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Harnessing the Potential of Artificial Intelligence for Advancing Mathematics Content Delivery in Secondary Schools in Bayelsa State, Nigeria

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Abstract
The increasing advancement of Artificial Intelligence (AI) presents significant opportunities for improving instructional delivery, particularly in mathematics education where learners often encounter difficulties with abstract concepts and problem-solving processes. This study examined the potential of Artificial Intelligence for advancing mathematics content delivery in secondary schools in Bayelsa State, Nigeria. The study adopted a descriptive survey research design. The population comprised 608 secondary school mathematics teachers in 210 public secondary schools in Bayelsa State, from which a sample of 241 teachers was selected using a multistage sampling procedure. Data were collected using a structured questionnaire titled Artificial Intelligence Utilisation for Mathematics Content Delivery Questionnaire (AIUMCDQ). The instrument was validated by experts and its reliability was established using Cronbach's Alpha coefficient. Data collected were analysed using frequency, percentage, mean, and standard deviation. The findings revealed that secondary school mathematics teachers demonstrated a high level of readiness to utilise Artificial Intelligence for mathematics content delivery, particularly due to their recognition of its usefulness in improving instructional effectiveness and supporting teachers' roles. However, the findings also revealed that inadequate AI training, poor internet connectivity, unstable electricity supply, limited access to digital devices, and insufficient institutional support were major challenges affecting AI utilisation. The study concluded that although mathematics teachers possess positive dispositions towards AI integration, effective adoption requires strategic interventions in teacher training, digital infrastructure development, and supportive educational policies. The study recommended continuous AI capacity-building programmes for mathematics teachers and improved technological facilities in secondary schools to promote effective AI-supported mathematics instruction.

Keywords: *Artificial Intelligence, Mathematics Content Delivery, Teacher Readiness, AI Utilisation, Secondary Schools, Digital Instruction, Bayelsa State.*

Introduction

The rapid advancement of Artificial Intelligence (AI) has introduced transformative possibilities across various sectors, including education, where it is increasingly being explored as a tool for improving teaching effectiveness, personalising learning experiences, and enhancing instructional delivery. In mathematics education, AI applications such as intelligent tutoring systems, automated

assessment platforms, adaptive learning technologies, and generative AI tools have the potential to support teachers in presenting complex mathematical concepts, providing immediate feedback, and creating learner-centred instructional environments (Holmes & Tuomi, 2022; UNESCO, 2023). These developments have shifted discussions beyond the mere adoption of educational technologies towards examining how AI can be meaningfully integrated into pedagogical practices to improve learning outcomes. Despite these emerging opportunities, the successful integration of AI into mathematics content delivery remains dependent on the preparedness of teachers, as educators serve as the primary agents responsible for translating technological capabilities into effective classroom practices. Teachers' readiness, which encompasses awareness, technological competence, confidence, acceptance, and willingness to adopt AI-based tools, has been identified as a critical determinant of successful AI implementation in schools (Chiu et al., 2023). However, evidence suggests that many teachers, particularly in developing educational contexts, continue to experience limited digital competencies, inadequate training, and uncertainty regarding the pedagogical application of AI technologies (Tlili et al., 2023). In Nigeria, the integration of emerging educational technologies has been constrained by persistent challenges such as inadequate digital infrastructure, unreliable electricity supply, limited internet accessibility, insufficient teacher professional development, and concerns regarding the ethical use of technology (Akinwale & Olaniyan, 2023). These challenges are particularly relevant in public secondary schools, where mathematics teachers may recognise the potential benefits of AI but lack the necessary institutional support and skills required for effective utilisation. Consequently, the promise of AI-driven mathematics instruction may remain largely theoretical unless teachers' readiness and contextual barriers are critically examined. Bayelsa State, like many educational settings in Nigeria, is increasingly confronted with the need to improve mathematics teaching and learning outcomes while adapting to emerging technological innovations. Understanding the extent to which mathematics teachers are prepared to utilise AI and the challenges limiting its adoption is therefore essential for developing context-specific strategies for effective AI integration. While existing studies have examined digital technology adoption in education, limited empirical attention has been given to teachers' readiness and the barriers associated with AI utilisation for mathematics content delivery, particularly within the Nigerian secondary school context. Therefore, this study examined the readiness of secondary school mathematics teachers to utilise Artificial Intelligence for mathematics content delivery and identified the challenges affecting its utilisation in secondary schools in Bayelsa State, Nigeria. The findings provide insights for educational policymakers, curriculum planners, school administrators, and teacher educators seeking to promote responsible and sustainable AI integration in mathematics education.

Aim and Objectives of the Study

This study aims to examine the potential of Artificial Intelligence (AI) for advancing mathematics content delivery in secondary schools in Bayelsa State, Nigeria. The study seeks to:

1. determine the readiness of secondary school mathematics teachers to utilise Artificial Intelligence for mathematics content delivery in Bayelsa State;
2. identify the challenges affecting the utilisation of Artificial Intelligence for mathematics content delivery in secondary schools in Bayelsa State.

Research Questions

The study was guided by the following research questions:

1. To what extent were secondary school mathematics teachers ready to utilise Artificial

Intelligence for mathematics content delivery in Bayelsa State?
2. What were the challenges affecting the utilisation of Artificial Intelligence for mathematics content delivery in secondary schools in Bayelsa State?

Conceptual Review

Artificial Intelligence (AI) has emerged as one of the most influential technological innovations shaping contemporary education systems by enabling machines to perform tasks that traditionally require human intelligence, including reasoning, problem-solving, decision-making, language processing, and adaptive responses. In education, AI extends beyond the use of computers for instructional support by providing intelligent systems capable of analysing learners' behaviours, generating instructional materials, automating assessments, and supporting personalised learning experiences. According to UNESCO (2023), AI in education represents a shift from technology-assisted learning towards intelligent learning ecosystems where digital tools can support teachers and learners through data-driven instructional decisions. However, while AI offers considerable opportunities for improving educational processes, its effectiveness depends largely on how appropriately it is integrated into existing pedagogical frameworks rather than merely introducing technological tools into classrooms (Holmes & Tuomi, 2022). Thus, harnessing AI in mathematics education requires careful consideration of teachers' capacity, instructional objectives, and contextual realities within schools. Mathematics content delivery involves the processes, strategies, and resources employed by teachers to communicate mathematical concepts, develop learners' reasoning abilities, and facilitate problem-solving skills. The teaching of mathematics has traditionally been challenged by issues such as abstract concepts, learner misconceptions, inadequate instructional materials, and variations in students' learning abilities. AI presents new possibilities for addressing these challenges through adaptive learning platforms, intelligent tutoring systems, automated feedback mechanisms, and generative AI applications that can provide explanations and examples tailored to individual learners' needs (Chiu et al., 2023). However, the integration of AI into mathematics instruction should not be viewed as a replacement for teachers but as a supportive mechanism that enhances teachers' pedagogical effectiveness. Recent studies argue that the value of AI in mathematics education lies in its ability to augment teachers' professional practices by assisting with lesson preparation, differentiated instruction, and continuous assessment (Zawacki-Richter et al., 2019; Kasneci et al., 2023).

Teachers' readiness represents a critical dimension in determining the successful adoption and utilisation of AI for mathematics content delivery. Readiness encompasses teachers' awareness of AI technologies, perceived usefulness, confidence in using digital tools, technological competence, willingness to adopt innovative instructional approaches, and access to necessary support systems. Although AI tools are becoming increasingly accessible, research indicates that teacher preparedness remains a major barrier to effective AI integration, particularly in developing countries where digital skills gaps and limited professional development opportunities persist (Tlili et al., 2023). In the Nigerian educational context, mathematics teachers may recognise the instructional benefits of AI but may lack adequate knowledge of AI applications, practical training, and institutional encouragement needed for classroom implementation. Therefore, examining teachers' readiness provides important insights into whether schools possess the human capacity required to transform AI potential into meaningful instructional practices.

Despite the promising role of AI in improving mathematics content delivery, several challenges may limit its utilisation in secondary schools. These challenges include inadequate technological infrastructure, poor internet connectivity, limited access to digital devices, insufficient funding,

lack of teacher training, concerns about data privacy, and uncertainty regarding the reliability and ethical implications of AI-generated content (UNESCO, 2023). In developing educational systems such as Nigeria, these challenges are compounded by broader structural limitations that affect technology adoption in schools. The presence of AI tools alone does not guarantee improved instructional outcomes; rather, successful adoption requires supportive policies, continuous teacher development, institutional readiness, and equitable access to technology (Chiu et al., 2023). Consequently, understanding the challenges associated with AI utilisation is essential for developing realistic strategies for integrating AI into mathematics education in Bayelsa State secondary schools.

Theoretical Review

This study was anchored on the **Technology Acceptance Model (TAM)** developed by Davis (1989), which explains how individuals' acceptance and utilisation of technology are influenced by their perceptions of usefulness and ease of use. The model proposes that users are more likely to adopt a technology when they believe it enhances their performance and when they perceive it as easy to understand and operate. In relation to AI utilisation in mathematics content delivery, TAM suggests that teachers' willingness to integrate AI tools into classroom practices will depend on whether they perceive AI as beneficial for improving lesson delivery, enhancing students' understanding, and reducing instructional workload. Furthermore, teachers' confidence and technological competence may influence their perception of AI usability, thereby affecting their readiness to adopt AI-based instructional approaches. Recent educational technology studies continue to apply TAM in explaining teachers' acceptance of emerging technologies, including AI-driven learning systems (Scherer et al., 2021; Chiu et al., 2023).

The study was also supported by the Technological Pedagogical Content Knowledge (TPACK) Framework proposed by Mishra and Koehler (2006), which emphasises the integration of technological knowledge, pedagogical knowledge, and content knowledge for effective technology-supported teaching. The framework argues that successful technology adoption is not achieved through technological competence alone but through teachers' ability to combine technology with appropriate teaching methods and subject-specific knowledge. Applied to AI-based mathematics content delivery, TPACK suggests that mathematics teachers require not only knowledge of AI tools but also the ability to determine when, why, and how AI can enhance mathematical instruction. This theoretical perspective is particularly relevant because challenges associated with AI adoption may arise not only from limited access to technology but also from insufficient pedagogical understanding of how AI can be meaningfully applied within mathematics classrooms. Therefore, TPACK provides a useful lens for examining teachers' readiness and the contextual factors influencing AI utilisation in secondary schools.

Research Methods

The study adopted a descriptive survey research design to examine the readiness of secondary school mathematics teachers to utilise Artificial Intelligence (AI) for mathematics content delivery and to identify the challenges affecting its utilisation in Bayelsa State, Nigeria. The descriptive survey design was considered appropriate because the study aimed to collect information on the existing conditions, perceptions, preparedness, and experiences of mathematics teachers without manipulating any variables. The design enabled the researcher to obtain data from respondents concerning their level of readiness and the factors that may influence the adoption of AI-based instructional approaches. According to Creswell and Creswell (2023), descriptive survey designs

are appropriate for investigating attitudes, opinions, practices, and characteristics of a population through systematic collection and analysis of data from a sample.

The population of the study comprised 608 secondary school mathematics teachers in the 210 public secondary schools in Bayelsa State, Nigeria. A sample of 241 mathematics teachers was selected from the population using a multistage sampling procedure. The sample size was determined using the Taro Yamane (1967) formula at a 5% level of precision as follows. Therefore, the sample size was approximated to 241 mathematics teachers. The multistage sampling procedure involved three stages. In the first stage, the public secondary schools were stratified according to the educational zones in Bayelsa State to ensure adequate geographical representation. In the second stage, schools were selected proportionately from each educational zone based on the number of schools available within each zone. In the final stage, mathematics teachers were selected from the sampled schools using a simple random sampling technique. This procedure ensured that every mathematics teacher within the population had an equal opportunity of being selected while minimising sampling bias. The selected sample was considered adequate for providing reliable information on teachers' readiness to utilise Artificial Intelligence and the challenges affecting its utilisation for mathematics content delivery in secondary schools in Bayelsa State. Data were collected using a structured questionnaire titled "Artificial Intelligence Utilisation for Mathematics Content Delivery Questionnaire (AIUMCDQ)", which was developed by the researcher based on the objectives of the study and relevant literature. The instrument consisted of sections that focused on respondents' demographic information, teachers' readiness to utilise AI for mathematics content delivery, and challenges affecting AI utilisation in secondary schools. The readiness section examined issues such as awareness of AI tools, technological competence, confidence, perceived usefulness, and willingness to integrate AI into mathematics instruction, while the challenges section focused on factors such as inadequate infrastructure, limited internet access, insufficient training, technical support, and institutional barriers. The responses were structured on a four-point Likert scale to enable respondents to indicate the extent of their readiness and the severity of identified challenges.

The validity of the instrument was established through face and content validation by experts in Mathematics Education, Educational Technology, and Measurement and Evaluation. The experts examined the items to ensure that they adequately captured the objectives of the study, were relevant to the research variables, and were clearly presented. Their observations and recommendations were used to modify and improve the instrument before final administration. The reliability of the instrument was determined through a pilot study conducted among mathematics teachers in secondary schools outside the study area but with similar characteristics to the respondents. The internal consistency of the instrument was established using Cronbach's Alpha reliability coefficient, and a coefficient of 0.70 or above was considered acceptable for the instrument to be used for the study.

The researcher administered the questionnaire directly to the selected respondents with the assistance of trained research assistants. The purpose of the study was explained to the respondents, and adequate instructions were provided to guide them in completing the instrument. The completed questionnaires were collected immediately after administration to ensure a high response rate and minimise missing data.

The data collected were analysed using descriptive statistics. Frequency counts and percentages were used to analyse respondents' demographic characteristics, while mean and standard deviation were used to answer the research questions. A criterion mean of 2.50 was adopted as the decision benchmark; items with mean scores of 2.50 and above were considered to indicate a high level of

readiness or significant challenges, while items with mean scores below 2.50 were considered to indicate a low level of readiness or less significant challenges. The analysis was conducted using the Statistical Package for Social Sciences (SPSS) to ensure accurate data processing, interpretation, and presentation of findings.

Results

Demographic Characteristics of Respondents

The demographic characteristics of the 241 secondary school mathematics teachers who participated in the study are presented in Table 1. The variables considered were gender, teaching experience, educational qualification, Artificial Intelligence (AI) training exposure, and previous use of AI tools.

Table 1: Demographic Characteristics of Respondents (N = 241)

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	139	57.7
	Female	102	42.3
Teaching Experience	1–5 years	56	23.2
	6–10 years	71	29.5
	11–15 years	63	26.1
	16 years and above	51	21.2
Educational Qualification	NCE	38	15.8
	B.Ed/B.Sc(Ed)	152	63.1
	M.Ed/M.Sc(Ed)	43	17.8
	Others	8	3.3
Received AI Training	Yes	74	30.7
	No	167	69.3
Previously Used AI Tools	Yes	61	25.3
	No	180	74.7

Table 1 indicates that male teachers constituted 57.7% of the respondents, while female teachers represented 42.3%. Regarding teaching experience, teachers with 6–10 years of experience formed the largest group (29.5%), followed by those with 11–15 years (26.1%). In terms of educational qualification, the majority of respondents possessed B.Ed/B.Sc(Ed) qualifications (63.1%), suggesting that most participants had professional teaching backgrounds. However, only 30.7% of the respondents had received AI-related training, and 25.3% had previously used AI tools for instructional purposes. This indicates that despite having the required academic qualifications, exposure and practical experience with AI applications among mathematics teachers remain limited.

Research Question One: To what extent were secondary school mathematics teachers ready to utilise Artificial Intelligence for mathematics content delivery in Bayelsa State?

Table 2: Mean and Standard Deviation of Teachers' Readiness to Utilise Artificial Intelligence for Mathematics Content Delivery (N = 241)

S/N	Readiness Items	Mean	SD	Remark
1	Awareness of AI tools that support mathematics teaching and learning	3.02	0.81	HE
2	Understanding of AI applications in education	2.89	0.86	HE
3	Possession of digital skills required for AI utilisation	2.71	0.91	HE
4	Confidence in using AI applications for mathematics lessons	2.63	0.95	HE
5	Willingness to integrate AI into mathematics teaching	3.14	0.78	HE
6	Ability to use AI for lesson planning and instructional materials	2.58	0.97	HE
7	Ability to use AI for explaining difficult mathematics concepts	2.54	0.94	HE
8	Ability to generate mathematics exercises and assessments using AI	2.61	0.92	HE
9	Belief that AI improves mathematics content delivery	3.25	0.72	HE
10	Perceived usefulness of AI for addressing learner differences	3.08	0.76	HE
11	Preparedness to learn new AI technologies	3.31	0.69	HE
12	Availability of school support for AI adoption	2.21	0.88	HE
13	Access to digital devices for AI applications	2.37	0.90	HE
14	Ability to evaluate AI-generated mathematics content	2.66	0.89	HE
15	Belief that AI complements mathematics teachers' roles	3.36	0.67	HE
	Grand Mean	**2.82**		HE

Criterion Mean = 2.50

The results in Table 2 reveal that mathematics teachers demonstrated a generally high level of readiness to utilise Artificial Intelligence for mathematics content delivery, as indicated by the grand mean score of 2.82. Teachers particularly showed strong acceptance of AI as a supportive instructional tool, with the highest mean recorded for the belief that AI complements the role of mathematics teachers (M = 3.36), followed by preparedness to learn new AI technologies (M = 3.31). However, school support for AI adoption (M = 2.21) and access to digital devices (M = 2.37) recorded lower ratings, suggesting that institutional and infrastructural limitations may constrain effective AI utilisation despite teachers' positive disposition.

Research Question Two: What were the challenges affecting the utilisation of Artificial Intelligence for mathematics content delivery in secondary schools in Bayelsa State?

Table 3: Mean and Standard Deviation of Challenges Affecting AI Utilisation (N = 241)

S/N	Challenges	Mean	SD
1	Inadequate knowledge of AI among mathematics teachers	3.31	0.71
2	Limited AI training opportunities	3.46	0.65
3	Poor availability of computers and digital devices	3.52	0.62
4	Unstable electricity supply	3.58	0.59
5	Poor internet connectivity	3.61	0.57
6	High cost of AI tools and resources	3.27	0.73

S/N	Challenges	Mean	SD
7	Lack of technical support	3.19	0.76
8	Limited administrative support	3.04	0.81
9	Absence of clear AI policies in schools	2.98	0.84
10	Fear of students' overdependence on AI	2.76	0.89
11	Concern about inaccurate AI-generated information	2.88	0.85
12	Limited time to learn AI tools	3.21	0.77
13	Large class sizes	3.07	0.80
14	Lack of awareness of suitable AI tools	3.34	0.70
15	Privacy and ethical concerns	2.91	0.83
	Grand Mean	3.28	

Criterion Mean = 2.50

Table 3 shows that respondents identified several factors as significant challenges affecting the utilisation of Artificial Intelligence for mathematics content delivery, with an overall mean score of 3.28. The most prominent challenges were poor internet connectivity (M = 3.61), unstable electricity supply (M = 3.58), inadequate availability of digital devices (M = 3.52), and limited AI training opportunities (M = 3.46). The findings suggest that while mathematics teachers demonstrate willingness and readiness to embrace AI, successful integration is hindered by technological infrastructure gaps, inadequate capacity-building opportunities, and limited institutional support.

Discussion of Findings

The first objective examined the readiness of secondary school mathematics teachers to utilise Artificial Intelligence (AI) for mathematics content delivery in Bayelsa State. The findings revealed that mathematics teachers demonstrated a relatively high level of readiness to adopt AI-based instructional tools, as indicated by the overall mean score of 2.82. Specifically, teachers expressed positive perceptions regarding the usefulness of AI in improving mathematics content delivery, supporting differentiated instruction, generating instructional materials, and complementing teachers' roles. This finding suggests that mathematics teachers have developed favourable attitudes towards AI and recognise its potential value in addressing some of the persistent challenges associated with mathematics teaching, particularly the explanation of abstract concepts, provision of immediate feedback, and adaptation of instruction to learners' needs. This finding agrees with Kasneci et al. (2023), who reported that emerging AI tools, particularly generative AI applications, provide significant opportunities for improving teaching practices by assisting educators with content creation, assessment development, and personalised learning support. Similarly, Chiu et al. (2023) found that teachers' perceived usefulness and awareness of AI applications are important predictors of their willingness to integrate AI into educational practices. However, despite the positive disposition towards AI adoption, the findings indicated relatively lower readiness in areas relating to institutional support and access to digital facilities. This implies that teachers' willingness to utilise AI may not automatically translate into effective classroom implementation without adequate technological infrastructure, professional training, and organisational support. The limited exposure of respondents to AI training and previous AI usage observed in the demographic analysis further reinforces this concern. This finding is

consistent with Tlili et al. (2023), who argued that although AI technologies provide promising educational benefits, many teachers lack the technical competence and confidence required for effective classroom integration due to insufficient professional development opportunities. Similarly, UNESCO (2023) emphasised that successful AI integration in education depends not only on access to AI tools but also on teacher capacity-building, ethical awareness, and supportive institutional policies. Therefore, while mathematics teachers in Bayelsa State appear psychologically prepared to embrace AI, their practical readiness requires further strengthening through targeted training programmes and improved digital learning environments.

The second objective investigated the challenges affecting the utilisation of Artificial Intelligence for mathematics content delivery in secondary schools in Bayelsa State. The findings revealed that inadequate internet connectivity, unstable electricity supply, insufficient digital devices, and limited AI training opportunities were the most significant barriers affecting AI utilisation. The overall challenge mean score of 3.28 indicates that respondents perceived the identified factors as substantial obstacles to effective AI adoption. This finding reflects the realities of technology integration in many developing educational contexts, where infrastructural limitations continue to constrain the effective use of emerging digital innovations. Similar findings were reported by Akinwale and Olaniyan (2023), who noted that inadequate digital infrastructure, unreliable power supply, and limited technological resources remain major barriers to educational technology adoption in Nigeria. In the same vein, Holmes and Tuomi (2022) argued that the benefits of AI in education can only be realised when technological systems are supported by appropriate infrastructure, institutional commitment, and human capacity.

Furthermore, the findings revealed that limited teacher training, lack of technical support, absence of clear AI policies, and concerns regarding ethical issues also affected AI utilisation. These findings suggest that AI adoption challenges extend beyond physical infrastructure to include issues of policy, professional competence, and responsible technology use. The result supports the argument of Zawacki-Richter et al. (2019) that successful application of AI in education requires a balanced consideration of technological, pedagogical, and organisational factors rather than focusing solely on the availability of AI tools. Similarly, Chiu et al. (2023) highlighted that inadequate AI literacy among educators, ethical concerns, and uncertainty about AI-generated content remain critical issues that influence teachers' acceptance and use of AI technologies. Therefore, advancing mathematics content delivery through AI in Bayelsa State requires a comprehensive approach that combines teacher professional development, infrastructure improvement, policy formulation, and continuous institutional support.

Conclusion

The study concluded that secondary school mathematics teachers in Bayelsa State demonstrated a positive level of readiness towards the utilisation of Artificial Intelligence for advancing mathematics content delivery, as they acknowledged its potential to enhance lesson preparation, instructional effectiveness, learner engagement, and personalised learning. However, the practical integration of AI into mathematics classrooms remains constrained by significant challenges, particularly inadequate teacher training, poor internet connectivity, unstable electricity supply, limited access to digital devices, and insufficient institutional support. These findings suggest that the successful adoption of AI in mathematics education requires more than teachers' willingness; it demands deliberate investments in digital infrastructure, continuous professional development, supportive educational policies, and responsible AI integration frameworks. Therefore, harnessing the potential of AI for mathematics content delivery in Bayelsa State requires a collaborative effort

among government agencies, school administrators, teacher educators, and teachers to create an enabling environment where AI can complement existing pedagogical practices and improve the quality of mathematics education.

Recommendations

The recommendations given after the conclusion of this study are:

1. The Bayelsa State Ministry of Education should organise continuous Artificial Intelligence training and capacity-building programmes for mathematics teachers to improve their digital competence and confidence in integrating AI into mathematics content delivery.
2. School administrators and relevant stakeholders should provide adequate digital infrastructure, reliable internet connectivity, electricity supply, and institutional support to facilitate the effective utilisation of Artificial Intelligence in secondary school mathematics classrooms.

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