

Beginning the Conversation: What is Responsible AI Use in Mathematics Education?

Kayla Chandler (Eastern Carolina University)

Artificial Intelligence (AI) has recently received significant attention for advances in generative AI and the implications these new tools have in our lives (e.g., Mohamed et al., 2022). While different applications of AI have been available for several years (e.g., face and voice recognition, predictive behavior modeling), the combination of breakthroughs in technology, access to more data, and increased awareness of its potential has exponentially increased AI's recent popularity (e.g., Gao, 2020).

In education, interest has centered around generative AI tools (e.g., Chat GPT, Bard, Perplexity AI, etc.) which rely on large language models and machine learning to quickly craft responses to user prompts. Educators' reception of generative AI has fallen across a broad spectrum from those denigrating classroom AI use to those who fully embrace its potential (e.g., Morgan, 2023; Woodruff et al., 2023). Coinciding with AI's rapid dissemination and application that continues to outpace progress towards a potential universal stance on the use of AI in teaching and learning, calls to guide educators' use (or avoidance) of AI have come from various levels within government (e.g., Exec. Order No. 14110, 2023) and education (e.g., Center for Excellence in Teaching and Learning, n.d.).

Mathematics education has also seen an uptick in discussions and research about AI. Similar to debates that emerged when calculators were introduced, educators hold varying views on the usefulness and appropriateness of AI for mathematics teaching and learning (Mohamed et al., 2022). Some see students' use of AI tools as a thought-inhibiting crutch or hindrance, since generating answers to questions is quick, efficient, and does not require students to problem solve. Others see AI tools as an opportunity for students to engage with mathematics in different ways, such as critiquing AI-produced outputs of mathematical problems to determine their validity or identify multiple approaches to solving a problem (e.g., NCTM, 2024). Despite one's position on AI's use in mathematics education, we can all agree that we must consider AI's implications on research and teaching practices. As calculators and search engines previously impacted these practices, so does AI today. However, given AI's unique functionality and its rapid growth, it is pressing that we quickly and carefully explore the possibilities and ramifications of AI implementation in mathematics teaching and research. As such, this paper aims to provoke conversations among mathematics teacher educators (MTEs) as we contemplate what constitutes responsible AI use in our field.

AI Usage of Mathematics Teachers

Potential uses of AI in mathematics teaching are rich, multifaceted, and ever-growing. As such, a comprehensive list of these uses would likely be outdated

before this paper is read (Gao, 2020). Nevertheless, this can be a starting point for those entertaining using AI in their teaching. Furthermore, since generative AI tools have lately drawn the most attention, that is the focus of this paper. Thus, herein, “AI” will refer to generative AI tools. To frame the conversation, I will first present uses of AI from two different perspectives (i.e., administrative tasks and content-specific tasks) and then discuss the implications of these uses for our work as MTEs.

Using AI for Administrative Tasks

Administrative uses of AI in teaching consider universal tasks teachers do. While these tasks can sometimes seem tangential to the content, they have great potential to enhance the learner’s experience. For example, AI can assist teachers in creating parent letters, planning the logistics of a community night, generating templates or rubrics, analyzing data, organizing school trips, managing emails, communicating updates, and much more. Doing these tasks well can make learners and their families feel more connected and informed about classroom happenings, positively affecting student learning (Chen et al., 2020). Leveraging AI to assist in completing these tasks can reduce the time and mental energy teachers spend on administrative work and allow them to focus more on the content-specific aspects of their job.

Using AI for Content-Specific Tasks

As with administrative tasks, the potential uses of AI for teachers relating to content-specific tasks are already numerous, and the list will only continue to grow. Teachers can use AI to help prepare for instruction and consider ways to best support students. To name a few examples, a mathematics teacher may use AI to:

1. Brainstorm ideas for an activity related to a specific topic.
2. Develop lesson plans (or parts of lesson plans) and assessments.
3. Create relevant projects and rubrics for their students' context.
4. Provide support for students with accommodations.
5. Serve as a translator to assist English as a Second Language (ESL) students.
6. Strengthen their content knowledge.
7. Anticipate students’ thinking or strategies for a mathematics problem.
8. Design differentiated instruction based on students’ needs or learning styles.

Additionally, mathematics teachers may have their students learn by engaging with AI. Teachers can ask students to use a tool like ChatGPT to explore a concept or as a resource for brainstorming different problem-solving approaches. Students can also perform error analyses, compare different responses from AI for the same prompt, and evaluate the accuracy of AI-generated outputs. Teachers can ask students to share their interactions with the AI tool and reflect on what they learned while using the AI for a particular learning experience. By reviewing the transcript of a student’s interactions and reading their reflections, teachers can glean information about *what* their students might be thinking and *how* those thoughts transpired. Such rich information would be valuable to guide future instruction.

Ethical Considerations

As with any tool, AI has aspects of its use that must be carefully considered. For instance, analyzing student data with AI can potentially put sensitive information at risk (e.g., U.S. Department of Education Office of Educational Technology, 2023). While a teacher's intent may be to import a student's data for analysis to inform instruction, the teacher may inadvertently access, use, and disseminate protected information. Generated parent letters or communication updates could also contain confidential data, while other tasks like generating templates or planning a community night are less likely to expose private information.

Teachers also need to recognize other potential student impacts (Kizilcec & Lee, 2022). When allowing students to interact with AI, teachers should ask themselves, "Does this make the student vulnerable in any way?" For example, we know that AI can provide outputs that are inconsistent, contradictory, incorrect, or unable to compensate for contextual nuances. These outputs are commonly called *hallucinations* (e.g., Jennings, 2023; NCTM, 2024; U.S. Department of Education Office of Educational Technology, 2023). Instances of AI hallucinating have been widely shared online, including in mathematics (Jennings, 2023). In an eSpark blog post, Jennings (2023) shares an example where AI was asked to generate "five math word problems to address the third grade standard for telling time to the nearest minute using analog clocks" (Figure 1). Three of the five generated problems presented no issues. The fourth problem imprecisely described the position of the hour hand (i.e., "the little hand points at four") when asking students to provide the time for half past four (Figure 2). But, as Jennings points out, the hour hand should fall between four and five, and while the distinction here is subtle, it could be confusing for third graders learning this concept. The AI's fifth problem was: "During snack time, the teacher let the students eat at twenty minutes to ten. The little hand points at ten, and the big hand points at four. What time is snack time?" (Figure 2). AI's answer of 9:40 AM is correct for the contextual description of snack time; however, the location of the hands on the clock in the problem describes 10:20 AM. Given that AI potentially provides such outputs, teachers should consider how this might contribute to students' misconceptions about a mathematics topic. Teachers using AI should be aware of these types of ethical considerations (with many more) and take precautions to mitigate negative impacts on students.

Implications for Mathematics Teacher Educators

Just as AI has many uses for those teaching mathematics, there are also many ways we as MTEs can use AI. Similar to the ideas provided above, MTEs can leverage the affordances of AI for both administrative and content-specific tasks. We need to learn how to use these tools for ourselves and ask: "What is it our preservice (or inservice) teachers need to know about using AI in teaching and learning math?" As we consider how to incorporate AI into our teaching to answer that question, we must lead the way with unique ideas and applications of AI in mathematics. We need to model what learning can look like when AI is incorporated. We must teach our students how to interact effectively with AI and give them time to practice those ideas. We need to show them how to teach their students to use AI appropriately. We need to teach them to be

aware that AI hallucinates and that they should always review AI output with a critical eye (U.S. Department of Education Office of Educational Technology, 2023). We need to teach them that biases from those who design AI tools may be at play (e.g., Kizilcec & Lee, 2022; Popenici & Kerr, 2017) and have conversations with them about other equity-related issues (e.g., access) surrounding AI. Lessons like these, and many others not included here, will be invaluable for our future (and current) teachers as AI continues to permeate education.

But, to make significant progress towards incorporating AI into mathematics education in meaningful ways, MTEs should provide recommendations for best practices in AI use. NCTM's (2024) AI Position Statement provides a starting point from which to build as we think through and develop guidelines for what responsible AI use in a mathematics classroom should look like. As Morgan (2023) states, "Early results in ed tech are seldom the best ones – we need sustained attention, experimentation, and refinement in order to reap the benefit of a particular tool or approach" (para. 3). In other words, we need to start the conversation, establish some guidelines, test them out through research, update as necessary, and continue this process to see the best results. So, I leave you with this: What can you do to contribute to the conversation?

References

- Center for Excellence in Teaching and Learning. (n.d.) *University Policies on Generative AI*. Padlet.
<https://padlet.com/cetl6/university-policies-on-generative-ai-m9n7wf05r7rdc6pe>
- Exec. Order No. 14110, 88 FR 75191, 75191 (2023).
<https://www.govinfo.gov/content/pkg/FR-2023-11-01/pdf/2023-24283.pdf>
- Gao, S. (2020). Innovative teaching of integration of artificial intelligence and university mathematics in big data environment. *IOP Conference Series: Materials Science and Engineering*, 750(1), 012137.
<https://doi.org/10.1088/1757-899X/750/1/012137>
- Jennings, J. (2023, October 10). AI in education: The problem with hallucinations. *eSpark*.
<https://www.esparklearning.com/blog/ai-in-education-the-problem-with-hallucinations/>
- Kizilcec, R. F., & Lee, H. (2022). Algorithmic fairness in education. In W. Holmes & K. Porayska-Pomsta (Eds.), *The Ethics of Artificial Intelligence in Education* (pp. 174-202). Routledge. <https://doi.org/10.4324/9780429329067-10>
- Mohamed, M. Z. b., Hidayat, R., Suhaizi, N. N. b., Sabri, N. b. M., Mahmud, M. K. H. b., & Baharuddin, S. N. b. (2022). Artificial intelligence in mathematics education: A systematic literature review. *International Electronic Journal of Mathematics Education*, 17(3). <https://doi.org/10.29333/iejme/12132>
- Morgan, G. (2023, May 4). *The five pathologies of EdTech discourse about generative AI*. On EdTech Newsletter.
<https://onedtech.philhillaa.com/p/the-five-pathologies-of-edtech-discourse-about-generative-ai>
- National Council of Teachers of Mathematics [NCTM]. (2024, February). *Artificial intelligence and mathematics teaching: A position of the National Council of*

Teachers of Mathematics.

<https://www.nctm.org/standards-and-positions/Position-Statements/Artificial-Intelligence-and-Mathematics-Teaching/>

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(22). <https://doi.org/10.1186/s41039-017-0062-8>

U.S. Department of Education Office of Educational Technology. (2023). *Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations*. <https://tech.ed.gov/ai-future-of-teaching-and-learning/>

Woodruff, K., Hutson, J., & Arnone, K. (2023). Perceptions and barriers to adopting artificial intelligence in K-12 education: A survey of educators in fifty states.

Faculty Scholarship. 506.

<https://digitalcommons.lindenwood.edu/faculty-research-papers/506>