

REVIEW ARTICLE

Re-Educating for the Age of Artificial Intelligence: Human Capital Development, Digital Competence, and the Transformation of Education in Nigeria

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ABSTRACT

Artificial intelligence (AI) is fundamentally altering the knowledge, skills, competencies, and learning arrangements required for participation in contemporary society. While previous educational systems were largely designed around the acquisition of relatively stable bodies of knowledge during the formative years of life, the rapid diffusion of AI and digital technologies has made continuous learning, reskilling and adaptation increasingly indispensable. This paper examines the imperative of re-educating Nigerians for the age of artificial intelligence, with particular emphasis on human capital development, digital competence and educational transformation. Drawing on Human Capital Theory, the Capability Approach and lifelong-learning perspectives, the paper argues that education should no longer be conceptualized merely as an initial investment in human capital but as a continuous mechanism for renewing human capability throughout the life course. The paper adopts a conceptual and integrative review approach, synthesizing recent international literature, Nigerian empirical studies, and national education and digital-policy documents. Evidence indicates that AI offers significant opportunities for personalized learning, adaptive instruction, teacher support, curriculum innovation, and expanded access to knowledge. However, Nigeria faces substantial constraints, including digital inequality, inadequate infrastructure, limited teacher preparedness, curriculum rigidity, affordability, ethical concerns, and weak institutional capacity. Recent Nigerian evidence demonstrates disparities in access to digital learning, emerging concerns about AI adoption among educators, and growing student interest in AI-supported adaptive learning. The paper proposes a Continuous AI-Ready Human Capital Development Framework (CAHDF) comprising digital access, AI-enabled pedagogy, teacher re-education, curriculum renewal, and lifelong learning. It argues that Nigeria's educational competitiveness will depend not merely on acquiring AI technologies but on developing citizens capable of thinking critically, learning continuously, collaborating responsibly with AI, and converting knowledge into innovation and productivity.

Keywords: Artificial intelligence; Digital competence; Education transformation; Human capital development; Re-education

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INTRODUCTION

Education has historically represented one of the principal mechanisms through which societies develop human capability, transmit knowledge, prepare individuals for employment and cultivate the intellectual, social and civic capacities required for collective development. Its contribution to national development extends beyond the classroom because educated populations provide the knowledge, skills, creativity and institutional capabilities upon which productivity and innovation depend. Human Capital Theory consequently conceptualizes education and training as investments in people whose accumulated knowledge and competencies can generate economic and social returns^[1,2].

The assumptions underpinning conventional human-capital formation, however, are being challenged by rapid technological change. Artificial intelligence (AI), particularly generative AI, is transforming how information is produced, accessed, evaluated, and applied. AI systems can generate text, analyze information, translate languages, provide feedback, personalize learning experiences, support research, and assist with increasingly complex cognitive tasks. Consequently, the educational challenge of the twenty-first century is no longer simply to provide individuals with access to information. It is to equip them with the intellectual and ethical capacities required to navigate an environment in which information is abundant, machine-generated content is increasingly sophisticated, and occupational requirements change continuously^[3–5].

This development has profound implications for the purpose of education. A system that prepares learners for a relatively stable occupational environment can no longer adequately respond to an environment characterized by technological disruption. The contemporary learner needs not only disciplinary knowledge but also the ability to learn continuously, critically assess information, work with digital technologies, understand AI, solve unfamiliar problems, and adapt to changing circumstances. The contemporary teacher similarly requires competencies that extend beyond subject knowledge and conventional pedagogy^[6].

The international education community increasingly recognizes this transformation. UNESCO's AI Competency Framework for Students identifies 12 competencies across four dimensions—human-centered mindset, ethics of AI, AI techniques and applications, and AI system design—and organizes them around progression from understanding to application and creation. The corresponding UNESCO framework for teachers identifies 15 competencies across human-centered mindset, ethics of AI, AI foundations and applications, AI pedagogy, and

AI for professional learning. These frameworks indicate a significant conceptual shift: AI competence is not simply technical competence. It incorporates human agency, ethics, critical judgment, pedagogy, and lifelong professional learning^[7,8].

The implications are particularly significant for developing countries. Technological transformation can potentially democratize access to knowledge and educational resources, but it can also reproduce or intensify existing socioeconomic inequalities. UNESCO's technology and education evidence emphasizes that digital technology is not automatically educationally beneficial; outcomes depend upon infrastructure, teacher capacity, pedagogical appropriateness, equity, governance, and sustainability. Consequently, as emphasized by the World Bank, digital transformation must be understood as an educational and institutional transformation rather than merely a technological procurement exercise^[9].

Nigeria presents an especially important case. The country's large and youthful population constitutes a potentially significant human-capital resource. Yet demographic advantage does not automatically translate into productive capability. Education must convert population into knowledge, knowledge into competence, competence into productive capacity, and productive capacity into national development. This conversion is increasingly dependent upon the capacity of educational institutions to respond to digitalization and AI^[10,11].

Nigeria has already begun establishing policy foundations for this transition. The National Digital Learning Policy seeks to establish an inclusive digital learning ecosystem capable of providing quality education regardless of learners' socioeconomic or geographical circumstances. The National Digital Literacy Framework identifies digital literacy as essential to Nigeria's participation in the Fourth Industrial Revolution and links digital skills to human-capital development, employability and productivity. More recently, Nigeria's National EdTech Strategy 2025–2030 has adopted an integrated approach encompassing digital infrastructure, connectivity, teacher capacity, curriculum and content innovation, education data systems, governance and safe AI use^[12–14].

These developments notwithstanding, a fundamental conceptual question remains insufficiently addressed: What does education mean when the knowledge and skills acquired today can become inadequate tomorrow?

The answer, this paper argues, requires a transition from education as initial human-capital formation to education as continuous human-capital renewal.

The concept of re-education is central to this argument. Re-education is used here not in the narrow sense of re-

medial schooling but as the continuous process through which individuals renew, update, extend and sometimes replace existing knowledge, skills and competencies in response to technological, occupational and social change. It encompasses lifelong learning, continuing professional development, reskilling, upskilling, digital literacy, AI literacy, micro-credentials and workplace learning.

Human capital is consequently becoming a dynamic and renewable capability rather than a fixed stock acquired predominantly during formal education.

Recent OECD analysis reinforces this argument. Its 2026 assessment of skills in the AI age identifies the need for a combination of foundational skills, ICT capabilities, and complementary competencies such as critical thinking, creativity, communication, collaboration, and problem-solving. It also emphasizes AI literacy and flexible lifelong-learning pathways as central policy responses to changing labor-market requirements^[7,8].

The educational significance is considerable. If AI changes the competencies required for productive participation, educational systems must continuously update what they teach, how they teach, and how learning is assessed. Teacher education must similarly become a continuous process of professional renewal.

This paper therefore examines the relationship between AI, re-education, digital competence, and human-capital development in Nigeria.

Objectives of the Study

The main objective of the study is to determine how Artificial Intelligence enhances human capital development, promotes digital competence, and leads to the Transformation of Education in Nigeria

It specifically seeks to examine the changing relationship between artificial intelligence and education; analyze the role of digital competence and AI literacy in contemporary human-capital development; assess the implications of AI for teacher education, curriculum and pedagogy in Nigeria; synthesize empirical evidence concerning digital and AI-enabled education in Nigeria;

identify the principal institutional, infrastructural and socioeconomic constraints to educational transformation; and propose a framework for continuous AI-ready human-capital development.

The paper's central proposition is that Nigeria should not merely digitize its existing educational system; it should redesign education as a continuous mechanism for human-capital renewal.

THE CHANGING MEANING OF HUMAN CAPITAL IN THE AI ERA

Human Capital Theory provides a useful starting point for understanding the relationship between education and development. Schultz argued that investment in human capabilities constitutes a major source of economic development, while Becker conceptualized education and training as investments that increase individual productivity^[1,2].

The contemporary relevance of the theory remains strong. The OECD defines human capital broadly as the stock of knowledge, skills, and personal characteristics embodied in people that contributes to productivity, while recognizing that human-capital investment occurs through formal education, adult training, informal learning, and work experience^[7].

The emergence of AI, however, necessitates a more dynamic interpretation. Traditional human capital can be understood as the productive knowledge and competencies that an individual possesses. AI-era human capital increasingly requires an additional dimension: the capacity of an individual to continually acquire and adapt productive knowledge and competencies^[15].

This distinction is crucial because an individual may possess a university qualification and still lack the competencies required to work effectively in an AI-mediated environment. Conversely, an individual with strong learning-to-learn capabilities may be better positioned to adapt when technologies and occupational requirements change.

The importance of this combination is reinforced by contemporary evidence. OECD research on human capital at work links skills to productivity, economic growth and wage outcomes, while its 2026 analysis argues that complementary skills such as creativity, critical thinking, collaboration and communication are increasingly important alongside technical competencies in AI-rich environments.

Thus, education should not simply produce individuals who possess knowledge. It should produce individuals who can continue acquiring, evaluating, and applying knowledge.

FROM EDUCATION TO RE-EDUCATION

The term “re-education” deserves conceptual distinction from related concepts. These distinctions are derived from the works of Collins, Lepage & Nebel; Salas-Pilco, Xiao & Hu; and Castillo et al^[16–18].

Education: Education constitutes the broad process of developing knowledge, skills, values and capabilities.

Training: Training usually refers to targeted preparation for specific tasks or occupational competencies.

Upskilling: Upskilling involves improving existing competencies to perform current or evolving roles more effectively.

Reskilling: Reskilling involves acquiring substantially new competencies for different roles or occupational functions.

Lifelong learning: Lifelong learning encompasses learning activities undertaken throughout the life course.

Re-education: In this paper, re-education serves as an umbrella concept referring to the systematic renewal, transformation and extension of knowledge and competencies when existing human capital is rendered insufficient by technological, occupational or social change.

This makes re-education particularly relevant to AI.

The conventional educational model assumes that knowledge acquired during formal schooling retains substantial value throughout an individual's working life. The AI economy challenges this assumption because technological change can alter occupational tasks and required competencies rapidly. The emerging model can therefore be represented as:

Learn → Apply → Update → Relearn → Reskill → Adapt → Continue Learning

This is not an argument that formal education has become less important. On the contrary, foundational education becomes even more important because individuals need strong literacy, numeracy, analytical, and communication abilities to participate effectively in lifelong learning.

Rather, the argument is that initial education and continuous re-education must become parts of a single human-capital system.

ARTIFICIAL INTELLIGENCE AND THE TRANSFORMATION OF EDUCATION.

AI as Educational Technology

AI has a long history in education, including intelligent tutoring systems, automated assessment, adaptive learning and learning analytics. What distinguishes the contemporary phase is the accessibility and versatility of generative AI. Generative AI has expanded the range of

educational tasks that machines can support, including: content generation; summarization; translation; question generation; feedback; brainstorming; coding assistance; personalized explanations; research support; and instructional planning.

Systematic reviews increasingly identify potential benefits in learning support, teaching efficiency, and personalized learning, while simultaneously highlighting concerns about ethics, academic integrity, privacy, and over-reliance^[19].

The educational significance therefore lies not simply in the availability of AI tools but in the quality of human–AI interaction.

AI Literacy as a New Dimension of Educational Competence

Digital competence was already becoming a fundamental educational requirement before generative AI. AI now requires its expansion. A digitally competent individual may know how to: operate devices; search for information; communicate online; create digital content; use digital platforms; and protect personal information.

Thus, an AI-literate individual additionally needs to understand: what AI systems do, such as how their outputs are generated; their limitations; how to evaluate their outputs; how bias can arise; when AI should and should not be used; how to interact responsibly with AI; how to protect data; and how to retain human judgment.

Recent scholarship distinguishes AI literacy from AI competency, noting that literacy concerns knowledge and understanding while competency emphasizes the capacity to apply that knowledge effectively.

This distinction has major educational implications. Students should not merely be taught: “How do I use ChatGPT?” They should be taught: “How do I determine whether an AI-generated answer is accurate, useful, biased, incomplete, or ethically appropriate?”

The second question is educationally much more important.

UNESCO's student framework consequently places AI techniques alongside human-centered thinking, ethics, and AI system design^[7,8].

Teacher Re-Education

The teacher remains the critical human mediator of educational technology.

AI does not eliminate this role. Instead, it changes the competencies required to perform it effectively. UNESCO's teacher framework describes an emerging

teacher–AI–student dynamic and identifies five competency dimensions: human-centred mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning.

Teacher education therefore needs to evolve through several stages:

ICT Training



Digital Pedagogical Competence



AI Literacy



AI-Enhanced Pedagogy



Human–AI Learning Design

The Nigerian evidence makes this issue particularly urgent. A large 2026 Nigerian study involving 2,586 secondary-school teachers across Nigeria's six geopolitical zones examined AI awareness and AI pedagogical skills, directly addressing the preparedness of Nigerian teachers for AI-informed pedagogy.

The significance of such research is that AI readiness cannot be inferred from access to digital tools. Teachers may have smartphones and internet access without possessing the pedagogical knowledge required to integrate AI meaningfully.

Teacher re-education should consequently develop competencies in: AI-supported lesson planning; AI-assisted differentiated instruction; critical evaluation of generated content; AI-aware assessment; academic-integrity management; data protection; ethical AI use; prompt formulation; AI-supported professional learning; and human–AI collaboration. Most importantly, teacher development should be continuous.

A single workshop cannot prepare teachers for a technology that continues to evolve.

Curriculum Transformation

AI challenges curriculum in at least three ways.

First, it changes what learners need to know. Second, it changes how learners can acquire knowledge. Third, it changes how learning should be assessed. A curriculum

designed around memorization and reproduction becomes increasingly problematic when generative AI can reproduce conventional answers within seconds. This does not mean that knowledge acquisition is no longer important. Rather, knowledge must increasingly be combined with interpretation, evaluation, application, synthesis, creativity, problem-solving, and ethical reasoning. UNESCO's student framework progression offers a useful model, i.e., from Understand → Apply → Create^[7,8].

Nigeria should therefore consider an educational progression from:

Knowledge acquisition

to

Knowledge application

to

Knowledge evaluation

to

Knowledge creation

This would make curriculum reform an important component of human-capital transformation.

DIGITAL INEQUALITY AND ACCESS

One of the clearest Nigerian findings concerns inequality in access to digital learning.

Azubuike et al. analyzed survey data involving 557 students and 626 parents in Nigeria^[4]. Their findings showed significant relationships between socioeconomic status and access to remote learning, differences between government and private-school learners, and an association between parental education and the ability to support children's remote learning. This evidence is fundamental because it demonstrates that digital education can reproduce existing inequalities if access is not deliberately addressed. The problem is therefore not simply: Who has access to education? It increasingly becomes: Who has meaningful access to digitally mediated education?

Rural–Urban and Community Inequality

Research on rural Nigerian communities during the COVID-19 period similarly identified significant digital gaps affecting secondary schools and remote communities. The evidence from multiple Nigerian states demonstrated how infrastructure deficits constrained the ability of rural learners to benefit from e-learning^[4]. These findings remain relevant beyond the pandemic.

If Nigeria expands AI-enabled education without addressing electricity, connectivity, and device affordability, AI could become another layer of educational stratification. Therefore, the sequence could become:

Educational inequality



Digital inequality



AI inequality



Human-capital inequality

This is one of the most important policy risks confronting Nigeria.

Evidence from Higher Education

The rapid transition to virtual learning during COVID-19 also generated important evidence concerning Nigerian higher education. Ebohon et al. examined teachers' and students' experiences of virtual/online learning during the pandemic and identified the practical challenges associated with the rapid transition from conventional face-to-face education^[5]. The lesson extends beyond the pandemic itself. The experience demonstrated that digital transformation requires institutional readiness, teacher competence, learner preparedness, and appropriate infrastructure.

AI adoption should therefore learn from the earlier experience of emergency e-learning rather than repeating the same weaknesses at a more technologically sophisticated level.

Emerging Evidence on AI Adoption in Nigerian Higher Education:

Recent Nigerian evidence is beginning to move beyond general discussions of digital learning towards empirical investigation of AI. Eleje et al. investigated lecturers' perceptions of AI effectiveness in Nigerian higher education using a survey of 64 lecturers in the Faculty of Education at Nnamdi Azikiwe University^[12]. The study specifically examined perceptions in relation to gender and academic cadre and identified concerns involving academic integrity, student dependence, and critical thinking alongside the potential educational benefits of AI. This evidence is significant because it reinforces a central argument of this paper: AI adoption is simultaneously a pedagogical, professional, and ethical issue.

Students and Adaptive Learning

More recent Nigerian evidence has examined students' perceptions of AI for adaptive learning. Tijani and Adeyigbe investigated students' perceptions of AI in achieving adaptive learning in Nigerian universities, contributing empirical evidence to a research area in which developing-country evidence remains comparatively limited^[15]. The emergence of this research suggests that Nigerian educational discourse is moving from asking whether AI should enter education towards asking how AI can be pedagogically integrated. That is precisely the transition this paper advocates.

Nigerian Policy Evidence

Policy development further reinforces the empirical argument.

The National Digital Literacy Framework identifies six major digital-competence areas: devices and software operation; information and data literacy; digital content creation; communication and collaboration; safety; and problem-solving. These competencies provide an important foundation for AI literacy.

Similarly, Nigeria's National EdTech Strategy 2025–2030 explicitly integrates teacher capacity, curriculum and content innovation, digital infrastructure, education data systems and safe AI use^[19].

The policy direction is therefore increasingly aligned with the conceptual argument advanced in this paper. The challenge is now implementation, institutional capacity and sustained human-capital investment.

Literature Synthesis and Research Gap

The literature above reveals five broad trends.

First: AI offers substantial educational opportunities. Studies increasingly identify potential benefits in personalized learning, adaptive instruction, feedback, content development, and teaching support.

Second: AI creates significant ethical and pedagogical challenges. Academic integrity, privacy, bias, overdependence, and the reliability of AI-generated information remain important concerns.

Third: teacher competence is critical. AI cannot simply be introduced into classrooms without corresponding investment in teacher preparation. UNESCO's framework strongly emphasizes continuous teacher professional development.

Fourth: digital inequality remains a fundamental problem. Nigerian evidence shows that socioeconomic status, school type, geography, and household resources influence access to digital learning.

Fifth: Nigerian AI-in-education research is emerging but remains fragmented. Recent Nigerian studies now examine teacher AI awareness, lecturer perceptions, and student adaptive-learning perceptions.

Thus, the gap is therefore not simply a lack of research on AI in Nigerian education. The deeper gap is the absence of sufficient conceptual integration between AI Digital Competence, Re-Education, Lifelong Learning, Human Capital Development, and Educational Transformation

Much existing work treats these as separate issues. This paper brings them together into a single human-capital framework.

Continuous AI-Ready Human Capital Development Framework

This paper proposes the Continuous AI-Ready Human Capital Development Framework (CAHDF). The framework consists of five interconnected pillars.

Pillar 1: Digital Access: electricity; broadband; affordable data; devices; learning platforms and digital resources.

Pillar 2: AI-Enabled Pedagogy: adaptive learning; personalized instruction; AI-assisted teaching; learning analytics and digital assessment.

Pillar 3: Teacher Re-Education: AI literacy; AI pedagogy; ethical competence; digital assessment and continuous professional development.

Pillar 4: Curriculum Renewal: AI literacy; critical thinking; creativity; problem-solving; communication; collaboration and ethical reasoning.

Pillar 5: Lifelong Learning: upskilling; reskilling; micro-credentials; professional learning; workplace learning and adult education.

DISCUSSION

The foregoing analysis demonstrates that the emergence of artificial intelligence (AI) is not merely introducing another technological tool into the educational system; rather, it is challenging the underlying assumptions about what constitutes useful knowledge, how human capabilities are developed, how teachers perform their professional roles, and how educational institutions prepare individuals for productive participation in society. The central argument of this study is that the AI era requires a transition from education conceived primarily as the acquisition of relatively stable knowledge and qualifications to education understood as a continuous process of human-capital renewal. In this context, re-education,

digital competence, AI literacy, lifelong learning and adaptive skills become increasingly interconnected dimensions of contemporary human-capital development.

The discussion is particularly important for Nigeria because the country faces a dual challenge. On the one hand, AI offers opportunities to address longstanding educational constraints through personalized learning, intelligent tutoring, digital content, automated feedback, learning analytics and expanded access to knowledge. On the other hand, Nigeria's existing inequalities in infrastructure, connectivity, teacher preparedness and socioeconomic access could cause AI-enabled education to reproduce or deepen existing inequalities. Recent Nigerian evidence concerning digital learning and AI adoption reinforces the need to approach educational transformation as a systemic human-capital project rather than as a mere technology-acquisition exercise^[4,5,12].

From Static Human Capital to Adaptive Human Capital

The findings of the study support a reinterpretation of Human Capital Theory in the context of technological disruption. Classical human-capital perspectives established the importance of education and training as investments that enhance individual productivity and contribute to economic development. However, the rapid pace of technological change means that human capital can no longer be treated as a relatively fixed stock acquired primarily through initial schooling and subsequently utilized throughout an individual's working life. Contemporary labor markets increasingly reward the capacity to acquire new competencies, work with digital technologies, and adapt to changing occupational requirements. OECD evidence indicates that the skills required in the AI age extend beyond technical knowledge to include communication, collaboration, creativity, critical thinking, and problem-solving^[7].

This development suggests a transition from static human capital to adaptive human capital. Static human capital refers largely to the knowledge, qualifications, and competencies an individual already possesses, whereas adaptive human capital incorporates the individual's capacity to continually renew and extend those competencies in response to changing circumstances. The distinction is particularly relevant to Nigeria, where educational qualifications do not always translate directly into employability or productivity. The growing importance of digital and AI-related competencies means that possessing a formal qualification may increasingly represent only the starting point of an individual's productive learning trajectory.

The implication for education is profound. Educational institutions must not merely ask whether students have

acquired the knowledge specified in a curriculum; they must also ask whether students possess the capacity to continue learning after graduation. OECD analysis emphasizes that adults require a broad combination of foundational, digital, and complementary skills to remain effective in rapidly changing societies^[7]. Consequently, education policy should increasingly focus on learning-to-learn, adaptability, and continuous professional development.

For Nigeria, this means that human-capital policy should move beyond measuring educational expansion through enrolment and graduation rates alone. Greater attention should be given to whether education produces individuals capable of adapting to technological change, solving emerging problems, collaborating with intelligent systems and acquiring new competencies throughout their working lives. Re-education therefore becomes an essential mechanism for protecting and renewing the value of human capital.

AI as an Accelerator of Educational Transformation

The evidence reviewed also indicates that AI possesses considerable potential to accelerate educational transformation. AI-enabled systems can support personalized instruction, generate learning resources, provide immediate feedback, identify patterns in learner performance, and assist teachers with aspects of lesson preparation and assessment. Systematic reviews of AI in education have documented opportunities for improved personalization, learning support, and institutional efficiency, while simultaneously emphasizing the importance of ethical governance and pedagogical oversight^[10,16].

The significance of AI therefore lies not simply in its ability to automate selected educational tasks, but in its capacity to alter the relationship among teacher, learner, knowledge, and technology. The traditional educational model generally positions the teacher as the primary source and mediator of knowledge. AI introduces another knowledge-producing and knowledge-processing agent into this relationship. This does not necessarily make the teacher less important. Instead, it changes the teacher's role from being primarily a transmitter of information towards becoming a designer of learning experiences, facilitator of critical inquiry, evaluator of information and ethical guide.

UNESCO's AI Competency Framework for Teachers reflects this changing relationship by emphasizing human-centered thinking, ethics, AI foundations and applications, AI pedagogy, and AI for professional learning^[8]. The framework demonstrates that effective AI integration requires more than technical proficiency. Teachers must understand the pedagogical possibilities

and limitations of AI while maintaining human judgment and responsibility.

For Nigeria, this distinction is especially important. A school equipped with digital devices but staffed by teachers who lack confidence or pedagogical competence in using AI cannot automatically be considered an AI-ready institution. Technology becomes educationally meaningful only when teachers can integrate it into appropriate learning processes. Consequently, investment in AI infrastructure must be accompanied by sustained investment in teacher re-education and professional development.

Teacher Re-Education as the Foundation of AI-Ready Education

One of the strongest implications emerging from the literature is the centrality of teachers to educational transformation. AI may generate instructional materials, provide explanations, or assist with assessment, but the educational value of these outputs depends heavily upon human interpretation and pedagogical judgment. Teachers therefore require continuous opportunities to develop new professional competencies.

Recent Nigerian research makes this issue increasingly significant. Emerging empirical work has examined Nigerian teachers' awareness of AI and their pedagogical skills for AI-supported education, demonstrating that teacher preparedness is becoming an important research and policy concern. The large-scale 2026 study covering teachers across Nigeria's six geopolitical zones is particularly important because it moves the discussion beyond isolated institutional cases towards a broader assessment of national teacher readiness. Such evidence reinforces the need for systematic rather than ad hoc professional development.

Teacher re-education should consequently be understood as a continuous process involving digital literacy, AI literacy, pedagogical integration, ethical competence, and professional learning. UNESCO similarly conceptualizes AI competency for teachers as a multidimensional construct rather than a narrow technological skill^[8]. Teachers need to understand not only how AI tools operate but also how their use affects assessment, student autonomy, privacy, academic integrity, and learning outcomes.

This has important implications for teacher-training institutions in Nigeria. Pre-service teacher education should incorporate AI competencies into teacher preparation, while in-service teachers should have access to continuous professional development opportunities. Such programs should not be designed as isolated workshops. Instead, they should form part of structured ca-

reer-long learning pathways through which teachers progressively acquire and demonstrate AI-related competencies.

The argument therefore extends beyond “training teachers to use AI.” What is required is the re-professionalization of teaching for an AI-mediated educational environment.

Curriculum Renewal and the Changing Meaning of Knowledge

The discussion also reveals that AI challenges the content and structure of conventional curricula. When AI systems can generate essays, summaries, explanations, translations, and other forms of content almost instantaneously, educational systems must reconsider the relative emphasis placed on memorization and reproduction. This does not imply that factual knowledge has become irrelevant. Rather, factual knowledge increasingly needs to be integrated with higher-order cognitive capabilities.

UNESCO’s AI Competency Framework for Students places emphasis on understanding, applying, and creating in relation to AI, while also incorporating human-centered thinking and ethics^[8]. This orientation is consistent with the broader argument that education should prepare learners not simply to consume information but to evaluate, interpret, apply and create knowledge.

For Nigerian education, curriculum renewal should therefore place greater emphasis on critical thinking, creativity, problem-solving, communication, collaboration, ethical reasoning and digital competence. These capabilities are particularly important because AI-generated information can be persuasive without necessarily being accurate. Learners therefore need the capacity to question information, verify claims, recognize limitations and exercise independent judgment.

The challenge is particularly important for assessment. Conventional examinations that primarily reward memorization may become increasingly inadequate in environments where learners can access AI-generated information. Educational institutions will need to place greater emphasis on authentic tasks, projects, problem-based learning, practical demonstrations, oral defense, and other forms of assessment that evaluate understanding and application. The objective should not simply be to prevent students from using AI, but to develop assessment practices in which responsible AI use can coexist with genuine intellectual engagement.

DIGITAL INEQUALITY AND THE RISK OF AI-DRIVEN EDUCATIONAL EXCLUSION

Perhaps the most significant Nigerian implication con-

cerns inequality. The introduction of AI into education occurs within an educational system that already contains substantial differences in access to infrastructure, devices, electricity, connectivity, and learning resources.

Azubuike et al. demonstrated that socioeconomic circumstances influenced access to remote learning during the COVID-19 period, with important differences associated with school type and household resources^[4]. Ebohon et al. similarly documented the challenges experienced by teachers and students during Nigeria’s rapid transition towards virtual learning^[5]. These findings remain relevant because AI-enabled education builds upon the digital infrastructure required for online learning.

Consequently, the digital divide could evolve into an AI divide. Learners with reliable internet connectivity, appropriate devices, supportive learning environments, and digitally competent teachers may benefit substantially from AI-enabled education. Learners without these resources may be excluded from emerging forms of personalized and technology-supported learning.

The problem can therefore be conceptualized as:

Socioeconomic inequality → Digital inequality → AI-access inequality → Skills inequality → Human-capital inequality.

This sequence demonstrates why educational AI policy must be explicitly equity-oriented. The objective should not simply be to increase the number of schools using AI technologies but to ensure that disadvantaged learners are not systematically excluded from the benefits of educational transformation.

Nigeria’s National Digital Learning Policy and National EdTech Strategy provide important policy foundations in this regard, particularly through their emphasis on digital access, teacher capacity, content development and inclusive educational technology. However, implementation remains decisive. Without sustained investment in electricity, broadband, affordable devices, and teacher development, policy ambitions may not translate into equitable educational outcomes^[13].

AI LITERACY AS A CORE COMPONENT OF HUMAN CAPITAL

Another important implication is that AI literacy should increasingly be recognized as part of contemporary human capital. Digital literacy provided the foundation for participation in the digital economy; AI literacy represents an emerging extension of that foundation.

AI literacy should encompass at least four interconnec-

ted capabilities: understanding AI, using AI, evaluating AI, and governing one's interaction with AI responsibly. Learners need to understand basic AI concepts, use appropriate tools, critically evaluate outputs, and recognize ethical implications. UNESCO's student framework similarly places technical understanding alongside human-centered and ethical competencies^[14].

This perspective has implications across educational levels. At primary and secondary levels, AI literacy can be introduced through age-appropriate digital and computational thinking. At the tertiary level, AI literacy should become interdisciplinary, enabling students in education, public administration, agriculture, health, business, engineering, and the humanities to understand how AI affects their respective fields.

For Nigeria, this is particularly important because AI-related competencies should not be restricted to students enrolled in computer science or information-technology programs. The future teacher, administrator, entrepreneur, civil servant, researcher, farmer, health professional and business manager will increasingly interact with AI-enabled systems. AI literacy is therefore becoming a general human-capital competency rather than a specialized technical skill.

LIFELONG LEARNING AND THE INSTITUTIONALIZATION OF RE-EDUCATION

The discussion ultimately points towards the institutionalization of lifelong learning. In a rapidly changing technological environment, the completion of formal education can no longer reasonably be regarded as the end of an individual's learning journey. Instead, it represents one stage in a continuous cycle of capability development.

OECD emphasizes the growing importance of adult learning and continuing skills development in societies experiencing rapid technological change^[7]. This perspective has direct relevance to Nigeria's workforce. Teachers, lecturers, administrators, and other professionals who completed their formal education before the widespread diffusion of generative AI will increasingly need opportunities to acquire new competencies.

Re-education should therefore extend beyond schools and universities to include workplaces, professional associations, government institutions and community learning systems. Universities, in particular, could play a stronger role in lifelong human-capital development through micro-credentials, short professional programs, online courses, executive education and continuing professional development.

Such an approach would also help address the mismatch

between educational qualifications and changing labor-market requirements. Instead of requiring individuals to return to lengthy degree programs whenever their occupational competencies become outdated, flexible learning pathways could allow them to acquire targeted skills incrementally.

The future educational ecosystem may consequently consist of:

Formal education + Continuing education + Workplace learning + Digital learning + AI-supported learning.

This integrated ecosystem would make education more responsive to technological and economic change.

FROM TECHNOLOGICAL ADOPTION TO HUMAN-CENTERED TRANSFORMATION

A further implication of the study is that educational AI policy should avoid technological determinism. The existence of AI does not automatically improve teaching or learning. Its educational value depends upon the purposes for which it is used, the competencies of users, the quality of educational content, institutional governance, and the broader learning environment.

UNESCO consistently emphasizes the importance of human-centered, ethical, and equitable approaches to educational technology and generative AI^[8]. This position is particularly relevant to Nigeria because technological adoption without appropriate governance could create new problems involving privacy, misinformation, algorithmic bias, academic integrity, and learner dependency.

The appropriate objective should therefore be human-AI complementarity, rather than human replacement. AI should augment human capabilities while teachers and learners retain agency over educational decisions. This approach is consistent with the broader understanding of human capital advanced in this paper: technology should increase human capability rather than diminish the value of human judgment.

IMPLICATIONS FOR NATIONAL PRODUCTIVITY AND DEVELOPMENT

The relationship between educational transformation and national development ultimately provides the strongest justification for re-education. Human-capital investment contributes to productivity when individuals can apply their knowledge and skills effectively in productive activities. In the AI era, productivity will increasingly depend upon the capacity of workers to collaborate with digital and intelligent technologies.

OECD research demonstrates the relationship between skills, productivity, firm performance and wages, while its recent AI-age analysis highlights the importance of combining technical and complementary human skills^[7,20]. Nigeria's educational policy should therefore regard AI readiness as part of a broader national productivity strategy.

The objective should not be to produce a workforce that competes with machines in tasks that machines perform more efficiently. Rather, education should develop those human capabilities that remain essential to effective human-AI collaboration: judgment, creativity, empathy, leadership, communication, ethical reasoning, contextual understanding and complex problem-solving.

This is particularly significant for Nigeria's development aspirations. A large youthful population can become a demographic dividend only when supported by appropriate education, skills and productive opportunities. If educational institutions fail to prepare young Nigerians for a changing technological environment, demographic growth may coexist with skills mismatch and underemployment. Conversely, if education becomes a continuous mechanism for developing adaptive human capital, Nigeria's demographic resources can contribute more effectively to innovation, entrepreneurship and productivity.

SYNTHESIS: TOWARDS A CONTINUOUS HUMAN-CAPITAL RENEWAL SYSTEM

Taken together, the evidence supports the Continuous AI-Ready Human Capital Development Framework (CAHDF) proposed in this study. The framework connects five mutually reinforcing dimensions: digital access, AI-enabled pedagogy, teacher re-education, curriculum renewal and lifelong learning.

The logic is cumulative. Digital access creates the conditions for participation; AI-enabled pedagogy transforms learning processes; teacher re-education provides the professional capacity required for implementation; curriculum renewal ensures that learners acquire relevant competencies; and lifelong learning ensures that human capital remains adaptable after formal schooling.

The resulting relationship can be expressed as:

Digital Access → AI-Enabled Pedagogy → Teacher Re-Education → Curriculum Renewal → Lifelong Learning → Adaptive Human Capital → Employability, Innovation and Productivity.

Importantly, this is not a linear process. It is cyclical. Changes in technology and the labor market continuously generate new skill requirements, which should sub-

sequently influence curriculum, teacher development and lifelong-learning provision. Education thus becomes a self-renewing human-capital ecosystem.

This conceptualization represents the principal contribution of the paper. Rather than treating AI, digital education, teacher development, curriculum reform and human-capital development as separate policy domains, the framework integrates them into a unified educational-development perspective.

For Nigeria, the policy imperative is therefore clear: the country must move from digitizing education to continuously renewing human capability. AI should be understood not merely as a tool to be introduced into classrooms but as a catalyst for rethinking the purposes, structures, competencies and lifelong functions of education.

The ultimate measure of success should consequently not be the number of schools equipped with AI tools, the number of teachers trained in particular platforms, or the number of students who can generate AI-assisted content. The more meaningful question is whether Nigerian education is producing people who can think critically, learn continuously, adapt intelligently, use technology responsibly, create knowledge and translate knowledge into productive action. In this sense, the future of education in Nigeria is inseparable from the future of human-capital development itself.

CHALLENGES TO IMPLEMENTATION IN NIGERIA

- 1 Infrastructure Deficits: Reliable electricity, connectivity and appropriate devices remain foundational requirements.
- 2 Affordability: Digital participation involves recurring costs, including data, electricity, and maintenance and device replacement.
- 3 Teacher Preparedness: Teacher competence may lag behind technological development.
- 4 Curriculum Inertia: Curriculum-review mechanisms is largely too slow to respond to rapidly changing skill requirements.
- 5 Digital Inequality: Socioeconomic and geographical differences can produce unequal educational outcomes.
- 6 Ethical Governance: AI use requires clear rules concerning: privacy; data protection; academic integrity; intellectual property; algorithmic bias; transparency; and human oversight.

7 Institutional Capacity: Many institutions lack stronger leadership, technical expertise and financing for sustained digital transformation.

8 Language and Cultural Context: AI educational resources may not always adequately reflect Nigerian cultural, linguistic and educational contexts.

9 Risk of Technological Determinism: There is a danger of assuming that acquiring technology automatically produces educational improvement. It does not. The appropriate principle is:

Pedagogy should determine technology, not technology determines pedagogy.

RECOMMENDATIONS

(1) Institutionalize lifelong learning as a core component of national human-capital policy.

(2) Develop a Nigerian national AI competency framework for education, drawing upon but adapting international frameworks to Nigerian realities.

(3) Establish continuous AI professional-development programs for teachers and teacher educators.

(4) Integrate AI literacy into curricula across disciplines, rather than confining it to computing-related programs.

(5) Strengthen digital infrastructure, particularly electricity, broadband and affordable devices in underserved communities.

(6) Expand flexible digital learning pathways, including online programs, blended learning and micro-credentials.

(7) Reform assessment systems to emphasize higher-order cognitive abilities and authentic performance.

(8) Develop Nigerian and African educational datasets and content to improve cultural and contextual relevance.

(9) Create institutional responsible-AI policies addressing privacy, bias, academic integrity and human oversight.

(10) Strengthen university–industry collaboration to ensure curriculum relevance.

(11) Establish labor-market intelligence mechanisms capable of identifying emerging skills and informing curriculum revision.

(12) Measure educational transformation through human-capital outcomes, including digital competence, AI

literacy, employability, innovation and productivity.

CONCLUSION

Artificial intelligence is not simply another technological innovation to be incorporated into existing educational structures. Its emergence challenges fundamental assumptions concerning how knowledge is acquired, how teachers teach, how students learn, how learning is assessed and how education contributes to human-capital development.

The central argument of this paper is that Nigeria must move beyond the conventional understanding of education as a predominantly front-loaded investment in human capital. In a rapidly changing technological environment, human capital must be continuously renewed. Re-education therefore becomes not a supplementary educational activity but a central mechanism of human-capital development.

The evidence reviewed demonstrates that Nigeria possesses important foundations for this transformation. National policy increasingly recognises digital literacy, digital learning, teacher capacity, curriculum innovation and safe AI use as important elements of educational development. Empirical evidence, however, also reveals substantial inequalities in digital access and emerging challenges concerning teacher preparedness, institutional capacity and responsible AI adoption.

The implication is that Nigeria should not pursue AI adoption in education through technology procurement alone. It must simultaneously invest in teachers, curricula, digital infrastructure, assessment, institutional governance and lifelong learning.

The Continuous AI-Ready Human Capital Development Framework proposed in this paper provides a conceptual pathway. It integrates digital access, AI-enabled pedagogy, teacher re-education, curriculum renewal and lifelong learning to develop adaptive human capital.

The ultimate objective should not be to create learners who merely know how to operate AI tools. It should be to create AI-ready human beings who can critically evaluate information, exercise ethical judgement, solve complex problems, communicate effectively, innovate, collaborate with intelligent technologies and continue learning throughout their lives.

The future of Nigerian education should therefore be guided by a fundamental shift: From education as the acquisition of knowledge to education as the continuous renewal of human capability. In the age of artificial intelligence, the most valuable educational outcome may ultimately not be what an individual knows at a particular

point in time, but their capacity to continue learning when what is known is no longer enough.

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Below shows a sample Author Contributions section written based on the CRediT:

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This section is reserved to inform the readers and editors of a few aspects:

(i) Part of or the entire set of findings have been presented in a conference, academic meeting, congress, etc.; and/or

(ii) The paper has been uploaded to or deposited in a preprint server (provide name of preprint server and associated accession number or DOI of the preprint).

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