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Teacher Education in the Digital Era Through Technological Transformation Pedagogy in Nigeria

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ABSTRACT

Teacher education systems worldwide face pressure to integrate digital technologies meaningfully into pre-service preparation. In Nigeria, demographic expansion, infrastructural constraints, and curricular rigidity make this imperative both urgent and complex. This analysis examines Nigeria's teacher education landscape in the digital era, synthesizing policy documents, empirical studies (2020–2025), and institutional audits across 24 teacher education institutions. Grounded in the Technological Pedagogical Content Knowledge (TPACK) framework and Sen's Capability Approach, the study positions digital competence as an enabling capability for pedagogical agency rather than a technocentric end. Findings reveal persistent gaps between national digital-education policies and ground-level practice: inadequate infrastructure (only 28% of institutions report reliable electricity), low ICT self-efficacy among teacher educators (68% use technology solely for administrative tasks), fragmented curriculum integration, and weak public–private partnerships. Emergent initiatives mobile-based micro-credentialing, virtual teaching-practicum platforms, and community driven open educational resource repositories demonstrate scalable potential. The paper advances a four-pillar framework for systems-oriented digital re-professionalization: curriculum infusion, continuous professional learning ecosystems, adaptive infrastructure investment, and robust monitoring-evaluation mechanisms, aligned with SDG 4.c and African Union Agenda 2063.

KEYWORDS: Teacher education; digital pedagogy; ICT integration; digital literacy; capability approach

1. INTRODUCTION

Teacher education is the cornerstone of educational quality and equity. Teacher preparation in Nigeria did not start as a digital enterprise, but as a formal teacher training dated to the immediate post-independence period. The recommendation of Ashby Commission's led to an expansion of teacher training colleges, establishment of colleges of education and the National Teachers' Institute as parallel routes into the profession (Saidu & Saliu, 2025). Also, the National Policy on Education formalized the Nigeria Certificate in Education (NCE) as the minimum qualification for classroom teaching, a standard that has anchored teacher-preparation curricula for over four decades (Federal Republic of Nigeria, 2014). That policy was developed for a print-based, lecture-and-examination model of instruction, produced a teaching corps trained primarily in content delivery, classroom management, and subject mastery, with comparatively little structural attention to instructional technology (Asaya, 2010). Nigeria is Africa's most populous nation, with a population exceeding 200 million people, and an estimated 20.2 million of its children and youth remain out of school, one of the highest national totals recorded globally (UNESCO

Institute for Statistics & Global Education Monitoring Report, 2022). Because teacher supply and quality are central to progress toward Sustainable Development Goal 4, the capacity of Nigeria's teacher-education system carries weight well beyond the colleges of education themselves. Yet as digital technologies reshape global knowledge production and assessment, Nigeria's teacher-education infrastructure remains anchored in an inheritance built for lecture-dominated, examination-focused instruction, rather than for hybrid teaching, open educational resources, or AI-mediated pedagogies.

Global frameworks such as UNESCO's ICT Competency Framework for Teachers (UNESCO, 2018) set out competencies for hybrid instruction, open educational resources, and technology-integrated pedagogy that presuppose an infrastructure and training base Nigerian teacher education was not

originally built to provide. Technology-integrated pedagogy grounded in the Technological Pedagogical Content Knowledge (TPACK) framework treats effective technology use as an interaction between subject knowledge, teaching method, and tool, rather than technology added onto existing instruction; Zhang et al. (2025) found that a technology-enhanced active learning environment measurably improved this integrated competency among pre-service teachers. Flipped-classroom pedagogy, in which content delivery precedes class time so that class time is reserved for application and discussion, has been studied as a variant of blended learning that deliberately recombines face-to-face and digital instruction (Lopes et al., 2024). It is frequently paired with gamified pedagogy as the use of points, badges, and leaderboard mechanics to sustain motivation with Borrás-Gené and Montes Díez (2025) reporting measurable gains in motivation and self-regulated learning among pre-service teachers taught through a gamified flipped-classroom design, and Sanz-Angulo et al. (2025) linking a similar blended, gamified methodology to gains in both academic performance and soft-skill development. Also, Halkiopoulos and Gkintoni (2024) reviewed how AI-based adaptive assessment models draw on cognitive neuropsychology to individualize instructional delivery, while Dharam Singh and Mohamad (2025) caution against conflating adaptive learning, which is largely performance-data driven, with genuine personalization, which requires accounting for learner identity, goals, and context as a distinction with direct implications for how teacher-education curricula should frame AI competency rather than treating it as a single undifferentiated skill.

Empirical assessments of ICT availability in teachers Education have repeatedly found resources largely unavailable, inaccessible, or underutilized in actual content delivery (Zubairu & Tukur, 2015), and evidence from other national contexts suggests this pattern is not unique to Nigeria: Landa (2025) found that infrastructural and training-related technological-pedagogical challenges significantly predicted whether university instructors in Tanzania actually used the technologies available to them. In response, the National Commission for Colleges of Education launched a 2025 review of the NCE Minimum Standards intended to embed AI awareness, data literacy, and adaptive digital pedagogy into teacher preparation (National Commission for Colleges of Education, 2025). Guided by Mishra and Koehler's (2006) TPACK framework and Sen's Capability Approach (1999), the analysis treats digital competence as an enabling capability rather than a hardware target, contributing an evidence-based synthesis of the digital landscape, a critical evaluation of emergent innovations, and a systems-oriented framework for digital re-professionalization.

2. BEYOND TECHNOCENTRIC INTEGRATION: INTEGRATING KNOWLEDGE DOMAINS FOR EFFECTIVE TECHNOLOGY USE

TPACK, developed by Mishra and Koehler (2006), conceptualizes effective technology integration as arising from the interaction of Technological, Pedagogical, and Content Knowledge and their derived combinations (TCK, TPK, PCK, and TPACK itself) (Koehler et al., 2013). Effective use requires understanding how technological affordances intersect with pedagogy and content in specific contexts (Voogt et al., 2013); a rural Katsina mathematics educator, for example, negotiates different digital affordances than an urban Lagos English educator (Adedoja & Adeyemi, 2024). Nigerian institutions, however, have often reduced digital competence to basic computer literacy, treating technology as a standalone subject rather than an integrated pedagogical tool (Okebukola&Okebukola, 2022). This reductionism appears in curriculum designs, in professional development divorced from pedagogical application, and in assessments that evaluate technological knowledge independently of teaching practice (Yusuf & Salawu, 2024). Recent scholarship extends TPACK through the concept of “TPACK-in-practice,” emphasizing sustained, situated application rather than decontextualized skills training (Rosenberg & Koehler, 2015), and shows that pre-service teachers need scaffolded, mentored experiences particularly relevant where Nigerian student teachers move directly from theoretical coursework to under-resourced school placements (Baran et al., 2011).

3. DIGITAL TOOLS AS EXPANSION OF HUMAN FUNCTIONING

Sen's (1999) Capability Approach shifts analytical focus from resource endowment to what individuals can do with available resources their substantive freedoms. Applied to digital teacher education, it redirects attention from inputs (tablets distributed, bandwidth capacity) to outcomes: what teachers can accomplish pedagogically with digital technologies (Zheng et al., 2023). This distinction matters in Nigeria, where mobile-phone ownership exceeds 85% of adults (National Bureau of Statistics, 2024) yet meaningful pedagogical use remains shallow; a teacher's capability to facilitate collaborative learning through cloud-based platforms depends on institutional support, mentoring networks, and incentives for innovation as much as on device access or connectivity (Adebayo &Okebukola, 2024). The approach distinguishes conversion factors—educator digital literacy, institutional culture, infrastructure reliability, policy environment from functionings, the abilities educators realize, such as designing digitally enhanced lessons or assessing learning through technology-mediated tools (Robeyns, 2005). Structural inequalities in geography, institutional resources, gender, and prior technology exposure differentially shape how educators convert resources into capabilities (Zheng et al., 2023), a lens especially relevant to Nigeria's rural–urban divides. Together, TPACK and the Capability Approach frame the analysis that follows: TPACK articulates the knowledge structures required for effective integration, while the Capability Approach attends to the social and institutional conditions that enable or constrain their development.

4. STRUCTURE OF NIGERIAN TEACHER EDUCATION

Nigeria's teacher-education system comprises 36 Federal Colleges of Education, 52 State Colleges of Education, over 100 private colleges, and university Faculties of Education (National Commission for Colleges of Education, 2023). The Nigerian Certificate in Education (NCE), a three-year post-secondary credential, remains the predominant qualification, producing about 85,000 graduates annually (National Commission for Colleges of Education, 2024). The National Commission for Colleges of Education (NCCE), established in 1989, sets academic standards, accredits programs, and conducts institutional audits, most recently revising its Minimum Standards in 2023 (National Commission for Colleges of Education, 2023). The National Teachers' Institute (NTI), established in 1976, offers distance-education programs for in-service teachers, though its reach remains constrained by limited digital infrastructure (National Teachers' Institute, 2024).

5. POLICY FRAMEWORK FOR DIGITAL INTEGRATION

The National Policy on ICT in Education (2018) mandates ICT integration across NCE programs and requires pre-service digital-literacy competencies and systematic educator professional development (Federal Ministry of Education, 2018). The 2023 Revised NCE Curriculum introduced mandatory courses such as Digital Pedagogy, Educational Data Literacy, and Emerging Technologies in Education and requires digitally mediated teaching-practice components and proficiency in at least two digital assessment tools (National Commission for Colleges of Education, 2023). Implementation, however, lags considerably: a 2023 NCCE audit found only 31% of Federal Colleges of Education with functional ICT laboratories, fewer than 15% of educators certified in digital pedagogy, and just 12% of programs implementing the mandatory digital teaching-practice component (National Commission for Colleges of Education, 2023). These deficits reflect low education funding (about 5.7% of the federal budget, well below UNESCO's recommended 15–20%), weak coordination between policymaking and implementing agencies, and limited accountability mechanisms for institutional compliance.

6. PEDAGOGICAL CONSERVATISM AND EDUCATOR PREPAREDNESS

A mixed-methods study using simple random and systematic random sampling method of 412 teacher educators across 12 institutions found that 68% used ICT solely for administrative tasks, 44% believed

technology distracts from core teaching objectives, and only 22% had designed lessons meaningfully integrating open educational resources or interactive simulations (Yusuf & Salawu, 2024). Resistance and psychological unpreparedness were studied by Avakyan (2024), who used nearly 1,800 university teachers across nine Russian institutions treated pedagogical conservatism as a measurable trait, finding it linked to psychological unreadiness for innovation and to emotional burnout, and correlated with job satisfaction levels among teaching staff studied across multiple universities.

Griffiths and Goddard (2015), working from a case study of an educational software deployment, built an explanatory framework combining positioning theory, Heidegger's concept of readiness-to-hand, and Popperian ideas about social engineering to explain why teachers resist adopting technologies even when institutions push them toward it. Mirriahi, Vaid, and Burns (2015) found that resistance among academic staff to integrating technology into language teaching tracked closely with the Technology Acceptance Model's constructs of perceived usefulness and ease of use and argued that adoption decisions often overlook the actual pedagogical value of the tools involved. Also, Institutional and structural conservatism by Zemsky and Massy's (2004) widely cited report "Thwarted Innovation" made the case, discussed in later journal literature, that the spread of ICT and online learning in American higher education had, if anything, entrenched conservative teaching practices rather than displacing them since the implementation of ICT and online learning has increased conservatism in American higher education. This connects to Ibatullina and Vorontsova's (2011) treatment of pedagogical conservatism as a structural barrier that institutions must actively work to overcome through defined organizational conditions, not just individual attitude change. Moreso, Ideological and philosophical framing by Bowers's (1980) much older but still-cited piece in Teachers College Record examined the assumption that technological progress in education is inherently good, framing that assumption itself as a form of conservatism dressed up as innovation, a critique of what he called technicism in curriculum thinking presenting a critique of technological consciousness in education from the perspective of philosophical conservatism. Prestridge's (2017) work in Technology, Pedagogy and Education takes a related but more applied angle, examining how teachers' existing pedagogical orientations shape which uses of technology they accept and which they filter out or reject. This pedagogical conservatism reflects legitimate concerns about assessment validity and classroom management, and a lack of institutional support and professional incentives, rather than mere resistance to change (Okebukola&Okebukola, 2022). Digital self-efficacy is a critical mediating variable: educators with higher self-efficacy are significantly more likely to experiment with innovative pedagogies and persist through technological challenges, yet fewer than 30% of Nigerian teacher educators report high digital self-efficacy, and professional development programs rarely address this affective dimension (Yusuf & Salawu, 2024).

7. CURRICULUM–PRACTICE DISJUNCTURE

Although the 2023 NCE curriculum mandates courses in digital pedagogy, educational data literacy, and emerging technologies, observational research across 18 institutions found such courses taught predominantly as theoretical content, without laboratory components or authentic assessment tasks (Eze et al., 2023). Analysis of 326 teaching-practice placements in 2023 found that 87% of student teachers taught without using any digital tools, even in schools where technological infrastructure existed (National Commission for Colleges of Education, 2024). This misalignment undermines the formation of a “digital habitus,” as student teachers rarely see digital pedagogy modeled by their own instructors during formative field experiences. Contributing factors include teacher educators' outdated technology expertise (Okebukola&Okebukola, 2022), assessment of digital competencies through written examinations rather than authentic performance tasks, and partner schools that themselves lack technological resources for placement.

8. GOVERNANCE FRAGMENTATION AND ACCOUNTABILITY DEFICITS

Responsibility for teacher education in Nigeria is dispersed across the NCCE, the Federal Ministry of Education, State Universal Basic Education Boards, the NTI, and individual autonomous institutions (Afe, 2023). This fragmentation produces coordination challenges, policy redundancies, and monitoring gaps: no integrated national indicator system tracks graduates' digital teaching efficacy post-certification, and independent program evaluations remain rare (National Commission for Colleges of Education, 2023). The NTI's e-learning portal, despite its mandate for continuous professional development, reaches fewer than 5% of registered teachers, constrained by infrastructure and digital-literacy gaps (National Teachers' Institute, 2024). No standardized assessment framework verifies graduates' attainment of mandated digital competencies, allowing significant variation in implementation quality across institutions.

9. EMERGING INNOVATIONS AND SCALABLE OPPORTUNITIES (2020–2025)

Despite formidable systemic constraints, several pandemic-era innovations demonstrate promising, scalable pathways. They share common design features: mobile-first or low-bandwidth delivery, use of existing social technologies, integration with rather than replacement of traditional structures, and measurable impact on educator practice.

Mobile-First Micro-Credentialing Programs

The Digital Teaching Badge program, piloted in Ogun and Kaduna States (2022–2024), delivers competency-based training in mobile-assisted language learning, digital storytelling, and formative e-assessment via USSD and WhatsApp platforms requiring no internet connectivity (EduTech Africa, 2024). Over 1,200 teacher educators completed Level 1 certification, with 78% reporting increased classroom technology use and 65% designing at least one mobile-integrated lesson within three months; the NCCE now accredits these credentials for professional advancement (EduTech Africa, 2024).

Virtual Teaching Practicum Platforms

Obafemi Awolowo University and Ahmadu Bello University developed Virtual Teaching Practicum (VTP) systems combining live-streamed lessons in partner schools, VR-based classroom-management simulations, and AI-assisted feedback on recorded teaching performances (Ojo et al., 2024). A quasi-experimental comparison (VTP participants, n = 210, vs. traditional practicum students, n = 198) found VTP participants scored 23% higher on digital lesson-design rubrics, though traditional-practicum students showed advantages in physical classroom management—suggesting hybrid models may optimize student-teacher development (Ojo et al., 2024). The Tertiary Education Trust Fund's Digital Practicum Grant Initiative has funded 12 universities (₦450 million, roughly $300,000) with plans to reach 30 institutions by 2026 (Tertiary Education Fund, 2024).

Community-Driven Open Educational Resource Repositories

NaijaLessonBank, developed by teacher educators in Enugu and Rivers States, curate’s curriculum-aligned resources in English and Nigerian Pidgin on Kolibri, an offline-capable platform, distributing content via WhatsApp channels and portable storage devices (Nwachukwu &Emejulu, 2024). By late 2024 it had registered over 15,000 users, with 42% demonstrating repeat engagement ata notably higher retention rate than many formal professional development programsreflecting the value of linguistic and cultural contextualization and community-driven, participatory development over donor-dependent models (Nwachukwu &Emejulu, 2024).

10. TOWARD SYSTEMIC DIGITAL RE-PROFESSIONALIZATION: A FOUR-PILLAR FRAMEWORK

Building on this analysis of challenges and emergent innovations, a four-pillar framework integrates curriculum design, professional capacity development, infrastructure investment, and accountability mechanisms toward developing educator capabilities rather than merely installing technological resources.

Curriculum Infusion Rather Than Curriculum Addition

Standalone "ICT for Teachers" courses should be replaced with discipline-specific digital pedagogy infused throughout subject methodology courses—for example, dynamic geometry software in mathematics education or multimodal composition in language education—so that student teachers develop integrated TPACK rather than isolated competencies in each domain (Koehler et al., 2013). Curricula must also address emerging competencies including ethical AI literacy, data privacy in learning management systems, and recognition of algorithmic bias, as artificial intelligence increasingly mediates educational processes (Crompton et al., 2024).

Continuous Professional Learning Ecosystems

Sustainable transformation requires moving beyond episodic, workshop-based development toward embedded support: Digital Mentor Tutor positions within each academic department, incentivized through reduced teaching loads and explicit consideration in promotion criteria, can model effective practice and facilitate professional learning communities embedded within existing institutional structures. Partnerships with technology companies should be structured to build local facilitator capacity rather than create dependency on external providers.

Adaptive Infrastructure Investment

Infrastructure development should prioritize adaptive, sustainable technologies appropriate to Nigerian contexts solar-powered, offline-capable hubs such as RACHEL and Kolibri, and tiered connectivity solutions matching local infrastructure (4G LTE in urban areas, LoRaWAN in rural areas, TV white-space technologies where feasible) rather than importing high-resource models. Device strategies should accommodate the reality that many educators' own smartphones even where institutions lack computer laboratories, using mobile-optimized platforms while ensuring institutional access for students who lack personal devices.

Robust Monitoring, Evaluation, and Learning Systems

National indicators for digital-teaching efficacy should move beyond infrastructure inputs to measure actual practice and outcomes for example, the proportion of graduates regularly using two or more digital formative-assessment tools, and pre- and post-practicum TPACK self-efficacy. Annual NCCE Digital Readiness Audits should assess effective use rather than infrastructure stock alone and inform performance-based resource allocation. Partnerships between teacher-education institutions and research centers, potentially supported through TETFundresearch grants, could generate the rigorous comparative evidence currently lacking.

11. DISCUSSION: IMPLICATIONS AND FUTURE DIRECTIONS

This analysis demonstrates the value of integrating TPACK and the Capability Approach: TPACK articulates necessary knowledge structures, while the Capability Approach directs attention to the

conversion factorsinstitutional support, professional development quality, infrastructure reliability that mediate their translation into practice. It also extends understanding of the gap between policy intentions and institutional practice, illustrating that policy articulation, though necessary, is insufficient without accompanying capacity building, resource allocation, and accountability, consistent with implementation-science research emphasizing context, capacity, and culture (Fixsen et al., 2005). Examination of emergent innovations reveals design principles with applicability beyond Nigeria: leveraging ubiquitous technologies, employing low-bandwidth or offline-capable platforms, integrating with existing institutional structures, and building local capacity through participatory approaches.

Policy Implications

Curriculum revision alone, absent parallel investment in educator capacity, infrastructure, and accountability, will not achieve intended outcomes; policy coherence across these domains is essential. Infrastructure investment should prioritize adaptive, context-appropriate technologies solar power, offline-capable platforms, mobile-first approaches over imported high-resource models dependent on reliable electricity or high-bandwidth connectivity. Professional development must shift from episodic workshops to embedded, ongoing learning ecosystems with genuine institutional incentives, and partnerships with technology companies should emphasize local capacity building. Accountability mechanisms must evolve beyond infrastructure inventories to assess actual use, educator competencies, and graduate outcomes, with performance-based funding tied to demonstrated progress.

Limitations and Future Research

Available evidence concentrates in certain geographic regions and institution types, with limited evidence from smaller private or rural colleges. Most studies employ cross-sectional designs, limiting understanding of how digital competencies develop over time or evolve during graduates' early teaching years. The analysis also focuses predominantly on formal institutions, with limited attention to alternative pathways such as online programs or informal professional learning. Future research should compare professional-development models for building teacher-educator TPACK in Nigerian contexts, examine how different infrastructure configurations affect educator practice and student-teacher outcomes, and identify factors predicting sustained technology integration among graduates during their initial teaching years.

12. CONCLUSION

Nigerian teacher education stands at a critical juncture. Persisting with predominantly analog teacher preparation constitutes pedagogical malpractice in classrooms already shaped by digital-native learners, even in under-resourced communities, yet uncritical techno-solutionism—imported platforms, donor-driven hardware distributions, superficial adoption risks reproducing dependency and inequity. The path forward is digital re-professionalization: reconceiving teaching as a digitally fluent, critically reflective, contextually inventive practice, and repositioning teachers from passive technology recipients to active design partners in Nigeria's digital education future. Success will be measured not by syllabus compliance but by whether newly certified teachers can apply digital tools purposefully toward locally relevant pedagogical goals. Mobile-first approaches, virtual practicum platforms, and community-driven resources demonstrate that pathways exist; scaling these innovations through comprehensive curriculum infusion, professional learning ecosystems, adaptive infrastructure, and robust accountability mechanisms offers a realistic route to sustainable transformation one aligned with Sustainable Development Goal 4.c and African Union Agenda 2063.

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