



Assessment of Teachers Preparedness and Challenges on Integration of ... Omagwu, A., Et. al. (2026)

Assessment of Teachers Preparedness and Challenges on Integration of Artificial-Intelligence Tools for Basic-Science Teaching among Universal-Basic-Education Schools in Kaduna State, Nigeria

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Abstract

This study investigates the preparedness of Basic Science teachers in Universal Basic Education (UBE) schools in Kaduna State to utilize Artificial Intelligence (AI) tools in teaching. A Descriptive research design was employed, gathering data through structured AI Integration in Basic Science Teaching Questionnaire" (AIIBST-Q) administered to 400 Basic Science teachers across UBE Schools in Kaduna State was validated through expert review and pilot testing, and its high reliability (Cronbach's Alpha = 0.87) was established, making it a robust tool for collecting the data presented in the study. The study utilized descriptive statistics and hypothesis testing to analyze the collected data Results reveal moderate technical proficiency ($M = 3.2$) but low pedagogical integration ($M = 2.8$), consistent with global patterns yet lower than in technologically advanced regions. Guided by the Diffusion of Innovation (DOI) theory, findings show AI adoption limited to early adopters mainly in private schools while a significant urban-rural gap ($t = 4.12, p < .001$) reflects deep infrastructure inequities. Major barriers include electricity shortages (78%), poor internet access (60%), lack of institutional support (90%), and inadequate training (65%), all of which hinder implementation of the Technological Pedagogical Content Knowledge (TPACK) framework. Additionally, psychological resistance (41%) suggests heightened techno-skepticism compared to other regions, shaped by local cultural contexts. The study concludes that AI integration in Kaduna's UBE schools is a systemic challenge, requiring multi-level action. Recommendations include creating a national AI education framework, investing in solar-powered solutions, subsidizing internet, embedding AI training in teacher professional development, and establishing supportive institutional policies. By addressing infrastructural, institutional, and attitudinal constraints, Kaduna State can leverage the moderate baseline preparedness of teachers to achieve sustainable AI adoption in education. This research offers practical roadmap for enhancing AI integration in low-resource settings.

Key Words: Universal Basic Education Schools, Artificial Intelligence, Basic Science

Introduction

The rapid advancement of Artificial Intelligence (AI) has ushered in transformative changes across various sectors, with education being one of the most significantly impacted. AI technologies, such as intelligent tutoring systems (ITS), chatbots, and adaptive learning platforms, are increasingly being leveraged to enhance teaching and learning processes (Luckin et al., 2016; Chen et al., 2020 & Babalola, et al., 2024). In science education, AI tools hold immense potential to personalize instruction, improve student engagement, and facilitate deeper conceptual understanding (Zawacki-Richter et al., 2019). For instance, AI-driven simulations and virtual labs have been shown to enhance students' problem-solving skills and scientific inquiry abilities (Bonnet et al., 2022). Despite these advancements, the successful integration of AI in classrooms largely depends on teachers' preparedness, which encompasses their technical proficiency, pedagogical adaptability, and confidence in using these tools (Hwang et al., 2020). Research indicates that teachers with higher



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digital literacy are more likely to adopt AI effectively, whereas those lacking adequate training or institutional support face significant barriers (Kumar et al., 2021; Pedro et al., 2019). In developing contexts like Nigeria, challenges such as inadequate infrastructure, limited internet access, and sporadic electricity supply further complicate AI adoption in education including basic education (Oyelere et al., 2020). Prior to the emergence of AI innovation in Nigeria, the “do-it-yourself” Barrio School approach of the Petro T. Orata in Philippines has been suggested to address Nigerian’s gross infrastructural deficit in her basic education schools (Babalola, 2015).

Basic Education is the cornerstone in the foundation of Nigerian education in which all other levels are building on. Basic education covers all classes in Nigerian schools below the senior secondary schools and the upper basic education is popularly known as the Junior Secondary School (Babalola, 2016). Nevertheless, all efforts must be geared towards avoiding wastages in basic education such as high drop-out rate and fail-out rate among the basic school students (Aliyu & Babalola 2016). An effort to prevent these wastages in basic education brought AI into the picture. In Kaduna State of Nigeria, the readiness of Basic Science teachers at the Upper Basic level to integrate AI tools into their instructional practices remains under-explored. While global studies highlight the benefits of AI in education, there is a paucity of empirical research focusing on the Nigerian context, particularly in science education at the foundational level (Atadoga et al., 2024 & Omagwu, et. at. 2025). Existing literature suggests that teachers in sub-Saharan Africa often struggle with technology integration due to insufficient professional development and a lack of policy frameworks supporting digital education (UNESCO, 2021). This study seeks to address this gap by assessing teachers' preparedness, identifying systemic challenges, and proposing actionable strategies to facilitate AI adoption in Basic Science education. The findings of this study will contribute to the broader discourse on AI in education by providing context-specific insights from Kaduna State. It will also inform policymakers, curriculum developers, and teacher training institutions on how to better support educators in harnessing AI's potential to improve science instruction. By bridging the gap between technological innovation and classroom practice, this research aims to foster a more inclusive and effective educational ecosystem in Nigeria.

Statement of the Problem

The integration of Artificial Intelligence (AI) in education presents both opportunities and challenges, particularly in developing regions like Nigeria. While AI tools have shown promise in enhancing science education globally, their effective implementation depends heavily on teachers' digital literacy, access to infrastructure, and institutional support. While AI technologies are rapidly transforming educational systems globally, the readiness of teachers to adopt and effectively use these tools remains a critical bottleneck, especially in developing contexts. In Kaduna State, the degree to which Basic Science teachers at the Upper Basic level are prepared to integrate AI tools is unclear. Their preparedness is influenced by factors such as digital competence, infrastructural support, and access to continuous training. The absence of empirical data on these dimensions poses a significant challenge to policy formulation, teacher training design, and curriculum development. This study seeks to bridge this gap by providing evidence-based insights into the current status of AI tool integration in Basic Science teaching in Kaduna State.

Research Objectives

1. Assess teachers' preparedness in using AI tools for Basic Science instruction.
2. Identify challenges in AI tool integration.
3. Examine institutional support and professional development opportunities.
4. Explore strategies to enhance teachers' readiness and address challenges.



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Research Questions

1. What is the level of teachers' preparedness in utilizing AI tools for Basic Science instruction?
2. What challenges hinder AI integration in Basic Science teaching?
3. What institutional support and professional development opportunities are available?
4. What strategies can improve teachers' readiness for AI adoption?

Artificial Intelligence in Education (AIED)

AIED refers to the application of machine learning, natural language processing, and data analytics to enhance teaching and learning processes (Luckin et al., 2022). In science education, AI tools such as adaptive learning platforms (e.g., Squirrel AI), virtual labs (e.g., Labster), and intelligent tutoring systems (e.g., Carnegie Learning) personalize instruction by analyzing student performance data and adjusting content delivery in real time (Holmes et al., 2023). Recent studies highlight AI's role in fostering inquiry-based learning for example, AI-driven simulations allow students to conduct virtual experiments, improving their conceptual grasp of scientific principles (Wang et al., 2023). However, the effectiveness of AIED depends on contextual factors such as curriculum alignment and infrastructural readiness (Chiu et al., 2023). In Nigeria, AI adoption remains nascent due to limited access to technology and electricity shortages (Oyelere et al., 2023), underscoring the need for localized frameworks.

Teacher Preparedness

Teacher preparedness encompasses digital literacy, pedagogical adaptability, and confidence in using AI tools (Hwang & Tu, 2023). The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) remains relevant, emphasizing that effective AI integration requires teachers to balance subject knowledge (Basic Science), teaching methods, and AI tool proficiency. A 2023 survey of Nigerian science teachers found that only 32% had received formal training on AI tools (Adewumi et al., 2023). Teachers in low-resource settings often resist AI adoption due to fear of job displacement or technical complexity (Selwyn, 2023).

Institutional Support Systems

Institutional support, including policy frameworks, infrastructure, and professional development, is essential for sustainable AI integration (Pedro et al., 2022). Successful models from other regions include:

1. Kenya's "AI for Teachers" program (UNESCO, 2023), which provided hands-on workshops and offline AI tools for rural educators.
2. India's National Digital Education Architecture (NDEAR, 2023), which mandated AI training for STEM teachers.

In Nigeria, the absence of a national AI education policy exacerbates disparities (Ogunleye, 2023). Schools with strong leadership support, however, report higher teacher engagement with AI (Ameh & Onojah, 2024).

Theoretical Framework

This study is based on two primary theories that explain how Artificial Intelligence (AI) is integrated into Basic Science education: the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) and the Diffusion of Innovation (DOI) theory (Rogers, 2003). Technological Pedagogical Content Knowledge (TPACK): The TPACK model stresses the importance of the connection between technology, pedagogy, and content knowledge, which is vital for successful AI integration (Mishra & Koehler, 2006). The framework highlights the dynamic relationship among teachers' expertise in science content (CK), teaching strategies (PK), and technological abilities (TK), showing that effective AI use depends on maintaining a balance among these areas. For example, a



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teacher using AI-powered virtual labs must grasp the science concepts (CK), apply suitable teaching methods (PK), and manage the technology involved (TK). Recent research in Nigeria indicates that teachers with stronger TPACK skills are more likely to successfully incorporate AI tools (Ameh & Onojah, 2024). Diffusion of Innovation (DOI) Theory explains how new technologies like AI are adopted in education, highlighting the roles of innovators, early adopters, and laggards (Rogers, 2003). In addition to TPACK, DOI describes how AI tools spread through educational systems, focusing on factors such as perceived benefits (relative advantage), compatibility with existing practices, and the availability of training (complexity). For instance, schools with strong institutional support and teacher training are more likely to adopt AI, while those without the necessary infrastructure or policies tend to lag. Evidence from contexts like Kenya's AI training programs (UNESCO, 2023) emphasizes the need to address systemic barriers. By integrating TPACK and DOI, this study offers a holistic perspective to assess teachers' individual preparedness alongside the institutional and systemic factors facilitating AI adoption. This combined method guarantees that the recommendations for AI implementation in Kaduna State are both pedagogically effective and feasible for wider application.

Empirical Review

AI Integration in Science Education

Recent research shows that AI tools like virtual labs and simulations enhance students' understanding of concepts and boost engagement in science (Zawacki-Richter et al., 2019). For example, AI-based platforms such as Labster have yielded positive results in STEM education (Bonnet et al., 2022). Chiu et al. (2023) investigated how AI virtual labs affect student performance through a quasi-experimental study involving 1,200 Upper Basic students in Nigeria and Kenya. Their results indicated a 22% increase in test scores for students utilizing AI tools, especially when teachers offered guided support. Nonetheless, the study's short-term scope and absence of socioeconomic analysis restrict its relevance across varied classroom environments. Adewumi et al. (2023) examined teacher resistance to AI implementation via a mixed-methods study involving 350 Basic Science teachers in Nigeria. The findings revealed that 52% of teachers opposed AI primarily due to concerns about job security and technical difficulties, although training efforts lowered resistance by 28%. However, the study's focus on urban areas, particularly Lagos, limits its applicability to rural regions where infrastructure and training are less developed. UNESCO's (2023) survey of 200 Kenyan schools found that institutional support significantly influences AI adoption, as schools with clear policies tend to implement tools three times more quickly. Nonetheless, the study equated having policies with their effective enactment, neglecting cultural and logistical challenges that may prevent practical use. These studies highlight AI's potential in science education while also revealing gaps in long-term impact evaluation, equity issues, and policy alignment. Future research should focus on longitudinal studies, include rural and marginalized groups, and explore how institutional support influences classroom implementation. Policymakers need to improve infrastructure and provide teacher training to promote fair AI integration in diverse educational settings.

Challenges in AI Adoption

Recent studies identify ongoing obstacles hindering effective AI use in science classrooms, especially where resources are limited. 2023 multi-country research by Oyelere et al. found that infrastructure issues are the main barrier, with 78% of surveyed Nigerian schools lacking dependable electricity and internet needed for AI technology. This corresponds with UNESCO's 2023 assessment across Africa, which showed that only 32% of rural science teachers could regularly access digital learning platforms. The infrastructure deficiency contributes to a significant digital divide, mainly impacting



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public and rural schools. Teacher-related challenges remain a significant obstacle. A 2024 mixed-methods study by Ameh and Onojah involving 500 Basic Science teachers in Northern Nigeria found that 67% of educators lacked confidence in using AI technologies, and 41% worried about AI replacing teaching jobs. This reluctance was especially common among older teachers and those without prior tech training. Although professional development programs showed some potential to change these attitudes, the study noted that most training efforts focused only on basic technical skills and did not effectively address how to integrate AI pedagogically. These studies collectively identify three key insights: First, infrastructure limitations create fundamental barriers to access. Second, teacher readiness involves both technical skills and psychological acceptance. Third, systemic issues like curriculum alignment and policy support greatly impact implementation success. However, current research often examines these challenges separately, with few studies exploring their combined effects. Future research should use holistic approaches that consider the interaction of technological, human, and systemic factors, especially in underrepresented regions. Common barriers include inadequate training, resistance to change, and lack of infrastructure (Selwyn, 2019). In Nigeria, electricity shortages and limited internet access further exacerbate these challenges (Oyelere et al., 2020).

Institutional Support

Recent research highlights the vital role of institutional support in ensuring successful AI integration in science classrooms. A 2023 international study by Pedro et al. surveyed 150 secondary schools in Sub-Saharan Africa and found that schools with comprehensive AI frameworks covering infrastructure, training, and policy alignment were 3.2 times more likely to succeed in implementation than those with limited or no support systems. The study's mixed-methods approach identified three key elements of effective institutional support: technological infrastructure (present in only 28% of Nigerian schools), ongoing professional development (offered by 19%), and curricular integration guidelines (available in 12%). The UNESCO (2023) report on AI readiness in African educational systems highlights notable inequalities in support structures. It found that 68% of private urban schools have dedicated AI budgets, compared to only 11% of rural public schools. The study emphasizes the influence of leadership, noting that schools where principals receive AI training are 4.5 times more likely to develop teacher support networks. Nonetheless, a significant gap remains, with 89% of current support efforts focused only on initial setup, overlooking ongoing maintenance and expansion. A longitudinal study by Chiu and Adewumi (2024), which tracked 45 Nigerian science classrooms over two years, provided nuanced insights into effective support structures. Their findings demonstrated that institutions combining formal training with informal peer-learning networks achieved 40% higher AI tool utilization rates. The research identified four levels of institutional support effectiveness: Basic (infrastructure only) - 12% adoption rate; Intermediate (infrastructure + training) - 34% adoption; Advanced (the above + curriculum integration) - 61% adoption; Comprehensive (all above + community partnerships) - 82% adoption

Emerging research by the African Educational Research Consortium (2024) uncovers innovative institutional support models. Their case study of a Lagos education district demonstrated how a "tripartite support system" involving government (policy), universities (expertise), and tech firms (resources) raised AI adoption from 8% to 63% within 18 months. A key factor was the creation of school-based "AI hubs" that serve as both resource centers and communities of practice. Although these studies offer valuable insights, several limitations remain. Most research focuses on urban settings (72% of studies in a 2024 meta-analysis), leaving the dynamics of rural institutions less explored. Furthermore, there's insufficient analysis of how support systems for institutions adapt to



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changing AI technologies. Future research should utilize design-based implementation methods to evaluate support frameworks across various contexts and assess the cost-effectiveness of different models. Schools that provide strong professional development and access to AI resources tend to have higher teacher readiness (Pedro et al., 2019). For instance, the "AI for Teachers" program in Kenya boosted educators' confidence in using AI tools (UNESCO, 2021).

Research Gap

Although many global studies explore AI in education, few concentrate on Nigeria, especially at the Basic Science level in Upper Basic education. This research fills that gap by examining the specific challenges and opportunities in Kaduna State.

Research Methodology

This study uses a descriptive survey research design that combines both quantitative and qualitative methods to thoroughly examine teachers' preparedness, challenges, and institutional support concerning AI integration in Basic Science education at the Upper Basic level in UBE Schools, Kaduna State, Nigeria.

Population and Sampling

The target population includes all Basic Science teachers in UBE Schools at Upper Basic levels across the state, with a representative sample of 400 teachers chosen through stratified random sampling to ensure balanced representation across school types, geographic locations (urban/rural), and teacher demographics.

Instruments

Data collection employs two primary tools: a structured questionnaire with Likert-scale and open-ended questions to assess AI readiness, challenges, and institutional support, and semi-structured interviews with 30 purposively selected teachers to gather detailed, qualitative insights.

Validity and Reliability

The questionnaire undergoes thorough validity assessments through expert review and pilot testing, while reliability is maintained with Cronbach's Alpha scores of 0.70 or higher.

Presentation of Results

This chapter presents the analysis of data collected from 400 Basic Science teachers in Kaduna State, Nigeria, addressing the study's research questions. The chapter is organized into quantitative analysis (descriptive and inferential statistics) and qualitative analysis (thematic analysis of interviews). Results are discussed with reference to existing literature, and key findings are summarized to provide actionable insights.

Quantitative Data Analysis

Descriptive Statistics

Table 1: Demographic Characteristics of Respondents (N=400)

Location	Urban	240	60%
	Rural	160	40%
Teaching Experience	1–5 years	160	40%
	6–10 years	140	35%
	11+ years	100	25%

Survey, 2025

The demographic data reveals significant patterns in the sample population of Basic Science teachers in Kaduna State. Geographical distribution indicates an urban concentration, with 60% (n=240) of teachers located in urban areas versus 40% (n=160) in rural settings. This urban-rural divide may influence technology adoption patterns, as urban educators typically have better access to infrastructure and training opportunities. Teaching experience presents a relatively balanced



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distribution across career stages: early-career teachers (1-5 years) comprise 40% (n=160) of the sample, mid-career (6-10 years) account for 35% (n=140), while veteran teachers (11+ years) represent 25% (n=100). This distribution suggests that while newer teachers dominate the workforce, there is substantial representation from more experienced educators who may bring different perspectives on technology integration.

Teachers' Preparedness in AI Utilization

Table 2: AI Preparedness Levels (5-Point Likert Scale, N=400)

Aspect	Mean Score (SD)	Interpretation
Technical Proficiency	3.2 (0.9)	Moderate
Pedagogical Integration	2.8 (1.1)	Low-Moderate
Confidence in AI Use	3.0 (0.8)	Moderate

The data reveals a moderate overall preparedness among Basic Science teachers in utilizing AI tools, with notable variations across different competency areas. Teachers demonstrated moderate technical proficiency (Mean = 3.2, SD = 0.9), suggesting that while many possess foundational skills to operate AI tools, there remains significant room for improvement in technical mastery. The slightly higher mean score in this domain compared to others may reflect growing exposure to digital technologies in teacher training programs. However, the standard deviation indicates variability in skill levels across the sample. However, pedagogical integration emerged as the weakest area (Mean = 2.8, SD = 1.1), falling into the low-moderate range. This suggests teachers struggle most with effectively incorporating AI tools into lesson planning, instructional delivery, and assessment strategies. The larger standard deviation here highlights substantial disparities. While some teachers may be experimenting with AI-enhanced teaching methods, others likely lack the pedagogical knowledge to move beyond basic technical use. Teachers reported moderate confidence in using AI (Mean = 3.0, SD = 0.8), indicating neither strong assurance nor complete discomfort with the technology. The narrower standard deviation for confidence compared to pedagogical integration suggests more consistent self-perceptions across the sample regarding their AI capabilities, though still below optimal levels for widespread implementation.

Challenges Hindering AI Integration

Table 3: Major Challenges Reported (Multiple Responses Allowed, N=400)

Challenge	Frequency (n)	Percentage (%)
Lack of Electricity	312	78%
Inadequate Training	260	65%
Poor Internet Access	240	60%
Resistance to Change	164	41%
Lack of AI Tools	148	37%

The data reveal a hierarchy of significant barriers preventing effective AI adoption among Basic Science teachers in Kaduna State. The most pervasive challenge is infrastructure deficiency, with 78% of teachers (n=312) reporting lack of electricity as a primary obstacle. This fundamental limitation creates an insurmountable barrier for most technology integration efforts, particularly in rural areas where power supply is most unreliable. Closely related is the issue of poor internet access, affecting 60% of respondents (n = 240), which severely restricts the use of cloud-based AI educational tools and digital resources. The second major category of challenges revolves around human capacity development, where 65% of teachers (n = 260) identified inadequate training as a critical barrier. This suggests that even when technological infrastructure is available, many educators lack the necessary skills to utilize AI tools in their pedagogy effectively. The resistance to change reported by 41% of teachers (n=164) indicates a significant psychological barrier, likely stemming from insufficient understanding of AI's educational benefits or fear of technological displacement.



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Resource scarcity emerges as another substantial challenge, with 37% of teachers (n=148) reporting a complete lack of AI tools in their schools. This deficiency is particularly acute in public schools, where funding for educational technology is typically limited.

Institutional Support and Professional Development

Table 4: Availability of Institutional Support (N=400)

Support Type	Frequency (n)	Percentage (%)
AI Workshops Attended	100	25%
Access to AI Tools	60	15%
School AI Policy	20	5%
No Support Received	360	90%

The data paints a concerning picture of institutional support for AI integration in Basic Science education, revealing systemic deficiencies that hinder technological progress in classrooms. A staggering 90% of teachers report receiving no support whatsoever, indicating a near-complete institutional failure to prepare educators for the digital age. The limited support that exists remains woefully inadequate - only one-quarter of teachers have attended AI workshops, a mere 15% have access to AI tools, and just 5% work in schools with any formal AI policy. These findings suggest that the few existing support mechanisms are fragmented, inconsistent, and lack strategic direction. The overwhelming lack of institutional backing creates an impossible environment for successful AI integration, regardless of individual teachers' capabilities or motivation. This systemic neglect stems from multiple root causes: severe resource constraints, misaligned spending priorities, and a fundamental lack of awareness among school leadership about AI's educational value. The near-total absence of institutional policies (95% of schools lacking them) means there are no frameworks to guide implementation, allocate resources effectively, or measure progress. This policy vacuum results in haphazard, uncoordinated efforts that fail to produce meaningful change. To address this crisis, education authorities must immediately implement mandatory AI policies for all schools, establish structured support systems with dedicated funding, and create accountability measures to track progress. Without first building these fundamental institutional frameworks, efforts to improve infrastructure or provide teacher training will remain ineffective and unsustainable. The data clearly shows that institutional support is the foundational barrier that must be addressed before any other AI integration challenges can be meaningfully tackled.

Table 5: Inferential Statistical Analysis of AI Integration Factors

Analysis	Variables Compared	Test Statistic	p-value	Effect Size	Interpretation
	Institutional Support × Location (Urban/Rural)	$\chi^2(1) = 12.40$	<0.001	Cramer's V = 0.22	Urban schools provide more support (30%) than rural (8%).
Independent t-test	AI Preparedness × Location (Urban/Rural)	t(398) = 4.12	<0.001	Cohen's d = 0.52	Urban teachers (M=3.8) are more prepared than rural (M=3.2).
	Confidence in AI × School Type (Public/Private)	t(398) = 3.85	<0.001	Cohen's d = 0.48	Private school teachers (M=3.5) report higher confidence than public (M=2.7).



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One-way ANOVA	Institutional Support Experience (1-5/6-10/11+ yrs)	×	F(2,397) = 6.94	0.001	$\eta^2 = 0.08$	Teachers with 6–10 years' experience receive significantly more support (p<0.05).
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Key Notes:

Effect Size Interpretation: Cramer's V: 0.1 (small), 0.3 (medium), 0.5 (large); Cohen's d: 0.2 (small), 0.5 (medium), 0.8 (large); η^2 (Eta-squared): 0.01 (small), 0.06 (medium), 0.14 (large); **Statistical Significance:** All tests are significant (*p* < .05), confirming observed differences are unlikely due to chance.

Practical Implications: School type and location significantly predict AI adoption and preparedness.; Mid-career teachers (6–10 years) receive the most institutional support, suggesting targeted policies for other groups.

Qualitative Data Analysis (Thematic Approach)

Emerging Themes

1. **Infrastructure Barriers** (70% of respondents)

"We received tablets, but no electricity to charge them." (Teacher #12, Rural Public School)

"Internet is too slow for AI applications." (Teacher #45, Urban Private School)

2. **Training and Skill Gaps** (65%)

"The one-day workshop was too basic we need hands-on practice." (Teacher #78, Urban Public School)

3. **Fear and Resistance** (41%)

"Will AI replace us? Nobody explains how it helps teaching." (Teacher #33, Rural Private School)

4. **Policy and Leadership Gaps** (55%)

"Our principal doesn't prioritize technology only exam results matter." (Teacher #92, Urban Public School)

Triangulation of Findings

Quantitative Data	Qualitative Support	Conclusion
Low AI adoption in public schools (18%)	"No funding for AI tools in government schools."	Systemic neglect
Urban teachers more prepared (M=3.8 vs. M=2.7)	"I learn from YouTube since my school offers no training."	Self-driven upskilling

Discussion of Findings

The findings of this study align closely with both prior empirical research and established theoretical frameworks, while also highlighting context-specific challenges in Kaduna State. The moderate preparedness levels observed (technical proficiency: M=3.2; pedagogical integration: M=2.8) mirror global studies (e.g., Chiu et al., 2023) but are notably lower than those reported in technologically advanced regions. This discrepancy supports the Diffusion of Innovation (DOI) theory, as Nigeria's educational system appears to lag in the adoption curve, with only early adopters (primarily in private schools) demonstrating meaningful AI integration. The significant urban-rural divide in preparedness (t = 4.12, p < .001) corroborates Oyelere et al.'s (2023) findings on infrastructure disparities in Sub-Saharan Africa, reinforcing how geographical inequities exacerbate technological marginalization.

The infrastructure challenges, particularly electricity shortages (78%) and poor internet access (60%), echo UNESCO's (2023) reports on low-resource settings, but are more severe in Kaduna compared to neighboring Kenya, where solar-powered solutions have mitigated some of these barriers. These systemic gaps directly inhibit the Technological Pedagogical Content Knowledge



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(TPACK) framework's implementation, as teachers cannot apply technological knowledge (TK) without reliable electricity a foundational prerequisite absent in most schools.

The lack of institutional support (90% of teachers unsupported) starkly contrasts with Brazil's success in AI integration (Pedro et al., 2019), where government-mandated policies and funding led to 70% teacher participation in AI programs. This validates DOI's emphasis on institutional factors as critical for mass adoption. Meanwhile, the psychological resistance (41%) aligns with Selwyn's (2023) work on techno-skepticism among educators but is higher than in India (Kumar et al., 2021: 28%), suggesting cultural and contextual nuances in technology acceptance.

CONCLUSION

This study assessed the preparedness of Basic Science teachers in Kaduna State to utilize AI tools, identifying critical challenges and institutional support gaps. The findings reveal moderate technical proficiency but low pedagogical integration, highlighting a significant disconnect between teachers' ability to operate AI tools and their capacity to incorporate them into lesson delivery effectively. The most pervasive barriers are electricity shortages (78%), inadequate training (65%), and lack of institutional policies (90%), demonstrating systemic failures that hinder AI adoption. These results align with the Technological Pedagogical Content Knowledge (TPACK) framework, confirming that successful AI integration requires more than just technical skills; it demands pedagogical adaptation and institutional support. Additionally, the Diffusion of Innovation (DOI) theory explains why adoption remains limited to early adopters (primarily private schools), as infrastructural and policy gaps stall broader implementation.

Recommendations

1. Government must prioritize developing a national AI education framework with dedicated funding for infrastructure and teacher training.
2. Immediate steps should include providing solar-powered solutions for UBE schools and subsidizing internet access.
3. Establish AI implementation committees and create supportive environments that encourage teacher innovation through mentoring programs and incentives.
4. Redesign to focus equally on technical skills and pedagogical integration, using blended formats accessible to rural educators.
5. Address psychological barriers by clearly positioning AI as a teaching aid rather than a replacement.
6. Piloting context-appropriate solutions like offline AI tools and advocating for equitable resource distribution.
7. Coordinated, sustained efforts across all stakeholders.
8. While the challenges are significant, the moderate baseline preparedness of teachers offers a foundation for progress.
9. By systematically addressing infrastructure gaps, strengthening institutional support, and empowering educators through targeted professional development, Kaduna State can harness AI's potential to transform Basic Science education.
10. This study provides both a sobering assessment of current limitations and a practical road map for meaningful improvement, emphasizing that technological integration must be grounded in realistic appraisals of local contexts and systemic capabilities.
11. The time for isolated interventions has passed, what is needed now is comprehensive, policy-driven reform that creates an enabling environment for sustainable AI adoption in education.



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