


The impact of artificial intelligence and the future of ChatGPT for mathematics teaching and learning in schools and higher education



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The rapid evolution of artificial intelligence (AI) has profoundly impacted various sectors, including education. Platforms like ChatGPT, developed by OpenAI, have begun to show potential as tools for mathematics teaching and learning (Baidoo-Anu & Ansah, 2023). These platforms leverage vast amounts of data, iterative training, and natural language processing capabilities to assist users such as learners and students in myriad of tasks, including answering mathematical queries. As the integration of AI into education grows, the potential benefits and challenges of employing tools like ChatGPT for mathematics teaching in both schools and higher education become more evident. Hence, it is imperative that future research in mathematics education focuses on the transformative role of ChatGPT and similar AI platforms in an effort to shed light on their advantages, limitations, and implications for future pedagogical approaches.

Advantages of ChatGPT in mathematics education

ChatGPT stands out for its ability to provide bespoke feedback, addressing the distinct needs of individual learners. This feature is especially beneficial for those confronting challenges in understanding mathematical principles, as it offers them personalised explanations and insights (Supriyadi & Kuncoro, 2023). In contrast to traditional teaching methodologies that might sometimes result in delayed feedback, ChatGPT ensures real-time responses, paving the way for swift understanding and adjustment (Escotet, 2023).

This immediacy in support is reminiscent of Vygotsky's influential concept of the Zone of Proximal Development, which emphasises the pivotal role of timely assistance in enhancing a student's developmental trajectory (Vygotsky, 1978). While in the past this guidance predominantly came from human tutors, the advent of modern technology has positioned AI tools as the new facilitators of such support. These AI systems, thanks to their advanced capabilities, provide instantaneous aid and can be fine-tuned to align with a student's educational level, preferences, and optimal learning strategies.

A study by Wardat et al. (2023) delved into ChatGPT's performance in answering geometry-related queries. Their findings revealed that while ChatGPT has the capability to carry out mathematical computations and resolve mathematical equations, its accuracy and efficiency can vary based on factors such as the intricacy of the problem, input data precision, and the clarity of the directives provided to the model.

In the context of schools and higher education, where large class sizes often present challenges in providing personalised guidance, ChatGPT offers a promising solution. Capable of catering to a multitude of students simultaneously, it promises an inclusive learning experience, ensuring no student is left without support (Wardat et al., 2023).

Implications for future pedagogical approaches

An escalating concern is the possibility of students becoming excessively dependent on AI, which might erode their analytical and critical thinking capacities (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 teaching techniques with AI-driven tools like ChatGPT can usher in a comprehensive learning environment. Such an approach leverages the combined strengths of

human tutors and AI systems. As the nature of mathematics education continues to evolve, there is a pressing need for AI models to undergo perpetual refinement to remain pertinent and effective. 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 accentuate 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.

Given the burgeoning prominence of data across disciplines, mathematics instruction might intensify its focus on data literacy and statistical acumen. Learners and students might be trained to gather, scrutinise, and decipher 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 tools. Such an integration promises to bolster problem-solving abilities, logical deduction, and the synergy between mathematics and computer science.

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

Limitations and concerns

The potential over-reliance on AI tools by students could undermine their intrinsic problem-solving and critical thinking abilities (Wardat et al., 2023). This dependence on ChatGPT could be counterproductive for both students and educators. For learners, it could lead to a decline in essential cognitive faculties such as creativity, analytical reasoning, and problem-solving prowess (Farrokhnia et al., 2023). Such a scenario can diminish their intrinsic motivation to engage

in independent research or form personal insights. For educators, an over-dependence could dilute the richness of their interaction with students and exacerbate educational disparities.

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

Conclusion

The introduction of AI tools, exemplified by platforms like ChatGPT, into mathematics pedagogy brings with it a plethora of advantages. However, the onus 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 realise the potential of AI in reshaping the future of mathematics education across all educational echelons.

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