Crowdsourcing Knowledge: Implications for Using AI in Mathematics Methods Courses

Juan M. Gerardo, Regan Blankenship, Sasha Cohn, and Julia Renfro (University of Cincinnati)

Introduction

As a mathematics teacher educator, I (lead author) integrate technology into my methods courses: with middle grade pre-service teachers we use GeoGebra and CODAP; with elementary pre-service teachers we use virtual manipulatives; and I use a Smart Board notebooks when discussing problems as a whole group. My goals are to address the recommendation that "mathematics teachers are comfortable using technology to engage in mathematics and to effectively support meaningful mathematics learning" (AMTE, 2017, p. 125) as well as to deepen their TPACK (Mishra & Koehler, 2006). And now with the widespread availability of AI Chatbots (e.g., ChatGPT, Bing, Gemini, Claude), I felt that pre-service teachers need to use, and consider the ethical implications of AI as students and teachers. So, this past academic year, I piloted the use of AI Chatbots with pre-service teachers. While still required to develop a three-phase lesson plan (Van de Walle et al., 2018), I wanted pre-service teachers to analyze and critique a lesson plan that AI Chatbots produce.

Background

First, our university does not have a campus-wide policy regarding the use of AI. Its usage is determined by the instructor.

Second, the guideline described below was adapted from the crowdsourcing phenomenon (Pedersen et al, 2013) evident in the AI Chatbot related sub-reddit forums. Reddit is a global online forum with an estimated number of 430 million monthly users worldwide across 130,000+ communities (Reddit). The AI Chatbot sub-reddit forums gained in popularity as AI Chatbots became more mainstream. Dedicated users were determined to "jailbreak" or push the limits of these AI chatbots - unfortunately some of these efforts were and are ethically and morally questionable. While others were wanting AI chatbots to generate programming code, research papers, and, more recently, images and videos.

Connections to Mathematics Education

So as online users were pushing the limits of ChatGPT, I saw their potential for mathematics education. Some users not only suggested a series prompts to use with ChatGPT, but others noted that you can have ChatGPT role-play and then complete a request. For example, some suggested ChatGPT be a Python programmer and create a Tetris-like game. Other roles that were used with ChatGPT were that of a screen writer or poet to produce scripts and poems.

So, in relation to mathematics education, not only could we provide a series of questions to have ChatGPT produce mathematics lesson plans, but we could also suggest that it role play as a 5th Grade mathematics teacher or 8th grade algebra

teacher. And we could then prompt ChatGPT to develop a lesson: a 5th grade lesson to teach division with fractions or an algebra lesson for graphing and slope. Because the first semester that I designed this task, many were special education majors, some had the AI Chatbot role-play as an elementary special education teacher while others asked ChatGPT to differentiate the lesson plan for a specific grade of students with special needs. The quality of the lesson plans varied (generic with no specific mathematical task or suggesting that students work on problems that were not provided). The possibilities of using AI are endless for mathematics teachers.

The following are the prompts I suggested for the assignment:

Begin to edit the following prompts [chunked]:
- Create a ___ grade lesson plan to teach ____
- Create three-phase lesson plan to teach [grade] [content]
- Special Education
- Create a [grade] lesson plan to teach [content] for special education students
- Create a [grade] three phase lesson plan to teach [content] for special education students.
- Anyone willing to include: social justice? Equity? Anti-racist? Bilingual

Or before you do any of the above, you can tell the AI Chat bot:
- You are a [grade or special education] pre-service teacher…
- You are a ___ grade teacher...
- You are a ___ grade special education mathematics teacher…
- And then type the prompts above (task, activity, lesson plan, etc.)

Possible other follow-up prompts:
- Can you help to differentiate or tier the lesson for students
- Can you help to provide accommodations for students with special needs or [language] bilingual students.

Note: at the end, type, "Thank you." [Recently I came across this suggestion to close a session with a Chatbot]

The following prompts were used by the co-authors, three pre-service teachers, to complete their assignment:
a) Write a launch activity to teach math to 3rd graders.
b) Write a launch activity to engage 3rd-grade students in learning multiplication.
c) Create a three-phase lesson plan to teach 3rd grade multiplication.
d) Adjust the lesson plan for students who have never learned multiplication.
e) Expand on Phase 1 please.

The triad began by asking general questions and then more specific prompts. The first two prompts resulted in two detailed activities: a multiplication activity using a deck of cards and the other multiplication bingo. The next two prompts resulted in an outline for two activities (that lacked detail). And the last prompt resulted in a more

detailed launch activity that involved discussing and demonstrating equal groups for multiplication.

Reflections and Ethical Use of AI Chatbots

For this assignment, I asked the pre-service teachers to analyze the lesson plan: to identify its strengths, weaknesses and if they would teach the lesson plan without changing it. I even asked them to consider the assignment's rubric and if it met the criteria as a high-quality lesson plan. Overall, I was impressed with their analysis of the AI Chatbot lesson plans. No pre-service teacher felt that the lesson plan was teachable without changes. For example, the co-authors concluded that ChatGPT was easy to use and a good start to generate ideas for a lesson. But the lesson suggested needed modifications if it were to be used with students because the lesson was often vague and assessments were lacking. In contrast, when writing "our own lesson plan, [we get] exactly what [we] need" to meet students' mathematical needs as well as appropriate assessments.

I discussed the ethics of using AI briefly in class but I would have liked to have spent more time discussing this topic with the pre-service teachers. Research indicates that the more aware pre-service teachers are with limits and ethics of the usage of AI Chatbots that they are more critical users of the technology (Celik, 2023). As a result of the limited time during the semester, I only superficially shared examples of students using ChatGPT and being caught (Sensitive-Job-8880, December, 2023), or not being caught using for assignments (Anonymous, May 2023). Other examples I shared consisted of professors grappling with the usage of AI technology by their students (Anonymous, December 2023). If I had more time, we would have discussed these examples and have them grapple with students and instructors' perspective on the usage of AI.

Endless Possibilities (Cautiously)

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 (NCTM, 2024, p. 1)

As stated above, mathematics teachers need "deeper knowledge of math instruction and assessment" to use AI chatbots effectively. As Mathematics teacher educators, we are in a position to leverage AI Chatbots in tandem with our goal of preparing highly qualified mathematics teachers that are responsive to and inclusive of students. For example, pre-service teachers could generate examples of a worthwhile task, differentiated or tiered work for students. Tasks could also be translated to different languages to assist emergent language learners. As a researcher, I am intrigued by the degree that AI Chatbot generates lessons that are culturally responsive, socially just, rehumanizing, and anti-racist. Considering the bias and concerns regarding how AI Chatbots came to be (data used without permission) (Rhem, 2023) and the siren-warning by AI ethicist of the lack of diversity among machine learning

programmers / designers that have resulted in natural language bots having biases (Crawford, 2019), it is important for pre-service teachers to analyze and be critical of AI generated tasks and lesson plans.

Perhaps, mathematics teacher educators need virtual and in-person spaces (e.g., working groups, symposia, SIGS) to discuss the strengths and concerns regarding the use of AI chatbots. After all, if "math [teacher] educators [are not] involved in developing and testing AI tools in math education," (NCTM, p. 1), then who is?

References

Association of Mathematics Teacher Educators [AMTE] (2017). *Standards for preparing teachers of mathematics*. https://amte.net/standards

Anonymous (2023, May) *Close call alert. Almost got caught using ChatGPT to write a paper - but I learned from my mistakes. Check out my lessons learned #chatgpt #academictricks.* [Online Forum Post]. Reddit https://www.reddit.com/r/ChatGPT/comments/106un7l/close_call_alert_almost_got_caught_using_chatgpt/

Anonymous (2023, December) *ChatGPT: It's getting worse.* [Online Forum Post]. Reddit https://www.reddit.com/r/Professors/comments/17v6478/chatgpt_its_getting_worse/

Celik, I. (2023). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior*, 138, 1-12. https://doi.org/10.1016/j.chb.2022.107468

Crawford, Kate (2019, January). *AI Now*. https://ainowinstitute.org/wp-content/uploads/2023/04/AI_Now_2019_Report.pdf

Pedersen, Jay, David Kocsis, Abhishek Tripathi, Alvin Tarrell, Aruna Weerakoon, Nargess Tahmasbi, Jie Xiong, Wei Deng, Onook Oh, and Gert-Jan De Vreede. (2013, January). Conceptual foundations of crowdsourcing: A review of IS research. *2013 46th Hawaii International Conference on System Sciences*, 579-588. https://www.researchgate.net/profile/Jay-Pedersen/publication/234096924_Conceptual_Foundations_of_Crowdsourcing_A_Review_of_IS_Research/links/02bfe50f0cb3faa23e000000/Conceptual-Foundations-of-Crowdsourcing-A-Review-of-IS-Research.pdf

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

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/uploadedFiles/Standards_and_Positions/Position_Statements/NCTM_AI_Position_Statement.pdf

Reddit. (2024, March). Wikipedia. Retrieved March 29, 2024, https://en.wikipedia.org/wiki/Reddit

Rhem, A. J. (2023). Ethical use of data in AI Applications. In M. Radenkovic (Ed.) *Ethics-Scientific Research, Ethical Issues, Artificial Intelligence and Education* [eBook Edition] (pp. 95-108). IntechOpen. https://www.intechopen.com/chapters/1121510

Sensitive-Job-8880 (December, 2023). *Caught using ChatGPT.* [Online Forum Post]. Reddit. https://www.reddit.com/r/Advice/comments/17rmrp8/caught_using_chatgpt/

Van de Walle, J.A., Karp, K.S., Lovin, L.H., & Bay-Williams, J.M. (2018). *Teaching Student-Centered Mathematics: Developmentally Appropriate Instruction for Grades 3-5* (3rd edition, Vol. II). Pearson, New York.