NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

Artificial Intelligence and Mathematics Teaching

A Position of the National Council of Teachers of Mathematics

NCTM Position

Artificial Intelligence (AI)-driven tools can respond to students' thinking and interests in ways that previous tools could not. By drawing from large language sets, AI has the potential to adjust application-based problems to student interests and identify the sense students have made even in their incorrect answers. Students will continue to need teachers' mathematical, pedagogical, and relational expertise, though teachers are also likely to benefit from AI-driven tools. In some cases, AI may serve as a teaching assistant, but students will need teachers to help them create a bridge between prior knowledge, new knowledge, and shared knowledge. Teachers must tell students to be very skeptical about AI results, especially about the unique challenges of using tools that may have been trained on biased datasets. This skepticism can be woven into existing pedagogical and assessment techniques. Knowing this, educators need to be involved in developing and testing AI tools in math education to stay up to date with current AI trends to best prepare students for an AI future. Contrary to some popular opinions, this effort will require teachers with even deeper knowledge of math instruction and assessment—math teachers with more experience, not less.

Defining Terms

At the time of this writing, advances in AI have come swiftly through the use of Large Language Models (LLM) and Machine Learning (ML) approaches, which build sophisticated statistical predictors by identifying patterns in a massive set of human-curated training data. This is commonly known as generative AI. While this approach is not the only one used in the broader field of AI, our use of the term in this paper is explicitly in reference to technologies derived from generative AI machine learning approaches (e.g., ChatGPT, Bard, etc.).

Historical Context

Mathematics teachers have considered the challenges and advantages of knowledge-generating tools for decades, including calculators, search engines, and Photomath. In 1980, NCTM stated that calculators helped students develop and use problem-solving skills (NCTM, 1980). In 2015, Webel and Otten stated that "In the conceptual problems, Photomath can assist only with computations; it cannot generalize the patterns" (p. 370). The outcomes of these tools have led teachers to create assessments that reduce computation and increase problem solving. As new answer-generating tools continue to evolve, mathematics teachers need to ensure that their assessments focus students on identifying the reasonableness of the output and the application of the output in specific application-based situations. With technology tools becoming widely available, TODOS (2020) reminds teachers to "ensure systems that maximize equitable access" (p.3) to these tools so that all students

can benefit from the technologies and the International Society for Technology in Education (ISTE) asks teachers to "consider the capabilities, risks and ethical questions related to using AI."

AI Tools Do Not Replace the Need to Teach Math or Problem Solving

- AI tools are only as good as the training input they receive, and conscious or unconscious bias may influence the choice of that training data. This *increases* the need to teach students to solve problems themselves in order to identify potential bias in the output.
- AI is known to "hallucinate" answers that are untrue or unreasonable. Problem-solving and strong fundamentals are essential to develop the intuition for whether an output is reasonable.
- AI does not consistently provide accurate citations for the references that it uses, giving users the illusion that the ideas do not need to be cited or vetted. Teachers must teach students how to use the AI output as a stepping point to uncover the primary sources and use those sources to cite their findings.

AI Tools Encourage Teachers to Reimagine Teaching and Assessment

- Blending the fundamental computational skills with sensemaking and creative problem solving requires a deep understanding of the math involved, as well as a deep understanding of Pedagogical Content Knowledge (PCK) and Mathematical Knowledge for Teaching (MKT). Educators lacking this expertise can fall into the trap of repetitive, strictly computation "shallow assessments."
- AI tools excel at recognizing and solving computational problems (e.g., students who use tools like Photomath when doing homework!). Rather than being threats to math instruction, these tools create positive pressure to avoid the "shallow assessment" trap and create assignments and assessments that blend the fundamentals and creative thinking. **This pressure makes the need for experienced math educators more critical—not less.**
- Even without using AI tools in the classroom, teachers can use the existence of those tools to shift students' thinking from solving alone to a mix of *solving and verifying*. This requires evolutionary—not revolutionary—change. When the word problems in the book are easily solved by AI tools, the solution isn't to throw out the book; it's to ask students to come up with examples they might use to verify the correctness of a solution generated by those tools. Figuring out how to verify the *correctness of multiple potential solutions* requires a deeper understanding than coming up with a single solution.

AI Tools Can Personalize Learning

- Many teachers are familiar with the need to produce multiple versions of the same test or homework questions, which are focused on the same learning goal but provide different examples of the same underlying math. When developed alongside or used by math educators, AI tools can reduce the labor associated with this task.

- Teachers are also familiar with the need to provide engaging, personally relevant problems and questions for every student. Beyond simply "making the math interesting," this is also a critical component of culturally relevant instruction. By dramatically reducing the labor associated with this task, teachers can develop batteries of math problems tailored to students' lived experiences and personal interests.
- AI tools can be used to generate multiple explanations for math concepts and formulas aimed at different audiences or levels of expertise. Likewise, they can be used to generate personalized learning experiences that are tailored to a particular audience or level of expertise.
- To make these benefits a reality, math educators must be involved in developing and testing AI tools in education. This is especially true given the tendency for AI to introduce or exacerbate existing biases based on patterns in the data on which it was trained.

References

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