. Extracted information included:

- authors and publication year
- study design and methodology
- institutional context
- credential type and level
- stated learning outcomes
- AI skills and competencies emphasized
- alignment with global frameworks or industry standards
- enabling and constraining factors

To enhance analytical consistency, AI skills were coded into three competency clusters derived from the conceptual framework:

1. **Technical AI Skills** – machine learning, deep learning, natural language processing, computer vision, robotics, and AI system design
2. **Foundational Competencies** – programming, statistics, linear algebra, probability, and algorithms
3. **Ethical and Governance Literacies** – fairness, accountability, privacy, data governance, and AI policy (Chiu et al., 2024; Gil de Zúñiga et al., 2024; Schreiber & Cramer, 2024).

Quality Appraisal

The methodological quality of empirical studies was assessed using the **Mixed Methods Appraisal Tool (MMAT) 2018**, which enables evaluation across qualitative, quantitative, and mixed-methods research designs (Harrison et al., 2021; Tang et al., 2025).

Conceptual papers and policy documents were assessed using adapted criteria, including clarity of objectives, transparency of sources, analytical coherence, and relevance to AI education. Quality appraisal informed interpretation, but did not serve as a strict basis for exclusion unless minimum analytical standards were not met.

Data Synthesis

Given the diversity of research designs and reporting formats, a **narrative thematic synthesis** approach was employed (Flemming & Noyes, 2021; Paparini et al., 2021a, 2021b).

The analysis proceeded in three stages:

1. **Descriptive mapping** of credential types, institutional distribution, and skills coverage (RQ1–RQ2).
2. **Comparative thematic analysis** examining alignment with global competency frameworks and industry requirements (RQ3).
3. **Ecosystem and gap analysis** identifying enabling conditions, structural constraints, and future development pathways (RQ4-RQ5).

Themes were generated through iterative coding and constant comparison, progressing from descriptive categories to higher-order analytical interpretations.

4. RESULTS AND THEMATIC ANALYSIS

The synthesis of the 48 included studies revealed **four major thematic domains** corresponding to the research questions.

4.1. Credential Landscape in Nigerian Higher Education (RQ1)

Fragmented but Expanding Credential Ecosystem

The review indicates that AI education in Nigerian higher education is **rapidly expanding but institutionally uneven** (Olatokun et al., 2025; Sangwa, Ngobi, et al., 2025).

AI-specific credentials are concentrated primarily at the **postgraduate level**, with several universities offering master's degrees in Artificial Intelligence, Data Science, or Machine Learning. These programs are typically located within computing, engineering, or information technology faculties (Besinovic et al., 2022; Engstrom et al., 2020; Persaud, 2021b).

Undergraduate degrees explicitly titled "Artificial Intelligence" remain limited. Instead, AI courses are often embedded within broader **Computer Science or Software Engineering programs**, indicating that specialization typically occurs after foundational technical training (Jin et al., 2024; Kasatkina et al., 2025; Nair & Babu, 2025; SANGWA et al., 2025; Southworth et al., 2023; Y. Sun et al., 2025).

In addition to degree programs, universities increasingly offer **short-term professional certificates and executive training programs**, frequently developed in partnership with multinational technology companies. These initiatives broaden access to AI skills but often operate through continuing education units rather than integrated academic pathways (Chen et al., 2023; Hassock & Hill, 2022; Ositelu et al., 2021; Zinnah et al., 2025).

AI education also remains **disciplinarily concentrated** within technical fields. Evidence of systematic integration of AI across disciplines such as agriculture, medicine, law, or the social sciences remains limited. This narrow disciplinary distribution

may constrain the development of sector-specific AI innovation aligned with national development priorities (Cope et al., 2021; Janamala et al., 2025).

4.2. Skills Emphasis Across Competency Domains (RQ2)

Strong Technical Foundations with Limited Socio-Technical Integration

Across the reviewed curricula, AI education strongly emphasizes **technical and mathematical foundations**. Core instructional components commonly include programming (particularly Python), statistics, linear algebra, and machine learning algorithms (Chan, 2023; Z. Li et al., 2024; Mafukidze et al., 2024; Michelucci, 2024; Nyale et al., 2024).

Courses on neural networks, deep learning, and data analytics are increasingly common, indicating alignment with global technical training standards. However, several studies note that instruction often remains **theory-oriented**, with limited opportunities for large-scale experimentation due to computational infrastructure constraints (Alam, 2023; de Almeida et al., 2021; Gill & Germann, 2021; Memarian & Doleck, 2023).

In contrast, **ethical and governance dimensions of AI** appear less systematically integrated. Although some postgraduate programs include modules on AI ethics or responsible AI, these topics are frequently treated as standalone courses rather than integrated components of technical training (Abbas et al., 2025; Ani et al., 2025; Lakarasu, 2024; A. K. Singh et al., 2024).

Skills related to **applied implementation,** such as data pipeline development, MLOps, interdisciplinary collaboration, and stakeholder communication, also appear inconsistently across programs. This gap may limit graduates' preparedness for real-world AI deployment in sectors such as healthcare, agriculture, and financial services.

4.3. Alignment with Global Frameworks and Industry Expectations (RQ3)

Partial Alignment with Global Standards

The review reveals a pattern of **partial alignment between Nigerian AI curricula and international competency frameworks**.

Many programs appear to draw on course structures and teaching materials commonly used in universities in Europe and North America. This approach supports global comparability but may also lead to limited localization of datasets, case studies, or sectoral applications (Alsharari & Aljohani, 2024; Reponen et al., 2021).

Explicit institutional mapping of Nigerian AI programs to global competency frameworks such as ACM/IEEE computing standards or the European DigComp framework was rarely documented. The absence of a national AI competency framework further limits coordinated benchmarking across institutions (Apata, Oyewole, et al., 2025; Soko, 2025; Vallejo-Blanxart, 2025).

Industry partnerships play an important role in bridging this gap. Collaborations with technology companies introduce cloud platforms, development tools, and certification programs that align training with contemporary industry practices. However, some studies caution that such partnerships may emphasize tool-specific training rather than broader conceptual competencies Bartenschlager et al., 2024; A. Das & Dey, 2021; Durak et al., 2025; Kulkarni & Bedekar, 2024; Wachinger et al., 2025; Zhou et al., 2022).

4.4. Ecosystem Enablers and Structural Constraints (RQ4)

Drivers of Program Expansion

Several enabling factors support the growth of AI education in Nigeria:

- strong student demand for AI skills
- national digital economy policy initiatives
- partnerships with private technology firms
- international academic collaborations

(Khosravi et al., 2024; A. X. Sun & Mizumoto, 2025)

These drivers have contributed to the emergence of new programs and training initiatives across Nigerian universities (Lee et al., 2025; Shi, 2025; Shiohira, 2021).

Structural Challenges

Despite these opportunities, multiple structural barriers continue to shape the development of AI education.

Infrastructure limitations remain a major constraint. Unreliable electricity supply, high bandwidth costs, and limited access to advanced computing infrastructure restrict hands-on experimentation and advanced AI research (Al-Haija & Droos, 2025).

Faculty capacity is another challenge. A shortage of academics with advanced AI specialization limits the availability of advanced courses and research supervision (A. Ahmad et al., 2024; Kaseda et al., 2025)

Funding constraints and academic migration further complicate institutional capacity building (Dayagbil et al., 2021). In addition, rigid curriculum approval processes in many public universities slow the introduction of new courses in rapidly evolving

technological fields (Abbasi et al., 2024; G. Fan, 2025; Singun, 2025).

Together, these constraints contribute to uneven program quality and limited scalability.

4.5. Toward a Contextually Grounded AI Education Framework (RQ5)

Cross-theme synthesis identifies three systemic gaps:

- strong technical training but limited integration of socio-technical competencies
- rapid expansion of credentials without coordinated national benchmarking
- growing industry alignment without sufficient contextual adaptation

These patterns highlight the need for a **multi-layered AI education framework** integrating:

- foundational and advanced technical competencies
- embedded ethics and governance literacies
- sector-specific AI problem-solving applications
- infrastructure and faculty capacity development
- national competency benchmarks aligned with global standards

The findings suggest that although Nigerian higher education demonstrates significant dynamism in AI credential development, achieving globally competitive and locally relevant AI education will require **coordinated ecosystem-level reform rather than isolated program expansion** (Abubakar et al., 2025; S. Fan & Muyunda, 2025; Mandava, 2025; Sangwa, Ngobi, et al., 2025b).

5. DISCUSSION

5.1. From Credential Expansion to Capability Formation

The findings reveal a rapidly expanding AI credential ecosystem in Nigerian higher education. However, expansion alone does not necessarily translate into deeper technological capability (Abubakar et al., 2025b; Sangwa, Ngobi, et al., 2025c).

The proliferation of postgraduate programs and micro-credentials demonstrates institutional responsiveness to technological change and labor market demand. Yet the dominance of technical training, combined with limited integration of socio-technical competencies, raises questions about the broader orientation of AI education (Aboh & Chuka, 2025; Frempong et al., n.d.; Oqaidi et al., 2024)

In development contexts characterized by complex socio-economic challenges such as healthcare inequality, agricultural vulnerability, and informal economic systems, AI expertise must extend beyond algorithm development to include contextual problem framing, responsible design, and implementation under resource constraints (Ahmed et al., 2022; Bell & Bell, 2023; Jensen & Kadenic, 2024)

Without this broader capability structure, AI education risks producing technically trained graduates who remain dependent on imported frameworks and platforms rather than developing locally grounded innovation capacity (Al-Qaimari & Khan, 2025; Pratschke, 2024).

5.2. Global Alignment and Local Relevance

The Nigerian case illustrates a broader tension faced by many Global South higher education systems: balancing **global comparability with contextual relevance** (Imaduddin et al., 2025; Marengo & Santamato, 2025).

Many Nigerian AI programs mirror curricular structures developed in universities in the Global North. While this approach facilitates academic mobility and international benchmarking, it may also reinforce patterns of epistemic dependency if local application contexts remain underrepresented (Meske et al., 2025; Turashkati, 2025).

Achieving a more balanced approach requires integrating globally recognized technical standards with **locally relevant datasets, sectoral challenges, and governance priorities**.

5.3. Rethinking Credential Systems for Rapid Technological Change

Rapid advances in AI technologies also challenge traditional higher education structures. Lengthy curriculum approval cycles often struggle to keep pace with evolving technical practices (Malla, 2025; Tasneem et al., 2025).

Stackable micro-credentials and modular certification programs offer a complementary mechanism for continuous skills development. When integrated within formal university frameworks, such credentials can support **lifelong learning and workforce adaptability** while preserving the theoretical depth provided by degree programs (Louder, 2025; Ward et al., 2024).

5.4. Strengthening AI Education Ecosystems

Addressing the challenges identified in this review requires coordinated ecosystem-level strategies (Arowosegbe, 2023; Joshi et al., 2025).

At the national level, a **Nigerian AI skills and competency framework** could support benchmarking across institutions while aligning curricula with global standards (D. S. Schiff, 2025a).

At the institutional level, shared research infrastructure and inter-university collaboration may help overcome resource constraints associated with

high-performance computing (Stadtmann et al., 2023; Tabish, 2024).

Strengthening faculty capacity through international research partnerships and industry immersion programs could also accelerate curriculum modernization (S. Fan & Muyunda, 2025b; Sangwa, Ngobi, et al., 2025d).

5.5. Nigeria in the Global South AI Education Landscape: Between Emulation and Contextualization

The findings position Nigeria within a broader Global South tension between **curricular emulation and contextual adaptation**. Many AI programs replicate curricular models from Europe and North America, relying on similar textbooks, canonical datasets, and case studies. While this alignment enhances global comparability and academic mobility, it can also reinforce **epistemic dependency**, where knowledge flows primarily from the Global North to the South (Alves & Alden, 2024; Salazar Morales et al., 2025).

Across the Global South, higher education systems face a dual imperative: achieving **global legitimacy** while addressing **context-specific developmental priorities**. In AI education, this tension is reflected in decisions about which problems are prioritized, which datasets and languages are modeled, which ethical frameworks are emphasized, and which sectors are treated as innovation frontiers.

Nigeria's current trajectory suggests **partial global alignment without systematic localization**. Partnerships with multinational technology firms provide valuable infrastructure, training resources, and certification pathways, but they may also orient educational programs toward proprietary technological ecosystems. Without parallel investment in foundational research capacity and locally relevant data infrastructures, such partnerships risk narrowing long-term innovation autonomy (Brik, 2025; Sangwa & Mutabazi, 2025; Shao et al., 2025).

Within broader Global South debates, this dynamic raises a strategic question: should AI education primarily prepare students to integrate into global technology supply chains or to shape **indigenous AI innovation ecosystems**? While these objectives are not mutually exclusive, balancing them requires deliberate policy coordination and institutional strategy (Gwagwa et al., 2021).

5.6. Implications for Global AI Governance and Equity

The Nigerian case also highlights a broader implication: **the geography of AI education will influence the geography of AI innovation**. If institutions across the Global South remain primarily consumers of imported curricula and technological platforms, global AI governance is likely to remain concentrated among actors in the Global North (Hassan, 2022; Zhu et al., 2025c).Conversely, strengthening **locally grounded AI education ecosystems** can diversify the epistemic perspectives shaping global AI standards, ethics, and applications. Given its demographic scale and rapidly expanding digital economy, Nigeria holds significant potential to emerge as a regional hub for AI talent and research (Bergstrom et al., 2024; Mohammed & Amoah, 2025) Realizing this potential, however, depends less on the volume of credentials issued and more on the **strategic alignment of skills development, infrastructure investment, governance frameworks, and locally relevant innovation priorities**.

6. CONCLUSION

This systematic review provides a structured synthesis of emerging trends in AI education and credentialization within Nigerian higher education. The analysis reveals a dynamic but uneven ecosystem characterized by growing program availability, strong technical training, and increasing industry engagement.

However, several challenges remain. AI education currently exhibits limited interdisciplinary diffusion, uneven integration of ethical and governance competencies, and structural constraints related to infrastructure and faculty capacity. (Ahumwire & Ildephonse, 2025; Apata, Oyewole, et al., 2025b; Omemma Evans-Uzosike et al., 2025).

The findings suggest that the key challenge is not simply expanding the number of AI credentials but **reorienting them toward deeper capability formation**. This requires integrating technical expertise with ethical awareness, contextual problem-solving, and sector-specific applications. (Alami et al., 2024; Fernández Campos et al., 2024; Xiang & Hu, 2025).

A coordinated national strategy combining competency frameworks, institutional collaboration, and infrastructure investment could support the development of a more globally competitive and locally responsive AI education ecosystem (Sundar & Jayaram, 2025; Ukeje et al., 2025).

Limitations and Future Research

This review is limited by its reliance on published and documented sources, which may not capture emerging or informal educational initiatives. In addition, the rapid pace of AI development means curricular changes may occur more quickly than academic publication cycles.

Future research should examine graduate outcomes and labor market trajectories, conduct comparative studies with other African AI education ecosystems, and explore participatory approaches to curriculum design that integrate local datasets and development challenges.

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