HARNESSING ARTIFICIAL INTELLIGENCE IN TERTIARY EDUCATION FOR NATIONAL DEVELOPMENT: OPPORTUNITIES, RISKS AND POLICY DIRECTIONS

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Abstract

This paper examines the integration of artificial intelligence in tertiary education and its implications for national development, with a particular focus on Nigeria. Drawing on recent literature and global policy developments, it defines artificial intelligence as computational systems that support personalized learning, adaptive assessment, institutional management, and research processes. It presents tertiary education as a key driver of human capital development, technological progress, and socio-economic transformation, and explains how the careful adoption of artificial intelligence can strengthen these functions. The paper identifies several opportunities. These include personalized and inclusive learning at scale, improved quality assurance and administrative efficiency, increased research productivity, and stronger graduate employability through artificial intelligence literacy and digital skills. In this way, tertiary institutions function both as users of artificial intelligence tools and as centers for developing artificial intelligence knowledge within national innovation systems. However, the paper also examines significant risks, especially in settings marked by weak infrastructure and limited regulatory capacity. Key concerns include data privacy and security vulnerabilities, algorithmic bias and digital exclusion, threats to academic integrity associated with generative systems, and potential disruptions to professional roles within and outside universities. The paper maintains that artificial intelligence is neither inherently beneficial nor harmful. Its contribution to national development depends on clear regulation, ethical safeguards, institutional preparedness, and sustained investment in infrastructure and human capacity. It concludes by recommending policy measures

that promote responsible governance, reform quality assurance systems, strengthen collaboration among stakeholders, and align artificial intelligence adoption with national development priorities to secure inclusive and sustainable outcomes.

Keywords: Artificial intelligence, Tertiary education, National development, Opportunities, Risk.

Introduction

Artificial intelligence, commonly referred to as AI, ranks among the most influential technologies of the twenty-first century, reshaping how knowledge is produced, shared, and applied across sectors such as healthcare, finance, transportation, manufacturing, and education. In healthcare, AI improves diagnosis, treatment planning, and patient care through advanced data analysis and predictive modelling. In finance, AI strengthens risk management, investment optimisation, and fraud detection processes. Transportation systems increasingly rely on AI for autonomous vehicle development and improved safety mechanisms. In education, AI supports individualised learning by adjusting content to learner needs and automates assessment processes to deliver timely feedback, improving teaching efficiency and learning outcomes.

Artificial intelligence refers to the design of computer systems capable of performing tasks that normally require human intelligence. Within education, AI now plays an important role in administration, instruction, learning support, data management, and continuous assessment processes. Personalised learning systems adjust instructional materials to suit learner ability, which improves engagement and retention. Tools such as intelligent tutoring systems, chatbots, and virtual assistants assist educators by reducing administrative workload, supporting grading, and facilitating timely feedback, thereby improving instructional quality (Chen et al., 2020; Labadze et al., 2023; Mittal et al., 2023). In addition, AI tools have increasingly been consulted in informal settings to provide basic first aid guidance for accident cases before the intervention of trained medical personnel, indicating the growing reliance on AI for practical decision support.

At the global level, the use of AI in tertiary education has moved from policy aspiration to sustained large-scale application that supports teaching quality, institutional efficiency, and economic competitiveness across both developed and emerging economies. In North America, universities record high levels of AI integration in academic administration and instruction, while institutions worldwide increasingly embed AI in teaching, assessment, and management practices (OECD, 2023; Zawacki-Richter et al., 2024). In Asia, China has committed extensive resources to university-based AI research centres as part of its national innovation agenda. Similarly, Saudi Arabia has incorporated AI training into tertiary education curricula under the Vision 2030 framework to strengthen workforce skills and economic diversification (Saudi Data and Artificial Intelligence Authority, 2023; UNESCO, 2023). In contrast, Sub-Saharan Africa records limited and uneven application of AI in tertiary education. Adoption is often driven by isolated institutional initiatives, pilot projects, or external technology providers rather than coordinated national policies. The Nigerian tertiary education system faces persistent challenges related to inadequate infrastructure, weak policy execution, and low institutional capacity for formal AI deployment. As a result, many students rely on informal exposure to AI tools, a situation that limits the potential contribution of AI to educational improvement and national development (World Bank, 2024).

Despite growing interest in AI, technological adoption does not automatically translate into positive development outcomes. While AI supports many benefits, it also raises ethical concerns that will be discussed in other sections of this paper. These challenges tend to be more severe in contexts where regulatory frameworks remain weak. For this reason, this paper examines, at a conceptual level, the use of artificial intelligence in tertiary education for national development, with specific attention to opportunities, risks, and policy directions.

Clarification of concepts

Artificial intelligence refers to engineered computational systems that are designed to perform tasks traditionally requiring human cognitive abilities, including problem-solving, pattern recognition, decision-making, and adaptive learning. For instance, in educational domain, artificial intelligence encompasses algorithmic models, machine learning systems, and generative tools that analyse learner data, provide customised instructional feedback, automate assessment, and support institutional decision-making (Mosha et al., 2026).

Tertiary education is understood as the post-secondary educational level that encompasses universities, polytechnics, colleges of education, and other accredited institutions offering advanced knowledge, professional training, and research opportunities. This level of education is central to cultivating specialised skills, fostering innovation, and generating the research knowledge necessary for socio-economic development. (Mosha et al., 2026).

National development is the comprehensive advancement of a country's economic, social, technological, and institutional capacities in ways that improve quality of life and broaden opportunities for citizens. It includes deliberate investments in human capital, research and innovation systems, infrastructure, governance frameworks, and economic diversification. National development presupposes that educational outputs, such as skilled graduates, applied research, and technological competencies, are aligned with societal needs and national strategic priorities.

Opportunities denote the favourable possibilities and beneficial outcomes that may arise from harnessing artificial intelligence in tertiary education. These opportunities include expanded access to personalised and adaptive learning, enhancement of pedagogical effectiveness, greater efficiency in administrative operations, and enriched research productivity through AI-enabled tools. (Ocen et'al 2025).

Risk is a potential adverse effect, unintended consequences, or negative outcomes associated with the adoption and deployment of artificial intelligence in tertiary education. Risks include threats to data privacy, algorithmic bias, inequitable access to technology, erosion of academic integrity, and disruption of established pedagogical relationships. .

Policy is a formalised principle, strategies, regulations, and governance frameworks developed by governments, educational authorities, and institutions to guide the adoption, use, oversight, and evaluation of artificial intelligence in tertiary education. Policy frameworks set boundaries for ethical practice, ensure accountability for data protection and fairness, and facilitate alignment with national development objectives (McDonald et al., 2024).

Global Trends in Artificial Intelligence and Tertiary Education

Several studies have shown that there is a rapid expansion of artificial intelligence applications in education, particularly within well-resourced institutions. Common uses include intelligent tutoring systems, automated assessment, personalized learning pathways, and student support chatbots integrated into learning management systems. Automated grading of quizzes and short responses, AI-based recommendation of learning resources, and adaptive testing systems are increasingly used to improve efficiency and accuracy in assessment. Computer adaptive testing, which adjusts item difficulty based on prior responses, provides a more precise measurement of learner ability and reduces testing time (Ahmed et al., 2025). AI-driven chatbots also guide learners through course materials and deliver immediate feedback, supporting engagement and self-paced learning. These advantages, however, depend on careful system design, continuous oversight, and alignment with sound teaching principles.

The emergence of AI has also contributed to the idea of a smart university, where digital systems support both academic and administrative functions. In such settings, AI assists with enrolment management, timetabling, facilities planning, resource allocation, and quality assurance. Learning analytics dashboards enable monitoring of key performance indicators, while predictive models support early interventions to improve student retention and completion. Despite these efficiencies, concerns remain about academic judgment, staff roles, and data privacy. Where data-driven tools influence curriculum decisions, staff appraisal, or student selection, governance frameworks become essential. Weak transparency and unclear accountability may reduce trust among staff and students and weaken institutional legitimacy (Bucea Manea ?oni? et al., 2022; George & Wooden, 2023; Kamalov et al., 2023).

At the international level, policy discussions on AI in education focus largely on ethics, privacy, fairness, and the need for trustworthy systems. A global Delphi study identified ethical use of data, algorithm transparency, and equity as the most pressing policy concerns (Ifenthaler et al., 2024). The study also pointed to geopolitical competition, market expansion, and efforts to shape global norms around educational technology. Many countries now link AI strategies in education to innovation, economic growth, and national security, with universities positioned as centres for talent development and experimentation, often in partnership with large technology firms (Tanveer et al., 2020). For Nigeria, engagement with these global trends requires careful policy choices to ensure that local values and development priorities remain central.

Artificial Intelligence in Tertiary Education and National Development

The Nigerian tertiary education system comprises federal, state, and private universities, polytechnics, and colleges of education, with significant variation in resources, infrastructure, and digital maturity. Although AI tools such as plagiarism checkers, basic learning analytics within learning management systems, and commercial generative AI services are beginning to enter classrooms and administrative offices, formal documentation of AI adoption in Nigerian higher education remains limited compared with other regions. Many of the structural constraints abound, including unstable electricity supply, limited broadband, large class sizes, underresourced laboratories, and uneven digital skills among staff and students. Given these realities, opportunities to harness AI for national development may remain unrealized unless Nigeria adopts a deliberate and coordinated policy approach that recognizes both potential benefits and risks.

In tertiary education, AI applications have several functions. These include intelligent tutoring systems, adaptive learning platforms, automated or semi-automated assessment, learning analytics and early warning systems, AI-supported academic advising, and AI-enabled administrative tools for admissions, scheduling, and resource allocation (Kamalov et al., 2023; Tanveer et al., 2020). These applications rely on large quantities of learner and institutional data, processed through machine learning models that identify patterns and generate recommendations. For example, adaptive learning systems adjust the pace and difficulty of material to each student, while predictive analytics attempt to flag students at risk of dropping out. AI can also support research through advanced search, summarization, and pattern detection in large data sets.

Tertiary education contributes to national development in several ways. It builds human capital by producing graduates with advanced knowledge and skills. It supports innovation and technological progress through research, and contributes to social cohesion and democratic participation through critical thinking, citizenship, and leadership training. In low and middleincome countries, expansion and reform of higher education are often linked to the Sustainable Development Goals, especially quality education, decent work, and reduced inequalities (Ahmed et al., 2025).

From a human capital perspective, AI is both an object of study and a tool. Tertiary institutions are expected to train AI specialists and a wider workforce that can operate in AI-rich environments, while also using AI systems

to manage large enrolments and limited resources. The interaction between AI, higher education, and national development is therefore two-way. Policy choices in education will influence the quality of AI-related skills in the economy, and AI-related choices in higher education will shape the effectiveness and fairness of educational systems that underpin development. See fig. 1

Opportunities for National Development

i. Personalised and inclusive learning at scale

Artificial intelligence systems can adapt instruction, pacing, and feedback to individual learners, which is particularly relevant for the large class sizes common in Nigerian universities. This capacity allows institutions to respond to varied learning needs without a proportional increase in academic staff. Adaptive platforms and AI-based tutoring can support students who experience learning difficulties while also extending more complex tasks to high-performing learners. In addition, tools such as text-to-speech, speech-to-text, translation, and summarisation can improve access to learning materials for students with disabilities and for those studying in a second language. When institutions deploy these tools within clear ethical guidelines, they can promote inclusive and learner-focused environments that align with national objectives to widen participation in tertiary education, particularly among underrepresented and disadvantaged groups (Abubakar et al., 2024; Bessong et al., 2025; Manir & Gwandu, 2025). ii. Enhancing quality, access, and equity in tertiary education

Artificial intelligence can support institutional management by improving course scheduling, monitoring attendance, and analysing progression and performance patterns across large student populations. Predictive systems may assist in identifying students at risk of withdrawal, which allows earlier intervention through academic advising, counselling, or financial support. Automated and semi-automated assessment of quizzes and assignments can also reduce academic workload and provide timely feedback, which may improve learning outcomes when applied carefully. From a national development perspective, AI-supported open and distance learning can extend higher education opportunities to rural and underserved areas where physical expansion is limited, provided that adequate infrastructure is available (Agbarakwe & Ogbonna, 2024; Bali et al., 2024; Naeem et al., 2025).

Strengthening research, innovation, and graduate employability

Artificial intelligence can improve research productivity across disciplines by accelerating literature review, data analysis, and modelling processes, particularly when handling large volumes of academic literature or complex data sets. In innovation and entrepreneurship, AI-related competencies support the development of practical solutions in sectors such as health, agriculture, finance, and public administration. Graduate employability is closely linked to these developments, as institutions that integrate AI literacy, data skills, and computational thinking across programmes are better positioned to prepare graduates for labour markets increasingly influenced by automation and machine learning (Amofa et al., 2025; Ayanwale et al., 2025; Bali et al., 2024).

AI skills, digital capabilities, and the future workforce

Adoption of artificial intelligence in tertiary education can serve both as preparation for specialised AI careers and as a means to build general awareness of AI across disciplines. Treating AI literacy as a general graduate competence can help develop a workforce that understands the strengths and limits of AI, can critically assess algorithmic outputs, and can contribute to responsible innovation. This competence extends beyond technical ability to include ethical judgement, awareness of data governance, and capacity for collaborative work across

disciplines, which are increasingly important for sustainable national development (Ayanwale et al., 2025; Amofa et al., 2025; Naeem et al., 2025).

Risks, Challenges, and Ethical Issues

Data governance, privacy, and security concerns

Artificial intelligence in tertiary education relies on extensive data drawn from students and staff, including personal information, academic records, and, in some cases, behavioural indicators. Without clear regulatory frameworks and effective technical safeguards, institutions risk data misuse and security breaches. Research on artificial intelligence in education identifies privacy protection, ethical data use, and the need for trustworthy algorithms as central policy concerns (Ifenthaler et al., 2024; Tanveer et al., 2020). In Nigeria, many tertiary institutions operate with weak data governance systems. Records are often fragmented across administrative units, and institutions frequently lack strong encryption, effective access controls, and clear data retention policies. Introducing artificial intelligence into such environments may increase existing vulnerabilities. In addition, reliance on foreign cloud services and proprietary platforms raises concerns about data sovereignty and compliance with national regulations, particularly in relation to the Nigerian Data Protection Act.

Algorithmic bias, inequality, and digital exclusion

Artificial intelligence systems trained on historical data can reproduce and intensify existing inequalities linked to gender, region, socioeconomic status, and disability. In tertiary education, this risk may appear in biased predictions of student performance, unequal allocation of academic opportunities, or incorrect identification of students who require support (Ifenthaler et al., 2024; Nemorin et al., 2023). When developers design algorithms using datasets from other countries or from socially advantaged groups, the likelihood of bias increases in Nigerian institutions. Digital exclusion further complicates this problem. Students in urban and well-resourced universities are more likely to benefit from artificial intelligence-driven platforms, while those in rural areas, conflict-affected zones, or underfunded institutions may fall further behind. A national strategy that prioritises advanced artificial intelligence tools without addressing basic infrastructure, stable electricity, reliable internet connectivity, and access to digital devices may widen existing regional and social divides.

Academic integrity, human agency, and the nature of learning

Generative artificial intelligence tools that produce essays, computer code, and other academic outputs raise serious concerns about academic integrity and assessment standards. Studies on artificial intelligence in higher education report challenges related to authenticity, critical thinking, meaningful human engagement, and the value of independent intellectual effort when machinegenerated content becomes widespread (Al Zahrani & Alasmari, 2024; Kamalov et al., 2023). These concerns are particularly relevant in tertiary institutions, where independent inquiry and original scholarship are core objectives. Excessive reliance on automated feedback systems or artificial intelligence-based explanation tools may reduce student motivation to engage deeply with course material. Where students can generate responses quickly through artificial intelligence systems, lecturers must redesign assessments to include oral examinations, practical demonstrations, and project-based tasks, and must provide clear guidelines on responsible use of these tools. Without such measures, artificial intelligence may weaken the development of critical thinking and academic honesty.

Labour market disruption and professional identities

The adoption of artificial intelligence in tertiary institutions can alter the roles of academic and non-academic staff. Automated systems for marking, scheduling, and student advising may reduce routine administrative tasks, yet they may also increase performance pressures or encourage workforce reductions. Academic staff may perceive that algorithmic recommendation systems diminish professional judgement, while support staff may fear job displacement. Reviews of smart universities and artificial intelligence in higher education identify these tensions and stress the importance of careful institutional change management (Ahmed et al., 2025; Bucea Manea ?oni? et al., 2022; George & Wooden, 2023). Beyond the university, automation in other sectors may reduce demand for certain graduate roles while increasing demand for new technical and analytical skills. If tertiary institutions fail to revise curricula and career guidance in response to these shifts, graduates may face misalignment with labour market requirements. Nigeria, therefore, confronts a dual challenge: managing workforce changes linked to artificial intelligence and repositioning higher education to support adaptable and resilient career pathways.

Policy Implications and Options

i. Principles for responsible and ethical AI in tertiary education

National policy for artificial intelligence in Nigerian tertiary education should rest on clearly defined ethical principles that prioritise human development, equity, privacy, transparency, accountability, and fairness. Recent scholarship in leading Q1 journals in educational technology and higher education stresses that responsible adoption requires governance frameworks that embed ethical safeguards within institutional policies, system design, and pedagogical practice (Bond et al., 2024; Zawacki-Richter et al., 2019). Such principles should guide the selection of artificial intelligence applications, the evaluation of technology vendors, and the establishment of data management standards. They should also promote meaningful stakeholder participation in decision-making, including students and academic staff, and ensure that partnerships with external providers strengthen local capacity rather than create dependency. ii. Regulatory frameworks, standards, and quality assurance

Effective integration of artificial intelligence into tertiary education requires regulatory clarity and robust quality assurance mechanisms. Evidence from Q1 indexed research indicates that welldefined regulatory frameworks can support responsible innovation by providing institutional certainty while protecting academic standards and fundamental rights (Bond et al., 2024). National regulators should therefore update accreditation criteria to address artificial intelligence-mediated teaching, learning, and assessment. Clear guidelines are also needed on the ethical use of student data for analytics and research, as well as transparent procurement standards for artificial intelligence systems. Early and sustained engagement of the National Universities Commission and related professional bodies will be essential to ensure coherence across institutions.

iii. Funding, infrastructure, and capacity building priorities

Artificial intelligence adoption requires sustained investment in infrastructure and human capacity. Reliable electricity supply, high-speed internet connectivity, secure data storage systems, and adequate digital devices remain foundational requirements. Studies have consistently shown that institutional readiness, including staff competence and digital infrastructure, strongly influences successful implementation (Bond et al., 2024; Zawacki-Richter et al., 2019). Capacity building must therefore extend beyond technical training to include ethical literacy, pedagogical redesign, and legal awareness. Teacher education programmes and continuing professional development frameworks in Nigeria should incorporate structured preparation for responsible artificial intelligence use in teaching, assessment, and academic administration. iv. Multi-stakeholder partnerships and regional cooperation

Artificial intelligence governance in tertiary education requires collaboration among government ministries, regulatory agencies, universities, student bodies, industry partners, and civil society organisations. Evidence from Web of Science emphasises that multi-stakeholder dialogue strengthens policy legitimacy, promotes shared standards, and supports coordinated responses to emerging risks (Zawacki-Richter et al., 2019). In addition, regional cooperation within West Africa and through the African Union can facilitate shared learning, harmonised regulatory approaches, and stronger collective negotiation with global technology providers. Coordinated positions on data protection, algorithmic accountability, and digital trade can enhance the strategic autonomy of African higher education systems.

Conclusion and Recommendations

Artificial intelligence is transforming tertiary education globally, and Nigeria must respond to both its opportunities and its risks. Evidence from leading research in educational technology and higher education indicates that artificial intelligence can improve personalised learning, support inclusive pedagogies, and strengthen research capacity when institutions adopt it within clear pedagogical and ethical frameworks. At the same time, research cautions that weak governance, limited infrastructure, and insufficient staff preparation can increase inequality, compromise data protection, and weaken academic standards. These findings suggest that artificial intelligence is neither inherently beneficial nor harmful, but depends on policy design and institutional practice.

For Nigeria, the central policy task is to align artificial intelligence adoption in tertiary education with national development priorities and constitutional values. This alignment requires clear ethical principles, effective regulation, sustained investment in infrastructure, and deliberate human capacity development. Institutions should establish transparent governance structures for artificial intelligence oversight, revise curricula to integrate emerging digital competencies, and redesign assessment practices to preserve academic integrity in an era of generative systems.

Teacher education and continuous professional development programmes must incorporate artificial intelligence literacy, including ethical, pedagogical, and legal dimensions, in order to strengthen responsible implementation.

National policy makers should develop a comprehensive artificial intelligence in education strategy that spans all educational levels while recognising the distinctive role of tertiary education in advanced skills formation, research production, and innovation ecosystems. Crosssector partnerships among government agencies, higher education institutions, industry actors, and civil society organisations can strengthen policy coherence and technical capacity. In addition, regional cooperation within West Africa and across the African Union can enhance knowledge exchange and improve collective negotiation on issues such as data governance and digital trade. Through deliberate, principled, and evidence-informed action, Nigeria can integrate artificial intelligence into tertiary education in ways that advance inclusive and sustainable national development.

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