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Influence of Artificial Intelligence (AI) on Mathematics Instruction in specific Junior Secondary Schools at Akoko Edo Local Government Area of Edo State, Nigeria

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Highlights:

The significants of AI improved personalization, problem-solving, motivation, and reduced mathematics anxiety among junior secondary students.

Highlight teachers positive perceptions of AI, but lack training and experience hinders readiness.

Enlist major barriers to AI integration which include unstable electricity, poor internet connectivity, and low digital skills.

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Abstract: The study examined the impact of Artificial Intelligence (AI) on the teaching and learning of Mathematics in Junior Secondary Schools within the Akoko Edo Local Government Area of Edo State, Nigeria. A survey research design was used in the study, where 40 mathematics teachers were selected using Simple random sampling technique. Data collection in this study employed a well-structured questionnaire instrument developed on a four-point Likert scale and data analysis employed mean statistics with 2.50 as the benchmark. From the results, it is evident that one of the biggest problems in Mathematics teaching includes the unavailability of appropriate facilities like stable electricity and adequate internet connectivity, poor digital skills among teachers, and social economic differences among learners. However, the study showed that the use of AI greatly improved personalization, problem-solving ability, motivation, and decreased Mathematics anxiety among others. The study further revealed that teachers have an appreciative perception towards the use of artificial intelligence and are ready to embrace its use, although the level of readiness among the teachers was hindered due to lack of training and experience. The study concludes that there is an enormous capacity for artificial intelligence to revolutionize mathematics education provided certain challenges are overcome.

Keywords: Artificial Intelligence (AI), Mathematics Education, Junior Secondary Schools, Teacher Readiness, Student Engagement.

Introduction

There is currently a revolutionary change happening in the field of education globally, and this revolution is being caused by the development of Artificial Intelligence (AI). AI refers to computer science technologies that can carry out tasks relating to human cognition, such as learning, problem solving, reasoning, and decision-making. The introduction of artificial intelligence in the field of education has had significant impacts on learning, teaching, assessment, and curriculum design especially in areas like Mathematics (Onesi-Ozigagun et al., 2024; Panqueban & Huincahue, 2024). Mathematics is a key subject in secondary schools in Nigeria, and due to this, the development of educational technologies that involve the use of AI has several benefits that can be exploited.

Mathematics is an essential part of the school curriculum because mathematical competence and problem-solving skills are vital for their involvement in science, technology, and other aspects of social and economic activities. In secondary schools, mathematics education should be aimed at providing students with skills in conceptual understanding, reasoning, problem solving, and application of mathematical knowledge to practical situations (Ajao & Adeleye, 2024). Nevertheless, mathematics education has to deal with a range of instructional

problems related to students' difficulties in conceptual understanding and engagement in mathematical reasoning and problem solving (Ajao & Adeleye, 2024). The progress made in AI creates new possibilities to solve some of these problems. AI-based educational technologies could help to create personalized learning conditions when learning activities and feedbacks are tailored according to learners' needs. The systematic review of AI in Mathematics education showed a range of AI-based applications used in intelligent tutoring systems, conversation AI, adaptive learning, automation support, and other AI technologies that can affect teaching-learning process (Opesemowo & Adewuyi, 2024; Panqueban & Huincahue, 2024). Generative AI can also support students by providing explanations, examples, feedback, and opportunities to engage with mathematical problems. However, evidence suggests that the effectiveness of AI is dependent on how it is pedagogically integrated rather than simply on the availability of the technology (Liu et al., 2026).

Learning tools based on AI technology are capable of analysing learner responses and offering personalized types of assistance in learning processes, thus enabling differentiated instruction. The use of such learning tools can include providing immediate feedback, creating personalized learning materials, solving problems, and helping learners to investigate concepts of different levels of difficulty (Onesi-Ozigagun et al., 2024; Panqueban & Huincahue, 2024). In Mathematics learning, such characteristics of tools are especially useful because students vary in terms of their knowledge, learning speed, misconceptions, and confidence in their mathematical abilities. There is recent research that proves the effectiveness of generative AI on the basis of empirical studies and demonstrates the positive impact of such AI on students' achievements in Mathematics learning (Liu et al., 2026). This is evident not only in international research but also in emerging research in Nigeria. Fawehinmi et al. (2025) found that integration of AI led to better results in Mathematics among secondary and tertiary students in Ondo State, and suggested that successful implementation depends on availability of digital infrastructure, competence of teachers, integration of curricula, and sufficient funding. This is especially relevant for Nigeria due to the fact that benefits of AI cannot be discussed independently from educational technology implementation process. However, there are challenges associated with the use of AI technology in the teaching-learning process. As noted by UNESCO (2023), the introduction of generative AI technology in education faces numerous challenges associated with privacy of data, human agency, equity, ethical use, and pedagogical and institutional safeguards. Besides, the availability of digital infrastructure and preparedness of teachers are factors that influence the effective implementation of AI technology in education. Systematic review of AI in Mathematics education also indicated that infrastructure, teacher preparedness, and policy issues are relevant for implementing AI technology (Opesemowo & Adewuyi, 2024). With regard to the context of the Nigerian junior secondary school, the above factors call for urgent attention since teachers of Mathematics in the Nigerian junior secondary school are required to assist learners with different aptitudes in the midst of diverse technological and institutional resources. The success of artificial intelligence in Mathematics instruction is not only dependent on the technology itself but also on the preparedness of teachers, resources and infrastructure. This current study aims at investigating the impact of artificial intelligence in mathematics instruction in selected junior secondary schools in

Akoko Edo Local Government Area of Edo State, Nigeria. The study will focus on the problems that exist in mathematics teaching and learning, the possible contribution of artificial intelligence educational technology to learning and motivation, problems of artificial intelligence in the classroom and the teachers' preparedness.

Statements of the problem

It is an important subject taught in secondary schools due to the development of analytical and problem-solving skills in the learners. Nevertheless, good teaching and learning practices in mathematics have been problematic in many situations especially in the presence of limited teaching materials and few ways of meeting the needs of the learners. Recent studies suggest that artificial intelligence (AI) is being explored to facilitate instruction in mathematics through personalization, automated feedback, assessments, among others (Opesemowo & Adewuyi, 2024; Opesemowo & Ndlovu, 2024).

In the junior secondary school, most students have challenges understanding concepts in mathematics, engaging in the subject as well as developing their problem-solving skills. Traditional methods might make it difficult to provide personalized instructions for each learner especially in heterogeneous classes. AI tools can help mitigate these problems in learning through the provision of interactive explanations, personalized learning tasks as well as immediate feedback. The use of AI tools in learning mathematics including ChatGPT has yielded successful results such as interactive and engaging experiences of learners (Gouia-Zarrad & Gunn, 2024; Serhan & Welcome, 2024). However, the use of AI technology in Mathematics education faces some challenges. The effective use of AI requires the presence of adequate technological infrastructure, competency of the teachers, appropriate pedagogical implementation, and institutional backing. According to a systematic review of the application of AI in Mathematics education, personalized learning, real-time assessment, and improved Mathematics instruction can be regarded as key areas of the application of AI in mathematics education (Opesemowo & Adewuyi, 2024). Issues relating to the reliability of the information generated through the use of AI and responsible use have also been raised in recent Mathematics education literature (Opesemowo & Ndlovu, 2024).

In this case, the issue is not whether there is AI available but whether the Mathematics teachers are sufficiently competent and supported to use AI appropriately in their teaching practices. Recent evidence indicates that students can welcome the use of AI in Mathematics education but the effectiveness of its use depends on how teachers apply AI in their teaching activities (Gouia-Zarrad & Gunn, 2024; Serhan & Welcome, 2024). Within Akoko Edo Local Government Area of Edo State, there is a need for empirical data about the extent to which AI can facilitate the teaching of Mathematics and any problems associated with its integration. The issue here is that there is limited research conducted within the scope of this area regarding the perception of AI by teachers, its role in personalizing education and engaging learners, problems associated with adopting AI technology, and teachers' willingness to integrate AI in Mathematics classes of junior secondary schools. This research aims at exploring the impact of artificial intelligence on the process of teaching Mathematics.

Purpose of the Study

The purpose of this study is to explore the influence of Artificial Intelligence on the teaching and learning of mathematics in junior secondary schools in Akoko Edo Local Government Area of Edo State. Specifically, the specific objectives are to:

i. Examine the current challenges that hinder effective mathematics instruction and learning at the junior secondary level;
ii. Investigate how AI-driven educational technologies can enhance personalized learning, student engagement, and academic performance in mathematics;
iii. Identify barriers to adopting AI tools in Nigerian junior secondary school mathematics classrooms; and
iv. Assess teachers' readiness, perceptions, and professional development needs regarding AI integration.

Research Questions

This study will be guided by the following research questions:

i. What are the major challenges affecting the teaching and learning of mathematics in Nigerian junior secondary schools?
ii. How can AI-driven educational tools personalize mathematics learning and improve student engagement?
iii. What infrastructural, pedagogical, and socio-economic barriers limit AI adoption in Nigerian junior secondary school mathematics classrooms?
iv. How prepared are mathematics teachers to integrate AI technologies, and what are their perceptions and training needs?

Empirical Review

Over the years several authors have conducted researches on many aspect of Artificial Intelligent (AI) in education. Besas et al. (2026) conducted a mixed-methods study to examine the impact of AI tools (specifically ChatGPT) on students' self-directed learning and mathematics performance. The study involved tertiary students and used both surveys and performance assessments. Findings revealed that students who used AI tools demonstrated improved independent learning skills and better understanding of mathematical concepts. However, the study also noted concerns about over-reliance on AI tools. Liu et al. (2026) carried out a meta-analysis of 22 empirical studies involving over 5,000 learners to determine the effectiveness of generative AI in mathematics education. The findings showed that AI has a moderate positive effect on students' mathematics achievement (effect size g = 0.534). The study also found that effectiveness depends on the level of AI integration and instructional design. Walkington et al. (2026) conducted an empirical classroom-based study on how teachers use generative AI to design mathematics problems tailored to students' interests. The study found that AI-supported personalization increased student engagement and improved conceptual understanding. It emphasized that AI helps teachers connect mathematics to real-life contexts.

Schorcht et al. (2026) conducted an empirical study examining how large language models improve mathematics learning quality. Their findings revealed that AI-supported instruction enhances problem-solving strategies but varies depending on how prompts they are structured. The study concluded that AI effectiveness is not universal but depends on pedagogical alignment. Song et al. (2026) conducted a systematic empirical review of AI applications in mathematics learning (2021–2025). The study found that AI tools such as intelligent tutoring systems significantly improve learning outcomes but are constrained by infrastructure, teacher readiness, and policy gaps. It also highlighted the digital divide as a major issue in developing countries.

Theoretical Review

The Constructivist Learning Theory explains that learners actively build their

own knowledge through interaction, experience, and reflection rather than passively receiving information. It emphasizes learner-centered teaching, where students engage in problem-solving, critical thinking, and discovery. In mathematics education, this theory supports instructional approaches that allow students to explore concepts and receive guidance as needed. The integration of Artificial Intelligence (AI) aligns with this theory by providing personalized learning, immediate feedback, and adaptive support, thereby enhancing students' understanding and engagement. This study fills the gap by providing context-specific evidence from Nigeria, focusing on junior secondary school mathematics examining teacher readiness and perceptions Identifying real-world, implementation barriers, using field-based survey. (Piaget, J. (1970), Vygotsky, L.S.(1978))

Methodology

Survey research design was used in the study. Survey research design can be used in research that aims at obtaining information from respondents about their perceptions, attitudes, experiences, or practices, and then describing the characteristics of the population using the gathered information (Creswell & Creswell, 2018). The study employed survey research design since it facilitated gathering information from Mathematics teachers about the influence of AI on their teaching practices. Mathematics teachers in the selected junior secondary schools in Akoko Edo Local Government Area, Edo State, Nigeria made up the population of the study. Ten secondary schools were selected for the study and four Mathematics teachers sampled from each school, making a total of 40 teachers, including two males and two females. Simple random sampling technique was employed in selecting the sample of teachers for the study. Simple random sampling technique provides all the eligible members of a population equal chance of being selected and is appropriate for situations where the researcher wishes to obtain a representative sample without prejudice to some population members (Creswell & Creswell, 2018).

Data were gathered through a structured questionnaire designed by the researchers in line with the research objectives and research questions. There were 21 questions arranged into four sets. Questions 1–7 dealt with problems that affect the teaching and learning of Mathematics. Meanwhile, questions 8–12 probed the effects of AI-enabled devices to personalized learning and student engagement; questions 13–17 involved the hindrances of AI implementation. Finally, questions 18–21 involved the readiness of the teachers in incorporating AI in Mathematics. The questionnaire utilized a four-point Likert scale consisting of Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1. Likert scales have been frequently used in educational and social sciences research in determining the respondents' attitudes or perceptions (Joshi et al., 2015). The instrument was put to test for its face and content validity by experts in Mathematics Education and education assessment to determine whether the questions are appropriate enough in measuring the constructs of interest. Content validity is concerned with testing the extent to which an instrument provides adequate coverage of the important aspects of the constructs (Polit & Beck, 2006). The data obtained was analyzed using descriptive statistics, specifically, mean scores. The mean score based on the four-point response scale was 2.50, which was obtained by dividing (4 + 3 + 2 + 1) by 4. It is, therefore, that all mean scores of 2.50 and above were considered to show agreement while those below 2.50 were considered to show disagreement.

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Table 1: The response of teachers and their mean on challenges affecting the teaching and learning of mathematics in Nigerian junior secondary schools

S/n	Statement	SA	A	D	SD	Total	Mean	Remark
1	Lack of stable electricity and internet access in schools hinders effective mathematics teaching.	16	12	10	2	40	**3.05**	Agree
2	Inadequate digital devices limit the use of AI tools in mathematics instruction in my school.	10	14	8	8	40	**2.65**	Agree
3	The training I have received on digital literacy for mathematics instruction is sufficient.	10	4	14	12	40	**2.30**	Disagree
4	The current mathematics curriculum is flexible enough to incorporate AI-driven teaching methods.	4	20	8	8	40	**2.50**	Agree
5	Data privacy and algorithmic bias concerns affect acceptance of AI educational tools among educators.	8	18	10	4	40	**2.75**	Agree
6	Math anxiety among students significantly affects their engagement and learning in mathematics.	10	22	2	6	40	**2.78**	Agree
7	Economic inequalities influence students' access to digital learning resources in my school.	8	22	2	8	40	**2.75**	Agree
	Grand Mean						**2.68**	

Table 2: The response of teachers and their mean on AI-driven educational tools personalize mathematics learning and improve student engagement.

S/N	Statement	SA	A	D	SD	Total	Mean	Remark
1	AI-driven personalized learning systems effectively address the diverse learning needs of students.	8	22	8	3	40	**2.90**	Agree
2	AI tutoring systems improve students' problem-solving skills in mathematics.	8	28	2	2	40	**3.05**	Agree
3	AI tools increase student motivation and reduce math anxiety in my classroom.	12	22	4	2	40	**3.10**	Agree
4	AI-generated diagnostic data is useful for identifying student learning gaps.	8	24	6	2	400	**3.15**	Agree
5	AI technology helps me differentiate instruction in my mathematics classroom.	4	22	8	6	40	**2.60**	Agree
	Grand Mean						**2.96**	

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From Table 1 the highest fall on Lack of stable electricity and internet access in schools hinders effective mathematics teaching with mean of 3.05, followed by Math anxiety among students significantly affects their engagement and learning in mathematics with mean of 2.78, followed by Data privacy and algorithmic bias concerns affect acceptance of AI educational tools among educators and Economic inequalities influence students' access to digital learning resources in my school with mean of 2.75, followed by Inadequate digital devices limit the use of AI tools in mathematics instruction in my school with mean of 2.65, followed by the current mathematics curriculum is flexible enough to incorporate AI-driven teaching methods with mean of 2.50, and The training I have received on digital literacy for mathematics instruction is sufficient with the least mean of 2.30 indicate disagreement. From the grand mean of 2.68 it shows that there are challenges affecting the teaching and learning of mathematics in Nigerian junior secondary schools.

From table 2 the highest fall on AI-generated diagnostic data is useful for identifying student learning gaps with mean of 3.15, followed by AI tools increase student motivation and reduce math anxiety in my classroom with mean of 3.10, followed by AI tutoring systems improve students' problem-solving skills in mathematics with mean of 3.05, followed by AI-driven personalized learning systems effectively address the diverse learning needs of students with mean of 2.90 and AI technology helps me differentiate instruction in my mathematics classroom with the least mean of 2.60 indicate agreement. From the grand mean of 2.96 shows that AI-driven educational tools can personalize mathematics learning and improve student engagement.

From table 3, the highest fall on financial constraints limit students' access to digital devices for learning Mathematics with mean of 3.45, followed by inconsistent power supply significantly limits the use of AI in mathematics classes with mean of 2.95, followed by Teacher resistance due to lack of digital skills hinders AI integration in mathematics teaching and Existing policies adequately address ethical concerns related to AI use in education with mean of 2.85, and the least mean fall on Support provided by school or education authorities for AI adoption is adequate with mean of 2.40 indicate disagreement. From the grand mean of 2.90 show that there are infrastructural, pedagogical, and socio-economic barriers limit AI adoption in Nigerian junior secondary school mathematics classrooms

From table 4, the highest fall on I am interested in participating in continuous professional development on AI for education with mean of 2.90, followed by The professional development I have received on AI integration in mathematics teaching is sufficient with mean of 2.75, followed by I perceive AI as a helpful assistant rather than a threat to my teaching role with mean of 2.65, the least mean fall on I feel confident using AI tools for mathematics instruction with mean of 2.60 indicate agreement. From the grand mean of 2.73 shows that mathematics teachers are prepared to integrate AI technologies into the teaching and learning of Mathematics at junior secondary level school level.

Discussion of Findings

From Table 1 above, where the grand mean value is 2.68, it is evident that the

respondents agreed that there were numerous challenges associated with Mathematics teaching and learning. The greatest challenge was the lack of reliable power and internet connectivity (M = 3.05), while the least challenge was insufficient digital literacy training (M = 2.30). These findings are in line with the research conducted by Opesemowo and Adewuyi (2024), who highlighted the importance of infrastructure and teacher-related challenges in AI integration into Mathematics. They are also in agreement with the findings made by Kuzmenko (2025), who noted that despite the knowledge of AI possessed by Mathematics teachers, their knowledge was fragmented, and they did not apply AI properly. Table 2 provided a grand mean of 2.96 showing that teachers agreed on the use of AI tools for personalized learning and student engagement. The top-ranked statement was the ability of the AI-generated diagnostic data to detect the learning gaps of students (M = 3.15), followed by the use of the technology for improving motivation and reducing Mathematics anxiety (M = 3.10). This observation is consistent with findings from the meta-analysis conducted by Liu et al. (2026), which found that the effect size of generative AI on Mathematics learning outcomes was moderate and positive (g = 0.534). This observation was reiterated by Opesemowo and Adewuyi (2024), who identified increased use of AI in personalized and adaptive Mathematics learning.

The grand mean of 2.90 in Table 3 above suggests that the respondents believe that there exist barriers to AI implementation. Constraints related to finances scored the highest mean (M = 3.45), followed by inconsistent power supply (M = 2.95). This is in agreement with the fact that infrastructure and availability of resources are significant factors in AI implementation. As stated by Opesemowo & Adewuyi (2024), contextual and technological conditions affect the successful implementation of AI in Mathematics lessons. Also, in agreement with Kuzmenko (2025) on a mismatch between Mathematics teachers' willingness to implement AI and its actual implementation. Table 4 presented a grand mean of 2.73, demonstrating mostly positive readiness of teachers. The maximum mean was observed in the category of interest in continuous professional development (M = 2.90). These results agree with Kuzmenko (2025), who found out that around 70% of Mathematics teachers expressed readiness to use AI, while their practical knowledge and experience in this area were diverse.

Conclusion(s)

This study concludes that Artificial Intelligence (AI) can positively transform the teaching and learning of mathematics in junior secondary schools by enhancing personalized learning, improving student engagement, and supporting effective instructional delivery. Despite these benefits, the integration of AI is hindered by critical challenges such as poor infrastructure, financial limitations, inadequate teacher training, and insufficient institutional support.

The study further establishes that teachers are willing to adopt AI and view it as a supportive instructional tool; however, their readiness is limited by gaps in digital skills and professional development. Therefore, for AI to be effectively implemented, there is a need for improved infrastructure, equitable access to digital resources.

Recommendations

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

1. Government and educational stakeholders should provide stable electricity and reliable internet connectivity in schools to facilitate the effective implementation of AI-powered instructional tools in mathematics education.
2. Regular training and professional development programs should be organized for mathematics teachers to enhance their digital literacy and competence in the use of Artificial Intelligence technologies for instruction.
3. Public-private partnerships should be encouraged to provide schools with digital devices and AI-based educational resources, thereby reducing inequalities in access to technology among learners.
4. AI-supported teaching strategies should be integrated into the junior secondary school mathematics curriculum to promote personalized learning and improve students' engagement and academic performance.
5. Educational policymakers should develop clear guidelines on the ethical use of AI in education, including issues related to data privacy, security, and algorithmic bias.

Mathematics teachers should adopt a blended instructional approach that combines AI technologies with learner-centered teaching methods to enhance conceptual understanding and problem-solving skills.

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