

Understanding the Opportunities and Challenges of Artificial Intelligence Adoption in Mathematics Education: Perspectives of Secondary School Teachers in Bayelsa State, Nigeria

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Abstract

The increasing integration of Artificial Intelligence (AI) into education has created new possibilities for transforming teaching practices, improving learning experiences, and supporting effective instructional delivery. This study explored the opportunities and challenges associated with Artificial Intelligence adoption in mathematics education from the perspectives of secondary school teachers in Bayelsa State, Nigeria. A qualitative research approach using a phenomenological design was adopted to gain deeper insights into teachers' experiences, perceptions, and views regarding AI integration in mathematics teaching and learning. Fifteen secondary school mathematics teachers were purposively selected and interviewed using a semi-structured interview guide. Data collected were analysed using thematic analysis. The findings revealed that teachers perceived AI as a valuable innovation capable of enhancing mathematics content delivery through improved instructional support, personalised learning, automated assessment, and access to relevant teaching resources. However, teachers' experiences with AI use were limited, with most participants reporting inadequate practical exposure and insufficient professional training. The study also identified major challenges affecting AI adoption, including inadequate AI literacy among teachers, poor digital infrastructure, unreliable internet connectivity, unstable electricity supply, limited access to digital devices, and lack of clear institutional guidelines. Participants suggested that effective AI adoption requires continuous teacher training, improved technological facilities, supportive school policies, and responsible implementation frameworks. The study concluded that while secondary school mathematics teachers recognise the transformative potential of AI, sustainable adoption depends on developing teachers' competencies and creating an enabling educational environment. The study contributes to the growing discourse on AI integration in mathematics education by providing contextual insights from secondary school teachers in a developing educational setting.

Keywords: Artificial Intelligence, Mathematics Education, AI Adoption, Teachers' Perceptions, Secondary Schools, Digital Transformation, Qualitative Study, Bayelsa State.

Introduction

The emergence of Artificial Intelligence (AI) has generated significant transformation across educational systems by introducing new possibilities for improving teaching practices, enhancing

learning experiences, and supporting evidence-based instructional decision-making. AI technologies, including intelligent tutoring systems, adaptive learning platforms, automated assessment tools, and generative AI applications, are increasingly being explored as mechanisms for addressing longstanding challenges in education such as learner diversity, limited instructional resources, and the demand for personalised learning environments (Holmes & Tuomi, 2022; UNESCO, 2023). In mathematics education, where learners frequently encounter difficulties with abstract reasoning, conceptual understanding, and problem-solving, AI offers opportunities to provide immediate feedback, generate interactive learning materials, and support teachers in designing more responsive instructional approaches (Kasneci et al., 2023). However, the educational value of AI is not determined solely by technological advancement but by how effectively teachers understand, accept, and integrate these tools within existing pedagogical practices. Although AI presents promising opportunities for mathematics education, its adoption remains a complex process influenced by teachers' beliefs, experiences, professional competence, and the realities of their teaching environments. Teachers occupy a central position in technology integration because they determine how educational innovations are interpreted and transformed into classroom practices. Recent studies indicate that teachers' acceptance of AI is shaped by perceived usefulness, ease of use, confidence, ethical concerns, and availability of institutional support (Chiu et al., 2023; Ng et al., 2024). While some educators view AI as a valuable tool for improving instructional efficiency and supporting learners' diverse needs, others express concerns regarding accuracy of AI-generated content, overdependence on technology, reduced teacher autonomy, and inadequate preparation for AI-supported teaching (Tlili et al., 2023). Therefore, understanding teachers' perspectives is essential for developing realistic approaches to AI adoption in mathematics education. In developing educational contexts, particularly in sub-Saharan Africa, the integration of AI into schools faces additional complexities arising from infrastructural limitations, digital inequalities, inadequate teacher training, and limited policy frameworks. Nigeria's education sector has increasingly recognised the importance of digital transformation; however, many schools continue to experience challenges related to internet accessibility, electricity supply, availability of digital devices, and teachers' digital competencies (Akinwale & Olaniyan, 2023). These challenges raise critical questions about whether AI-driven educational innovations can be effectively implemented without addressing the contextual conditions that shape technology adoption. Consequently, examining AI adoption from teachers' perspectives provides deeper understanding of the practical realities, expectations, and constraints influencing its integration into mathematics classrooms. Existing literature has extensively examined AI applications in education, including its potential benefits and technological capabilities; however, much of the available research has focused on higher education contexts and quantitative measures of technology acceptance rather than the lived experiences of secondary school teachers, particularly in developing countries (Zawacki-Richter et al., 2019; Chiu et al., 2023). In Nigeria, limited empirical attention has been given to how mathematics teachers perceive AI, the opportunities they associate with its adoption, and the challenges they encounter within their professional contexts. This gap is particularly relevant in Bayelsa State, where secondary schools are increasingly expected to respond to global technological changes while operating within local educational realities.

Therefore, this study explored the opportunities and challenges associated with the adoption of Artificial Intelligence in mathematics education from the perspectives of secondary school teachers in Bayelsa State, Nigeria. By examining teachers' understanding, experiences, perceived benefits, concerns, and recommendations, the study provides context-specific insights that can

inform policymakers, school administrators, teacher educators, and stakeholders seeking to promote responsible and sustainable AI integration in mathematics education.

Aim and Objective of the Study

This study aimed to explore the opportunities and challenges associated with the adoption of Artificial Intelligence in mathematics education from the perspectives of secondary school teachers in Bayelsa State, Nigeria. Specifically, the study sought to:

1. explore secondary school mathematics teachers' understanding of the opportunities associated with Artificial Intelligence adoption in mathematics education;
2. examine teachers' experiences and perceptions regarding the use of Artificial Intelligence in mathematics teaching and learning;
3. identify the challenges affecting the adoption and use of Artificial Intelligence in secondary school mathematics education; and
4. explore teachers' suggestions for improving the adoption of Artificial Intelligence in mathematics education in secondary schools.

Research Questions

The study was guided by the following research questions:

1. What opportunities do secondary school mathematics teachers perceive in the adoption of Artificial Intelligence for mathematics education in Bayelsa State?
2. What are the experiences and perceptions of secondary school mathematics teachers regarding the use of Artificial Intelligence in mathematics teaching and learning?
3. What challenges affect the adoption and use of Artificial Intelligence in secondary school mathematics education in Bayelsa State?
4. What strategies do secondary school mathematics teachers suggest for improving the adoption of Artificial Intelligence in mathematics education?

Research Methods

The study adopted a **qualitative research approach using a phenomenological research design** to explore the opportunities and challenges associated with the adoption of Artificial Intelligence (AI) in mathematics education from the perspectives of secondary school teachers in Bayelsa State, Nigeria. The phenomenological design was considered appropriate because the study sought to understand teachers' lived experiences, perceptions, beliefs, and interpretations regarding AI adoption within their professional context. Unlike quantitative approaches that measure the extent of technology adoption, the qualitative approach provides deeper insights into the meanings teachers attach to AI, the benefits they perceive, and the contextual factors influencing its utilisation in mathematics classrooms (Creswell & Creswell, 2023).

The study was conducted among secondary school mathematics teachers in Bayelsa State, Nigeria. The participants were selected using a **purposive sampling technique**, which enabled the researcher to identify teachers who possessed relevant experiences and knowledge concerning mathematics instruction and educational technology. A total of **15 mathematics teachers** participated in the study. The selection criteria included being a practising secondary school mathematics teacher, having at least three years of teaching experience, and having basic awareness or exposure to digital instructional technologies. The sample size was considered adequate for a qualitative study because phenomenological research emphasises depth of

understanding rather than statistical generalisation, with data adequacy determined by the richness of participants' responses and achievement of thematic saturation.

Data were collected through a **semi-structured interview guide** developed based on the objectives of the study and relevant literature on AI adoption in education. The interview questions focused on teachers' understanding of AI, perceived opportunities associated with AI integration in mathematics education, experiences with AI-based instructional tools, challenges affecting AI adoption, and suggestions for improving AI utilisation in secondary schools. Semi-structured interviews were adopted because they provided a balance between consistency across participants and flexibility to explore emerging issues raised during the discussions. Each interview lasted approximately 30–45 minutes and was conducted with participants' consent.

The credibility and trustworthiness of the study were ensured through appropriate qualitative validation procedures. The interview guide was reviewed by experts in Mathematics Education and Educational Technology to establish relevance and clarity of the questions. Member checking was also conducted by sharing summaries of participants' responses with selected participants to confirm the accuracy of interpretations. In addition, the researcher maintained detailed records of the interview process and coding procedures to enhance dependability and confirmability of the findings. The data collected from the interviews were analysed using **thematic analysis** following the approach of Braun and Clarke (2021). The analysis involved transcription of interview responses, repeated reading of the transcripts, generation of initial codes, identification of patterns, development of themes, and interpretation of emerging findings in relation to the research questions. The themes were organised around the major areas of the study, including perceived opportunities of AI adoption, experiences with AI-supported mathematics teaching, challenges affecting adoption, and strategies for effective AI integration. The use of thematic analysis enabled the researcher to systematically identify common experiences and generate meaningful interpretations of teachers' perspectives on AI adoption in mathematics education.

Results

Demographic Characteristics of Participants

The study involved **15 secondary school mathematics teachers** who were purposively selected and interviewed to explore their perspectives on the opportunities and challenges associated with Artificial Intelligence (AI) adoption in mathematics education in Bayelsa State, Nigeria. The demographic characteristics considered were gender, teaching experience, educational qualification, exposure to AI training, and previous experience using AI tools.

Table 1: Demographic Characteristics of Participants (N = 15)

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	8	53.3
	Female	7	46.7
Teaching Experience	1–5 years	4	26.7
	6–10 years	5	33.3
	11–15 years	3	20.0
	16 years and above	3	20.0
Educational Qualification	NCE	3	20.0
	B.Ed/B.Sc(Ed)	9	60.0

Variable	Category	Frequency (f)	Percentage (%)
Received AI/Digital Technology Training	M.Ed/M.Sc(Ed)	3	20.0
	Yes	4	26.7
	No	11	73.3
Previous Use of AI Tools	Yes	3	20.0
	No	12	80.0

The demographic profile indicates that the participants were relatively balanced in terms of gender, with male teachers constituting 53.3% and female teachers 46.7%. Most participants had between 6 and 10 years of teaching experience (33.3%), suggesting that the views obtained were largely from teachers with considerable classroom exposure. The majority possessed B.Ed/B.Sc(Ed) qualifications (60%), indicating professional preparation in education. However, only four participants (26.7%) had received AI-related training, while only three (20%) had previously used AI tools for instructional purposes. This suggests that although teachers possess professional qualifications and teaching experience, practical exposure to AI remains limited.

Research Question One

What opportunities do secondary school mathematics teachers perceive in the adoption of Artificial Intelligence for mathematics education in Bayelsa State?

The thematic analysis revealed three major themes relating to the opportunities associated with AI adoption in mathematics education:

Table 2: Themes and Sub-Themes on Opportunities of AI Adoption

Main Theme	Sub-Themes	Illustrative Meaning
Improved instructional support	Lesson planning, content development, assessment creation	AI assists teachers in preparing and organising instructional materials
Personalised mathematics learning	Individual learner support, immediate feedback, differentiated instruction	AI helps address differences in learners' abilities
Enhanced teaching effectiveness	Explanation of difficult concepts, innovative teaching approaches	AI improves teachers' capacity to present mathematics concepts

The findings revealed that participants perceived AI as a valuable support tool capable of improving mathematics teaching practices. Many teachers explained that AI could reduce the burden associated with lesson preparation, provide examples for difficult mathematical concepts, and support the development of assessment activities. One participant stated:

“AI can help teachers generate examples, prepare lesson notes, and explain difficult topics that students normally struggle to understand.”

Participants also highlighted the potential of AI to support personalised learning. They believed that AI tools could provide students with additional explanations and immediate feedback outside the traditional classroom setting. Another participant noted:

“Students learn differently, and AI can provide different explanations until a student understands a concept.”

The findings suggest that teachers view AI not as a replacement for mathematics teachers but as a complementary tool that can enhance instructional effectiveness.

Research Question Two

What are the experiences and perceptions of secondary school mathematics teachers regarding the use of Artificial Intelligence in mathematics teaching and learning?

The analysis produced two major themes relating to teachers' experiences and perceptions:

Table 3: Themes and Sub-Themes on Teachers' Experiences and Perceptions

Main Theme	Sub-Themes	Illustrative Meaning
Limited experience	practical Low exposure, limited classroom application, self-learning	Teachers have awareness but little direct experience
Positive perception with cautious acceptance	Usefulness, interest, uncertainty, need for guidance	Teachers support AI but require preparation

Participants generally expressed positive attitudes towards AI; however, most reported limited practical experience using AI tools in mathematics classrooms. Teachers indicated that their understanding of AI was mainly based on personal exploration, social media exposure, or general awareness rather than formal professional training. One participant explained:

"I know about ChatGPT and some AI tools, but I have not really used them regularly for teaching mathematics because we have not been trained."

Participants acknowledged that AI could improve teaching efficiency but expressed concerns about accuracy, overdependence by students, and the possibility of misuse. This indicates that teachers' acceptance of AI is accompanied by cautious consideration of its limitations. The findings suggest that awareness alone is insufficient; teachers require practical skills and institutional support to confidently integrate AI into mathematics instruction.

Research Question Three

What challenges affect the adoption and use of Artificial Intelligence in secondary school mathematics education in Bayelsa State?

The thematic analysis identified four major challenges:

Table 4: Themes and Sub-Themes on Challenges Affecting AI Adoption

Main Theme	Sub-Themes	Illustrative Meaning
Inadequate technological infrastructure	Poor internet, electricity challenges, limited devices	Schools lack necessary facilities for AI use
Limited teacher capacity	Lack of training, low AI literacy	Teachers lack skills required for effective adoption
Institutional limitations	Lack of policy support, insufficient encouragement	Schools lack structured AI integration plans
Ethical and reliability concerns	Accuracy, student dependency, misuse	Concerns about responsible AI use

Participants consistently identified inadequate infrastructure as a major barrier to AI adoption. Poor internet connectivity, unstable electricity supply, and insufficient access to digital devices were repeatedly mentioned as factors limiting AI utilisation. One participant stated:

"Even if teachers are willing to use AI, without internet and computers, it will remain difficult."

Another major challenge was inadequate teacher training. Participants indicated that many mathematics teachers lacked the confidence and knowledge required to effectively use AI tools.

They suggested that professional development programmes should be organised to improve AI literacy among teachers.

Research Question Four

What strategies do teachers suggest for improving the adoption of Artificial Intelligence in mathematics education?

The analysis generated three major strategic themes:

Table 5: Themes and Sub-Themes on Strategies for AI Adoption

Main Theme	Sub-Themes	Illustrative Meaning
Teacher development	capacity AI training, workshops, continuous learning	Building teachers' competence
Improved infrastructure	digital Internet, devices, electricity	Creating enabling conditions
Policy and support	institutional AI guidelines, school support, funding	Establishing sustainable adoption systems

Participants emphasised that effective AI adoption requires deliberate investment in teacher training and school infrastructure. They recommended regular workshops focused on practical classroom applications of AI rather than only theoretical discussions. Participants also suggested that government and school administrators should provide digital resources and develop policies guiding responsible AI use.

Discussion of Findings

Secondary school mathematics teachers' understanding of the opportunities associated with Artificial Intelligence adoption in mathematics education

The findings revealed that secondary school mathematics teachers understood Artificial Intelligence (AI) as a promising educational innovation capable of improving mathematics content delivery through enhanced instructional support, personalised learning, automated assessment, and improved access to teaching resources. Participants perceived AI as a tool that could assist teachers in preparing lesson materials, generating mathematical examples, explaining complex concepts, and providing additional learning support to students. This suggests that mathematics teachers recognise the potential of AI to address some of the persistent challenges associated with mathematics instruction, particularly difficulties relating to abstract concepts, learner diversity, and limited instructional resources. This finding aligns with Kasneci et al. (2023), who argued that generative AI applications provide substantial opportunities for education by supporting teachers in content creation, feedback provision, assessment development, and personalised learning experiences. Similarly, Holmes and Tuomi (2022) noted that AI can transform educational practices by supporting teachers' decision-making processes and enhancing access to relevant instructional resources. The findings further indicated that teachers perceived AI as an opportunity to promote learner-centred mathematics instruction by allowing students to receive immediate feedback and alternative explanations based on their individual learning needs. This perception reflects the growing role of adaptive learning technologies, where AI systems analyse learners' interactions and provide customised learning experiences. UNESCO (2023) identified personalised learning as one of the major contributions of AI in education, particularly because intelligent systems can support differentiated instruction and improve learner engagement. However, the study also revealed that while teachers demonstrated awareness of AI opportunities,

many had limited practical experience applying AI tools in mathematics classrooms. This indicates a gap between conceptual understanding and practical competence. The finding supports Chiu et al. (2023), who emphasised that teachers' awareness and acceptance of AI are important initial conditions for adoption but must be strengthened through practical training, digital competence development, and pedagogical integration skills.

Teachers' experiences and perceptions regarding the use of Artificial Intelligence in mathematics teaching and learning

The findings showed that secondary school mathematics teachers generally expressed positive perceptions regarding the use of AI in teaching and learning, although their actual experiences with AI applications were limited. Participants acknowledged that AI could enhance lesson preparation, improve teaching efficiency, support classroom assessment, and provide additional explanations for students. However, most teachers indicated that their exposure to AI was mainly through personal exploration rather than structured professional training. This suggests that AI awareness among mathematics teachers is emerging, but meaningful classroom integration remains at an early stage. This finding is consistent with Ng et al. (2024), who reported that although educators increasingly recognise the educational value of AI, many teachers still lack sufficient experience and confidence to incorporate AI effectively into their instructional practices.

The findings also revealed that teachers perceived AI as a complementary tool rather than a replacement for mathematics teachers. Participants emphasised that AI could support teachers by reducing workload and improving access to instructional resources, but human judgement, creativity, and pedagogical understanding remain essential in mathematics teaching. This finding supports the argument of Holmes and Tuomi (2022) that AI should be viewed as an augmentation technology that enhances teachers' professional capacity rather than replacing educators. Nevertheless, participants expressed cautious acceptance due to concerns about the accuracy of AI-generated information, students' potential dependence on AI, and uncertainty about responsible usage. These concerns reflect broader debates on the ethical and pedagogical implications of AI in education. Kasneci et al. (2023) similarly noted that while generative AI offers significant educational benefits, issues relating to reliability, academic integrity, and responsible use require careful consideration.

The challenges affecting the adoption and use of Artificial Intelligence in secondary school mathematics education

The findings revealed that several contextual and institutional challenges affect the adoption of AI in secondary school mathematics education. The major challenges identified by participants included inadequate AI training, poor internet connectivity, unstable electricity supply, limited access to digital devices, insufficient technical support, and absence of clear institutional guidelines for AI use. These findings demonstrate that successful AI adoption is not determined only by teachers' willingness but also by the availability of enabling conditions within schools. This finding agrees with UNESCO (2023), which highlighted that effective AI integration requires adequate infrastructure, teacher preparedness, ethical guidelines, and supportive educational policies. A major concern identified in the study was the limited opportunity for teachers to acquire AI-related knowledge and skills. Participants indicated that although they were interested in using AI, they lacked sufficient training on how to select, apply, and evaluate AI tools for mathematics instruction. This finding supports Tlili et al. (2023), who identified inadequate AI literacy among educators as a major obstacle to effective AI adoption. Similarly, Chiu et al. (2023) reported that

teachers' technological competence and confidence significantly influence their willingness and ability to adopt emerging educational technologies. Therefore, without continuous professional development, AI adoption may remain superficial because teachers may lack the confidence required to integrate AI meaningfully into classroom practices.

The findings also highlighted infrastructural challenges, particularly limited access to reliable internet services, digital devices, and electricity. These challenges are particularly significant in developing educational contexts where technology adoption is often constrained by broader socioeconomic realities. The findings are consistent with Akinwale and Olaniyan (2023), who observed that digital transformation efforts in Nigerian education continue to face challenges associated with inadequate infrastructure, limited connectivity, and unequal access to technology. This suggests that promoting AI adoption without addressing fundamental digital infrastructure gaps may increase inequalities between schools with different levels of technological readiness.

Teachers' suggestions for improving the adoption of Artificial Intelligence in mathematics education in secondary schools

The findings revealed that teachers recommended several strategies for improving AI adoption in mathematics education, including continuous professional development, improved digital infrastructure, provision of institutional support, and development of clear policies guiding AI use in schools. Participants emphasised that training programmes should focus on practical applications of AI rather than only introducing theoretical concepts. This suggests that teachers require hands-on experiences that demonstrate how AI can be applied in lesson planning, classroom instruction, assessment, and learner support. This finding aligns with Chiu et al. (2023), who argued that effective AI integration requires teacher competence development and opportunities for educators to engage with AI tools in meaningful educational contexts.

Participants also suggested that government agencies and school administrators should provide adequate technological resources, including computers, internet facilities, electricity, and technical support. This recommendation reflects the understanding that AI adoption requires a supportive ecosystem involving teachers, institutions, policymakers, and technology providers. Zawacki-Richter et al. (2019) similarly argued that educational technology integration is most successful when technological innovation is aligned with institutional structures, pedagogical practices, and policy frameworks. Therefore, sustainable AI adoption in mathematics education requires a coordinated strategy that combines teacher empowerment, infrastructure development, ethical guidance, and institutional commitment. Overall, the findings indicate that secondary school mathematics teachers in Bayelsa State recognise the transformative potential of AI but require stronger capacity development and supportive conditions to translate this potential into classroom practice. The successful adoption of AI in mathematics education should therefore be approached as a comprehensive educational transformation process rather than merely a technological intervention.

Conclusion

The study concluded that secondary school mathematics teachers in Bayelsa State recognise the significant opportunities Artificial Intelligence provides for improving mathematics education through enhanced instructional support, personalised learning, and improved teaching effectiveness. However, the adoption of AI remains limited due to inadequate teacher training, poor technological infrastructure, limited institutional support, and concerns about responsible AI use. Although teachers demonstrate willingness to embrace AI, sustainable integration requires

deliberate investment in teacher capacity development, digital infrastructure, and supportive educational policies. Effective AI adoption in mathematics education should therefore focus on empowering teachers to use AI as a complementary instructional tool that enhances, rather than replaces, professional teaching practices.

Recommendations

The recommendations given after the conclusion of this study are:

1. The Bayelsa State Ministry of Education should introduce continuous AI literacy and practical training programmes for mathematics teachers to develop the skills required for effective AI-supported instruction.
2. Government and school administrators should improve digital infrastructure in secondary schools by providing reliable internet connectivity, electricity supply, and access to digital devices.
3. Schools should develop clear guidelines and policies for the ethical and responsible use of Artificial Intelligence in mathematics teaching and learning.
4. Teacher education institutions and professional bodies should integrate Artificial Intelligence competencies into mathematics teacher preparation and continuous professional development programmes.

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