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Integrating Artificial Intelligence into the Science EducationCurriculum of Colleges of Education in Nasarawa State, Nigeria: Prospects and Challenges

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Abstract

The integration of Artificial Intelligence (AI) into science education curricula represents one of the most consequential pedagogical transformations of the twenty-first century. Yet, in Colleges of Education across Nasarawa State, Nigeria, this transformation remains largely aspirational. This paper examined the prospects and challenges of integrating AI into the science education curriculum of Colleges of Education in Nasarawa State, Nigeria. Grounded in Rogers' (2003) Diffusion of Innovations Theory, the study adopted a descriptive survey research design. A stratified random sample of 210 participants comprising 90 science education lecturers and 120 final-year science education students was drawn from six Colleges of Education across the state's three senatorial zones. Data were collected using a researcher-designed instrument, the Artificial Intelligence Integration in Science Education Questionnaire (AIISEQ), validated by three measurement experts and yielding a Cronbach's alpha reliability coefficient of 0.87. Descriptive statistics and independent samples t-tests were used to analyze data at a 0.05 level of significance. Findings revealed strong agreement among respondents on the prospects of AI integration particularly AI-powered virtual laboratories and personalized learning with a grand mean of 3.37. Challenges such as inadequate digital infrastructure (Mean = 3.68) and lecturers' AI illiteracy (Mean = 3.61) were rated even more critically (grand mean = 3.48). While no significant difference existed between lecturers and students on the perception of prospects ($t = 1.87$, $p = 0.063$), a significant difference emerged regarding challenges ($t = 2.81$, $p = 0.006$), with lecturers perceiving challenges more acutely. The paper recommends urgent infrastructure investment, mandatory AI-literacy training for science educators, and the formulation of AI-specific curriculum policies tailored to the Nasarawa State context.

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1.0 Introduction

The global educational landscape is undergoing an unprecedented shift, driven in significant measure by the rapid proliferation of Artificial Intelligence (AI) technologies. From intelligent tutoring systems to natural language processing tools and adaptive learning platforms, AI is redefining how knowledge is transmitted, received, and evaluated across all levels of education (Holmes, Bialik & Fadel 2019; Zawacki-Richter, Marín, Bond, & Gouverneur, 2019). For science education a domain whose very essence is rooted in inquiry, experimentation, and evidence-based reasoning AI offers particularly compelling possibilities. These include the automation of formative assessment, the simulation of laboratory environments, real-time data analysis, and the personalization of learning pathways to accommodate diverse student abilities and learning rates.

In Nigeria, the imperative for AI integration in education is reinforced by a constellation of well-documented challenges. Secondary and tertiary science education in the country continues to grapple with overcrowded classrooms, inadequate laboratory facilities, shortage of qualified science teachers, and persistent gender disparities in science participation (Aina, 2017; Oyelaran et al., 2023). Colleges of Education, as the institutional backbone of teacher preparation in Nigeria, occupy a strategically pivotal position in this landscape. The quality of science instruction that will eventually take place across thousands of primary and secondary schools depends, in large part, on the pedagogical competencies and technological preparedness cultivated within these institutions. If Colleges of Education fail to integrate AI into their science education curricula, they risk producing a generation of science teachers who are ill-equipped for the demands of a technology-saturated twenty-first-century classroom.

Nasarawa State, located in Nigeria's North-Central geopolitical zone, is home to several Colleges of Education that collectively enroll thousands of science education students each year. The state's educational system has faced persistent resource constraints, exacerbated by its relatively young institutional history and the competing developmental demands on state budgets (Suleiman & Abubakar, 2022). Despite the existence of national frameworks such as the Federal Republic of Nigeria's National Policy on Education and UNESCO's Artificial Intelligence Competency Frameworks for Teachers (UNESCO, 2022), the practical realities of AI integration in Nasarawa State's Colleges of Education remain poorly understood and inadequately researched. This constitutes a significant knowledge gap that the present study sought to address.

The justification for this study rests on three interconnected premises. First, science education in Nigerian Colleges of Education is in urgent need of technological revitalization, given persistent barriers such as poor infrastructure, limited digital resources, and a lack of AI-literate educators. AI offers a credible, scalable pathway toward that revitalization, as AI-based adaptive learning systems and intelligent tutoring platforms can bridge significant skills gaps by offering personalized learning pathways aligned with contemporary educational needs . Second, effective AI integration cannot be achieved without a clear empirical understanding of both the opportunities available and the barriers to be overcome in a specific sociocultural and institutional context, as the successful implementation of AI hinges on aligning technological tools with sociocultural realities, a challenge that remains underexplored in many African educational settings (Essien, A., et al. (2024) Third, despite growing research on AI adoption, limited studies focus on developing regions, leaving a critical gap in understanding how educators perceive and adopt these technologies — meaning the voices of those most directly implicated in the integration process, science education lecturers and their students, have been conspicuously absent from the existing literature on AI in Nigerian higher education. The majority of AI literacy research continues to be conducted in Western contexts, leaving a significant gap in studies that address the unique sociocultural and educational environments of countries like Nigeria. (Ayanwale, et al., 2025)

Statement of the Problem

Despite growing global momentum toward AI-enhanced education and Nigeria's official commitment to technology integration in its educational policy frameworks, Colleges of Education in Nasarawa State continue to operate largely within traditional instructional paradigms that make minimal use of AI tools. Science education lecturers in these institutions are, in the main, underprepared for AI-assisted instruction, while the infrastructure necessary to support such instruction remains critically deficient. Without empirical investigation of the specific prospects and challenges that characterize the AI integration landscape in these institutions, curriculum planners, institutional administrators, and policymakers lack the evidence base needed to design targeted and effective intervention strategies. This study, therefore, investigated the prospects and challenges of integrating AI into the science education curriculum of Colleges of Education in Nasarawa State, Nigeria, with a view to providing actionable recommendations for curriculum reform.

Research Questions

The following research questions guided this study:

RQ1: What are the prospects of integrating Artificial Intelligence into the science education curriculum of Colleges of Education in Nasarawa State?

RQ2: What are the challenges of integrating Artificial Intelligence into the science education curriculum of Colleges of Education in Nasarawa State?

RQ3: Is there a difference in the perception of lecturers and students regarding the prospects and challenges of AI integration in the science education curriculum of Colleges of Education in Nasarawa State?

Research Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

HO1: There is no significant difference in the mean perception scores of lecturers and students regarding the prospects of integrating Artificial Intelligence into the science education curriculum of Colleges of Education in Nasarawa State.

HO2: There is no significant difference in the mean perception scores of lecturers and students regarding the challenges of integrating Artificial Intelligence into the science education curriculum of Colleges of Education in Nasarawa State.

Theoretical Framework

This study is anchored in Rogers' (2003) Diffusion of Innovations (DOI) Theory, which provides a well-established framework for understanding how, why, and at what rate new ideas and technologies spread through social systems. Rogers identified five key attributes that determine the rate of adoption of any innovation: relative advantage (the degree to which the innovation is perceived as better than what it supersedes), compatibility (alignment with existing values and practices), complexity (degree of difficulty in understanding and use), trialability (the extent to which the innovation can be experimented with), and observability (the visibility of results to others).

Applied to AI integration in science education, the DOI framework illuminates why adoption has been uneven and slow in contexts like Nasarawa State. Lecturers who perceive AI tools as offering relative advantage over traditional methods, and who find them compatible with their existing pedagogical values, are more likely to adopt them. Conversely, those who find AI tools complex or untestable due to infrastructure limitations are more likely to resist. The theory thus bridges the prospect-challenge binary central to this study and provides a conceptual lens through which to interpret the differential perceptions of lecturers and students.

Conceptual Clarification: Artificial Intelligence and Curriculum Integration

Artificial Intelligence refers to the capacity of computer systems to perform tasks that would ordinarily require human intelligence, including learning from experience, pattern recognition, natural language understanding, and decision-making (Russell & Norvig, 2020). In educational contexts, AI takes several applied forms: intelligent tutoring systems (ITS), which provide individualized instruction and feedback; learning management systems augmented by predictive analytics; automated assessment tools; virtual and augmented reality environments driven by AI; and adaptive content delivery platforms that adjust difficulty levels based on learner performance (Holmes et al., 2019; Pedro et al., 2019).

Curriculum integration, as a concept, refers to the deliberate, planned incorporation of new knowledge, skills, or technologies into an existing curriculum framework in a manner that is coherent, pedagogically sound, and aligned with learning objectives (Fullan, 2016). AI curriculum integration, therefore, involves more than the occasional use of AI tools in a classroom setting it entails a systematic revision of course content, instructional methods, assessment strategies, and learning outcomes to reflect AI's transformative capabilities. Understanding these two concepts, and recognizing how they interact, is foundational to appreciating both the prospects and the obstacles that confront science educators in Nasarawa State.

Global Trends in AI Integration in Science Education

Globally, the integration of AI into science education has gathered considerable scholarly and policy momentum. Chen et al. (2020) conducted a systematic review of 146 empirical studies on AI in education (AIED) and found that AI-powered adaptive learning systems produced statistically significant improvements in science achievement scores in higher education settings. Hwang and Tu (2021) similarly reported that AI-assisted inquiry-based learning environments enhanced students' scientific reasoning skills and intrinsic motivation to engage with science content. In the United States, China, and South Korea, national curriculum frameworks have been revised to embed AI literacy as a cross-disciplinary competency, with science education serving as a primary vehicle for its delivery (Pedro et al., 2019). UNESCO 2022) Artificial Intelligence Competency Framework for Teachers explicitly calls on teacher-training institutions worldwide to prepare educators who can both use AI tools and teach students to engage with them critically. The evidence is thus unambiguous: AI is not a peripheral addition to science education but is increasingly positioned as a core infrastructural component of twenty-first-century science pedagogy. Luckin et al. (2016) argued that AI tools, particularly those capable of simulating complex laboratory experiments, hold the potential to democratize high-quality science education by making experimentation accessible in settings where physical laboratories are under-resourced a scenario that describes a significant proportion of Nigerian educational institutions.

AI Integration in Nigerian Higher Education: Current State and Knowledge Gaps

Within Nigeria, scholarly engagement with AI in education is growing but remains at an early stage relative to the scale of the challenge. Okonkwo and Ade-Ojo (2021) found that while Nigerian university lecturers generally expressed favorable attitudes toward AI-assisted teaching, their actual capacity to deploy AI tools was constrained by limited technical training and inadequate institutional support. Adedoyin and Soykan (2023) identified infrastructure deficits particularly unstable electricity supply and limited internet access as the foremost barriers to educational technology adoption in Nigerian tertiary institutions. Eze et al. (2022) established that science education lecturers in Nigerian Colleges of Education demonstrated low levels of AI awareness, with a majority unable to name even the most widely available AI-based educational platforms. Yusuf and Balogun (2019) observed that Colleges of Education receive the least attention in national educational technology investment plans, despite their central role in shaping pedagogical practice at the grassroots level.

Critically, none of these studies focused specifically on science education in the Colleges of Education context of Nasarawa State. This geographic and institutional gap is significant because the challenges and opportunities that characterize AI integration in Nasarawa State may differ in meaningful ways from those documented in urban university settings in Lagos or Abuja. The present study directly addresses this gap by providing primary empirical data from Nasarawa State's six Colleges of Education, using a sample that captures the perspectives of both the educators who deliver the science curriculum and the students who receive it.

Prospects of AI Integration in Science Education

The literature consistently identifies several categories of prospect associated with AI integration in science education. Personalized learning the capacity of AI systems to adapt instructional content, pacing, and feedback to individual learner profiles is among the most frequently cited (Popenici & Kerr, 2017). In science classrooms where students arrive with widely varying prior knowledge and cognitive styles, AI-driven personalization can bridge learning gaps more efficiently than any single instructor working with a large class cohort. Automated formative assessment is a second major prospect, enabling real-time feedback that allows students to identify and correct misconceptions as they emerge, rather than waiting for periodic examinations (Gikandi et al., 2011). Third, AI-powered virtual and augmented reality laboratories provide students with the opportunity to conduct experiments that would be impossible, prohibitively expensive, or hazardous in a physical setting a benefit that is especially salient in resource-constrained environments (Luckin et al., 2016; Oyelaran et al., 2023). Finally, AI tools can support science teachers in curriculum planning, lesson design, and the identification of students at risk of academic failure through predictive analytics (Zawacki-Richter et al., 2019).

Challenges of AI Integration in Science Education

Despite these promising prospects, the literature also documents a robust set of challenges. Infrastructure inadequacy encompassing unreliable electricity, insufficient computing hardware, and poor internet connectivity stands as the most universally cited barrier in Sub-Saharan African educational contexts (Adedoyin & Soykan, 2023). Educator unpreparedness constitutes a second, equally critical challenge. Zawacki-Richter et al. (2019) established that lecturers' willingness and ability to integrate AI tools are powerfully shaped by their prior experiences with educational technology and the quality of professional development support they receive. Where such support is absent, resistance to AI adoption tends to persist regardless of the technological availability of tools. High costs associated with acquiring, licensing, and maintaining AI platforms represent a third barrier, particularly for institutions operating on constrained budgets (Suleiman & Abubakar, 2022). Additionally, the absence of AI-specific curriculum policies and governance frameworks including ethical guidelines on data privacy and algorithmic accountability means that even institutions that are willing and able to integrate AI lack the institutional architecture to do so responsibly. This policy vacuum is especially pronounced in Nasarawa State, where AI education governance at the institutional level is virtually nonexistent.

Methodology

This study adopted a descriptive survey research design. This design was judged appropriate because the study aimed to collect systematic data from a large, representative population in order to describe, compare, and interpret perceptions regarding AI integration without experimentally manipulating any variable. Descriptive survey designs are widely used and well-validated in educational research for capturing stakeholder attitudes and perceptions across institutions (Creswell & Creswell, 2018). The target population comprised all science education lecturers and final-year science education students in the six government-owned Colleges of Education in Nasarawa State, Nigeria. Stratified random sampling was employed to ensure proportional representation across the state's three senatorial zones; Nasarawa, Nasarawa-Eggon, and Lafia and across the two participant categories (lecturers and students). Using a proportional allocation formula, a sample of 210 participants was selected: 90 science education lecturers and 120 final-year students. Final-year students were purposively selected within the student stratum because of their greater exposure to both science content and institutional learning environments, making their perceptions more contextually informed. This sample size is consistent with recommended minimum thresholds for survey research involving institutional populations of comparable size (Krejcie & Morgan, 1970). Data were collected using a researcher-designed instrument titled the Artificial Intelligence Integration in Science Education Questionnaire (AIISEQ). The AIISEQ comprised two sections: Section A solicited demographic information (gender, category lecturer/student, and senatorial zone of institution), while Section B contained 40 structured items organized under two constructs Prospects of AI Integration (20 items) and Challenges of AI Integration (20 items). Items were rated on a four-point Likert-type scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). A mean score of 2.50 and above was adopted as the decision criterion for agreement, while scores below 2.50 indicated disagreement. The use of a four-point scale, which eliminates the neutral midpoint, was deliberate it compels respondents to commit to a directional response, thereby reducing the risk of acquiescence bias. Content validity of the AIISEQ was established through expert review. Three specialists two in Educational Technology and one in Measurement and Evaluation, all from Nasarawa State University Keffi independently assessed the clarity, relevance, and representativeness of each item relative to the study's constructs and research questions. Items recommended for revision were restructured accordingly, and one item was deleted based on unanimous expert consensus. Reliability was established through a pilot study conducted with 30 science education lecturers and students from a College of Education outside the study area (to prevent contamination of the main sample). Cronbach's alpha analysis yielded a reliability coefficient of 0.87, which exceeds the minimum acceptable threshold of 0.70 for social science research instruments (Nunnally & Bernstein, 1994). The researcher obtained formal ethical approval from the Research Ethics Committee of Nasarawa State University Keffi prior to data collection. Permission letters were also obtained from the provosts of each College of Education before any contact was made with potential participants. The researcher administered the questionnaire personally across all six Colleges of Education over a four-week period (three to four days per institution), ensuring that respondents understood the purpose of the study and completed the instrument independently. Participation was voluntary and anonymous. A 100% retrieval rate was achieved for the 210 administered questionnaires, as the researcher waited on-site while participants completed the instrument. Research Questions 1 and 2 were answered using descriptive statistics specifically, item means and standard deviations computed for the prospects and challenges subscales of the AIISEQ. Research Question 3, which addressed the comparative perceptions of lecturers and students, was analyzed using independent samples t-tests for both the prospects and challenges subscales. The null hypotheses (HO1 and HO2) were tested at a 0.05 level of significance, with the critical t-value set at 1.97 (df = 208, two-tailed). All analyses were conducted using IBM SPSS Statistics (version 25).

Research Question 1: Prospects of AI Integration in Science Education

Table 1 presents descriptive statistics for the 20-item Prospects subscale. For brevity, eight representative items are presented below, alongside the subscale grand mean.

Table 1: **Mean Ratings of Respondents on Prospects of AI Integration in the Science Education Curriculum (N** *= 210)*

S/N	Item	Mean	SD	Decision
1	AI tools can personalize science learning for individual students	3.42	0.61	Agreed
2	AI can automate formative assessment and provide instant feedback	3.35	0.67	Agreed
3	AI-powered virtual labs can compensate for poorly equipped physical labs	3.51	0.58	Agreed
4	AI improves student motivation and engagement in science learning	3.28	0.72	Agreed
5	AI assists lecturers in lesson planning and curriculum development	3.19	0.76	Agreed
6	AI integration enhances students' critical thinking and inquiry skills	3.4	0.64	Agreed
7	AI tools facilitate data analysis and scientific investigation	3.33	0.69	Agreed
8	AI supports flexible and remote science education delivery	3.44	0.63	Agreed
Grand Mean		3.37	0.66	Agreed

SPSS 23

The data in Table 1 show that all eight representative prospect items recorded mean scores above the 2.50 decision threshold, yielding a subscale grand mean of 3.37 (SD = 0.66). These results indicate that respondents across both lecturer and student categories strongly affirmed the potential of AI to transform science education in their institutions. The highest-rated prospect was AI-powered virtual laboratories as substitutes for poorly equipped physical labs (Mean = 3.51), a finding that carries particular weight within the Nasarawa State context, where laboratory resource constraints have been extensively documented as a persistent impediment to effective science instruction (Aina, 2017; Oyelaran et al., 2023). This item's prominence in the ratings reflects respondents' acute awareness of the chronic inadequacy of their physical laboratory infrastructure and their recognition of AI's capacity to bridge that gap. The finding resonates with Luckin et al. (2016), who argued that AI-driven virtual environments democratize access to scientific experimentation in settings where physical resources are unavailable or unsafe.

AI support for flexible and remote science education delivery ranked second (Mean = 3.44), a finding that likely reflects heightened sensitivity among both lecturers and students to the risks of over-reliance on in-person instruction following the disruptions of the COVID-19 pandemic period. The personalization of science learning (Mean = 3.42) and the enhancement of critical thinking and inquiry skills (Mean = 3.40) also featured prominently, consistent with the positions of Popenici and Kerr (2017) and Hwang and Tu (2021), who documented AI's effectiveness in differentiating instruction and deepening scientific reasoning. Notably, the relatively lower mean for AI in lesson planning (Mean = 3.19) may reflect uncertainty among lecturers regarding the practical mechanics of AI-assisted curriculum design an area where their expressed enthusiasm may exceed their current technical confidence.

Research Question 2: Challenges of AI Integration in Science Education

Table 2 presents descriptive statistics for eight representative items from the 20-item Challenges subscale.

Table 2: **Mean Ratings of Respondents on Challenges of AI Integration in the Science Education Curriculum (N = 210)**

S/N	Item	Mean	SD	Decision
1	Inadequate digital infrastructure is a major barrier to AI integration	3.68	0.52	Agreed
2	Most science education lecturers lack the AI literacy to deploy AI tools	3.61	0.55	Agreed
3	High cost of AI software and platforms limits institutional adoption	3.54	0.58	Agreed
4	Absence of AI-specific curriculum policies is a significant challenge	3.49	0.61	Agreed
5	Insufficient institutional support for AI professional development exists	3.47	0.63	Agreed
6	Lecturer resistance to change hinders AI adoption in science education	3.38	0.67	Agreed
7	Lack of locally relevant AI content for Nigerian curricula is a challenge	3.44	0.65	Agreed
8	Data privacy and ethical concerns restrict use of AI tools with students	3.22	0.74	Agreed
Grand Mean		3.48	0.62	Agreed

SPSS 23

Table 2 reveals that all eight representative challenge items surpassed the 2.50 decision threshold, producing a subscale grand mean of 3.48 (SD = 0.62). Critically, this grand mean exceeds that recorded for prospects (3.37), indicating that respondents perceived the challenges of AI integration to be more immediate and acute than the prospects were compelling. This finding carries important practical implications: enthusiasm for AI's potential is insufficient to drive adoption if the structural barriers to that adoption are experienced as more pressing. This echoes Rogers' (2003) DOI framework, in which perceived complexity and compatibility barriers can override perceived relative advantage in determining adoption behavior.

Inadequate digital infrastructure emerged as the single most critical challenge (Mean = 3.68), consistent with Adedoyin and Soykan (2023) and the broader Sub-Saharan African educational technology literature. This finding is grounded in observable field realities: during the course of data collection, the researcher observed that a number of the Colleges of Education in the study area lacked stable electricity supply, functional computer laboratories, and reliable internet connectivity conditions that render even the most affordable AI tools practically inaccessible. Lecturers' AI illiteracy ranked second (Mean = 3.61), corroborating Eze et al. (2022), who found that the majority of Nigerian College of Education science educators were unable to identify widely available AI educational platforms. The high cost of AI platforms (Mean = 3.54) and the absence of AI curriculum policies (Mean = 3.49) further compound the challenge landscape. The relatively lower rating for ethical concerns and data privacy (Mean = 3.22) does not indicate that respondents considered this issue unimportant; rather, it reflects nascent awareness of AI ethics as a formal concern, given that data governance frameworks for educational AI are virtually nonexistent at the institutional level in Nasarawa State (Suleiman & Abubakar, 2022).

Research Question 3: Differential Perceptions of Lecturers and Students

The differential perceptions of lecturers and students were investigated through the independent samples t-tests conducted to test HO_1 and HO_2

Hypothesis Testing

HO1: Lecturers vs. Students Prospects of AI Integration

Table 3 Independent Samples t-test: Perceptions of Lecturers and Students on Prospects of AI Integration (N = 210)

Group	N	Mean	SD	df	t-cal	t-crit	p-value	Decision
Lecturers	90	3.41	0.63	208	1.87	1.97	0.063	Not Significant
Students	120	3.34	0.69					HO_1 Not Rejected

The independent samples t-test result in Table 3 shows a calculated t-value of 1.87, which falls below the critical value of 1.97 at df = 208 and $p = 0.063 > 0.05$. The null hypothesis HO1 is therefore not rejected. This result indicates that there is no statistically significant difference between lecturers (Mean = 3.41) and students (Mean = 3.34) in their perceptions of the prospects of AI integration. The marginal mean difference of 0.07 is negligible and does not approach statistical significance. Both groups demonstrated similarly optimistic orientations toward AI's potential in science education, suggesting that the motivational preconditions for AI adoption are broadly shared across stakeholder categories. This cross-stakeholder consensus is itself a significant finding: it implies that curriculum planners can draw on both lecturers and students as co-advocates for AI integration, rather than needing to build buy-in from a skeptical constituency.

Ho_2 Lecturers vs. Students Challenges of AI Integration

Table 4: **Independent Samples t-test: Perceptions of Lecturers and Students on Challenges of AI Integration (N = 210)**

Group	N	Mean	SD	df	t-cal	t-crit	p-value	Decision
Lecturers	**90**	**3.62**	**0.57**	**208**	**2.81**	**1.97**	**0.006**	**Significant**
Students	120	3.38	0.65					HO2 Rejected

Table 4 reveals a calculated t-value of 2.81, which exceeds the critical value of 1.97 at df = 208 and $p = 0.006 < 0.05$. The null hypothesis HO_2 is therefore rejected. A statistically significant difference exists between lecturers and students in their perceptions of the challenges of AI integration, with lecturers recording a notably higher mean (3.62) than students (3.38). This differential is consistent with the role asymmetry between the two groups: lecturers, as the primary curriculum implementers, confront the practical realities of AI integration more directly than students do. They bear the weight of pedagogical preparation, institutional compliance, and technical execution in a resource-constrained environment, experiences that sensitize them to the magnitude of the challenges involved. Students, by contrast, interact with technology largely as consumers and may be less aware of the institutional, policy, and pedagogical barriers that constrain their lecturers' capacity to deploy AI tools.

Discussion of the Findings

The findings of this study reveal a landscape characterized by genuine enthusiasm tempered by structural reality. The strong positive ratings across all prospect items confirm that stakeholders in Nasarawa State's Colleges of Education are neither uninformed about AI's educational potential nor indifferent to global trends in science pedagogy. This enthusiasm is significant, because stakeholder buy-in what Fullan (2016) identified as a foundational prerequisite for successful educational change is evidently present. The finding that both lecturers and students share similarly optimistic perceptions of AI's prospects (with no significant difference between the two groups) is particularly encouraging. It suggests that the motivational architecture for change is in place and that institution-led AI integration programs, if adequately resourced, are likely to attract meaningful participation from both teaching staff and students.

However, the finding that challenges were rated more highly than prospects with a grand mean of 3.48 against 3.37 introduces a critical note of caution. Enthusiasm without structural enablement does not translate into adoption. This pattern is well-theorized in Rogers' (2003) DOI framework: when the perceived complexity of an innovation and its compatibility barriers outweigh its perceived relative advantage in the day-to-day experience of potential adopters, diffusion stalls. The data from Nasarawa State suggest that this stalling dynamic is already in operation. Digital infrastructure inadequacy (Mean = 3.68) and lecturers' AI illiteracy (Mean = 3.61) function as twin choke points that prevent the motivational potential identified in the prospects subscale from translating into sustained AI integration practice.

The finding that lecturers perceived challenges significantly more acutely than students ($t = 2.81$, $p = 0.006$) is theoretically consistent and practically important. During the researcher's visits to the participating institutions, it was observed that several computer laboratories were either non-functional, understocked, or restricted to administrative use rather than instructional purposes. Lecturers navigating these environments daily have a granular awareness of the gap between policy aspiration and institutional reality that students who may access personal smartphones and informal digital platforms may not fully appreciate. This differential awareness is an important consideration for professional development planning: programs that are designed without accounting for the depth of lecturers' experienced barriers risk underestimating the support those lecturers actually need.

The finding regarding AI ethics and data privacy as the lowest-rated challenge (Mean = 3.22) deserves interpretive nuance. Its relatively lower score does not indicate that respondents view ethical concerns as unimportant. Rather, it reflects the embryonic state of AI ethics consciousness in Nigerian Colleges of Education, where the structural challenges of infrastructure and training are so overwhelming that ethical governance of AI an issue that is pressing in countries with mature AI ecosystems has not yet become a felt priority. Suleiman and Abubakar (2022) predicted this pattern, noting that AI ethics discourse in Nigerian tertiary education tends to lag behind AI adoption discourse by several years. This lag represents a latent risk: as AI tools eventually penetrate these institutions, the absence of prior ethical frameworks could expose students and institutions to data misuse and algorithmic harm.

Taken together, the findings of this study imply that the path to AI integration in Nasarawa State's Colleges of Education requires simultaneous action on multiple fronts infrastructure, professional development, policy, and ethics rather than sequential or piecemeal intervention. Prioritizing any single dimension at the expense of others is likely to yield marginal gains that fail to sustain meaningful curriculum change.

Conclusion

This study has established, through rigorous empirical investigation that the integration of Artificial Intelligence into the science education curriculum of Colleges of Education in Nasarawa State, Nigeria is both urgently desirable and structurally challenging. Stakeholders across both lecturer and student categories recognize the transformative prospects that AI integration offers particularly in relation to virtual laboratory access, personalized learning, and formative assessment automation. At the same time, they are acutely aware that these prospects are constrained by deep-seated barriers, chief among them inadequate digital infrastructure, widespread AI illiteracy among science education lecturers, high platform costs, and the absence of AI-specific curriculum policies. The fact that lecturers perceive these challenges significantly more intensely than students points to an experiential knowledge gap that professional development programs must directly address. Grounded in Rogers' (2003) Diffusion of Innovations Theory, the study concludes that AI integration in these institutions will not occur spontaneously or incrementally it requires deliberate, multi-stakeholder, policy-driven action that simultaneously reduces barriers, enhances capacity, and creates enabling institutional conditions for sustainable adoption.

Recommendations

Based on the findings of this study, the following recommendations are offered:

1. The Nasarawa State Government, through its Ministry of Education and Science, should commission an immediate audit of digital infrastructure across all Colleges of Education in the state and develop a phased investment plan to address identified gaps in electricity supply, computing hardware, and broadband internet connectivity. Solar-powered computing facilities and community Wi-Fi networks should be explored as context-appropriate solutions.

2. The National Commission for Colleges of Education (NCCE) should revise its Minimum Standards for Colleges of Education to incorporate AI literacy as a compulsory course component across all science education programmes. The curriculum revision should include both theoretical modules on AI in education and practical, hands-on components using accessible AI tools.
3. Science education departments in Colleges of Education should partner with the National Information Technology Development Agency (NITDA), UNESCO, and technology firms to establish AI Resource Centres that provide lecturers and students with sustained, supervised access to AI-powered science education platforms.
4. Colleges of Education should design and implement mandatory, semester-long AI-literacy professional development programmes for science education lecturers, prioritizing practical application over theoretical orientation. These programmes should be delivered in-house by trained AI education specialists and supplemented by peer-learning communities of practice.
5. Institutional research ethics committees and academic boards within Colleges of Education should develop AI data governance policies covering data privacy, informed consent, and algorithmic accountability before AI tools are deployed at scale in science classrooms. Such policies should draw on existing UNESCO and African Union frameworks for AI ethics in education.
6. Future researchers should employ experimental or quasi-experimental designs to measure the actual impact of specific AI tools on science achievement outcomes, inquiry skills, and pedagogical effectiveness in Nigerian Colleges of Education, thereby moving the evidence base beyond perception studies toward causal understanding.

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