

Exploring the Potential of Artificial Intelligence tools in ... Haruna, A., Et. al. (2025)

Exploring the Potential of Artificial Intelligence Tools in Teaching and Learning: Mathematics Education Considerations

HARUNA, Auwalu¹

Email: auwalungeral@gmail.com

Phone: +2348033472272, +2348095425119

ALHASSAN, Isa D.²

Phone: 07031646483

YAKUBU, Lawan¹

lawanyakubu931@yahoo.com

Phone: +2348034411592

AHMAD, Manko Umar²

Email: ahmadmanko@yahoo.com

Phone: +2348065386808

GURJIYA, Sahabi Ibrahim¹

sahabigurjiya@gmail.com

Phone: +2347065822072,

¹Department of Mathematics, Sa'adatu Rimi University of Education Kumbotso, Kano

²Department of Mathematics, Niger State College of Education, Minna

Abstract

This position paper is an exposition of the practical relevance of Artificial Intelligent (AI) to the teaching and learning Mathematics, the bedrock of science, and a foundation knowledge for scientific development and economic growth of every nation. Mathematics is an academic discipline that embraces all courses, scientific models, critical thinking, creative thinking, problem-solving and development of Artificial Intelligent (AI). AI is transforming various fields of human endeavors, including health care, politics, economics, research and education. The rapid development of AI technology has become a need for mathematics educators, to enhancing teaching and learning of mathematics. Therefore, the concept of AI is examined along its benefits in teaching and learning of mathematics. The paper also explained some AI tools use in mathematics classroom, such as MathGPTPro, Wolfram Alpha, Julius AI, Maple calculator, etc. It then highlighted some constrictions in using AI tools in teaching and learning of mathematics. In conclusion, utilizing AI tools has a lot of benefits, as such mathematics educators, curriculum planners and stakeholders in the education industry must put their hands on desk to maximize the merits of AI in mathematics teaching-learning, while mitigating associated challenges. It is recommended that Educators and developers should collaborate to create AI powered resources that cater for diverse learning needs and styles, Teacher professional development programs should also be designed to support the effective integration of AI tools in mathematics education.

Keywords: Mathematics, Mathematics Education, e – Learning, Artificial Intelligence, AI tools

Introduction

Mathematics is the bedrock of sciences and foundation knowledge for scientific advancement. Mathematics is concerned with unending activities without limitations. It prepares man for life and involves life itself. It is an indispensable subject in all human activities. Mathematics is also known as the ‘Universal language of science’, it is essential to comprehending and explaining many facets of physical universe as well as the interaction between elements. It also offers a structure of applying mathematical language and symbols to represent complicated events to solve problems and reason logically (Nwuke & Anaekwe, 2023). Similarly, mathematics was seen to have provided the framework for scientific models, powers algorithm in computers, assists markets behavior, optimizes logistics, predicts weather patterns, and development of technological tools for teaching and learning of mathematics. The appliance of ICT can assist mathematics educators to obtain resources for outside their network, thus enabling them rework the teaching and learning process (Owolabi, et al., 2021). The application of ICT is intended to refine and elevate both learners’ learning and educators’ teaching qualities (Khalid, et al., 2014). In addition, it is a process of fitting technology to various teaching and learning environment whether



Exploring the Potential of Artificial Intelligence tools in ... Haruna, A., Et. al. (2025)

inside or outside classroom. Moreover, the mixing of ICT in education could increase students' competence supported global needs through skill shaping and increasing knowledge. All these advancements take place within educational settings, where teaching and learning are essential for nurturing the understanding and application of mathematical principles to meet up with the rent less pace technological innovation. The National Council of Teachers of Mathematics (NCTM 2014) said that technology is an essential tool for learning mathematics in the 21th century, and all schools must ensure that all their students have access to technology. Now let us discuss e-learning concept. The integration of technology in education has transformed the teaching and learning landscape. Artificial Intelligence (AI) tools, in particular, have shown great promise in enhancing the learning experience. Mathematics, a subject that requires critical thinking and problem-solving skills, can benefit significantly from AI-powered tools. The integration of Artificial Intelligence (AI) in education has transformed the way mathematics is taught and learned (Zawacki-Richter et al., 2019). AI tools can enhance personalized learning, automate grading, and provide real-time feedback, thereby improving student outcomes (Bairaktarova et al., 2021).

Despite the potential benefits of AI in mathematics education, many institutions struggle to effectively integrate AI tools into their teaching practices (Kearns, 2018). These challenges include limited access to AI-powered resources, inadequate teacher training, and concerns about the reliability and validity of AI-generated feedback. Furthermore, the lack of research on the impact of AI tools on mathematics learning outcomes and teacher pedagogy exacerbates the problem. This study aims to explore the potential of AI tools in teaching and learning mathematics, addressing the challenges and opportunities associated with their adoption. The discussion will inform educators, policymakers, and researchers on the potential benefits and challenges of AI adoption in mathematics teaching and learning (Ifenthaler & Yau, 2020).

Teacher and E- learning

Teacher serves a vital role in the e-learning experience for learners as they scaffold and facilitate their learning progress (Elliott & Soifer, 2022; Adelana et al., 2023). Teacher-student interaction, evaluation, and guidance in online learning are very important. As the implemental of any curriculum, teacher must create opportunity for effective online – learning. To align with stated educational objectives to meets diverse learners' need. Mathematics teacher can utilize digital tools and technologies to design learning environments that promote collaborative learning, creative thinking and problem- solving skills. The teacher supervises students' progress and provide support where necessary during the e- learning curriculum development and implementation. Then what is e-learning. E- learning is sometimes referring to as computer- based learning or online learning or distance learning. E- learning covers a range of applications, learning methods and processes. It is a kind of learning that makes use of internet and other important technologies to produce materials for learning, teaching and also regulate courses in an organization (Adelana et al., 2023). E- learning can be explaining as one kind of “distance learning” that take place across distance. However, the followings are some of distance learning: (i) Correspondence courses conducted through regular mail with little interaction. (ii) Tele courses: where content is delivered via radio of television board cast. (iii) CD-ROM courses where the interacts with static computer content. (iv) Mobile learning: by means of device, such as a cellular phone, PDAs and Digital audio players, such as iPods, MP3 Players.

E – learning is an instructional support by the use of ICT tools and applications which allows students to acquire new knowledge and skills, and enhance interactive learning among learners and teachers. It covers pedagogical approaches and electronically supported technologies (Egara, et al., 2020). ICT has become an important means for mathematics educators to accumulate teaching – learning resources in the forms of simulations, notes, exercises, brainstorming, and knowledge sharing. Studies shown that technology advancement has been integrate in mathematics teaching – learning through using Micro soft Excel, DERIVE, MATHEMATICA, MAPLE and Artificial Intelligence (AI). According to Ngwu (2015) revealed that e-learning have a positive impact on teaching and learning and their interest in mathematics learning especial statistics. In another study conducted by Mailizar et al., (2020) reported that e- learning is learners' center that improves academic performance and encourages group learning. Raheem and Khan (2020) also submitted that e – learning has been assisting learners to study at home and improves their academic performance. Alam (2022) opined that e-learning machine model is concerned with need to improve the sub-stain development of our students, from the procedure; students can analyze what they have gained through online lesson with the application of technological tools by interactive with video lessons. Mathematics teachers provide structure support and exposed students to visit online lessons and, also listening to



Exploring the Potential of Artificial Intelligence tools in ... Haruna, A., Et. al. (2025)

the recorded lesson on floppy disc or memory card, which in turn bring a better understanding. With these little literatures, there is need to incorporate e-learning into all levels of our educational systems especially in this era of Artificial Intelligence (AI).

Concept of Artificial Intelligence (AI)

Artificial intelligence (AI) is the theory and development of computer systems capable of performing tasks that historically required human intelligence, such as recognizing speech, making decisions, and identifying patterns. AI is an umbrella term that encompasses a wide variety of technologies, including machine learning, deep learning, and natural language processing (NLP). Asha and Herrman (2021) defined AI as computers that do cognitive functions, such as learning and problem solving, that are often associated with human brains. Data mining, natural language processing, machine learning, neural networks, and algorithms are some examples of technologies and methodologies in AI. According to Spencer and Fibersima (2023) submitted that AI is built up of five major areas. These include: Expert System (ES), Natural Language Processing (NLP), Robotic(R), Fuzzy Logic (FL) and Neutral Networks (NN). With all these areas in AI has make it potential to transform many different industries including education sector, since our focus point is education especially areas of teaching-learning of mathematics. These areas exist and are combination of rule-based systems, machine learning, deep learning and cognitive computing. The major branches of AI are:

Expert Systems (ES): ES in Artificial Intelligence are computer programs designed to emulate the decision-making abilities of human experts in a particular discipline. It is the knowledge base, which collect facts and rules to make decisions and solve problems in a specific domain, such as education, finance or medicine. ES is developed and maintained by human experts.

Natural Language Processing (NLP): NLP is sub-section of AI that deals with interaction between computers and humans in natural human language with objectives to create understanding, interpret and generate human language. It has applications in machine translation, sentiment analysis, text classification and question-answering systems. It also has difficulties in context, is ambiguous, or is sarcastic.

Robotics: It is the section of AI that deals with designs, construct, operate as well as computer systems for their control, sensory feedback, and information processing. Robotics involves the integration of mechanics, electronics and software engineering to develop robots that can perform different tasks and it is also AI agents that operate real- world. Robots are developed to manipulate objects by seeing, picking, moving, altering the physical qualities of the objects, destroying it or having an impact, freeing human labor or exhausting repetitive tasks or distracting. Demerit of robotics is destroying the jobs that require human labors manually.

Fuzzy Logic: FL is alternative to classical (Boolean) which perform binary decisions (true/false or 1/0) and is a mathematical framework that permits the modeling of uncertainty, vagueness, and imprecision in complex system. FL has applications in various fields, including control systems, decision making, pattern structure, and can uses degrees of truth that can range between 0 and 9, representing the degree of membership of an element in a certain group.

Neural Networks: NN is a kind of machine learning algorithm, modeled after the structure and functions as the human brain, which are composed of interconnected processing nodes, called artificial neurons, which process and transmit information. NN involves adjusting the strengths of the connections between neurons based on input and desired output data. This allows the network to make predictions or decisions based on the input data, and also improve its accuracy over a period of time based on training. It is applied in different fields, including image and speech recognition, natural language processing and game-playing.

In this era, the Intelligent Tutoring System (ITS) has become very popular and useful in our institutions of learning, health and financial institutions. It has been described as computer-based instruction systems, which provide students opportunities for self-directed and personalized learning by giving intelligence that will assist and guide (Ayelaage, 2024). The usage of ITS has provide an opportunity for learners to learn at their own pace and receive adaptive feedback on their advancement in the task. Mathematics educators were trained in shaping the students' mathematical thinking, reasoning and confidence. They are also charged to develop the students' academic, personal, social skills and mentorship, guides and role model. Mathematics educators and mathematics teachers need to collaborate with I.T practitioners in developing effective and innovative methods in our classroom settings through the usage of AI tools in mathematics. This will also assist in remediate mathematics learning disabilities to tackle mathematics contents that may be seen difficult, abstract in



Exploring the Potential of Artificial Intelligence tools in ... Haruna, A., Et. al. (2025)

nature and not too exciting. Practical applications of AI tools in the mathematics discipline are diverse and implemented using different methods. Some of the AI models used are presented in this section and they are discussed:

AI Tools in Mathematics Education

According to Mohamed, et al., (2022), Owan, et al., (2023) and Zakariyya, et al., (2024) that AI tools are potential to bring about effective teaching and learning in classroom setting and they are as follows:

Personalized Learning: These are tools and systems based on AI, which have potential to customize learning experiences, boost the productivity of mathematics teacher and heighten student engagement.

Automated Grading: It is an AI tool that can use to assist in score grading process, saving time for teachers and providing students with immediate feedback on their assignments.

Predictive Analytics: This AI tool can be used to identify students who may need additional support, enabling mathematics teacher to provide targeted interventions. It also can analyze student attendance, engagement, and performance data to predict future outcome.

MathGPTPro: This is an advanced AI- powered mathematics tutor designed to offer swift and interactive solutions to mathematics powers. It can also facilitate a progressive learning experience in teaching and learning of mathematics.

Wolfram Alpha: It is a computational engine that excels in solving mathematics queries and providing detailed explanation. It is capable to handle diverse mathematics areas and also can serve as resource for students seeking to deepen their comprehension and analytical skills.

Julius AI: It stands out as educational AI tools that offer the most powerful AI math-solving engine with features like scan-and-solve, step-by-step answer generation, and chat explanations.

Maple calculator: It is designed to solve complex mathematics problems swiftly and its strength lies in comprehensive features, including advanced function solving, graphing tools, educational games, making mathematics learning both effective and engaging.

Camera-math: It is an AI app, offers solutions, tutoring and a wealth of mathematics resources, which provides personal supports and step-by-step solutions catering to students' diverse needs in calculus, algebra and beyond.

Challenges

AI offers a lot benefits to both teachers and students in mathematics education. At this new era of AI in education, students learn and engage with mathematics, they often find smooth and effective integration of new educational technologies. Some of these benefits include; personalized instruction, adaptive assessment, collaborative learning, grading automation, real time feedback, and among others (Owan, et al., 2023 and Zakariyya, et al., 2024). Despite the facts that artificial intelligence (AI) has the potential to revolutionize mathematics education, it poses numerous challenges, and here are some, identified under the following types.

Ethical and Socio-Economic Challenges

- i. Job Displacement - AI could potentially displace human teachers, particularly for routine or procedural math tasks.
- ii. Lack of transparency-that is to say no transparency in decision-making. It can be challenging to understand how AI algorithm arrived at some conclusions. This makes it difficult for mathematics educators to assess the accuracy and fairness of the assessments.
- iii. The utilization of AI tools in mathematics raises much concerns, such as privacy and ownership, as well as issues around using technology to replace human educators. It is also great challenge in this process.
- iv. Cost- the development and implementation of this newly educational technologies may involves large financial resources, which some schools or institutions may not have the resources to invest, that can lead to unequal access to these AI tools for mathematics education.
- v. Bias in AI Systems: AI algorithms may perpetuate existing biases in math education, such as gender or cultural biases.

Teacher-Related Challenges

- i. Lack of stakeholders- mathematics educators, curriculum planners, parents were not included in development of artificial intelligence some questions rise in using it are not well address during development.



Exploring the Potential of Artificial Intelligence tools in ... Haruna, A., Et. al. (2025)

- ii. Inadequate training- mathematics educators must be trained to understand how to use the technology effectively. Without adequate training of mathematics educators, they may be unable to use the tools effectively which may lead to underachievement in learning outcome.
- iii. Limited understanding – another challenge with using AI powered tools in mathematics education is that the educators may have limited understanding of how the technology operates. They may lack technical expertise to fully comprehend the algorithm used in AI tools, and how they affect learning outcome.

Pedagogical and Learning Challenges

- i. Dependence on Technology - Over-reliance on AI-powered tools might hinder students' ability to develop essential math skills, such as problem-solving and critical thinking.
- ii. Lack of creativity and problem –solving skills - mathematics education is more than just finding solution to a stated problem; it is also aimed to cultivating creativity and problem solving abilities among learners of mathematics. AI algorithms are excellent at pattern detection and optimization but lack human creativity and ability to think aloud. This will result to discouraging learners to try new problem – solving methods. Furthermore, whenever confronted with real – life situations in which critical and creative thinking is required, they will solely depend on AI.
- iii. Lack of emotional intelligence – mathematics is more than presenting knowledge; it also needs creating welcoming learning atmosphere. With AI usage, emotional intelligence may be lacking and cannot provide the equal level of empathy, encouragement and emotional support human teachers can.

Technical and Infrastructural Challenges

- i. Data management- AI- powered mathematics tool generate large amount of data that must be stored, managed and analyzed. Mathematics educators must ensure that the data is accurate, secure, and compliant with privacy regulation.
- ii. Technical difficulties – AI powered mathematics tools require a stable and reliable technology infrastructure. Technical difficulties; like power outage, internet disruptions or software malfunctions can disrupt the effectiveness teaching and learning process in mathematics.

Conclusion

Mathematics AI tools are newly educational technologies to improve teaching and learning in this era of 21st century. The mathematics AI tools can diagnose students with special needs, when the tools are well integrated with caution considering alongside with traditional methods, like textbooks, classroom instruction, teacher guidance and ethical implication. This can then build a future where AI and mathematics educators collaborate to empower students with the mathematical skills, critical thinking talents, problem-solving skill and ethical awareness required for success in everlasting era of technological era. The integration of AI into mathematics education has opened new phase for personalized collaborative, interactive and effective learning in mathematics. As we embrace the changes and demands of the AI era, the future of mathematics education in Nigeria is poised for a transformative journey. It is a future where mathematics is not seen as numbers and equations, but about understanding complex systems, solving real-world problems and preparing our students for a world, where AI is not only a tool, but a fundamental phase of their lives.

Recommendations

The following suggestions were made, among others:

1. Develop AI-powered resources: Educators and developers should collaborate to create AI powered resources that cater for diverse learning needs and styles.
2. Provide teacher training: Teacher professional development programs should be designed to support the effective integration of AI tools in mathematics education.
3. Conduct further research: Researchers should conduct longitudinal studies to investigate the impact of AI-powered tools on mathematics learning outcomes and teacher pedagogy.
4. Address equity and access concerns: Policymakers and educators should ensure that AI powered tools are accessible to all students, regardless of socio-economic background or geographical location.



Exploring the Potential of Artificial Intelligence tools in ... Haruna, A., Et. al. (2025)

References

- Adelana, O. P., Ayanwale, M. A., Ishola, A. M., Oladeja, A. I., & Adewuyi, H. O. (2023). Exploring pre-service teachers' intention to use virtual reality: A mixed method approach. *Computers and Education: x Reality*, 3, 100045.10.1016/j.cexr.2023.100045
- Alam, A. (2022). Educational robotics and computer programming in early childhood education: A conceptual framework for assessing elementary school students' computational thinking for designing powerful educational scenarios: *International Conference on Smart Technologies and Systems for Next Generation Computing(ICSTSNGC)*
- Asha, A. & Herrmann, H. (2021). Artificial intelligence and fintech: An overview of opportunities and risks for banking, investments, and macro finance strategic change, 30(3), 211- 222
- Bairaktarova, D., et al. (2021). Artificial intelligence in education: A review of the literature. *Journal of Educational Computing Research*, 64(4), 419-437.
- Egara, F. O., Nzendibe, A. C., Inweregbuh, O. C., Osakwe, I. J. & Okeke, A. M. (2020). Secondary school students' perception of e-learning in the study of mathematics amidst Covid-19 pandemic. *Abacus The Journal of Mathematical Association of Nigeria*, 49(1), 344 – 359
- Elliott, D., & Soifer, E. (2022). Artificial Intelligence technologies, privacy, and security frontiers in Artificial Intelligence, 5,826737.10.3389/frai.2022.8263375493613
- Ifenthaler, D., & Yau, J. (2020). Artificial intelligence in education: A review of the current state of the art. *Educational Technology Research and Development*, 68(1), 15-34.
- Kearns, D. T. (2018). Artificial intelligence in education: Opportunities and challenges. *Journal of Educational Data Mining*, 10(1), 1-15.
- Khalid, F., Joyes, G., Ellison, L. & David, M. D. (2024). Factors influencing teachers' level of participation in online communities. *International Educational Studies*, 7, 23 – 32
- Mailizar, M., Manlina, S. & Bruce, S. (2020). Secondary school mathematics teachers' views on e-learning implementation barriers during COVID- 19 pandemic: The case study of Indonesia. *Eurasia Journal of Mathematics, Science and Educational Technology*, 11(7), 1 - 9
- Mohammed, M. Z., Hidayat, R. Suhaizi, N. N., Sabri, N. B., Mahmud, M.K. & Baharuddi, S. N. (2022). Artificial Intelligence in mathematics education: A systematic literature review. *International Electronic Journal of Mathematics Educ*, 17(3), 69-145
- National Council of Teachers of Mathematics (2014). *Principles to Action: Ensuring Mathematical Success for all*. Reston, VA: Author
- Ngwu, O. G. (2015). The effect of e –learning on secondary school students' interest in basic statistics. *The International Conference on E – Learning in the Workplace*, June 10th – 12th, 2015 New York, NY, USA, 1 – 5 <http://www.icew.org>
- Nwoke, N., & Anaekwe, E. (2023). Diagnosis and remediation of mathemaphobia among junior secondary students in Etche Local Government Area of River State, *FNAS, Journal of Mathematics and Science Education*, 4(1), 51 - 59
- Owan, V. J., Abang, K. B. & Idika, D. O. (2023). Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Eurasia Journal of Mathematics, Science and Educational Technology*, 19(8), 1305 -8223(online)
- Owolabi, Y. T., Lawal, A. A. & Issa, A. R. (2021). Benefits and constrictions of using ICT in teaching mathematics in Nigeria schools, *Nigerian Journal of Educational Studies and Research (NJESR)*, 14(1), 78 -89
- Spencer, P. & Fibersima, A. R. (2023). Artificial Intelligence driven medical diagnostic systems for quality service delivery and business prospects, *FNAS, Journal of Mathematics and Science Education*, 5(1), 133 -142
- Zakirayya, A.A., Ahmad, M. U. & Kure, D. I (2024). Promoting diversity and inclusiveness in the learning of mathematics through the use of artificial intelligence. *A Paper Presented at 60th Annual MAN National Conference*
- Zawacki-Richter, O., et al. (2019). Systematic review of research on artificial intelligence in education. *International Journal of Artificial Intelligence in Educ*, 29(1), 39-61.