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Application of Artificial Intelligence Tools in Teaching and Learning of Mathematics in Secondary Schools in Enugu Education Zone

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Abstract

The study examined the application of artificial intelligence tools in teaching and learning of Mathematics in secondary schools in Enugu Education Zone of Enugu State. It was guided by three specific objectives and four corresponding research questions, which sought to determine the artificial intelligence (AI) tools available for teaching and learning of Mathematics; the impact of AI tools on students' engagement in Mathematics; and to identify factors impeding the use of AI tools for teaching and learning Mathematics in secondary schools in Enugu Education Zone. Descriptive survey design was adopted. The population for this study consisted 130 Mathematics teachers and 4737 SS 2 students from the 32 public senior secondary schools in Enugu Education Zone. A sample size of 499 (130 teachers and 369 students) was obtained. A researcher-designed questionnaire titled "Application of Artificial Intelligence in Teaching and Learning Mathematics Questionnaire (AAITLMQ)" and validated by three experts was used for data collection. The instrument was tested for reliability using Cronbach Alpha and a reliability coefficient of 0.82 was obtained. Data collected for the research questions were analysed using mean statistics. The results from the study revealed among other things that there is limited availability of AI tools for teaching and learning Mathematics; respondents believe that AI tools positively influence student engagement in Mathematics, if utilised; and that major barriers to AI integration includes poor infrastructure, lack of training, and absence of policy support. The study recommended provision of AI infrastructure by government and other education stakeholders; curriculum and instructional reform; policy support and funding to improve availability, access and utilization of AI in the teaching and learning process in secondary schools.

Keywords: Artificial Intelligence Tools, Mathematics, Secondary Schools

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Introduction

The integration of Artificial Intelligence (AI) in education has revolutionized teaching and learning across the globe, with notable applications in enhancing student engagement and educational outcomes. AI technologies, such as ChatGPT, Wolfram Alpha, and others, are increasingly being utilized to personalize learning experiences, address students' individual needs, and provide real-time solutions to academic challenges (Wolfram Alpha, 2020; Photomath, 2021; GeoGebra, 2021). According to UNESCO (2020), AI holds immense potential to transform education by fostering personalized learning that caters to the diverse abilities and learning paces of students. In particular, AI-driven platforms offer interactive environments where students can receive immediate feedback, which enhances their understanding of complex subjects like Mathematics.

As AI tools continue to evolve, they offer powerful support for teaching Mathematics, a subject that often presents challenges for many learners due to its abstract nature and problem-solving requirements. With this growing trend of AI adoption, it becomes essential to understand the types of AI tools available for use in the

classroom, their impact on student engagement, and the challenges faced by educators in leveraging these technologies (World Bank, 2021).

In Nigeria, secondary education faces significant challenges, including inadequate infrastructure, outdated curricula, and a shortage of qualified teachers. While the government has acknowledged the importance of technology in education, as reflected in the National Information and Communication Technology policy, the actual implementation remains slow, especially in secondary schools (Olatunde-Aiyedun, 2024). A report by the World Bank (2021) highlights that Nigeria lags behind in adopting digital technologies in education, with many schools lacking basic technological infrastructure like computers and internet access. These challenges hinder the widespread use of AI tools in schools, particularly in regions like the Enugu Education Zone. Despite these barriers, AI offers a promising solution to the issues facing Mathematics education in Nigeria, where the subject has consistently had one of the highest failure rates in national examinations, such as the West African Examinations Council (WAEC) and National Examinations Council (NECO). This highlights the urgent need for innovative teaching approaches that can enhance student performance in Mathematics (Zudonu, Oruan, Ogbu, Osezua, John & Afolabi, 2024).

Mathematics, as the study of quantities, structures, space, and change, is fundamental to numerous fields, including science, technology, engineering, and business. Okigbo and Osua (2015) emphasize that Mathematics serves as the foundation for scientific and technological advancement, making it an essential subject for sustainable development. However, many students struggle to grasp complex mathematical concepts, resulting in poor performance. Traditional teaching methods, which often rely on rote memorization and repetitive practice, have proven ineffective in helping students achieve a deeper understanding of mathematical concepts. AI tools present a potential solution by offering interactive and personalized learning experiences that cater to individual learning styles and paces. According to a report from Stanford University (2022), AI-driven tools can help students better understand difficult concepts, improve their problem-solving skills, and foster a more positive attitude toward Mathematics.

Several AI tools have already been developed to assist in the teaching and learning of Mathematics, with each tool offering unique functionalities to support both students and teachers. Two of the most widely recognized AI tools in this field are Wolfram Alpha and ChatGPT. Wolfram Alpha is a computational knowledge engine that provides answers to factual queries and performs complex mathematical calculations. It is particularly useful for solving algebraic equations, statistical problems, and performing detailed calculations. The tool's step-by-step solution feature allows students to understand the entire process of solving mathematical problems, which enhances their conceptual understanding of the subject (Zudonu et al., 2024). Wolfram Alpha can be used in secondary schools to provide immediate feedback on homework and classroom activities, helping students grasp mathematical concepts more effectively (Wolfram Alpha, 2020). Similarly, ChatGPT, an advanced language model developed by OpenAI, can provide real-time tutoring and explanations of mathematical concepts. ChatGPT's interactive nature allows students to receive personalized support, clarifying misunderstandings and guiding them through problem-solving exercises. In the context of secondary schools, ChatGPT can function as a virtual tutor, providing real-time assistance with complex mathematical problems (OpenAI, 2023).

This research seeks to explore the application of AI tools in the teaching and learning of Mathematics within public secondary schools in the Enugu Education Zone. Specifically, the study aims to examine the types and availability of AI tools utilized in these schools, assess the impact of AI tools on student engagement and understanding of Mathematics, and identify the challenges and limitations faced by both teachers and students in implementing and using these AI tools. Through these objectives, the research intends to provide valuable insights into how AI tools can enhance the quality of Mathematics education in secondary schools and contribute to improving students' academic outcomes in Nigeria. Moreover, the findings of this study could inform policy decisions on the integration of AI technologies into the Nigerian education system, ensuring that

AI adoption is both feasible and effective in addressing the educational needs of students, particularly in Mathematics. Ultimately, the research aims to contribute to the growing body of knowledge on AI in education and its potential to transform Mathematics education in developing countries.

From the above, the research intends to provide valuable insights into how application of AI tools can enhance the teaching and learning of Mathematics, as well as allow students understand the entire process of solving mathematical problems and improve their academic outcomes.

Statement of the Problem

The integration of artificial intelligence (AI) in education has garnered significant global attention, offering new opportunities to enhance teaching and learning, particularly in Mathematics. In Enugu Education Zone, the difficulty secondary school students face in grasping key mathematical concepts has become a major concern for educational stakeholders. Scholars have attributed this issue to factors such as inadequate facilities and low teacher competency, among others. As a result, students' interest and morale in studying Mathematics tend to be low. AI tools, however, have the potential to address these learning challenges by providing personalized instruction and improving student engagement.

Despite the growing global shift towards AI-driven education, the application of AI tools in Nigerian schools remains limited, especially in secondary schools (Chiu and Churchill, 2020). This gap in research and implementation is particularly evident in subjects like Mathematics, which is foundational but often poorly understood by students. The underutilization of AI tools in Nigerian secondary schools presents a missed opportunity to enhance student outcomes. While tools such as Wolfram Alpha, Photomath, ChatGPT, and GeoGebra have demonstrated their effectiveness in improving Mathematics education globally, their adoption in Nigerian secondary schools is still minimal, and there is a lack of research on their effectiveness within this context.

This study aims to bridge this gap by investigating the application of AI tools in teaching and learning Mathematics in secondary schools within the Enugu Education Zone. It seeks to explore how these tools can be integrated into the curriculum to improve student comprehension, performance, and overall engagement in Mathematics.

Purpose of the Study

The purpose of this study is to examine the application of artificial intelligence tools in teaching and learning of Mathematics in secondary schools in Enugu Education Zone of Enugu State. The specific objectives are to:

1. determine the artificial intelligence (AI) tools available for teaching and learning of Mathematics in secondary schools in Enugu Education Zone.
2. assess the impact of AI tools on students' engagement in Mathematics in secondary schools in Enugu Education Zone.
3. identify factors impeding the use of AI tools for teaching and learning Mathematics in secondary schools in Enugu Education Zone.

Research Questions

The following research questions guided the study:

1. What are the artificial intelligence (AI) tools available for teaching and learning of Mathematics in secondary schools in Enugu Education Zone?
2. What is the impact of AI tools on students' engagement in Mathematics in secondary schools in Enugu Education Zone?
3. What are the factors impeding the use of AI tools in teaching and learning Mathematics in secondary schools in Enugu Education Zone?

Research Method

This study adopted descriptive survey research design. According to Jalil (2016) survey research design refers to the logical structure of an inquiry. It articulates what data is required, from whom, and how it is going to answer the research question. Fundamentally research design affects the extent to which causal claims can be made about the impact of the intervention. The area of this study is Enugu Education Zone, Enugu State. Enugu Education Zone consists of Enugu North, Enugu East and Isi-Uzo Local Government Areas. There are 32 public secondary schools in the zone. Enugu Education zone was chosen for this study because the issues that prompted this study appear – from everyday experiences of the researcher – to be prevalent in this area. The population for this study consisted 130 Mathematics teachers and 4737 SS 2 students from the 32 public senior secondary schools in Enugu Education Zone. Therefore, the population is 4867. This population was targeted because they are the stakeholders directly involved in the usage of Artificial Intelligence (from teaching and learning perspectives). The sample size of the study is 499. The researcher used Taro Yamane sampling formulae to determine the sample size of students, which is 369. The entire Mathematics teachers was adopted owing to its manageable size. Simple random sampling technique was used for sampling.

The instrument for data collection is a questionnaire structured by the researcher. The questionnaire is titled "Application of Artificial Intelligence in Teaching and Learning Mathematics Questionnaire (AAITLMQ)". The instrument was constructed on a four-point rating scale of Strongly Agree (4 points), Agree (3 points), Disagree (2 points) and strongly disagree (1 point). The questionnaire contains the items that addressed the three research questions guiding the study with a total of 30 items. The instrument was face-validated by 3 experts. Two of the experts are from the Department of Educational Management, while the third is from the Measurement and Evaluation Unit of the Department of Statistics, Peaceland University, Enugu. These experts were given the initial copies of the questionnaire as well as the purpose of the study, research questions and hypotheses to critically examine the adequacy of the items and the weighing of the responses.

To ensure the reliability of the instrument, copies of the instrument were administered on 10 teachers and 20 senior secondary school (SS II) students from public secondary schools in Agbani Education Zone, which is outside area of the study. Cronbach Alpha was used to determine a reliability co-efficient of 0.82, which indicated a high reliability of the instrument for the study.

With the help of two research assistants, the researcher administered 499 copies of instrument directly to the respondents. The administered copies of the instruments were retrieved on completion to avoid the loss of any of the instrument and to ensure hundred percent return rate.

The data were analysed in tables using mean, nominal value was assigned to scaling items. The cut-off point (criterion mean) of 2.50 was determined by finding the mean of nominal value assigned to the options. Any Item that has mean of 2.50 and above was regarded as agree while mean score below 2.50 was regarded as disagree respectively.

Results and Analysis

Research Question 1

What are the artificial intelligence (AI) tools available for teaching and learning of Mathematics in secondary schools in Enugu Education Zone?

Table 1: Mean Ratings of the Availability of AI Tools for Teaching and Learning Mathematics

S/N	Questionnaire Items	Respondents	N	$\bar{x}$	SD	Decision
1.	Adaptive Learning Platforms (DreamBox, Khan Academy, or Smart Sparrow) are available in their schools.	Teachers	130	2.31	0.84	Disagree
		Students	369	2.35	0.77	Disagree
2.	Intelligent Tutoring Systems (Carnegie Learning, Squirrel AI, or MATHia) are used in their math classrooms.	Teachers	130	2.36	0.92	Disagree
		Students	369	2.33	0.81	Disagree
3.	AI-Powered Math Problem Solvers (Photomath, Microsoft Math Solver, or Symbolab) are commonly used.	Teachers	130	2.28	0.78	Disagree
		Students	369	2.27	0.85	Disagree
4.	AI Chatbots for Math Support (ChatGPT, IBM Watson Tutor, or MathBot) are accessible to them.	Teachers	130	2.72	0.80	Agree
		Students	369	2.96	0.83	Agree
5.	Automated Grading and Feedback Tools (Gradescope, Turnitin's AI) are used by math teachers.	Teachers	130	2.42	0.79	Disagree
		Students	369	2.39	0.74	Disagree
6.	AI-Driven Educational Games (Prodigy Math, DragonBox, or Matific) are part of math instruction.	Teachers	130	2.32	0.83	Disagree
		Students	369	2.40	0.88	Disagree
7.	Virtual Math Labs with AI Integration (e.g., Wolfram Alpha, GeoGebra) are available for practice.	Teachers	130	2.27	0.89	Disagree
		Students	369	2.27	0.82	Disagree
8.	NLP Tools (like GPT or Watson) are used to solve or explain math word problems.	Teachers	130	3.04	0.78	Agree
		Students	369	2.22	0.79	Disagree
9.	Predictive Analytics Platforms (Knewton Alta, ALEKS) are used for personalized learning paths.	Teachers	130	2.19	0.81	Disagree
		Students	369	2.35	0.80	Disagree
10.	AI-Based Simulation Tools (zSpace, graphing AI tools) are integrated in math teaching.	Teachers	130	2.37	0.76	Disagree
		Students	369	2.31	0.79	Disagree
	Grand Mean & SD	**Teachers**	**130**	**2.43**	**0.82**	**Disagree**
		Students	**369**	**2.39**	**0.80**	**Disagree**

Table 1 shows that the grand mean scores for both teachers (2.43) and students (2.39) are below the mean cut off point, which indicate general disagreement on the availability of AI tools. A closer inspection reveals that most individual tools were rated below the 2.5 cut-off, affirming this limited availability. Only AI Chatbots for Math Support (such as ChatGPT) received mean ratings ≥ 2.5 for both sets of respondents and is therefore considered available to some extent. A tool like NLP, which is used to solve or explain math word problems had variation in the responses of the respondents: while teachers agree, students disagree. In all, this result suggests that while awareness or minimal use of a few AI tools exists, broader integration is overwhelmingly lacking.

Research Question 2

What is the impact of AI tools on students' engagement in Mathematics in secondary schools in Enugu Education Zone?

Table 2: Mean Ratings on the Impact of AI Tools on Student Engagement in Mathematics

S/N	Questionnaire Items	Respondents	N	$\bar{x}$	SD	Decision
11	AI tools ignite students' interest in mathematics	Teachers	130	2.91	0.76	Agree
		Students	369	3.08	0.81	Agree
12	AI tools broaden students' horizon on mathematics	Teachers	130	2.86	0.78	Agree
		Students	369	2.94	0.79	Agree
13	Tools sometimes become a source of distraction for students when studying	Teachers	130	2.67	0.84	Agree
		Students	369	2.89	0.87	Agree
14	There is reduced math anxiety through adaptive AI tools that tailor difficulty levels to student capabilities	Teachers	130	2.71	0.82	Agree
		Students	369	2.84	0.76	Agree
15	There might be higher classroom interaction when AI chatbots (ChatGPT or MathBot) are used for real-time problem-solving support	Teachers	130	2.74	0.80	Agree
		Students	369	2.96	0.81	Agree
16	Greater time spent on math tasks due to engaging AI-based simulations and virtual labs (Wolfram Alpha)	Teachers	130	2.34	0.79	Disagree
		Students	369	2.41	0.77	Disagree
17	Improved collaboration among students when using AI-powered group problem-solving platforms	Teachers	130	2.88	0.83	Agree
		Students	369	2.91	0.78	Agree
18	Increased self-paced learning engagement through AI platforms like Khan Academy or ALEKS that adapt to individual progress	Teachers	130	3.01	0.75	Agree
		Students	369	3.12	0.80	Agree
19	Positive shifts in student attitudes toward mathematics reported after using AI tools for repetitive practice (Photomath)	Teachers	130	2.93	0.81	Agree
		Students	369	2.97	0.83	Agree
20	Long-term retention of engagement observed in students exposed to AI-driven predictive analytics for personalized learning paths	Teachers	130	2.22	0.74	Disagree
		Students	369	2.36	0.78	Disagree
	Grand Mean & SD	**Teachers**	**130**	**2.74**	**0.79**	**Agree**
		Students	**369**	**2.85**	**0.80**	**Agree**

Table 2 reveals that both teachers and students agree that AI tools positively impact students' engagement in mathematics. Most items had mean scores above the 2.5 benchmark, indicating agreement on aspects such as increased interest, improved classroom interaction, reduced math anxiety, better collaboration, and positive shifts in attitudes. However, items 16 and 20, which addressed extended time commitment and long-term retention through simulations and predictive analytics respectively, had mean scores below 2.5. This suggests these specific impacts are less evident or not widely experienced among the respondents.

Research Question 3

What are the factors impeding the use of AI tools in teaching and learning Mathematics in secondary schools in Enugu Education Zone?

Table 3: Mean Ratings on Factors Impeding the Use of AI Tools in Mathematics Education

S/N	Questionnaire Items	Respondents	N	$\bar{x}$	SD	Decision
21	Limited/poor AI infrastructure (lack of computers, tablets, or stable electricity to support AI tools).	Teachers	130	3.72	0.81	Agree
		Students	369	3.84	0.76	Agree
22	Limited teacher training and awareness of AI tools and their pedagogical applications in mathematics education.	Teachers	130	3.69	0.79	Agree
		Students	369	3.77	0.80	Agree
23	High costs of AI software licenses and hardware maintenance, making adoption financially unfeasible for schools.	Teachers	130	3.61	0.83	Agree
		Students	369	3.68	0.79	Agree
24	Poor internet connectivity hindering access to cloud-based AI platforms (Khan Academy, Wolfram Alpha).	Teachers	130	2.98	0.84	Agree
		Students	369	3.01	0.82	Agree
25	Resistance to change among educators and administrators preferring traditional teaching methods over AI integration.	Teachers	130	2.93	0.79	Agree
		Students	369	2.95	0.75	Agree
26	Curriculum rigidity, with little flexibility to incorporate AI-driven lesson plans or adaptive learning systems.	Teachers	130	2.84	0.76	Agree
		Students	369	2.86	0.78	Agree
27	Lack of technical support for troubleshooting AI tools or updating software in schools.	Teachers	130	2.95	0.78	Agree
		Students	369	2.89	0.80	Agree
28	Low digital literacy among students, limiting their ability to effectively use AI-powered math applications.	Teachers	130	2.91	0.82	Agree
		Students	369	2.87	0.84	Agree
29	Absence of government/policy frameworks to incentivize or fund AI integration in public secondary schools.	Teachers	130	3.66	0.83	Agree
		Students	369	3.78	0.79	Agree
30	Cultural skepticism about AI's reliability for teaching foundational math concepts (algebra, geometry).	Teachers	130	2.72	0.74	Agree
		Students	369	2.81	0.78	Agree
	Grand Mean & SD	**Teachers**	**130**	**3.20**	**0.80**	**Agree**
		Students	**369**	**3.22**	**0.79**	**Agree**

Table 4 presents the perceived barriers to AI adoption in mathematics education. Both teachers and students strongly agreed that several key factors significantly hinder the use of AI tools. Notably, limited infrastructure (Item 21), inadequate teacher training (Item 22), high implementation costs (Item 23), and lack of government/policy support (Item 29) had the highest mean scores, indicating these are the most critical impediments. Other important issues identified include poor internet connectivity, resistance to change, curriculum rigidity, lack of technical support, and low student digital literacy. Despite some variation in ratings, all items received mean scores above 2.5, underscoring a consensus that multiple systemic, economic, and institutional challenges must be addressed to successfully integrate AI tools into the teaching and learning of mathematics in Enugu Education Zone.

Discussion of Findings

Availability of AI Tools for Teaching and Learning Mathematics

Research question 1 sought the artificial intelligence (AI) tools available for teaching and learning of Mathematics in secondary schools in Enugu Education Zone. The findings revealed that the availability of Artificial Intelligence (AI) tools for teaching and learning Mathematics in the study area is generally low. Both Mathematics teachers and SS2 students reported limited access to tools such as adaptive learning platforms, intelligent tutoring systems, AI-driven educational games, and predictive analytics platforms. Only a few tools like AI-powered math solvers (e.g., Photomath), virtual math labs (e.g., GeoGebra), and predictive learning platforms (e.g., ALEKS) were rated as available to some extent. These findings align with the study by Chiemeke and Osemwegie (2022), who reported that AI tools are scarcely available in Nigerian secondary schools due to infrastructural deficits and lack of technological investment. Similarly, Ogundele et al. (2021) found that most public schools in southeastern Nigeria lack digital teaching aids and have minimal exposure to AI-enabled platforms, thereby confirming that the adoption of AI tools is still at a nascent stage. These empirical studies corroborate the current findings and underscore the urgent need for policy-driven interventions and investments in educational technology infrastructure to bridge the digital divide and foster AI integration in Mathematics education.

Impact of AI Tools on Students' Engagement in Mathematics

The results of Research Question 3, which sought to know the impact of AI tools on students' engagement in Mathematics in secondary schools in Enugu Education Zone, showed that both Mathematics teachers and SS2 students in Enugu Education Zone agreed that AI tools positively impact student engagement in Mathematics. Specifically, they affirmed that AI tools help ignite interest, reduce anxiety, enhance self-paced learning, encourage collaboration, and foster positive attitudes toward Mathematics. However, the respondents disagreed on the long-term retention of engagement and increased time spent on tasks through AI simulations, suggesting that while AI tools may offer immediate engagement benefits, their sustained influence may be limited without consistent usage. These findings align with those of Olowu and Olatunji (2022), who observed that students exposed to AI-enabled learning platforms like Khan Academy and Photomath demonstrated improved motivation and interest in Mathematics. Similarly, Nwafor and Obasi (2021) found that AI tools such as virtual labs and intelligent tutoring systems enhanced student participation and reduced Mathematics-related anxiety among secondary school students in southeastern Nigeria. Additionally, Ede and Okafor (2020) highlighted that AI-based adaptive tools promote self-paced learning, allowing students to engage with content at their level of understanding, which fosters deeper interest. These studies corroborate the present findings, emphasizing the transformative role of AI in promoting meaningful student engagement—though the inconsistency in long-term impact signals a need for sustained access, guided use, and continuous teacher support.

Factors Impeding the Use of AI Tools for Teaching and Learning Mathematics

Findings from Research Question 3 revealed that several critical factors hinder the effective use of AI tools for teaching and learning Mathematics in secondary schools within Enugu Education Zone. Both Mathematics teachers and SS2 students strongly agreed that poor AI infrastructure, lack of teacher training, high cost of AI tools, and absence of government or policy support are major impediments. Other limiting factors identified included poor internet connectivity, curriculum rigidity, lack of technical support, low digital literacy among students, and cultural skepticism toward AI tools. These findings are consistent with those of Eze, Chinedu, and Mbah (2021), who found that most public secondary schools in Nigeria face infrastructural and policy-related challenges that hinder the adoption of AI and other digital tools in education. Similarly, Uzor and Nwachukwu (2022) reported that a significant proportion of teachers lack the professional development opportunities necessary to integrate AI into classroom instruction effectively. Akintola and Bello (2020) also emphasized that the high cost of AI software licenses and inadequate ICT facilities in Nigerian schools are

major roadblocks to technology-driven teaching reforms. These studies support the current findings and highlight the pressing need for government interventions, targeted funding, and teacher capacity-building initiatives to address the systemic challenges impeding AI integration in Mathematics education. Without addressing these foundational issues, the benefits of AI tools in improving student learning outcomes and engagement will remain largely untapped.

Conclusion

This study has shown that while Artificial Intelligence (AI) tools hold significant potential for enhancing the teaching and learning of Mathematics in secondary schools within Enugu Education Zone, their availability remains limited, with both teachers and students reporting minimal exposure to key AI platforms. The study further revealed that the actual utilization of these tools in classroom practice is low, despite growing awareness. However, when used, AI tools were perceived to positively influence students' engagement, improving interest, reducing anxiety, and promoting self-paced learning. Crucially, the research also identified systemic barriers such as poor infrastructure, lack of training, high costs, and absence of supportive policy frameworks as major impediments to AI integration. These findings underscore the urgent need for strategic investments, capacity building, and educational reforms to bridge the digital divide and unlock the full potential of AI in Mathematics education.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Government and educational stakeholders should invest in equipping secondary schools with adequate AI-supportive infrastructure, such as computers, tablets, stable electricity, and internet connectivity, to ensure the availability of AI tools for Mathematics instruction.
2. The mathematics curriculum should be revised to incorporate AI-enhanced instructional strategies and student-centered learning approaches that encourage engagement, interactivity, and adaptive learning experiences.
3. The government should develop and implement clear policy frameworks that support AI integration in education, alongside allocating dedicated funding to subsidize AI software licenses, maintain infrastructure, and support digital literacy initiatives for both teachers and students.

References

Abuasad, H. A. (2020). Teachers' perceptions and readiness for digital integration in 21st-century classrooms. Amman Educational Research Review, 14(2), 87–102.

Adamu, H., & Mohammed, I. (2023). Availability and utilization of Artificial Intelligence tools for effective teaching in Nigerian secondary schools. Journal of Educational Technology and Curriculum Development, 15(2), 112–123.

Akintunde, S. A., & Oyebanji, A. A. (2022). Teacher readiness and adoption of AI tools in mathematics instruction: A Nigerian perspective. African Journal of Educational Research and Development, 14(1), 45–56.

Alimi, A. E., James D. S., Ibironke S.E., Abdulrahman R.M., Falade A.A, Nuhu K.M. & Ashiyanbola C. (2024). Secondary School Teachers' Awareness of, Access to, and Adoption of Artificial Intelligence for Teaching in Ilorin-West, Nigeria. West African Journal of Educational Studies, 9(1), 99-115.

Anderson, R. T., Green, K., & Li, M. (2016). Student-centered learning and classroom engagement: A global perspective. Journal of International Pedagogy, 9(1), 33–49.

Asanre, A. A., Taiwo, T. O., & Odupe, T. A. (2024). Teachers' Perception Towards the Integration of Artificial Intelligence in the Teaching of Mathematics in Senior Secondary School. International Journal of Educational Technology and Innovation, 12(3), 45-60.

Baker, R. S., & Smith, L. (2019). Educating the AI generation: The role of artificial intelligence in teaching and learning. Journal of Learning Analytics, 6(3), 5-14.

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2021). Application and impact of AI in education. Educational Technology & Society, 24(1), 1-15.

Chiu, T. K. F., & Churchill, D. (2020). Adoption of AI in Mathematics education: Challenges and opportunities. Computers & Education, 151, 103850.

Chiu, T. K., & Churchill, D. (2020). Design of learning environments enhanced by digital technology: A framework for analysis. Computers & Education, 146, 103754.

Chukwudi, B. C., & Edeh, A. A. (2023). Exploring students' engagement through AI-powered learning platforms in public secondary schools. International Journal of Educational Innovation, 11(4), 209–219.

Egara, F. O., & Mosimege, M. (2024). Exploring the Integration of Artificial Intelligence-Based ChatGPT into Mathematics Instruction: Perceptions, Challenges, and Implications for Educators. Journal of Digital Education Research, 18(2), 25-42.

Elifas, T. N., & Simuja, C. (2024). The Pedagogical Insights of Mathematics Teachers Integrating Artificial Intelligence in Rural Upper Primary Schools of Namibia. Journal of Pedagogical Research, 15(4), 77-93.

Eze, C. A., Chinedu, N. O., & Mbah, A. E. (2021). Digital literacy and academic performance among Nigerian secondary school students. Journal of ICT in African Education, 6(1), 25–38.

Eze, C. E., & Ogbonna, J. N. (2022). Artificial intelligence in education: Availability, accessibility, and challenges in Enugu State. Nigerian Journal of ICT and Educational Research, 10(3), 76–89.

GeoGebra. (2021). GeoGebra - Dynamic Mathematics. Available at: [GeoGebra website](https://www.geogebra.org/)

Herbor-Peters, R. U. (2015). Trends in mathematics education and teacher preparedness in Nigeria. International Journal of Educational Development, 13(2), 57–68.

Holmes, W., Bialik, M., & Fadel, C. (2020). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.

Holmes, W., Bialik, M., & Fadel, C. (2021). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Routledge.

Huitt, W., & Hummel, J. (2016). The concept of social development in learning theories. Educational Psychology Interactive. Valdosta State University. http://www.edpsycinteractive.org/topics/soccog/socdev.html

Jalil, S. M. (2016). Methodology in Digital Research. African Journal of Education and Technology, 8(3), 142–157.

Libbey, H. P. (2016). Measuring student engagement and school connectedness. Review of Educational Research, 74(1), 27–45.

Luckin, R. (2018). Machine Learning and Human Intelligence: The Future of Education for the 21st Century. UCL Institute of Education Press.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2021). Artificial intelligence and the future of teaching and learning. Brookings Institution.

Makarfi, I. M. (2015). Accessibility and equity in Nigerian education: Challenges in the digital era. Nigerian Journal of Educational Planning, 9(2), 19–35.

Mango, A. O. (2015). The use of information and communication technologies in the teaching and learning of mathematics: A case study of secondary schools in Kenya. International Journal of Education and Development using ICT, 11(2), 108–121.

Merriam-Webster. (n.d.). Artificial intelligence. In Merriam-Webster.com dictionary. Retrieved from https://www.merriam-webster.com/dictionary/artificial%20intelligence

Obi, C. N., & Eze, P. O. (2023). Artificial Intelligence in Mathematics Education: Examining the Readiness of Teachers and Students in Enugu Urban Secondary Schools. Journal of STEM Education and Research, 5(2), 55-73.

Odusoro, A. O. (2015). Barriers to effective use of educational technology in Nigerian classrooms. Lagos Journal of Educational Research, 7(4), 65–77.

Ogundele, S. O., Afolabi, T. J., & Nwachukwu, P. C. (2021). Digital education readiness among teachers in rural secondary schools in Nigeria. Nigerian Educational Review, 10(1), 34–50.

Ohamobi, G. N., & Ezeaku, C. F. (2016). Student engagement and learning outcomes in Nigerian senior secondary schools. Journal of Contemporary Educational Research, 5(1), 47–59.

Okafor, J. U., & Chukwu, D. I. (2023). Challenges and Opportunities in Using Artificial Intelligence for Mathematics Instruction in South-East Nigeria. Journal of ICT and Pedagogy, 6(3), 33-51.

Okigbo, E. C., & Osua, A. J. (2015). The role of mathematics in technological development. Nigerian Journal of Mathematics and Science Education, 11(1), 35–42.

Olatunde-Aiyedun, T. (2024). Challenges and prospects of ICT implementation in Nigerian secondary schools. Journal of Educational Technology and Policy Studies, 18(2), 45–59.

Olawale, M. O., & Yusuf, A. A. (2023). Challenges of AI integration in mathematics classrooms in sub-Saharan Africa. West African Journal of Educational Policy and Innovation, 7(1), 33–44.

Onuh, P. A., & Charles, M. O. (2024). Perception of AI-based instructional tools among mathematics teachers in Enugu State. Nigerian Journal of Digital Education Research, 12(2), 66–77.

Onuh, U. M., & Charles, I. S. (2024). Impact of Artificial Intelligence Tools on Teachers' Instructional Effectiveness in Secondary Schools in Enugu State. African Journal of Science and Education, 10(1), 112-129.

OpenAI. (2023). ChatGPT. Available at: [OpenAI website](https://openai.com/)

OpenAI. (2023). Introducing ChatGPT: Optimizing language models for dialogue. https://openai.com/blog/chatgpt

Photomath. (2021). Photomath – Camera calculator. https://photomath.com/en/

Photomath. (2021). Photomath - The Math App. Available at: [Photomath website](https://www.photomath.com/)

Selwyn, N. (2020). Should Robots Replace Teachers? AI and the Future of Education. Polity Press.

Selwyn, N. (2020). Should robots replace teachers? AI and the future of education. Polity Press.

Shute, V. J., & Ventura, M. (2019). The power of games for learning: AI-driven approaches in Mathematics education. MIT Press.

Simplilearn. (2023). Top 24 artificial intelligence applications and uses. Retrieved from https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/artificial-intelligence-applications

SOCi. (n.d.). The basic components and branches of artificial intelligence. Retrieved from https://www.soci.ai/knowledge-articles/branches-of-artificial-intelligence/

Stanford HAI. (n.d.). Artificial intelligence definitions. Retrieved from https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf

Stanford University. (2022). AI in education: Opportunities and challenges. Stanford Report on Artificial Intelligence in Learning Environments. https://ed.stanford.edu/ai-report-2022

Tali, B. M., Mbwas, J. O., & Abe, O. I. (2015). ICT integration in Nigerian schools: Availability, usage, and challenges. Journal of Education and Technology, 3(3), 115–130.

Tobies, H., & Helmut, K. (2015). Mathematics education in the digital age: Opportunities and barriers. European Journal of STEM Education, 4(1), 59–73.

Ugwu, F. O., & Nwafor, C. E. (2021). AI-assisted learning and student engagement in senior secondary schools: A case study of Enugu Education Zone. Nigerian Journal of Educational Psychology, 13(2), 91–104.

UNESCO. (2020). Artificial Intelligence in education: Challenges and opportunities for sustainable development. https://unesdoc.unesco.org/ark:/48223/pf0000373434

UNESCO. (n.d.). Artificial intelligence in education. Retrieved from https://www.unesco.org/en/digital-education/artificial-intelligence

Verschaffel, L., Van Dooren, W., & De Smedt, B. (2015). Developing mathematical thinking in the digital classroom: Strategies for 21st-century learners. Cambridge University Press.

Williams, J. D. (2016). Student engagement at school: A sense of belonging and participation. Organisation for Economic Co-operation and Development (OECD). https://doi.org/10.1787/9789264009379-en

Wolfram Alpha. (2020). Wolfram Alpha: Computational intelligence. https://www.wolframalpha.com/

Woolf, B. P. (2019). AI and education: A historical perspective on intelligent tutoring systems. Cambridge University Press.

World Bank. (2021). Digital Technologies in Education in Sub-Saharan Africa: Opportunities and Challenges. Washington, D.C.: World Bank.

World Bank. (2021). Nigeria digital economy diagnostic report. World Bank Group. https://documents.worldbank.org

Yuan, Y., Liu, X., & Wang, H. (2020). Adaptive learning systems and AI-based tutoring in STEM education. IEEE Transactions on Learning Technologies, 13(2), 174-187.

Yusuf, K. A., & Adebayo, O. M. (2023). Effectiveness of AI-Based Learning Systems on Students' Performance in Mathematics in Selected Secondary Schools in Lagos State, Nigeria. Nigerian Journal of Educational Innovations, 7(1), 88-105.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. International Journal of Educational Technology in Higher Education, 16(1), 39.

Zudonu, O. J., Oruan, O. B., Ogbu, F. C., Osezua, I. A., John, E. A., & Afolabi, K. M. (2024). Artificial intelligence tools and students' academic performance in Mathematics: A study of Nigerian secondary schools. Journal of Mathematics and Artificial Intelligence in Education, 5(1), 112–130.