THE TRANSFORMATIVE ROLE OF CHATGPT IN THE TEACHING AND LEARNING OF MATHEMATICS IN THE NIGERIAN EDUCATION SYSTEM

PAUL AIGHEGBESE EBHOMIEN[1]*

DEPARTMENT OF SCIENCE AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION, AMBROSE ALLI UNIVERSITY, EKPOMA, NIGERIA

*Corresponding author: ebhospaul@aauekpoma.edu.ng

Abstract

Chat Generative Pre-Trained Transformer (ChatGPT) is an AI-powered Chatbot that offers coherent and useful response based on large volume of data. In this article, academicians, researchers, scientists, and engineers discussed the Effective and Transformative Role of ChatGPT in the Teaching and Learning of Mathematics in Schools, which is aimed at enhancing students' learning experience in mathematics classrooms. The study looked at the opportunities of ChatGPT model in mathematics education; prospects of ChatGPT in mathematics education; cue of ChatGPT for future pedagogical approaches; and constraints and worries of ChatGPT model to mathematics education. Our preliminary evaluation indicated that ChatGPT perform effectively in different subject areas including finance, coding and mathematics. ChatGPT has the ability to help mathematics educators to create instructional content, offers suggestions and act as an online educator to students by answering questions, transforming education through smartphones, IoT gadgets, and promoting group work. There are possible and clear drawbacks in its implementation, such as the possibility of producing inaccurate or false data and circumventing duplicate content (plagiarism) detectors where originality is essential. What ChatGPT lacks is a stochastic measure to help provide sincere and sensitive communication with its users. Academic regulations and evaluation practices used in educational institutions need to be updated, when ChatGPT is been used as a tool in education. To address the transformative effects of ChatGPT on the learning environment, educating teachers and students alike about its capabilities and limitations will be crucial.

Keywords: Artificial intelligence, Chatbot, ChatGPT, IoT gadgets, Mathematics Education, Teaching and Learning.

Introduction

Mathematics also known as the queen of science and technology is a field of study that explores numbers, quantities, shapes, patterns, and relationships. It is both a theoretical discipline as well as a practical tool used to understand and describe the world. The key aspects of mathematics not limited to these are: Arithmetic, Algebra, Geometry, Calculus, Statistics, Probability and Discrete Mathematics. Mathematics is applied in science, technology, engineering, economics, finance as well as everyday life. The importance of mathematics in every sector of any economy cannot be overemphasized hence researchers all over the world have searched for a more modern, attractive, encouraging and simulating method of teaching and learning this all importance subject. Among many modern methods of teaching and learning mathematics in the world today, Artificial intelligence (AI)

and its tools stand out in this 21st century.

In the last few years, Artificial intelligence (AI) has generated a lot of interest among researchers and scholars in the field of mathematics, science and technology education. AI has been described by researchers and scholars as a creative and imaginative advancement in many fields, including mathematics instruction. Many researchers have analyzed a number of studies that looked into the application of AI in different discipline such as medical (Jianxing et al., 2019), education (Lijia et al., 2020, Bill et al., 2021; Xuan-Quy et al., 2021, Thi-My-Thanh et al., 2021) and pandemics (Raju et al., 2020). They have argued that the role of educators should not be replaced by AI rather, it should be used to enhance and improve the teaching and learning process in school which will help to improve the overall performance of the learners (Stefan, et al., 2017).

The implementation of AI in education may have its own challenges despite the potential benefits. However, in order to improve student learning outcomes and get around obstacles like a shortage of qualified teachers and teaching resources (Ke & Ayse, 2021) using AI in education may have the potential of becoming more popular and helping to resolve the gaps created by shortage of human and materials for effective teaching and learning. According to researcher, AI is critical for sustainable societal innovation, growth and can boost student academic achievement in mathematics as well as other subjects. Academic achievement in mathematics is important for learners' academic progress, future employment prospects and social growth, and it is connected to civil rights issues (Adam & Eileen, 2021). Therefore, preparing students with mathematics skills and knowledge is crucial for adapting to a society that is changing rapidly and ensuring sustainable development and growth. A comprehensive literature review was conducted by a team of researchers and scholars to provide an overview of AI in mathematics education for students at all levels of education, which represented one of the few studies on the effects of AI on mathematics education. This review contributed to the discussion about enhancing teaching and learning in mathematics education through the use of AI.

Artificial intelligence (AI) has developed in a fast and rapid manner in recent years spanning across all sphere of human endeavour including education. AI Platforms like ChatGPT, developed by OpenAI and launched in 2022 have began to show as a potential tool for mathematics teaching and learning in schools (Baidoo-Anu & Ansah, 2023). This platform leverage vast amounts of data, iterative training, and natural language processing capabilities to assist users such as learners and students in a lot of tasks, including answering mathematical questions.

It is becoming clear from previous researches that ChatGPT in mathematics education has the potential to transform teaching and learning, making mathematics more accessible, engaging, and tailored to individual needs while emphasizing critical thinking and collaboration. ChatGPT stands out for its ability to provide prompt feedback, addressing the distinct needs of individual learners. This feature is especially beneficial for those having challenges in understanding mathematical drills, concepts and principles, as it offers the students personalized explanations and insights (Supriyadi & Kuncoro, 2023). In contrary to traditional or conventional instructional methods that might sometimes result in delayed feedback, ChatGPT guarantee real-time responses, paving the way for swift understanding and adjustment of learners (Escotet, 2023).

A study by Wardat et al. (2023) studied ChatGPT's performance in answering geometry related questions. Their findings revealed that while ChatGPT has the capability to carry out mathematical computations and resolve mathematical equations, its accuracy and efficiency could vary based on factors such as the intricacy of the problem, input data precision, and the clarity of the directives provided to the ChatGPT model. In the context of schools where large class sizes often present challenges in providing personalized guidance, ChatGPT could offer a promising solution capable of catering for the multitude of students simultaneously. It promises an inclusive learning experience, ensuring no student is left behind without support (Wardat et al., 2023).

As the integration of AI tools into education grows rapidly, the potential benefits and

challenges of employing ChatGPT as a tool for effective and efficient mathematics teaching in schools become more evident. Hence, it is imperative that researcher in mathematics education focuses on the effective and transformative role of ChatGPT in the teaching and learning of mathematics in schools. The interest is to critically shed light on ChaTGPT advantages, disadvantages, future, limitations, features, and implications for future pedagogical approaches.

Opportunities of ChatGPT Model in Mathematics Education

Incorporating ChatGPT into the classroom can enhance both teaching and learning experiences in mathematics. Therefore, the use of ChatGPT can offer several opportunities in the teaching and learning of mathematics in schools:

1. Personalized Learning Pace: ChatGPT is effective in adapting to students' learning paces and styles, providing suitable explanations and examples to meet their respective needs.
2. Availability/Accessibility: Students can access quality help at any time using ChatGPT and it can allow students to work through problems and concepts outside of classroom or school hours.
3. Instant Feedback: The use of ChatGPT can offer immediate feedback on students' work thereby helping them to understand mistakes and learn from them in real time.
4. Engaging Practice: ChatGPT create interactive problem sets and quizzes thereby making students practice more engaging and enjoyable.
5. Clarification of Concepts: ChatGPT can break down complex mathematical concepts into simpler, more digestible parts, making it easier for students to understand.
6. Supplementary Resources: ChatGPT can recommend additional resources, such as videos, articles, or exercises, to enhance student understanding of mathematics concepts and skills.
7. Encouraging Exploration: Students can ask questions freely and explore various mathematical topics beyond the curriculum, fostering a love for the teaching and learning of mathematics in schools.
8. Support for Teachers: ChatGPT can assist Mathematics teachers by providing lesson plans, explanations, and even grading assistance, allowing them to focus more on students' engagement.
9. Collaboration Opportunities: ChatGPT can facilitate group work by helping mathematics students brainstorm solutions together or offering group problem-solving activities.
10. Building Confidence: By providing a safe space for students to ask questions and practice, ChatGPT can help build their confidence in their mathematical abilities.

Drawbacks of ChatGPT Model in Mathematics Education

In as much as ChatGPT can be a valuable or a viable tool in the teaching and learning of mathematics in schools, there are also several drawbacks to consider:

1. Lack of Deep Understanding: Students over reliance on ChatGPT for answers could hinder their ability to develop critical thinking and problem-solving skills.
2. Inaccurate Information: The use of ChatGPT may occasionally provide incorrect or misleading answers, which can confuse students or reinforce misconceptions.
3. Over-reliance on Technology: Over dependence on ChatGPT tools could reduce students' motivation to learn using traditional or conventional instructional resources and methods.
4. Limited Contextual Understanding: ChatGPT maybe slow to understand specific classroom contexts, grills or individual student needs. That could lead to generic responses that may not be helpful or useful to the student.
5. Interpersonal Skills Development: Excessive use of ChatGPT tools for mathematical problem-solving could limit opportunities for students' collaborative learning and interpersonal skill development.

6. Reduced Engagement: Some students may find interactions with ChatGPT tools less interesting more than traditional conventional instructional methods, which can lead to decreased motivation.

7. Privacy and Security Concerns: The use of ChatGPT tools may raise concerns about data privacy and security of student information.

8. Difficulty with Advanced Topics: While ChatGPT can handle many mathematical concepts, it may find it difficult with advanced topics, limiting its usefulness in higher-level mathematics.

9. Misinterpretation of Questions: Students inability to phrase their questions clearly may lead to misunderstandings and irrelevant or off-topic responses.

10. Equity Issues: Depending on location and family background, not all students may have equal access to technology or the internet, creating disparities in learning and learning opportunities.

Balancing the use of ChatGPT with traditional or conventional teaching methods and critical thinking exercises can help mitigate these disadvantages.

The Prospect of ChatGPT in Mathematics Education

The prospect of ChatGPT in the teaching and learning of mathematics in schools holds exciting possibilities:

1. Enhanced Personalization: As AI technology evolves over time, ChatGPT could offer even more personalized learning experiences, adapting to individual student needs and learning styles more effectively.

2. Integration with Curriculum: Schools may integrate AI tools such as ChatGPT directly into the curriculum to complement traditional teaching methods and enhance lesson plans.

3. Real-Time Collaboration: Future versions of ChatGPT model may support effective real-time collaboration among students and teachers, allowing for interactive problem-solving sessions and discussions.

4. Adaptive Learning Environments: AI such as ChatGPT could create dynamic learning environments that adjust based on student performance, providing additional resources or challenges when needed.

5. Gamification of Learning: ChatGPT could help develop gamified learning experiences that make mathematics more interesting, engaging and enjoyable for students, encouraging exploration and creativity.

6. Teacher Support: AI tools such as ChatGPT may assist educators by automating administrative tasks, generating assessments, and providing insights into student academic performance, allowing teachers to focus on classroom instruction.

7. Increased Accessibility: ChatGPT as an AI tool could help bridge gaps in education, offering support to students in areas with learning difficulties, providing them with resources and explanations they might not otherwise receive.

8. Integration with other Technologies: Future applications may incorporate augmented reality (AR) or virtual reality (VR) to create immersive mathematics learning experiences, thereby helping students visualize concepts in a new way.

9. Focus on Critical Thinking: As AI tools evolve, there could be a greater emphasis on fostering critical thinking and problem-solving skills, thereby encouraging students to engage with mathematical concepts more deeply.

10. Ethical and Responsible Use: Ongoing discussions about the ethical use of AI tools in education will shape how ChatGPT and similar technologies are implemented, ensuring that they promote equity and respect privacy.

Cue for Future Pedagogical Approaches

Researchers growing concern is the possibility of mathematics students becoming excessively dependent on AI, which might erode their analytical and critical thinking skills (Wardat et al., 2023). Furthermore, the evident shortfall of AI in emotional intelligence, an integral aspect of human educators essential for motivation and comprehension, presents a considerable challenge. The careful integration of AI into academic environments necessitates thorough deliberation, especially concerning data privacy and potential misuse (Farrokhnia et al., 2023; Kortemeyer, 2023; Liu et al., 2023) Marrying traditional or conventional teaching methods with AI tools like ChatGPT can usher in a comprehensive and smart learning environment for learners. Such an approach leverages the combined strengths of human educators and AI systems. As the nature of mathematics education continues to evolve, there is a pressing need for AI tools to undergo perpetual refinement to remain pertinent, effective and efficient. The insights derived from various research studies (Baidoo-Anu & Ansah, 2023; Escotet, 2023; Supriyadi & Kuncoro, 2023) amplify the existing discussions on the incorporation of Chatbots in pedagogical settings. These insights highlight the significance of various theoretical frameworks during Chatbot creation and evolution. Furthermore, they highlight the need to reconsider long-standing educational philosophies to make room for the growing influence of Chatbots in learning spaces.

A close look at the importance of data across disciplines, mathematics instruction might intensify its focus on data literacy and statistical acumen. Learners and students might be trained to gather, scrutinize, and analyze data, base decisions on statistical findings, and comprehend the role of statistics across various fields such as the sciences, social sciences, and commerce. Moreover, with the rising emphasis on computational thinking, coding and programming are poised to become intrinsic to mathematics instruction. This would allow students to craft mathematical algorithms, delve into mathematical theories via coding, and dissect mathematical challenges using digital technologies or tools. Such integration promises to boost problem-solving abilities, logical deduction, and the synergy between mathematics and computer science.

Furthermore, AI platforms like ChatGPT are equipped to tackle intricate mathematical challenges, spanning integrals to differential equations. However, it is paramount to recognize that ChatGPT might not invariably provide the most optimal solutions, necessitating validation from other reliable sources (Wardat et al., 2023).

Constraints and Worries of AI to Mathematics Education

The potential over-reliance on AI technologies or tools by mathematics students could undermine their intrinsic problem-solving and critical thinking skills or abilities (Wardat et al., 2023). This dependence on ChatGPT could be counterproductive for both mathematics students and educators. For learners, it could lead to a decline in essential cognitive faculties such as creativity, analytical reasoning, and problem-solving skills (Farrokhnia et al., 2023). Such a situation can reduce the learners' intrinsic motivation to engage in independent research or form personal insights. On the part of mathematics educators, over-dependence could dilute the richness of their interaction with students and exacerbate educational disparities.

Another limitation is AI inability to emulate the emotional intelligence of a human teacher, which often undermines motivation and comprehension in educational settings. Moreover, concerns related to data privacy and potential misuse loom largely when introducing any AI tool in educational contexts (Farrokhnia et al., 2023; Kortemeyer, 2023; Liu et al., 2023).

Conclusion

The introduction of AI technologies or tools such as ChatGPT into the teaching and learning of mathematics education brings robust and desired advantages. However, the critical point lies in

striking a judicious balance between leveraging these benefits and being wary of potential challenges. As the educational landscape continues to evolve, a collaborative initiative involving educators, technologists, and policymakers becomes indispensable to fully realize the potential of AI in reshaping the future of mathematics education across all educational echo system.

References

Adam, G., & Eileen, C. H., (2000). Algebra for everyone? Benefits of college-preparatory mathematics for students with diverse abilities in early secondary school. *Educational Evaluation and Policy Analysis, 22*(3), 241–254.

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI, 7* (1), 52–62. https://doi. org/10.2139/ssrn.4337484.

Bill, C., Mary, K., & Duane, S., (2021). Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies. *Educational Philosophy and Theory, 53* (12), 1229–1245.

Escotet, M. Á. (2023). The optimistic future of Artificial Intelligence in higher education. *Prospects,* 1–10. https://doi.org/10.1007/s11125-023-09642-z.

Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2023). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International,* 1–15. https://doi.org/10.1080/14703297.2 023.2195846.

Jianxing, H., Sally, L. B., Jie, X., Jiming, U., Xingtao, Z., & Kang, Z., (2019). The practical implementation of artificial intelligence technologies in medicine. *Nature medicine, 25* (1), 30–36.

Ke, Z., & Ayse, B. A., (2012). AI technologies for education: Recent research & future directions. *Computers and Education: Artificial Intelligence, 2*.

Kortemeyer, G. (2023). Could an artificial-intelligence agent pass an introductory physics course? *Physical Review Physics Education Research, 19 (1).* https://doi.org/10.1103/PhysRevPhysEducRes.19.010132

Lijia, C., Pingping, C., & Zhijian, L., (2020). Artificial intelligence in education: A review. *Ieee Access, 8,* 75264– 75278.

Liu, M., Ren, Y., Nyagoga, L.M., Stonier, F., Wu, Z., & Yu, L. (2023). Future of education in the era of generative artificial intelligence: Consensus among Chinese scholars on applications of ChatGPT in schools. *Future in Educational Research, 1* (1), 72–101. https://doi.org/10.1002/fer3.10.

Raju, V., Mohd, J., Ibrahim, Haleem, K., & Abid, H., (2020). Artificial intelligence (AI) applications for covid-19 pandemic. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14* (4), 337–339.

Stefan, A. D., Popenici, T., & Sharon, K., (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning, 12* (1), 1–13.

Supriyadi, E., & Kuncoro, K. S., (2023). Exploring the future of mathematics teaching: Insight with ChatGPT. *Union: Journal Ilmiah Pendidikan Matematika, 11* (2), 305–316. https://doi.org/10.30738/union.v11i2.14898

Thi-My-Thanh, N., Thanh-Hai, D., Bac-Bien, N., Ngoc-Bich, L., & Xuan-Quy, D., (2021), *Design of online learning platform with vietnamese virtual assistant.* A paper delivered at the 6th International Conference on Intelligent Information Technology, pp. 51–57.

Vygotsky, L.S. (1978). *Mind and society: The development of higher psychological processes.* Harvard University Press.

Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. Eurasia Journal of Mathematics, Science and Technology Education, 19 (7). https://doi.org/10.29333/ejmste/13272.

Xuan-Quy, D., Ngoc-Bich, L., & Thi-My-Thanh, N., (2021). *Ai-powered moocs: Video lecture generation.* A paper delivered at the 3rd International Conference on Image, Video and Signal Processing, pages 95–102.