



Unlocking new frontiers: AI-Enabled innovation in research, teaching and community engagement in Nigeria: A systematic review

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ABSTRACT

This article systematically reviews how artificial intelligence (AI) is being mobilized to support research, teaching, and community engagement in Nigeria, and identifies the governance conditions required for responsible and inclusive adoption. The study follows PRISMA 2020 reporting principles and synthesises peer-reviewed literature and relevant policy documents published between 2022 and 2025. Searches were conducted across Scopus, Web of Science, ERIC, and Google Scholar, yielding 87 records, of which 51 met the inclusion criteria. Thematic synthesis was used to organise evidence across research innovation, teaching and learning, community-facing applications, ethics and implementation constraints. The review shows that AI can strengthen literature discovery, data analysis, adaptive learning, multilingual support, health diagnostics, agricultural decision-making and institutional administration. However, adoption remains uneven because of weak infrastructure, high data costs, limited AI literacy, fragmented policy implementation, data governance risks, algorithmic bias and limited local language capacity. The article reframes AI adoption in Nigeria as a governance, equity and capacity-building challenge rather than a purely technological opportunity. It proposes a responsible AI integration framework linking infrastructure, literacy, local innovation, ethics, research productivity, teaching quality and community development.

Keywords: Artificial intelligence, Nigeria, research innovation, personalised learning, community engagement

INTRODUCTION

Artificial intelligence (AI) has moved from a specialised computational field into a pervasive socio-technical infrastructure shaping knowledge production, education, health care, agriculture, public administration and economic development. In higher education, AI is now used for literature discovery, automated feedback, adaptive learning, predictive analytics, language support, research assistance, institutional planning and student services.¹ Generative AI has further intensified this transformation by

¹ Lijia Chen, Pingping Chen, and Zhijian Lin, “Artificial Intelligence in Education: A Review,” *IEEE Access* 8 (2020): 75264–78, <https://doi.org/10.1109/ACCESS.2020.2988510>; Helen Crompton and Diane Burke, “Artificial Intelligence in Higher Education: The State of the Field,” *International Journal of Educational Technology in Higher Education* 20, no. 1 (April 24, 2023): 22,

making machine-generated text, code, summaries, translations and explanations accessible to students, lecturers and researchers at scale.² For Nigeria, these developments are not peripheral. They intersect directly with persistent national concerns around research productivity, educational quality, graduate skills, digital inclusion, public service delivery and community development.

The Nigerian context makes AI both promising and risky. Nigeria has one of Africa's largest higher education systems, a large youth population, a growing technology sector and increasing policy attention to digital transformation. The National Digital Economy Policy and Strategy 2020-2030 and the National Artificial Intelligence Strategy indicate the state's ambition to position digital technology and AI as drivers of innovation, economic competitiveness and social development.³ At the same time, universities and communities operate within uneven conditions of electricity supply, broadband access, device availability, institutional funding and digital literacy. These constraints matter because AI systems depend on data, connectivity, computational infrastructure, human capacity and regulatory safeguards. Without these conditions, AI may widen existing inequalities instead of reducing them.⁴

The debate is therefore not whether Nigeria should adopt AI, but how AI can be adopted in ways that are pedagogically meaningful, ethically governed, locally relevant and socially inclusive. International scholarship cautions that AI systems can reproduce bias, concentrate power, extract data, distort knowledge, threaten privacy and marginalise low-resource contexts when they are imported without critical adaptation.⁵ This warning is crucial for Nigeria, where imported platforms, English-dominant models and foreign-owned digital infrastructures may not adequately reflect indigenous languages, local knowledge systems, rural realities or the needs of resource-constrained institutions. AI-enabled innovation must therefore be examined not only through efficiency, but through equity, accountability, capacity and public value.

Research, teaching and community engagement are the three domains through which this review organises the evidence. In research, AI can support literature mining, bibliometric mapping, data analysis, modelling, translation and interdisciplinary collaboration. In teaching, AI can support personalised learning, intelligent tutoring, automated feedback, assessment support, accessibility and multilingual learning. In community engagement, AI can support health information, agriculture, food security, civic services and local innovation. Yet these opportunities are accompanied by risks: academic

<https://doi.org/10.1186/s41239-023-00392-8>; Olaf Zawacki-Richter et al., "Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where Are the Educators?," *International Journal of Educational Technology in Higher Education* 16, no. 1 (December 28, 2019): 39, <https://doi.org/10.1186/s41239-019-0171-0>.

² Yogesh K. Dwivedi et al., "Opinion Paper: 'So What If ChatGPT Wrote It?' Multidisciplinary Perspectives on Opportunities, Challenges and Implications of Generative Conversational AI for Research, Practice and Policy," *International Journal of Information Management* 71 (August 2023): 102642, <https://doi.org/10.1016/j.ijinfomgt.2023.102642>; Enkelejda Kasneci et al., "ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education," *Learning and Individual Differences* 103 (April 2023): 102274, <https://doi.org/10.1016/j.lindif.2023.102274>; Ahmed Tlili et al., "What If the Devil Is My Guardian Angel: ChatGPT as a Case Study of Using Chatbots in Education," *Smart Learning Environments* 10, no. 1 (February 22, 2023): 15, <https://doi.org/10.1186/s40561-023-00237-x>.

³ Nigerian Communications Commission, "National Digital Economy Policy and Strategy (2020-2030)," 2020; & National Information Technology Development Agency. National Centre for Artificial Intelligence and Robotics, *National Artificial Intelligence Strategy* (NCAIR/NITDA., 2024AD).

⁴ Adebayo Olusegun Aderibigbe et al., "Artificial Intelligence in Developing Countries: Bridging the Gap between Potential and Implementation," *Computer Science & IT Research Journal* 4, no. 3 (2023): 185–99; Chinasa T Okolo, "AI in the Global South: Opportunities and Challenges towards More Inclusive Governance," *The Brookings Institution* 2 (2023); World Bank, "Nigeria Digital Economy Diagnostic Report," *A Plan for Building Nigeria's Inclusive Digital Future* (World Bank Washington DC. USA, 2019).

⁵ Emily M. Bender et al., "On the Dangers of Stochastic Parrots," in *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (New York, NY, USA: ACM, 2021), 610–23, <https://doi.org/10.1145/3442188.3445922>; Abeba Birhane, "Algorithmic Injustice: A Relational Ethics Approach," *Patterns* 2, no. 2 (February 2021): 100205, <https://doi.org/10.1016/j.patter.2021.100205>; Joy Buolamwini and Timnit Gebru, "Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification," in *Conference on Fairness, Accountability and Transparency* (PMLR, 2018), 77–91; Anna Jobin, Marcello Ienca, and Effy Vayena, "The Global Landscape of AI Ethics Guidelines," *Nature Machine Intelligence* 1, no. 9 (September 2, 2019): 389–99, <https://doi.org/10.1038/s42256-019-0088-2>; Shakir Mohamed, Marie-Therese Png, and William Isaac, "Decolonial AI: Decolonial Theory as Sociotechnical Foresight in Artificial Intelligence," *Philosophy & Technology* 33, no. 4 (December 12, 2020): 659–84, <https://doi.org/10.1007/s13347-020-00405-8>; S. B Apata and S. O Oladapo, *From Chalkboards to Chatbots: Revolutionising the Future of Teaching in Universities through Artificial Intelligence. In The Role of AI in Enhancing Teaching/Learning, Research and Community Service in Higher Education*, 1st ed. (Sterling, 2025).

integrity concerns, inaccurate or fabricated outputs, surveillance, algorithmic bias, data protection gaps, labour displacement, poor contextual fit and unequal access.⁶

This article adopts a more critical synthesis. It does not treat AI as an automatic solution to Nigeria's research, education and development challenges. Instead, it asks what the literature shows about AI-enabled innovation, what conditions shape adoption, and what governance framework can support responsible implementation. The review is guided by three questions: (1) How is AI being applied or proposed to enhance research, teaching and community engagement in Nigeria? (2) What benefits, risks and implementation barriers recur across the literature? (3) What policy and institutional conditions are required for an inclusive AI ecosystem that supports national development while protecting rights, equity and academic integrity?

The article contributes to scholarship in three ways. First, it integrates evidence across research, teaching and community engagement instead of treating these as separate conversations. Second, it situates AI adoption in Nigeria within the wider debates on responsible AI, digital inequality, decolonial AI and AI for social good. Third, it proposes a practical framework for universities, policymakers and development actors, arguing that AI adoption should be governed as a socio-technical transformation requiring infrastructure, literacy, ethical regulation, local innovation and community participation.

CONCEPTUAL FRAMEWORK

AI-enabled innovation as socio-technical transformation

AI-enabled innovation is best understood as a socio-technical process rather than a neutral technological upgrade. AI systems do not operate independently of the institutions, data infrastructures, values and power relations in which they are embedded. This point has become central in responsible AI scholarship. Jobin et al. show that AI ethics guidelines converge around values such as transparency, fairness, non-maleficence, responsibility and privacy, yet differ substantially in implementation.⁷ Floridi et al. similarly argue that AI for social good must be guided by beneficence, non-maleficence, autonomy, justice and explicability.⁸ For Nigeria, these principles are not abstract. They determine whether AI supports inclusive educational development or becomes another mechanism through which global technological inequality is reproduced.

The literature on AI for social good provides one useful lens. Vinuesa et al. demonstrate that AI can support several Sustainable Development Goal (SDG) targets, but can also inhibit others where governance, inequality and environmental costs are ignored.⁹ Cows et al. argue that AI for social good should be judged against concrete social outcomes rather than technological novelty alone.¹⁰ In this article, AI is therefore evaluated by its contribution to research productivity, quality teaching, inclusion, community problem-solving, ethical governance and local capacity. This framing prevents the paper from treating AI adoption as inherently beneficial.

A second lens comes from decolonial AI scholarship. Mohamed et al. argue that AI must be examined through histories of coloniality, knowledge asymmetry and technological power.¹¹ Birhane warns that African contexts risk algorithmic colonisation when foreign-built systems extract data,

⁶ Mohammadreza Farrokhnia et al., "A SWOT Analysis of ChatGPT: Implications for Educational Practice and Research," *Innovations in Education and Teaching International* 61, no. 3 (May 3, 2024): 460–74, <https://doi.org/10.1080/14703297.2023.2195846>; Chung Kwan Lo, Khe Foon Hew, and Morris Siu-yung Jong, "The Influence of ChatGPT on Student Engagement: A Systematic Review and Future Research Agenda," *Computers & Education* 219 (October 2024): 105100, <https://doi.org/10.1016/j.compedu.2024.105100>; Brent Mittelstadt, "Principles Alone Cannot Guarantee Ethical AI," *Nature Machine Intelligence* 1, no. 11 (November 4, 2019): 501–7, <https://doi.org/10.1038/s42256-019-0114-4>; Haotian Zhu, Yao Sun, and Junfeng Yang, "Towards Responsible Artificial Intelligence in Education: A Systematic Review on Identifying and Mitigating Ethical Risks," *Humanities and Social Sciences Communications* 12, no. 1 (July 16, 2025): 1111, <https://doi.org/10.1057/s41599-025-05252-6>.

⁷ Jobin, Ienca, and Vayena, "The Global Landscape of AI Ethics Guidelines."

⁸ Luciano Floridi et al., "AI4People—An Ethical Framework for a Good AI Society: Opportunities, Risks, Principles, and Recommendations," *Minds and Machines* 28, no. 4 (December 26, 2018): 689–707, <https://doi.org/10.1007/s11023-018-9482-5>.

⁹ Ricardo Vinuesa et al., "The Role of Artificial Intelligence in Achieving the Sustainable Development Goals," *Nature Communications* 11, no. 1 (January 13, 2020): 233, <https://doi.org/10.1038/s41467-019-14108-y>.

¹⁰ Josh Cows et al., "A Definition, Benchmark and Database of AI for Social Good Initiatives," *Nature Machine Intelligence* 3, no. 2 (February 17, 2021): 111–15, <https://doi.org/10.1038/s42256-021-00296-0>.

¹¹ Mohamed, Png, and Isaac, "Decolonial AI: Decolonial Theory as Sociotechnical Foresight in Artificial Intelligence."

impose external categories or ignore local forms of knowledge.¹² For Nigeria, these concerns are especially relevant to education and language. AI systems trained primarily on dominant global languages and data sources may underrepresent Nigerian languages, cultural references, indigenous knowledge and local educational realities. This does not mean that AI should be rejected; rather, it must be localised, audited and governed.

The third lens is educational transformation. AI in education research increasingly shows that the field is expanding rapidly but remains unevenly distributed across countries, disciplines and stakeholders.¹³ Ouyang and Jiao identify three broad paradigms in AI in education: AI-directed, learner-as-recipient systems; AI-supported, learner-as-collaborator systems; and AI-empowered, learner-as-leader systems.¹⁴ This distinction is useful for Nigeria because AI adoption should not reduce learners and teachers to passive users of imported platforms. It should strengthen teacher agency, student voice, multilingual learning, inclusive pedagogy and locally meaningful knowledge production.¹⁵

METHODOLOGY

This study adopted a systematic literature review design guided by PRISMA 2020 reporting principles.¹⁶ A systematic review was appropriate because scholarship on AI in Nigeria is dispersed across education, information systems, health, agriculture, policy, ethics and development studies. The approach allowed the review to identify patterns, compare evidence across domains, reduce selection bias and respond to the reviewer's concern that the methodology required greater rigour.

Searches were conducted in Scopus, Web of Science, ERIC and Google Scholar. Google Scholar was used cautiously as a supplementary source because some Nigeria-focused publications and policy materials are not consistently indexed in Scopus or Web of Science. Search strings combined AI-related terms with domain and country terms: "artificial intelligence" OR "machine learning" OR "generative AI" OR "ChatGPT" AND "Nigeria" AND "higher education" OR "teaching" OR "research" OR "community development" OR "healthcare" OR "agriculture" OR "ethics" OR "digital literacy". Searches covered publications from 2022 to 2025, while foundational international works on AI ethics, AI in education, AI for social good and methodology were added to strengthen conceptual grounding.

Studies were included if they met four criteria: (1) they addressed AI, machine learning, generative AI or intelligent systems; (2) they focused on Nigeria or offered directly applicable evidence for low-resource or African contexts; (3) they discussed research, teaching, community engagement, policy, ethics or implementation; and (4) they were peer-reviewed or official policy documents. Studies were excluded if they were unrelated to Nigeria or comparable low-resource contexts, lacked methodological clarity, were purely promotional, duplicated another source, or made unsupported claims without empirical or conceptual grounding.

The initial search identified 87 records. After excluding ineligible document types and duplicates, 61 records were assessed in full. Ten full-text records were excluded because they were outside scope, methodologically weak, insufficiently contextualised or not directly relevant to the review questions. A final set of 51 studies and policy documents was included in thematic synthesis. The screening process is summarised in Figure 1. The review did not conduct statistical meta-analysis because the included studies varied substantially in design, domain, methods and outcome measures. Quality appraisal was undertaken through an interpretive rather than purely numerical procedure. Empirical studies were assessed for clarity of research purpose, methodological transparency, relevance to Nigeria or low-resource contexts, evidence quality and contribution to one or more review domains. Conceptual and policy sources were assessed for authority, analytical value and relevance to AI

¹² Birhane, "Algorithmic Injustice: A Relational Ethics Approach."

¹³ Crompton and Burke, "Artificial Intelligence in Higher Education: The State of the Field"; Zawacki-Richter et al., "Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where Are the Educators?"

¹⁴ Fan Ouyang and Pengcheng Jiao, "Artificial Intelligence in Education: The Three Paradigms," *Computers and Education: Artificial Intelligence* 2 (2021): 100020, <https://doi.org/10.1016/j.caeai.2021.100020>.

¹⁵ Stella Bolanle Apata et al., "Artificial Intelligence and Multiliteracies: Preparing Learners for a Technologically Evolving World," *International Journal of New Education*, no. 15 (July 31, 2025), <https://doi.org/10.24310/ijne.15.2025.21332>.

¹⁶ Matthew J Page et al., "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ*, March 29, 2021, n71, <https://doi.org/10.1136/bmj.n71>.

governance, education, ethics or development. The process was informed by the logic of mixed-methods appraisal, where the suitability of evidence is judged in relation to the research question and study design.¹⁷

To strengthen transparency, each included source was recorded against five fields: bibliographic details, context, domain of AI use, main contribution and limitations. Studies with strong empirical grounding were used to support claims about observed practices, while conceptual and policy texts were used to interpret governance, ethics and implementation conditions. This distinction was important because several publications in the AI field make broad claims about transformation without providing evidence of actual adoption. The synthesis therefore separates demonstrated applications from projected possibilities and identifies where the literature remains speculative.

Thematic synthesis proceeded in three stages. First, the included studies were coded deductively according to the three focal domains: research, teaching and community engagement. Second, inductive coding identified cross-cutting themes such as infrastructure constraints, digital literacy, data governance, algorithmic bias, multilingual inclusion, institutional readiness and local innovation. Third, themes were interpreted through the conceptual lenses of responsible AI, AI for social good, decolonial AI and AI in education. This process allowed the review to move beyond description toward critical synthesis, addressing the reviewer's concern that the earlier manuscript lacked analytical depth.

Table 1: Search strategy and eligibility criteria

Review element	Specification
Databases/sources	Scopus, Web of Science, ERIC, Google Scholar and selected policy sources
Time frame	2022-2025 for Nigeria-focused evidence; foundational AI and review-method literature added where necessary
Search terms	artificial intelligence OR machine learning OR generative AI OR ChatGPT AND Nigeria AND higher education OR teaching OR research OR community development OR healthcare OR agriculture OR ethics
Inclusion criteria	Nigeria/Africa relevance; AI focus; research, teaching, community, ethics or policy domain; peer-reviewed or official policy source
Exclusion criteria	Non-relevant context; weak method; promotional discussion; duplication; unsupported speculative claims
Final synthesis	51 records included in thematic synthesis

¹⁷ Quan Nha Hong et al., "The Mixed Methods Appraisal Tool (MMAT) Version 2018 for Information Professionals and Researchers," *Education for Information* 34, no. 4 (December 18, 2018): 285–91, <https://doi.org/10.3233/EFI-180221>.

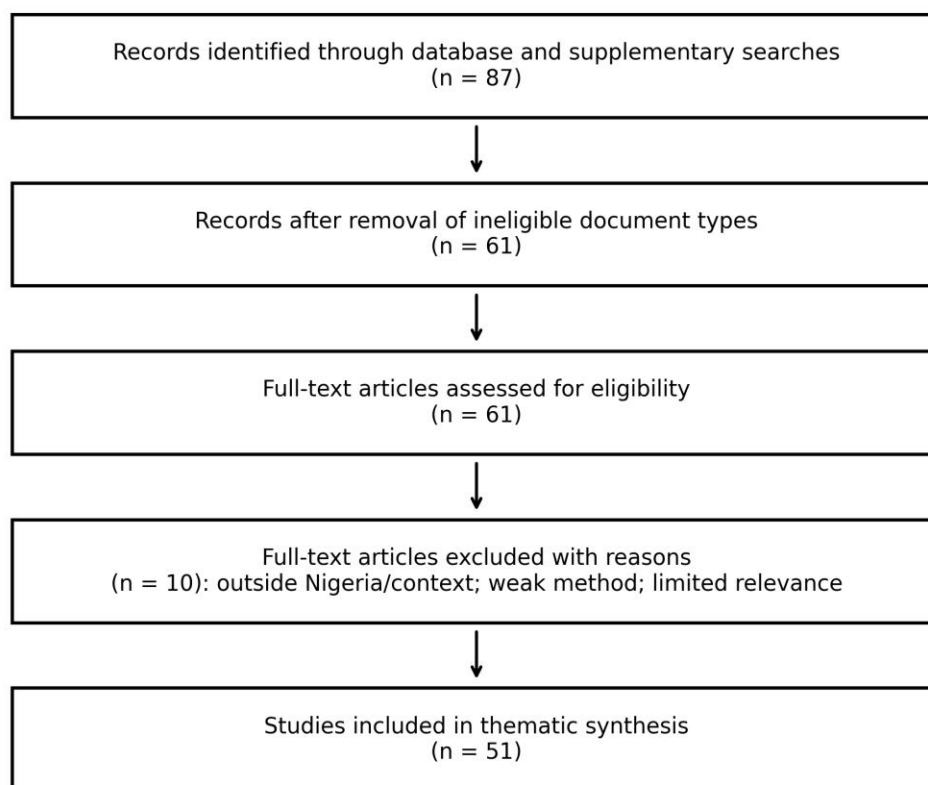


Figure 1. PRISMA 2020 flow diagram for study identification, screening and inclusion

PRESENTATION OF FINDINGS

The review generated four major findings. First, AI is beginning to reshape research work by expanding data analysis, literature mapping and modelling capacity, but this potential is constrained by uneven access to infrastructure and skills. Second, AI can support personalised and inclusive teaching, yet adoption is limited by teacher preparedness, academic integrity concerns and unequal digital access. Third, AI has significant community-facing potential in health, agriculture and public services, but local data quality and governance remain weak. Fourth, responsible adoption requires integrated policy, infrastructure, literacy and ethics rather than isolated technological acquisition. Table 2 provides a synthesis of the major evidence patterns.

Table 2: Thematic synthesis of AI-enabled innovation in Nigeria

Domain	Main opportunities	Evidence pattern	Critical risks/conditions
Research	Literature discovery, data mining, modelling, language processing, research administration	AI can reduce repetitive research labour and support complex analysis	Requires data access, verification, research integrity and local capacity
Teaching	Adaptive learning, feedback, assessment support, accessibility, multilingual learning	AI may personalise learning and support large classes	Risks include academic misconduct, bias, privacy, weak teacher training and digital exclusion
Community engagement	Health diagnostics, agricultural prediction,	AI can support SDGs and community problem-solving	Requires local datasets, ethical governance and participatory design

	local service delivery, civic information		
Governance	National AI strategy, data protection, institutional policy, capacity building	Policy momentum is increasing in Nigeria.	Implementation gaps, enforcement limits and infrastructure deficits remain decisive.

AI-enabled research transformation

AI is increasingly important for research because it can accelerate tasks that are time-consuming, data-intensive or technically demanding. International evidence shows that AI systems can support literature classification, pattern recognition, predictive modelling, automated transcription, image analysis, language processing and decision support.¹⁸ In the Nigerian research context, these capabilities are particularly valuable because many institutions operate with limited funding, fragmented research infrastructure and uneven access to advanced laboratories. AI can help researchers work more efficiently, but it cannot compensate for weak research governance or limited human capacity.

The strongest research opportunities are in data-intensive fields such as health, agriculture, education, social science and language studies. In health research, machine learning can support disease surveillance, diagnostic support and patient data analysis.¹⁹ For Nigeria, where public health challenges include infectious diseases, maternal health, mental health gaps and uneven access to specialists, AI-supported modelling may assist with prioritisation and early warning. Yet medical AI requires high-quality data, ethical clearance, clinician oversight and governance. Without these conditions, it may produce misleading outputs or intensify inequities in already fragile health systems.

Agricultural research also demonstrates clear potential. Machine learning and deep learning have been used globally for crop disease detection, yield prediction, soil monitoring, irrigation planning and precision agriculture.²⁰ In Nigeria, where agriculture remains central to livelihood and food security, such tools could support climate adaptation and smallholder decision-making. However, the evidence also suggests that imported models may not transfer well unless they are trained on local data and adapted to local agro-ecological conditions. The promise of AI in agriculture is therefore not just technical; it depends on farmer access, extension services, data quality and affordability.

AI also has implications for humanities, language and education research. Natural language processing can support corpus development, translation, literacy research and indigenous language documentation. This is important in Nigeria's multilingual context, where more than 500 languages are spoken and where English-dominant digital systems can marginalise local languages. Apata et al. argue that AI integration in education should be linked to multiliteracies so that learners and researchers become critical users and producers of digital knowledge rather than passive consumers.²¹ From a decolonial perspective, language-sensitive AI is not an optional extension but a condition for epistemic inclusion.²²

¹⁸ Chen, Chen, and Lin, "Artificial Intelligence in Education: A Review"; Zawacki-Richter et al., "Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where Are the Educators?"

¹⁹ Alvin Rajkomar, Jeffrey Dean, and Isaac Kohane, "Machine Learning in Medicine," *New England Journal of Medicine* 380, no. 14 (April 4, 2019): 1347–58, <https://doi.org/10.1056/NEJMra1814259>; Silvana Secinaro et al., "The Role of Artificial Intelligence in Healthcare: A Structured Literature Review," *BMC Medical Informatics and Decision Making* 21, no. 1 (December 10, 2021): 125, <https://doi.org/10.1186/s12911-021-01488-9>; Eric J. Topol, "High-Performance Medicine: The Convergence of Human and Artificial Intelligence," *Nature Medicine* 25, no. 1 (January 7, 2019): 44–56, <https://doi.org/10.1038/s41591-018-0300-7>; Kun-Hsing Yu, Andrew L. Beam, and Isaac S. Kohane, "Artificial Intelligence in Healthcare," *Nature Biomedical Engineering* 2, no. 10 (October 10, 2018): 719–31, <https://doi.org/10.1038/s41551-018-0305-z>.

²⁰ Andreas Kamilaris and Francesc X. Prenafeta-Boldú, "Deep Learning in Agriculture: A Survey," *Computers and Electronics in Agriculture* 147 (April 2018): 70–90, <https://doi.org/10.1016/j.compag.2018.02.016>; Konstantinos Liakos et al., "Machine Learning in Agriculture: A Review," *Sensors* 18, no. 8 (August 14, 2018): 2674, <https://doi.org/10.3390/s18082674>; Thomas van Klompenburg, Ayalew Kassahun, and Cagatay Catal, "Crop Yield Prediction Using Machine Learning: A Systematic Literature Review," *Computers and Electronics in Agriculture* 177 (October 2020): 105709, <https://doi.org/10.1016/j.compag.2020.105709>.

²¹ Stella B. Apata, et al., "Digital Transformation in Teaching: The Preparedness of In-Service Teachers in Nigeria for the Fourth Industrial Revolution (4IR)," *British Journal of Contemporary Education* 5, no. 1 (January 28, 2025): 16–33, <https://doi.org/10.52589/BJCE-S8GBY9M3>.

²² Birhane, "Algorithmic Injustice: A Relational Ethics Approach"; Mohamed, Png, and Isaac, "Decolonial AI: Decolonial Theory as Sociotechnical Foresight in Artificial Intelligence."

At the same time, AI can create new risks for research integrity. Generative AI tools can assist with drafting, summarising and coding, but they can also fabricate references, misattribute claims, reproduce bias and blur authorship responsibility.²³ Nigerian universities therefore need research policies that define acceptable AI use, require disclosure, protect data privacy and maintain human responsibility for scholarly judgement. AI should be positioned as a research aid, not an epistemic authority.

AI, teaching and inclusive learning

The education literature shows that AI can support adaptive learning, intelligent tutoring, automated feedback, learning analytics and administrative efficiency.²⁴ These applications are relevant to Nigeria because many schools and universities face large classes, teacher shortages, uneven student preparation and limited student support systems. AI can offer differentiated content, formative feedback and learning pathways that respond to student performance. When used carefully, it can help lecturers identify students who need support and reduce the burden of repetitive administrative tasks.

However, the review also shows that personalised learning should not be treated as a purely technical achievement. Personalisation is educationally meaningful only when it is connected to sound pedagogy, curriculum goals, teacher agency and learner context. AI systems can recommend content, but teachers still interpret learning needs, support motivation, evaluate understanding and attend to social and emotional dimensions of learning. The danger is that AI-driven personalisation may become a narrow optimisation system that tracks performance without addressing deeper educational inequality. This is why AI in education must be framed as human-centred and teacher-supported rather than teacher-replacing.²⁵

Generative AI has intensified these debates. Tools such as ChatGPT can support brainstorming, explanation, translation and formative feedback, but they also create risks for academic integrity, assessment validity and overdependence.²⁶ For Nigerian universities, the policy issue is not whether students will use these tools; they already can. The more important question is whether institutions will redesign assessment, teach AI literacy and establish transparent guidelines. Prohibition alone is unlikely to work. A more sustainable approach is to teach students how to use AI critically, cite or disclose its use where appropriate, verify outputs and protect personal and institutional data.

AI also has inclusion potential. Text-to-speech, speech-to-text, captioning, translation and adaptive interfaces can support students with disabilities and students from linguistically diverse backgrounds. Yet these benefits depend on affordability, device access, local language support and platform accessibility. Where students lack reliable electricity, internet connectivity or data, AI may deepen inequality. Therefore, digital inclusion must be treated as part of educational quality. Apata et al. show that teacher preparedness for digital transformation is not simply a matter of tool availability; it requires professional development, institutional support and curriculum alignment. This finding is crucial for AI adoption in Nigerian education.²⁷

The review therefore supports a cautious conclusion. AI can improve teaching and learning in Nigeria, but only if institutions invest in teacher capacity, ethical assessment, inclusive access and

²³ Bender et al., "On the Dangers of Stochastic Parrots"; Dwivedi et al., "Opinion Paper: 'So What If ChatGPT Wrote It?' Multidisciplinary Perspectives on Opportunities, Challenges and Implications of Generative Conversational AI for Research, Practice and Policy"; Kasneci et al., "ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education."

²⁴ Florence Martin et al., "Systematic Review of Adaptive Learning Research Designs, Context, Strategies, and Technologies from 2009 to 2018," *Educational Technology Research and Development* 68, no. 4 (August 15, 2020): 1903–29, <https://doi.org/10.1007/s11423-020-09793-2>; Crompton and Burke, "Artificial Intelligence in Higher Education: The State of the Field"; Ouyang and Jiao, "Artificial Intelligence in Education: The Three Paradigms."

²⁵ Crompton and Burke, "Artificial Intelligence in Higher Education: The State of the Field"; Wayne Holmes and Fengchun Miao, *Guidance for Generative AI in Education and Research* (UNESCO Publishing, 2023).

²⁶ Farrokhnia et al., "A SWOT Analysis of ChatGPT: Implications for Educational Practice and Research"; Kasneci et al., "ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education"; Lo, Hew, and Jong, "The Influence of ChatGPT on Student Engagement: A Systematic Review and Future Research Agenda"; Tlili et al., "What If the Devil Is My Guardian Angel: ChatGPT as a Case Study of Using Chatbots in Education."

²⁷ Apata et al., "Digital Transformation in Teaching: The Preparedness of In-Service Teachers in Nigeria for the Fourth Industrial Revolution (4IR)."

pedagogical integration. Without these conditions, AI will remain unevenly adopted by privileged students and institutions, while under-resourced learners are left behind.

AI for community engagement: health, agriculture and public value

Community engagement is a defining function of higher education, yet it is often discussed less systematically than research and teaching. AI offers Nigerian universities an opportunity to connect academic knowledge with community needs in health, agriculture, local governance, entrepreneurship and public information. This aligns with AI for social good scholarship, which argues that AI should be evaluated by its contribution to measurable social outcomes and SDG-related priorities.²⁸

In health, AI applications include diagnostic support, risk prediction, triage, imaging analysis, patient monitoring and health information systems.²⁹ These possibilities are significant for underserved Nigerian communities where specialist health workers and diagnostic facilities may be limited. University-community partnerships could support locally adapted health information tools, predictive modelling for disease outbreaks and public health education. However, health AI requires strong safeguards because health data are sensitive and errors may have serious consequences. Data privacy, informed consent, clinical validation and professional oversight must therefore be central to any health-facing AI project.³⁰

In agriculture, AI can support crop monitoring, pest detection, weather prediction, yield forecasting and supply-chain planning.³¹ Nigerian universities of agriculture and extension networks are well positioned to translate these tools into local advisory services for farmers. Yet community-facing AI should not assume that farmers have smartphones, broadband access or the digital literacy required to interpret complex outputs. Effective agricultural AI requires participatory design, local language interfaces, low-bandwidth delivery and collaboration with extension officers. Community applications also raise questions of trust. AI systems introduced into communities may fail if they are perceived as external, opaque or misaligned with local priorities. Raji et al. emphasise the importance of auditing and accountability,³² while Buolamwini and Gebru show how AI systems can produce discriminatory outcomes when training data are unrepresentative.³³ For Nigeria, community trust requires transparency about what AI can and cannot do, who owns the data, who benefits from the system and how harms will be addressed. Universities can play a mediating role by linking technical expertise with ethical review, community consultation and local knowledge.

The review therefore suggests that community engagement should be treated as a test of responsible AI. AI systems that work only for urban elites or well-funded institutions do not constitute national innovation. High-impact adoption requires tools that work for rural communities, low-resource schools, smallholder farmers, local languages and public health needs.

Barriers: infrastructure, literacy, governance and equity

The most consistent barrier across the literature is infrastructure. AI requires reliable electricity, connectivity, devices, data storage, computing resources and technical support. Nigeria's digital transformation agenda recognises these needs, but implementation remains uneven across regions and institutions.³⁴ Rural communities and underfunded institutions are especially disadvantaged. This

²⁸ Cowls et al., "A Definition, Benchmark and Database of AI for Social Good Initiatives"; Vinuesa et al., "The Role of Artificial Intelligence in Achieving the Sustainable Development Goals."

²⁹ Rajkomar, Dean, and Kohane, "Machine Learning in Medicine"; Secinaro et al., "The Role of Artificial Intelligence in Healthcare: A Structured Literature Review"; Topol, "High-Performance Medicine: The Convergence of Human and Artificial Intelligence."

³⁰ Nigerian Communications Commission, "National Digital Economy Policy and Strategy (2020-2030)"; Jobin, Ienca, and Vayena, "The Global Landscape of AI Ethics Guidelines."

³¹ Kamilaris and Prenafeta-Boldú, "Deep Learning in Agriculture: A Survey"; Liakos et al., "Machine Learning in Agriculture: A Review"; van Klompenburg, Kassahun, and Catal, "Crop Yield Prediction Using Machine Learning: A Systematic Literature Review."

³² Inioluwa Deborah Raji et al., "Closing the AI Accountability Gap," in *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency* (New York, NY, USA: ACM, 2020), 33–44, <https://doi.org/10.1145/3351095.3372873>.

³³ Buolamwini and Gebru, "Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification."

³⁴ Commission, "National Digital Economy Policy and Strategy (2020-2030)"; World Bank, "Nigeria Digital Economy Diagnostic Report."

means that AI adoption can easily become an elite phenomenon concentrated in better-resourced universities, urban schools and private-sector spaces.

Digital and AI literacy constitute a second barrier. AI tools require users who can frame questions, interpret outputs, identify errors, protect data and understand ethical risks. For lecturers and researchers, AI literacy includes prompt design, source verification, bias detection, data protection, academic integrity and pedagogical integration. For students, it includes responsible use, disclosure, critical evaluation and awareness of hallucination. For policymakers, it includes understanding how regulation, procurement, data governance and capacity building shape responsible adoption.³⁵

A third barrier is governance. Nigeria has made progress through the Nigeria Data Protection Act and the National Artificial Intelligence Strategy, but the translation of policy into institutional practice remains a major challenge.³⁶ Universities need AI policies that address research integrity, student use, assessment, data privacy, procurement, algorithmic accountability and human oversight. National policy is important, but institutional implementation is where responsible use becomes real.

Finally, there is the risk of algorithmic inequality. AI systems are not neutral. They may reproduce racial, gender, linguistic, geographical or socioeconomic bias if trained on unrepresentative data.³⁷ In Nigeria, this risk includes English-language dominance, urban bias, limited representation of indigenous knowledge, poor recognition of local names and insufficient data from rural communities. A high-impact AI ecosystem must therefore be built around inclusion, transparency and local validation.

Institutional readiness, policy implementation and local innovation

A cross-cutting finding from the review is that AI adoption in Nigeria is shaped less by awareness of AI than by institutional readiness to implement it responsibly. Awareness has increased rapidly because generative AI tools are publicly accessible, but institutional systems have not always evolved at the same pace. Many universities lack explicit AI policies, staff development structures, procurement criteria, data-governance protocols and assessment redesign processes. This creates a gap between individual experimentation and institutional accountability. In practice, students and lecturers may already be using AI tools while universities remain uncertain about disclosure, authorship, privacy, misconduct, accessibility and acceptable use.

Policy momentum is evident at the national level. The National Digital Economy Policy and Strategy and the National Artificial Intelligence Strategy show that Nigeria recognises digital transformation and AI as strategic development priorities.³⁸ The Nigeria Data Protection Act also provides an important legal basis for privacy, lawful processing and data-subject rights.³⁹ (However, the review suggests that national policy does not automatically become institutional practice. The major implementation challenge is the translation of policy into campus-level systems, including research ethics review, student guidance, lecturer training, AI procurement procedures and mechanisms for accountability.

Local innovation is equally important. If AI adoption depends mainly on imported platforms, Nigerian institutions may remain consumers rather than producers of AI knowledge. The literature on decolonial AI warns against technology transfer models that ignore local epistemologies, language ecologies and community priorities.⁴⁰ Nigeria's AI ecosystem should therefore prioritise local datasets, indigenous language resources, locally relevant educational applications, university-industry collaboration and open research infrastructures. Such local innovation would also reduce the risk that

³⁵ Holmes and Miao, *Guidance for Generative AI in Education and Research*; Zhu, Sun, and Yang, "Towards Responsible Artificial Intelligence in Education: A Systematic Review on Identifying and Mitigating Ethical Risks."

³⁶ Nigeria Data Protection Commission, "Nigeria Data Protection Act 2023," 2023; National Centre for Artificial Intelligence and Robotics, *National Artificial Intelligence Strategy*.

³⁷ Buolamwini and Gebru, "Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification"; Jobin, Ienca, and Vayena, "The Global Landscape of AI Ethics Guidelines"; Mittelstadt, "Principles Alone Cannot Guarantee Ethical AI."

³⁸ Nigerian Communications Commission, "National Digital Economy Policy and Strategy (2020-2030)"; National Centre for Artificial Intelligence and Robotics, *National Artificial Intelligence Strategy*.

³⁹ Commission, "Nigeria Data Protection Act 2023."

⁴⁰ Birhane, "Algorithmic Injustice: A Relational Ethics Approach"; Mohamed, Png, and Isaac, "Decolonial AI: Decolonial Theory as Sociotechnical Foresight in Artificial Intelligence."

AI systems reproduce cultural misrecognition, linguistic exclusion or inappropriate assumptions about learners, patients, farmers and communities.

The review further shows that AI governance must include public engagement. Community trust is central to adoption in health, agriculture and education, where data can be sensitive and where harms may be difficult to reverse. A responsible AI ecosystem should therefore include civil society, students, lecturers, farmers, health workers, local technology developers, policymakers and affected communities. This participatory orientation is not only ethical; it is practical. Systems designed without users are less likely to be trusted, maintained or used effectively. For this reason, the Nigerian AI ecosystem should move beyond top-down policy statements toward participatory implementation that embeds accountability at institutional and community levels.

DISCUSSION

The review demonstrates that AI-enabled innovation in Nigeria is best understood as a contested development pathway. AI has genuine potential to strengthen research productivity, personalise learning, improve community services and support SDG-related outcomes. Yet the same technologies can intensify inequality, weaken academic integrity, expose personal data, reproduce bias and deepen dependence on external platforms. This dual character is consistent with Vinuesa et al., who show that AI can enable many SDG targets while also inhibiting others.⁴¹ The Nigerian case therefore demands governance realism rather than technological optimism.

The first analytical insight is that AI adoption must be linked to institutional capacity. Many manuscripts on AI in developing contexts celebrate potential without asking whether institutions can sustain implementation. The evidence reviewed here suggests that AI requires organisational readiness: staff training, digital infrastructure, data governance, ethical oversight, procurement standards, technical maintenance and evaluation. Without these, AI adoption may become superficial. Universities may announce AI initiatives without changing research workflows, teaching practices or community engagement systems. This is why the article proposes capacity building as a core dimension of responsible AI, not a secondary consideration.

A second critical insight is that AI should be evaluated by the quality of the human and institutional decisions it enables. In research, the most valuable use of AI is not automatic production of text but improved capacity to discover literature, organise evidence, detect patterns and test models while preserving scholarly judgement. In teaching, the most valuable use is not automated delivery but richer feedback, inclusive access and assessment designs that require students to reason, explain, verify and apply knowledge. In community engagement, the most valuable use is not novelty but locally accountable problem-solving. This distinction matters because AI tools are often marketed through efficiency claims. A high-impact Nigerian AI agenda must instead ask whether AI improves epistemic quality, public trust, learner agency and community benefit.

The second insight concerns knowledge justice. AI systems are built from data, and data reflect histories of power. If Nigerian universities depend mainly on imported AI platforms trained on external corpora, local languages, indigenous knowledge and African educational realities may remain marginal. Bender et al., Birhane, and Mohamed et al. warn that language models and AI systems can reproduce dominant epistemologies while appearing neutral.⁴² The implications for Nigeria are profound. AI should not merely help Nigerian institutions consume external knowledge more efficiently; it should also support local knowledge production, African language resources and research agendas rooted in Nigerian realities.

The third insight is that AI in teaching must be governed through assessment reform. Generative AI challenges traditional assignments because it can produce plausible essays, summaries and code. However, banning AI does not address the deeper issue: assessment must increasingly evaluate process, judgement, oral explanation, context-specific application, ethical reasoning and original analysis. The literature suggests that generative AI can be useful when embedded in transparent pedagogical designs,

⁴¹ Vinuesa et al., "The Role of Artificial Intelligence in Achieving the Sustainable Development Goals."

⁴² Bender et al., "On the Dangers of Stochastic Parrots"; Birhane, "Algorithmic Injustice: A Relational Ethics Approach"; Mohamed, Png, and Isaac, "Decolonial AI: Decolonial Theory as Sociotechnical Foresight in Artificial Intelligence."

but harmful when used covertly or uncritically.⁴³ Nigerian institutions therefore need assessment policies that combine disclosure, redesign and AI literacy.

The fourth insight is that community engagement should be central to AI strategy. AI policy is often written for economic competitiveness, but universities have a broader public mission. Community-facing AI can support health information, agricultural resilience, small business innovation, local language communication and civic participation. However, community applications require trust, consent and participatory design. An AI tool that is technically advanced but not trusted, accessible or locally meaningful will have limited social impact. This is why community engagement should not be treated as an outreach add-on, but as an accountability mechanism for AI development.

The fifth insight concerns ethics. AI ethics in Nigeria cannot be reduced to privacy statements or general principles. It must address the full lifecycle of AI systems: data collection, consent, model training, deployment, monitoring, audit, redress and decommissioning. The Nigeria Data Protection Act provides an important legal foundation, but AI raises additional issues around automated decision-making, explainability, bias, surveillance and platform dependency.⁴⁴ Universities should therefore establish AI ethics committees or expand existing research ethics structures to cover educational, administrative and community-facing AI systems.

Taken together, the findings point toward a responsible AI integration framework for Nigeria. The framework has six interdependent dimensions: (1) infrastructure and access; (2) AI literacy and professional development; (3) research innovation and integrity; (4) teaching, learning and assessment redesign; (5) community-facing social impact; and (6) ethics, governance and local innovation. These dimensions are mutually reinforcing. Infrastructure without ethics may produce harm. Ethics without infrastructure may remain symbolic. Literacy without policy may produce uneven practice. Policy without local innovation may reproduce dependency.

Proposed responsible AI integration framework for Nigeria

The proposed framework responds directly to the evidence synthesised in this review. It is not a technical implementation model, but a policy and institutional guide for Nigerian universities, government agencies and development partners. Its first pillar is infrastructure and access. AI policy must be tied to broadband expansion, electricity reliability, device access, cloud capacity and affordable data. Without this, AI adoption will be restricted to privileged institutions and users.

The second pillar is AI literacy. Universities should develop AI literacy programmes for students, lecturers, researchers, administrators and community partners. These programmes should cover prompt design, verification, data protection, bias, academic integrity, disciplinary applications and ethical decision-making. AI literacy should not be limited to computer science; it should be embedded across education, health, agriculture, humanities, social sciences and professional programmes.

The third pillar is research innovation with integrity. Nigerian universities should support AI-assisted data analysis, research management, indigenous language technology, health modelling and agricultural prediction, while requiring disclosure of AI use, human verification, ethical approval and data governance. Research offices and postgraduate schools should develop guidance on acceptable AI use in theses, publications and grant writing.

The fourth pillar is teaching and assessment redesign. Institutions should move beyond ad hoc responses to ChatGPT and related tools. Policies should define acceptable use, redesign assessments, train lecturers and teach students' responsible use. Assessment should increasingly value critical thinking, oral defence, reflective process, local application and evidence-based reasoning.

The fifth pillar is community impact. Universities should develop AI projects with communities, not merely for them. This includes participatory design, local language interfaces, rural access strategies and community feedback. Health, agriculture and education projects should be evaluated by social usefulness, accessibility and equity.

⁴³ Farrokhnia et al., "A SWOT Analysis of ChatGPT: Implications for Educational Practice and Research"; Kasneci et al., "ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education"; Lo, Hew, and Jong, "The Influence of ChatGPT on Student Engagement: A Systematic Review and Future Research Agenda."

⁴⁴ Commission, "Nigeria Data Protection Act 2023"; Raji et al., "Closing the AI Accountability Gap."

The sixth pillar is ethics and governance. Institutional AI governance should include data protection, bias audits, procurement review, human oversight, accountability mechanisms and grievance procedures. National strategies should support local AI research and open datasets while preventing extractive data practices. This framework aligns with responsible AI scholarship and responds to Nigeria's development needs by connecting innovation to rights, equity and public value.

Table 3. Responsible AI integration framework for Nigerian research, teaching and community engagement

Framework pillar	Core institutional action	Expected outcome
Infrastructure and access	Invest in connectivity, electricity, devices, computing and affordable data	Reduced digital exclusion and wider AI participation
AI literacy	Train students, lecturers, researchers, administrators and communities	Critical, ethical and effective AI use
Research innovation	Support AI-assisted analysis, disclosure, integrity and local datasets	Higher research productivity without weakening scholarly standards
Teaching and assessment	Develop AI-use policies, redesign assessment and support lecturers	Pedagogically meaningful and integrity-conscious AI adoption
Community impact	Co-design health, agriculture and civic AI tools with communities	Locally relevant and socially trusted AI applications
Ethics and governance	Implement data protection, audits, oversight and accountability	Responsible AI aligned with equity and public value

Implications for policy, practice and future research

For policymakers, the review suggests that AI strategy must be coordinated across education, data protection, infrastructure, labour, agriculture, health and innovation policy. Nigeria's National Artificial Intelligence Strategy provides a useful starting point, but its success will depend on implementation capacity, funding, institutional coordination and evaluation.⁴⁵ The state should support AI talent development, local language resources, research infrastructure and public-interest datasets while ensuring that data protection enforcement is credible.

For universities, the main implication is that AI adoption should be managed through governance structures rather than left to individual enthusiasm. Institutions should establish AI committees, update academic integrity policies, train lecturers, provide student guidance and review digital procurement. AI should be incorporated into research strategy, teaching policy, community engagement and ethics review. This is particularly important because students' use of generative AI is likely to expand faster than institutional policy.

For lecturers and researchers, the implication is that AI requires professional judgment. AI tools can support scholarly work, but researchers must verify outputs, protect data, avoid fabricated citations, and maintain responsibility for interpretation. Lecturers should use AI to enrich pedagogy rather than outsource teaching. For students, AI literacy should include critical awareness of hallucination, bias, plagiarism, data privacy, and responsible disclosure.

For future research, more empirical studies are needed. Many Nigeria-focused discussions remain conceptual or descriptive. Future research should examine actual AI use by students, lecturers, researchers, farmers, health workers, and community organisations. Comparative studies across Nigerian regions, institution types and language communities would provide stronger evidence on

⁴⁵ National Centre for Artificial Intelligence and Robotics, *National Artificial Intelligence Strategy*.

equity. There is also a need for longitudinal studies on learning outcomes, research productivity, community impact and ethical governance.

The findings also have implications for the Sustainable Development Goals. AI can support SDG 4 through personalised learning and educator support, SDG 3 through health diagnostics and public health information, SDG 9 through innovation infrastructure, and SDG 10 through inclusion-oriented design. However, AI can also undermine these goals if it expands surveillance, excludes low-income users, automates bias or concentrates digital power. Nigeria's AI strategy should therefore treat SDG alignment as an evaluative framework: projects should be assessed not only by technical performance, but by equity, accessibility, safety, environmental cost, local capacity and public value.

For development partners and private-sector actors, the review suggests that investment should prioritise ecosystem building rather than isolated pilots. Short-term pilots often fail because they do not address maintenance, training, governance and ownership. More sustainable models would invest in local datasets, open educational resources, AI literacy programmes, research infrastructure, local language technologies and institutional ethics capacity. Partnerships should also avoid data extractivism by clarifying data ownership, benefit sharing, community consent and accountability.

CONCLUSION

AI-enabled innovation offers Nigeria significant opportunities in research, teaching and community engagement, but those opportunities are conditional. AI can accelerate research, support personalised learning, improve health and agricultural services, and strengthen institutional administration. Yet it can also reproduce inequality, undermine academic integrity, expose personal data, marginalise local languages and deepen dependency on external platforms. The decisive issue is not technological availability alone, but governance, capacity and justice. The review argues that Nigeria requires a responsible AI ecosystem built around infrastructure, literacy, research integrity, pedagogical redesign, community participation, data protection and local innovation. Universities have a central role because they are sites of research, teaching, community engagement and ethical formation. If AI is to serve national development, it must be locally grounded, critically governed and socially inclusive. AI should not simply unlock new frontiers; it should help ensure that those frontiers are equitable, accountable and beneficial to Nigerian society.

LIMITATIONS

This review has limitations. First, although the search strategy was systematic, the AI literature is expanding rapidly, and relevant studies may have appeared after the review period. Second, the review used Google Scholar to capture Nigeria-focused work that may not be indexed elsewhere, but this also required stricter quality screening. Third, the review synthesised diverse studies rather than conducting a meta-analysis because methods and outcomes were heterogeneous. Fourth, some Nigerian AI applications are reported in policy, media, institutional and grey literature rather than peer-reviewed studies. The article therefore privileges peer-reviewed evidence while using policy sources to contextualise governance developments.

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