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Science Educators' Perceived Challenges in Implementing Intelligent Tutoring Systems in Pedagogical Practices at Public Universities in Kogi State, Nigeria

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Abstract

Purpose: This study explored the perceived challenges faced by science educators in implementing Intelligent Tutoring Systems (ITS) in pedagogical practices at public universities in Kogi State, Nigeria. **Methodology:** The study employed an exploratory approach using data from 52 science educators across four public universities. There was no sampling since the population was manageable. The study adopted a descriptive survey research design. An online Google form survey questionnaire titled Challenges of Implementing Intelligent Tutoring System Questionnaire (CIITSQ) was used for data collection. CIITSQ was trial tested, yielding a reliability value of 0.88 using Cronbach's alpha. The CIITSQ contained 22 items. Two research questions and two null hypotheses guided the study. The research questions were answered using mean and standard deviation scores, while the null hypotheses were tested using t-test statistics. **Findings:** The study revealed inadequate technological infrastructure, financial constraints, lack of skilled personnel and training and ethical and social concerns as major barriers to the effective Implementation of ITS in pedagogical practices. The study also revealed that measures to address the challenges of implementing ITS in pedagogical practices involve a multifaceted approach, focusing on educators' training, investment in technological infrastructure, curriculum development, institutional support, and addressing attitudinal and ethical concerns. **Significance:** The findings suggest that to harness the benefits of ITS in pedagogical practices successfully, a balanced approach is required, emphasizing strategic investments in robust AI-ITS and other ICT infrastructure, comprehensive training programs for educators, and the development of ethical guidelines and regulatory frameworks tailored to the local context.

Keywords: Intelligent Tutoring Systems; Pedagogical Practices; Public Universities; Science Educators.

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Introduction

Today, we're diving deeper into the practical implementation of AI-driven Intelligent tutoring systems (ITS), exploring key considerations, challenges and best strategies to help you integrate AI-driven tutoring into pedagogical practices effectively. ITS have the potential to transform pedagogical practices by providing personalized, adaptive, and efficient learning experiences. ITS can adapt content, pace, and difficulty to match each student's specific needs and learning style. They offer immediate feedback (Students receive immediate feedback on their work, helping them correct mistakes and reinforce learning before misconceptions take root), freeing up science educators' time by handling routine tasks like grading, and can increase student engagement and improve learning outcomes by tailoring content and pace to individual needs. AI-powered ITS are revolutionising education, making learning more personalised (AI adapts to individual student needs), more efficient (science educators save time on grading and assessments) and more engaging (Interactive AI tutors boost student participation) (Silva et al., 2022). By implication, ITS are important because they enable personalized learning by adapting to each student's pace and knowledge gaps, provide immediate and specific feedback to reinforce learning, and free up teachers' time by automating administrative tasks. This allows for a more efficient, engaging, and effective pedagogical practice that can be particularly beneficial for diverse learners in large classrooms.

AI-driven intelligent tutoring systems (ITS) are computer-based educational tools that use AI-driven ITS to provide personalized instruction and support, mimicking a human tutor. They analyze a student's performance to adapt the difficulty, pace, and focus of lessons, offering customized guidance, instant feedback, and step-by-step help to improve learning outcomes (Yarlagadda, 2025). AI-driven intelligent tutoring systems (ITS) can automate time-consuming tasks like grading and administrative work, allowing teachers to focus more on instruction and student interaction. ITS provide educators with data and analytics on student progress, helping them identify struggling students and tailor future lessons. The impact of ITS on pedagogy cannot be overemphasized, as it supports a move toward more individualized and student-led learning experiences, and the combination of personalization, immediate feedback, and adaptive content can lead to significant improvements in academic performance (Ogunkunle & Qu, 2020; Silva et al., 2022). Thus, ITS can offer high-quality, one-on-one tutoring support to more students, which is especially valuable in distance learning or large classrooms where individual attention is limited.

AI-driven intelligent tutoring systems (ITS) can transform the educational landscape by creating more equitable, efficient, and effective learning environments that cater to the diverse needs of all learners. AI-driven ITS can offload science educators' workload on routine tasks, such as grading feedback and remediation, so that educators can focus more on teaching itself (Tobarra et al., 2021). Ultimately, educators will promote lifelong learning and professional development not only to students but also to themselves. Ajayi et al. (2025) concluded that educators that struggled with grading, feedback, and repetitive administrative tasks can leverage AI-driven ITS such as Walter (an ITS that automated formative assessment grading, personalized tutoring sessions and real-time feedback) to enhance students' engagement, and to reduced educators' administrative workload by over 50%, allowing more time for personalised instruction. Similarly, Yarlagadda (2025) concluded that educators who faced challenges of challenges managing assessments for large student cohorts can implement AI-driven ITS for students to gain 24/7 access to AI tutors, thus improving independent learning skills and overall perfor-

mance. The importance of science educators' responsibilities in implementing AI-driven intelligent tutoring systems (ITS) cannot be overstated.

Implementing AI-driven ITS requires aligning technological tools with student-centered, socio-constructivist strategies to learning to enhance engagement and skill development. Thus, science educators are expected to integrate AI-driven ITS into their pedagogical practices to foster digital literacy, highly personalized learning at scale, leading to improved academic performance, increased student engagement, and enhanced efficiency for educators. Despite these benefits, the researchers observe that educators in public universities in Nigeria still struggle with grading, feedback, repetitive administrative tasks and managing assessments for large student cohorts due to challenges in implementing AI-driven intelligent tutoring systems in pedagogical practices. However, the researchers observed that science educators in public universities in Kogi State are making efforts to implement AI-driven ITS and despite these efforts to integrate AI-driven ITS in pedagogical practices. Yet, there are a number of challenges that need to be addressed in order to realize fully the anticipated benefits of these efforts.

Kane and Staiger (2017) found that teachers score lowest on complex teaching abilities, such as using technology means to communicate with students about the subject. A study by Preechasil and Thamrongchai (2023) revealed that teachers face a multitude of challenges when integrating technology into classroom learning, which include poor technical support, poor internet access, excessive work, and inadequate technology pedagogical knowledge. However, there is a scarcity of studies on science educators' perceived challenges in implementing AI-driven intelligent tutoring systems in pedagogical practices. Gender refers to the socially constructed roles, behaviors, expressions, and identities of girls, women, boys, men, and gender-diverse people, which are distinct from biological sex. These social constructions can indeed lead to forms of inequality, such as disparities in power, resources, and opportunities (Ajayi, 2019). Gender is one of the factors that could influence science educators' ability to implement AI-driven ITS. Differences in characteristics, attitudes, and abilities between male and female science educators could influence science educators' ability to implement AI-driven ITS. Thus, the study investigated science educators' perceived challenges in implementing AI-driven intelligent tutoring systems in pedagogical practices with respect to gender in public universities in Kogi State, Nigeria.

Purpose of the Study

The purpose of this study was to explore science educators' perceived challenges in implementing AI-driven intelligent tutoring systems (ITS) in pedagogical practices at public universities in Kogi State, Nigeria. Specifically, the study:

1. ascertain the science educators' perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities; and
2. determine the measures that could address the perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities.

Research Questions

The following research questions guided this study:

1. What are the science educators' perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities?
2. What are the measures that could address the perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities?

Hypotheses

The following null hypotheses were tested:

1. There is no significant difference between the mean rating of male and female science educators on perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities.
2. There is no significant difference between the mean rating of male and female science educators on measures that could address the challenges of implementing AI-driven ITS in pedagogical practices in public universities.

Method

A descriptive survey research design was used in this study. This design was adopted because it is a method for studying a group by collecting and analyzing data from a representative sample. This approach is useful for describing characteristics, trends, or opinions without manipulating variables and is often used when not much is known about a topic initially. The study area was in Kogi State, Nigeria. Kogi State is a state in the North Central region of Nigeria. The target population for this study comprises all 52 science educators in the four public universities in Kogi State, Nigeria. The public universities are Prince Abubakar Audu University, Anyigba (PAAU), Confluence University of Science and Technology, Osara (CUSTECH), Kogi State University, Kabba (KSU) and Federal University, Lokoja (FUL). In this study, Science educators are lecturers or professional educators who teach science education subjects such as biology, chemistry, physics, integrated science, computer science, and mathematics in public universities in Kogi State, Nigeria. There was no sample size since the population size involved was small and easily accessible; it was feasible to collect data from every science educator, especially with the use of an online Google Form survey questionnaire, making sampling unnecessary. Ajayi (2023) opined that when the entire population for a study is small, well-defined, and manageable, researchers can conduct a census (collecting data from every single member) instead of using sampling because it would provide a true measure of the population parameters, such as the mean, standard deviation. After all, data is collected from all units, eliminating sampling error, and a small random sample can lead to unreliable results, reduced statistical power, and high variability due to the increased impact of outliers or unusual distributions. Thus, a census avoids these problems by providing full data.

An online Google form survey questionnaire titled Challenges of Implementing Intelligent Tutoring System Questionnaire (CIITSQ) was the instrument used for data collection. CIITSQ contained two sections. Section "A" contained demographic information of the respondents, while section "B" contained a 20-item questionnaire, which is intended to help lecturers express their opinions on the challenges of implementing AI-driven ITS and their opinions on measures that could address the challenges of implementing AI-driven ITS. Each of the items is a 4-point Likert scale with 4 response options. The options are Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). CIITSQ is a 4 Likert scale with number indicators as 4 (Strongly Agree), 3 (Agree), 2 (Disagree) and 1(Strongly Disagree). The online Google form survey questionnaire was face validated by two experts in Science Education/Measurement and Evaluation in the department of Science Education, Prince Abubakar Audu University, Anyigba and an expert in Science Education in the department of Science Education, Federal University Lokoja. The items were scrutinized by these experts. The instrument was reviewed based on the experts' corrections and suggestions. The online Google form survey questionnaire was trial-tested to establish the reliability coefficient, which yielded 0.89 using Cronbach's alpha. Thus, the question-

naire was used for data collection.

The online Google Form survey questionnaire was administered to respondents through email addresses/WhatsApp phone nos. by the researchers. To ensure ethical data practices with Google Forms survey questionnaire via email/WhatsApp, a clear consent script before the survey, restrict access to one response per person using a Google account, enable IP filtering (via Google Forms Settings), and personally identifiable information was not collected to maintain anonymity. Google Forms' built-in security features were used to avoid insecure data-sharing methods. To minimize social desirability bias, the researchers ensure anonymity, use open-ended or neutral questions, and frame questions carefully to avoid leading participants. A total of 52 copies of the online Google Form survey questionnaire were completed by the science educators, and the data collected were analyzed. Mean and Standard deviation scores were used to answer the research questions, while the null hypotheses were tested at a 0.05 level of significance using an independent t-test. A 2.50 cut-off on a 4-point scale typically represents the midpoint, where a score of 2.50 on a 1-to-4 scale indicates an even split between positive and negative sentiment, or the boundary between "strongly agree" and "strongly disagree" responses. This value serves as a threshold to categorize responses, often to identify overall positive or negative attitudes by grouping scores above 2.50 as positive and those below as negative, thus facilitating interpretation of the data without a neutral option. The two null hypotheses were tested at a 0.05 level of significance using an independent sample t-test. In all cases, the decision rule was that the null hypothesis is rejected if the p-value is less than 0.05, and it is not rejected if the p-value is more than 0.05. Effect size (strength of association) for the hypotheses was analyzed to quantify the difference between two means in terms of standard deviation units, indicating how far apart the group distributions are. Pallant (2001) outlines the guidelines on how to interpret the range of effect sizes for the independent t-test as follows: 0.20 indicates a small effect, 0.50 indicates a medium effect, and 0.80 indicates a large effect.

Results and Discussions

Presentations in this section are based on research questions and null hypotheses

Research Question One

What are the science educators' perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities? The answer to research question one is presented in Table 1 and Figure 1, respectively.

Table 1

Mean rating of science educators' challenges of implementing AI-driven ITS in Pedagogical Practices

S/N	Item(s)	Mean x	Std. dev δ	Remark
1.	The high cost of investment in AI-driven intelligent tutoring systems (ITS), infrastructure, and ongoing maintenance is one of the challenges of implementing AI-driven ITS.	3.76	0.27	Positive
2.	Inability of educators to integrate ITS into existing curricula is one of the challenges of implementing AI-driven ITS.	3.86	0.31	Positive

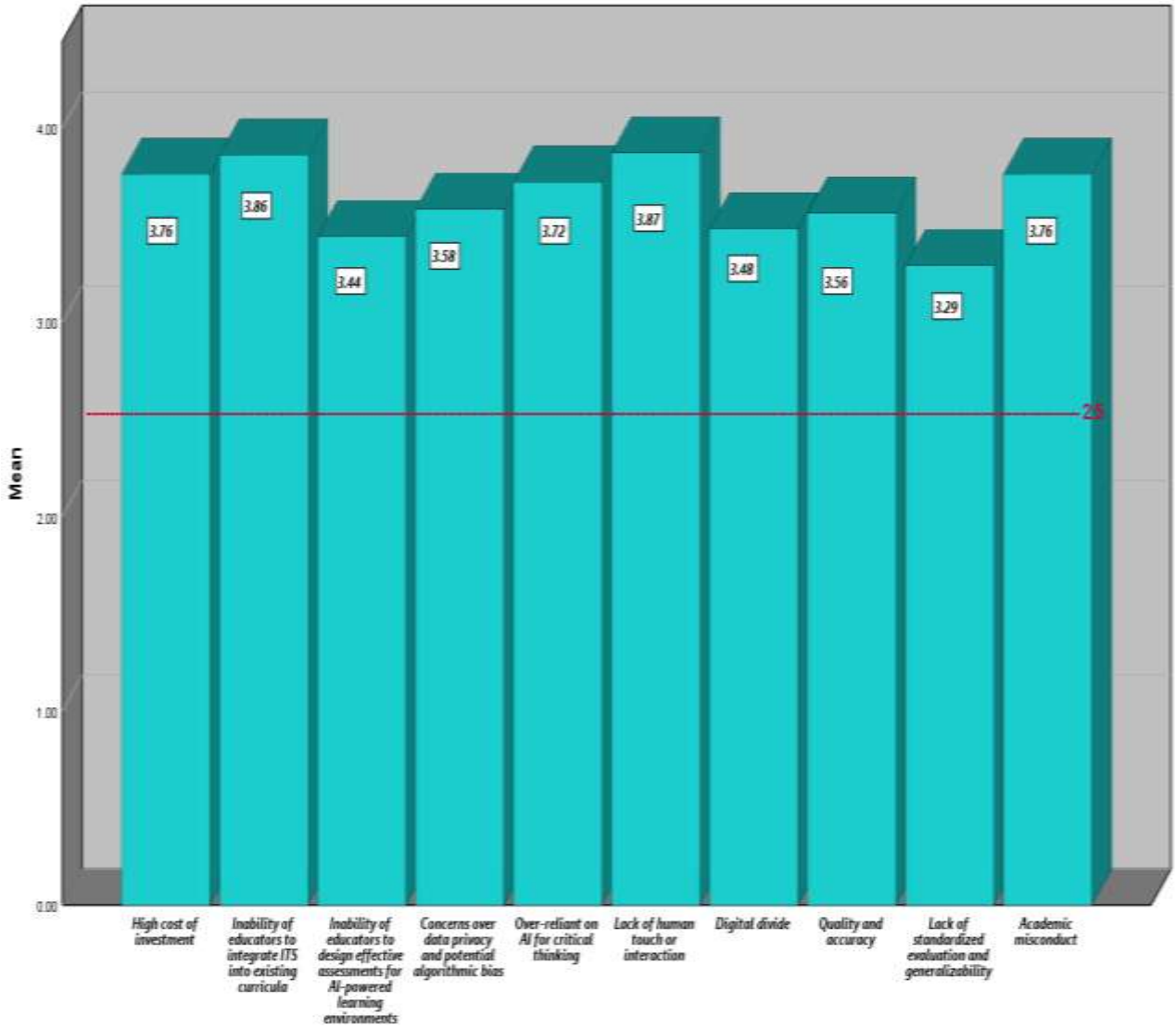
S/N	Item(s)	Mean x	Std. dev δ	Remark
3.	The inability of educators to design effective assessments for AI-powered learning environments is one of the challenges of implementing AI-driven ITS.	3.44	0.21	Positive
4.	Concerns over data privacy and potential algorithmic bias is one of the challenges of implementing AI-driven ITS	3.58	0.24	Positive
5.	Over-reliance on AI for critical thinking is one of the challenges of implementing AI-driven ITS.	3.72	0.26	Positive
6.	Lack of human touch or interaction is one of the challenges of implementing AI-driven ITS.	3.87	0.30	Positive
7.	Digital divide is one of the challenges of implementing AI-driven ITS.	3.48	0.22	Positive
8.	Quality and accuracy issues are one of the challenges of implementing AI-driven ITS.	3.56	0.25	Positive
9.	Lack of standardized evaluation and generalizability is one of the challenges of implementing AI-driven intelligent tutoring systems.	3.29	0.19	Positive
10.	Academic misconduct is one of the challenges of implementing AI-driven ITS.	3.76	0.27	Positive
	Total	36.32	2.52	Positive
	Cluster Mean & Std. Dev.	**3.632**	**0.252**	**Positive**

Source: Online Survey, 2025

The summary of the mean ratings of science educators' challenges of implementing AI-driven intelligent tutoring systems (ITS) in pedagogical practices in public universities in Kogi State, Nigeria is represented in figure 1. Figure shows that, the responses of science educators on all the ten items on challenges of implementing AI-driven ITS was above cut-off point of 2.50. The data in table 1 show that, the responses of science educators on all the ten items on challenges of implementing AI-driven ITS were positive, giving a cluster mean responses of 3.632 which is positive. This implies that all the points mentioned are recognized challenges of implementing AI-driven intelligent tutoring systems (ITS) in pedagogical practices in public universities in Kogi State, Nigeria. These issues range from practical and financial barriers to profound ethical and educational concerns. By implication, implementing AI-driven Intelligent Tutoring Systems (ITS) in pedagogical practices faces challenges spanning high costs, technical and integration hurdles, ethical and equity concerns, and limitations in fully replicating the human teaching experience.

Figure 1

Bar Chart of mean rating of science educators' challenges of implementing AI-driven intelligent tutoring systems (ITS)



Research Question Two

What are the measures that could address the perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities? The answer to research question two is presented in Table 2 and Figure 2, respectively.

Table 2

Mean Rating of measures that could address educators' challenges of implementing AI-driven ITS

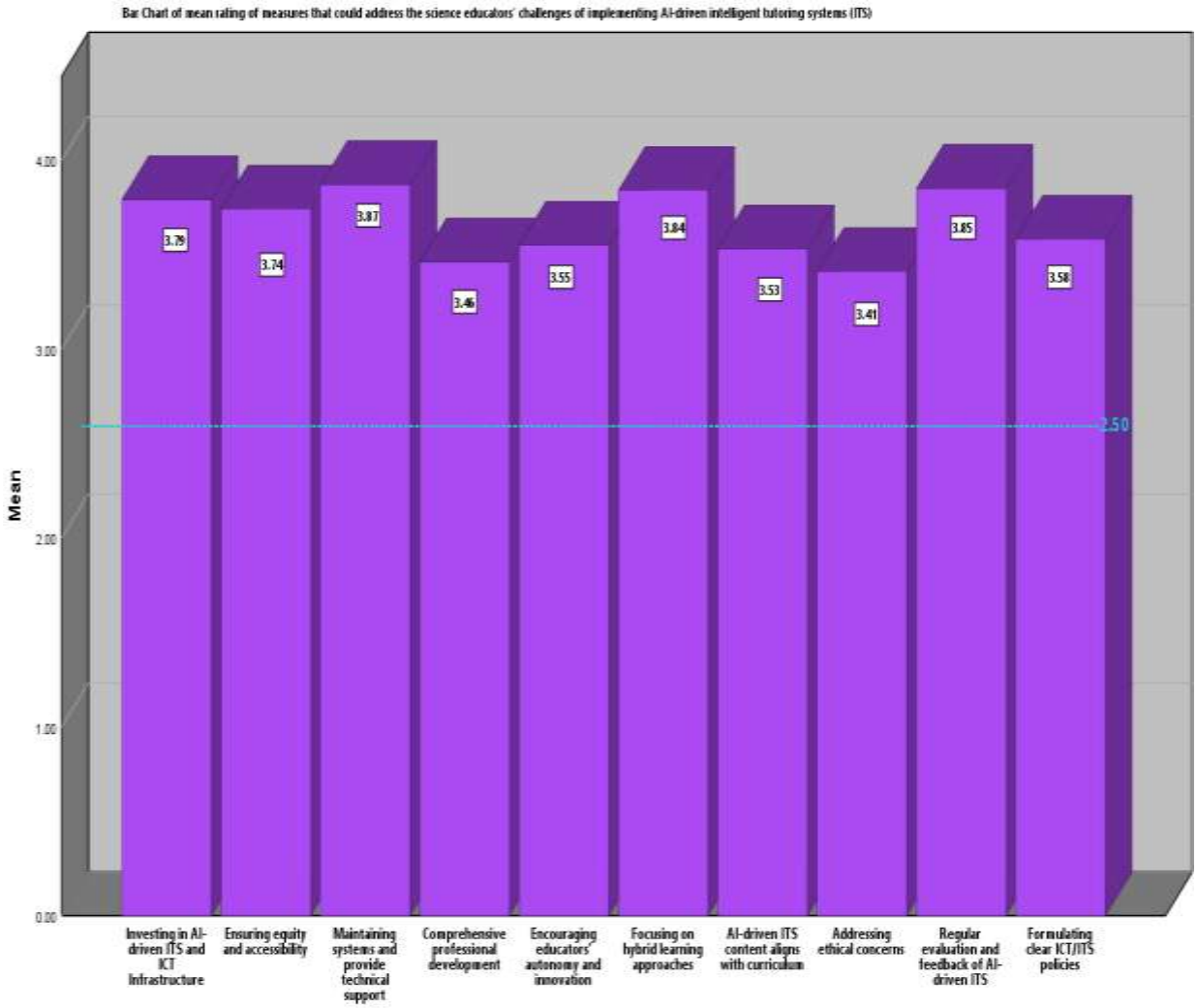
S/N	Item(s)	Mean $\bar{x}$	Std.dev δ	Remark
1.	Investing in AI-driven ITS and ICT Infrastructure will address the challenges of implementing AI-driven ITS	3.79	0.28	Positive
2.	Ensuring equity and accessibility will address the challenges of imple-	3.74	0.27	Positive

S/N	Item(s)	Mean x	Std.dev δ	Remark
	menting AI-driven ITS			
3.	Maintaining systems and providing technical support will address the challenges of implementing AI-driven ITS	3.87	0.30	Positive
4.	Comprehensive professional development will address the challenges of implementing AI-driven ITS	3.46	0.21	Positive
5.	Encouraging educators' autonomy and innovation will address the challenges of implementing AI-driven ITS	3.55	0.24	Positive
6.	Focusing on hybrid learning approaches (utilizing a blend of face-to-face instruction and ITS to maintain valuable human interaction) will address the challenges of implementing AI-driven ITS	3.84	0.26	Positive
7.	Ensuring ITS content aligns with the university's curriculum and educational standards will address the challenges of implementing AI-driven ITS	3.53	0.25	Positive
8.	Addressing ethical concerns will address the challenges of implementing AI-driven ITS	3.41	0.19	Positive
9.	Regular evaluation and feedback of the AI-driven ITS will address the challenges of implementing AI-driven ITS	3.85	0.31	Positive
10.	Formulating clear ICT/ITS policies will address the challenges of implementing AI-driven ITS	3.58	0.25	Positive
	Total	36.62	2.56	Positive
	Cluster Mean & Std. Dev.	**3.662**	**0.256**	**Positive**

Source: Online Survey, 2025

Figure 2

Bar Chart of mean rating of measures that could address the science educators' challenges of implementing AI-driven intelligent tutoring systems (ITS)



The summary of the mean ratings of respondents' opinions on measures that could address the challenges of implementing AI-driven intelligent tutoring systems (ITS) in pedagogical practices in public universities in Kogi State, Nigeria, is represented in Figure 2. The figure shows that the responses of respondents on all ten items on measures that could address the challenges of implementing AI-driven ITS in pedagogical practices were above the cut-off point of 2.50. The data in Table 2 show that the responses of respondents on all ten items on the measures that could address the challenges of implementing AI-driven ITS in pedagogical practices were positive, giving a cluster mean response of 3.47, which is positive. This implies that all the mentioned areas are measures that could address the challenges of implementing AI-driven ITS in pedagogical practices in public universities in Kogi State. By implication, the measures outlined, such as investing in infrastructure, ensuring equity, providing technical support and comprehensive professional development, actively monitor ITS for algorithmic biases, integrate systems with clear pedagogical goals, encourage critical thinking to prevent students from over-relying on the technology for answers and ensure a balanced, human-centric integration with ex-

isting pedagogical practices and establishing clear policies are all recognized strategies to address the challenges of implementing AI-driven intelligent tutoring systems (ITS) in public universities. These strategies are essential for navigating the complex pedagogical, ethical, and technical hurdles involved in AI-driven ITS implementation.

Hypothesis One

There is no significant difference between the mean rating of male and female science educators on perceived challenges of implementing AI-driven ITS in pedagogical practices in public universities. The hypothesis test one is presented in Table 3.

Table 3

Independent-samples t-test of male and female respondents' opinions on challenges of implementing AI-driven ITS in pedagogical practices

Sex	*N*	Mean x	Std.dev δ	t	df	$p-value$	$Cohen's\ D$	$level\ of\ significant$	$decision$
Male	28	3.59	0.23	1.68	50	.241	0.22	0.05	Fail to Reject Ho
Female	24	3.53	0.20						

Source: Online Survey, 2025

Table 3 presents the summary of the t-test analysis of the mean rating of male and female respondents' opinions on the challenges of implementing AI-driven intelligent tutoring systems (ITS) in pedagogical practices in public universities in Nigeria. The t-test result reveals that there is no significant difference between the mean ratings of male and female respondents' opinions on the challenges of implementing AI-driven ITS in pedagogical practices in public universities (t = 1.68, df = 50, $p > 0.05$). The null hypothesis is therefore not rejected. This implies that there is no significant difference between the mean rating of male and female respondents' opinions on the challenges of implementing AI-driven ITS in pedagogical practices in public universities in Kogi State, Nigeria. However, small effect $(d = 022)$ indicate that the difference between the group means is small, representing a minor difference in effect.

Hypothesis Two

There is no significant difference between the mean rating of male and female science educators on measures that could address the challenges of implementing AI-driven ITS in pedagogical practices in public universities. The test for hypothesis two is presented in Table 4.

Table 4

Independent-samples t-test of mean rating of male and female respondents' opinions on measures that could address the challenges of implementing AI-driven ITS

Sex	*N*	Mean x	Std.dev δ	t	df	$p-value$	$Cohen's\ D$	$level\ of\ significant$	$decision$
Male	28	3.52	0.26	1.78	50	.131	0.21	0.05	Fail to Reject Ho
Female	24	3.47	0.23						

Source: Online Survey, 2025.

Table 4 presents a summary of the t-test analysis of the mean ratings of male and female respondents' opinions on measures that could address the challenges of implementing AI-driven intelligent tutoring systems (ITS) in pedagogical practices in public universities in Nigeria. The t-test result reveals that there is no significant difference between the mean ratings of male and female respondents' opinions on the measures that could address the challenges of implementing AI-driven ITS in pedagogical practices (t = 1.78, df = 50, $p > 0.05$). The null hypothesis is therefore not rejected. This implies that there is no significant difference between the mean rating of male and female respondents' opinions on the measures that could address the challenges of implementing AI-driven ITS in pedagogical practices in public universities in Kogi State, Nigeria. However, small effect $(d = 021)$ indicate that the difference between the group means is small, representing a minor difference in effect.

The research explored science educators' perceived challenges in implementing AI-driven intelligent tutoring systems in pedagogical practices at public universities in Kogi State, Nigeria. The finding revealed that there is no significant difference between the mean rating of male and female science educators on the challenges of implementing AI-driven ITS. It was revealed that the high cost of implementing AI-driven Intelligent Tutoring Systems (ITS) is a major challenge due to significant investments needed for research, development, and technology infrastructure. Developing complex, adaptive algorithms, creating interactive content, and acquiring necessary hardware are resource-intensive, making the initial and ongoing costs prohibitive for many educational institutions. The inability of educators to integrate AI-driven ITS into existing curricula and the inability to design effective assessments for AI-powered learning environments pose significant challenges to the successful implementation of AI-driven ITS. The difficulty in integrating AI-driven ITS into existing curricula stems from a combination of pedagogical, technical, and systemic barriers. While the difficulty in designing effective assessments for AI-powered learning environments stems from a lack of adequate training and a struggle to adapt traditional pedagogical practices to the new capabilities of AI, it raises concerns about accurately measuring modern learning outcomes, academic integrity, and fairness. Implementing AI-driven ITS faces challenges from data privacy concerns and potential algorithmic bias. These issues involve the collection of sensitive student data, the risk of breaches, and the potential for algorithms to perpetuate

inequalities based on factors like race, gender, or socioeconomic status. Additionally, these systems can raise fears of surveillance and may lack the transparency and accountability needed for educators to trust their outcomes.

An over-reliance on AI in Intelligent Tutoring Systems (ITS) challenges critical thinking by potentially reducing student effort, while the lack of human interaction can hinder the development of crucial soft skills like empathy and creativity. Students may become dependent on AI for answers, leading to passive learning and diminished problem-solving skills instead of actively engaging with the material. The absence of human teachers can also limit opportunities for meaningful dialogue, nuanced feedback, and the development of emotional intelligence. The implementation of AI-driven ITS in pedagogical practices faces significant challenges from the digital divide and quality and accuracy issues, which can exacerbate existing educational inequalities. The lack of standardized evaluation frameworks and benchmarks is a significant challenge in implementing AI-driven ITS, directly impeding their generalizability across diverse university settings. The primary academic misconduct challenge in implementing AI-driven ITS is students' ability to use AI to generate work and present it as their own, undermining originality and critical thinking skills. Other challenges include difficulties in detecting AI-generated content and students' confusion over ethical boundaries. AI-driven ITS and other AI tools provide students with easy access to sophisticated writing assistance and potential solutions for assignments, making it simpler to plagiarize or cheat. Students may use AI to generate entire essays or answers and submit them without proper attribution or significant original input. This finding agrees with Pacheco-Castillo and Vega-Estrella (2025), who revealed that teachers face a multitude of challenges, such as poor technical support, poor internet access, excessive work, and inadequate technology pedagogical knowledge when integrating technology into classroom learning in grade 3 classes in Thailand. This finding also agrees with Mokhele (2024), who concluded that teachers' inability to develop and use technology-supported instructions and inadequate staff development training hindered the implementation of smart technology in High Schools in South Africa. Ajayi and Audu (2023) concluded that the performance of teachers in providing quality education has been significantly diminished due to teachers' inadequate access to AI-driven tools and inadequate training on technologies.

The finding revealed that there is no significant difference between the mean rating of male and female science educators on measures that could address the challenges of implementing AI-driven ITS in public universities in Kogi State, Nigeria. It was revealed that investing in AI-driven ITS and ICT infrastructure can address implementation challenges by improving access, providing personalized learning, and automating tasks. Addressing infrastructure limitations with reliable internet and computing resources is crucial, while investing in ITS can improve teaching by offering automated grading, instant feedback, and personalized learning paths, thereby freeing up instructors and supporting student success. Ensuring equity and accessibility, along with maintaining robust technical support and systems, are critical measures for addressing the challenges of implementing AI-driven ITS in public universities. Universities must bridge the digital divide by providing access to necessary hardware (laptops, tablets) and reliable high-speed internet for all students. It was revealed that comprehensive professional development can address challenges of AI-driven ITS by focusing on technical skills, pedagogical integration, and ethical considerations. It should train educators on using ITS effectively for personalized learning, interpreting data-driven insights, and maintaining academic integrity, while also fostering critical engagement and addressing concerns like bias and data privacy.

Educators' autonomy and innovation, combined with hybrid learning approaches, can effec-

tively address the challenges of implementing AI-driven ITS by fostering a human-centered, flexible integration that leverages AI to support, rather than replace, the educator's role. This strategy mitigates common challenges such as resistance to change, concerns over data privacy, and the potential for diminished critical thinking skills. It was revealed that aligning the content of AI-driven ITS with the established public university curriculum is crucial because it directly addresses significant implementation challenges, such as faculty buy-in, ensuring academic rigour maintaining educational standards, and improving student outcomes and engagement. Addressing ethical concerns directly manages challenges related to trust, equity, data privacy, and autonomy, while regular evaluation and feedback cycles ensure pedagogical effectiveness, fairness, and system improvement. Likewise, it was revealed that formulating clear ICT/ITS policies is crucial for addressing the challenges of implementing AI-driven Intelligent Tutoring Systems (ITS) in public universities by providing a structured framework that tackles infrastructural limitations, ethical concerns, digital literacy gaps, and resistance to change.

Conclusions

It is apparent from the findings of this research that implementing AI-driven intelligent tutoring systems (ITS) presents challenges, including the high cost of implementing AI-driven ITS, ethical concerns such as data privacy and algorithmic bias, technical issues such as system compatibility and the need for continuous updates, and pedagogical limitations like the risk of reducing human interaction and fostering over-dependence on AI-driven ITS. To address these, this study concludes that ITS should augment, not replace, educators and require a focus on comprehensive professional development, ethical design, inclusivity, and ongoing maintenance to be successfully implemented into pedagogical practices in public universities in Kogi State, Nigeria.

There is a need for the Ministry of Education, university administrators and relevant stakeholders to subsidize, partner with tech companies, and invest in AI-driven Intelligent Tutoring Systems (ITS) to support its implementation. University administrators and other educational stakeholders should ensure comprehensive professional development to equip educators with the skills to effectively use and manage AI-driven ITS in pedagogical practices. University administrators and other educational stakeholders should train both educators and students to understand how AI-driven ITS works, including its potential for bias and the importance of data privacy. Educational stakeholders should collaborate with AI-driven ITS developers to ensure that ITS content and functionalities align with the university's curriculum and educational standards and specific learning objectives. There is a need for university administrators and other educational stakeholders to employ effective strategies to ensure equitable access to ITS for all students, regardless of their socioeconomic background or location. University administrators and other educational stakeholders should prioritize data privacy and ethical considerations by establishing clear policies and transparent systems

Ethics Statements

This study received ethical clearance from the Director of Research Studies, Federal University Lokoja, Kogi State, Nigeria. Subsequently, the Head of Department of Science Education granted permission to facilitate data collection from science educators. Thus, the research procedures complied with ethical standards for studies involving human participants.

Declaration of Conflicting Interests

The authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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