Modeling AI as a Thought Partner for Mathematics Instruction

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In this article we focus on the expansion of Artificial Intelligence (AI) in K-12 education, particularly for teacher candidates' (TC) planning and teaching of math concepts. We address the importance of preparing TCs to integrate generative AI tools as thought partners for teaching. Although AI cannot replace the unique qualities of a classroom teacher, our goal is to ensure TCs develop skills to effectively utilize AI within math contexts.

AI is an active part of K-12 classroom teachers' planning. Free-access generative AI tools assist teachers with designing lessons, developing assessments, addressing gaps in knowledge, supporting multilingual learners, and enhancing problem-solving and creative thinking skills (Finley, 2023; OpenAI blog, 2023; Staake, 2023; Wilichowski, 2023; Zumpano, 2023). It is essential teacher educators stay ahead of technological trends to ensure our TCs are prepared for the onset of their careers. While AI cannot replace the personal touch and instant adaptability of a classroom teacher, AI tools can manage specific instructional tasks (Roose, 2023). We want to ensure TCs develop skills to use AI purposefully as thought partners.

Our TCs begin their program with a range of knowledge and experiences with AI, from those who have not used generative AI tools to those who subscribe to advanced-feature services. AI provides us with the opportunity to develop TCs' skills for planning for instruction; that is, we can seize these teachable moments to help them identify the short-comings of AI-generated text to build an effective lesson. The challenge for us is to help TCs find the fine balance between AI as a thought-partner and AI as a thought-doer.

In pedagogy courses, TCs develop skills and strategies for instruction and design a comprehensive lesson. Lesson plans to enhance problem-solving and creative thinking skills, in short, include standards, objectives, and assessments with a description of explicit teaching and learning activities. In our work to provide plans for TCs to critique as they learn to design their own, we considered our ability to efficiently generate examples and decided to explore AI's effectiveness for planning a lesson. Using AI and reviewing its output can help TCs better understand what it is they are required to teach and the ways in which standards support the content (McMurtrie & Supiano, 2023). Rather than cautioning students against using AI, we confront the design biases of the plan and critically analyze the structure for quality and accuracy, including methodologies that do not support students' development of problem-solving skills (Miles et al., 2019).

Lesson Design with ChatGPT

We selected ChatGPT 3.5 because it is free and widely accessible. In January 2024, we submitted the following on two different computers: "Provide a lesson plan for

Use a variety of representations and strategies to find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors."

Although our AI-generated plans are structured similarly using the Gradual Release of Responsibility framework (Fisher & Frey, 2013) with the same sections (Materials, Introduction, Direct Instruction) and an objective that restates the prompt, the content differs. The output reveals differences in how the concepts and activities unfold. For example, place value blocks are not called for in Lesson A, with manipulatives optional (Table 1). Additionally, Lesson B includes a journal, leading us to anticipate a writing activity. Nonetheless, both lessons fall short of engaging students in problem solving, and developing conceptual understanding and procedural fluency. This leaves room for refinement and improvement.

Table 1:
The Materials

ChatGPT Lesson A	ChatGPT Lesson B
1. Whiteboard and markers or chart paper and markers 2. Math manipulatives (optional) 3. Worksheets with division problems 4. Calculators (optional) 5. Chart or poster paper	1. Whiteboard and markers 2. Chart paper 3. Place value blocks or manipulatives 4. Worksheets with division problems 5. Math journals or notebooks

Subtle differences are found in the introduction (Table 2). Both lessons begin with a review. This may lead TCs to interpret it as *telling* students about the concepts rather than *engaging* students. ChatGPT does not explicitly describe the ways in which the teacher reviews the previously taught concepts, discusses terms or understandings, or introduces the objectives. The plan focuses on *what* to teach and lacks a vivid description of *how* to teach.

Table 2:
Introduction

ChatGPT Lesson A (10 min)	ChatGPT Lesson B (15 min)
● Begin by reviewing the concept of division and its connection to multiplication. ● Discuss the terms dividend, divisor, and quotient. ● Introduce the objective of the lesson: to find whole-number quotients using various methods.	● Begin the lesson by reviewing the concept of division and its connection to multiplication. ● Discuss the importance of understanding different strategies for division and how it can be applied to real-life situations.

Rather than delving into a critical analysis of ChatGPT's plans (Table 3), we approach the output as a teaching opportunity from which TCs can respond as professional educators. To ensure they understand the *how* of teaching, we ask them to collaborate using their shared knowledge, course text or other resources, and additional prompts in ChatGPT to clarify essential teaching methods and math concepts and get to the "what's next" in student' learning.

We ask: Does the plan inform effective practice and process? What aspects of the lesson need to be more explicit? TCs discuss ways to explain the targeted math concepts, and how they will demonstrate problem solving techniques and lead discussions. If TCs use ChatGPT to generate a worksheet, it is essential to determine if the worksheet provides practice for solving problems and demonstrating an understanding of concepts. Teachers can also generate rubrics through AI and determine the criteria by which they want their students measured, demonstrating a clear understanding of their expectations and the lesson's objectives.

We expect TCs to identify a lesson's strengths and improve upon its weaknesses. For example, TCs can connect different strategies using concrete (base-10 blocks), semi-concrete (number line), and abstract (partial quotients, long division) representations, to help students develop concepts and procedures (Fuchs et al., 2021). TCs should recognize the importance of developing each strategy (Table 3) prior to incorporating them into a single lesson and strive to create an iterative learning cycle to better align with best practices than either AI-generated plan.

Table 3:
Direct Instruction

ChatGPT Lesson A (15 min)	ChatGPT Lesson B (20 min)
1. **Modeling with Base-10 Blocks:** ○ Use base-10 blocks to model division problems. ○ Demonstrate how to divide a four-digit dividend by a two-digit divisor using the base-10 blocks. ○ Emphasize the importance of regrouping when necessary. 2. **Partial Quotients Method:** ○ Introduce the partial quotients method as an alternative strategy. ○ Demonstrate how to break down the division problem into simpler parts and find partial quotients. 3. **Number Line Representation:** ○ Show how to use a number line to represent the division process. ○ Discuss how students can skip count or use jumps on the number line to find the quotient.	● Teach the long division method with a four-digit dividend and two-digit divisor. Model the steps on the whiteboard, emphasizing each step. ● Use place value blocks or manipulatives to provide a hands-on demonstration of long division. ● Discuss key terms such as dividend, divisor, quotient, and remainder.

As AI becomes more refined, teachers can better rely on AI-generated plans to guide effective teaching. If a goal of education is to teach us to be critical consumers of media, critiquing AI-generated text is a part of this work. Teacher educators can help TCs critically analyze and revise AI plans to determine what makes sense in the context of *their* teaching and *their* students. It is essential for TCs to critique all aspects of an AI-generated (as with any) plan and aim for cohesive, clearly aligned lessons. Providing TCs the opportunity to pause and critique throughout the lesson allows them to dissect the fundamental components of teaching. Comparing AI-generated plans gives us a window into how AI can serve as a thought partner, taking us beyond the motions of teaching and moving toward an understanding of the nature of learning, a step AI has not yet achieved.

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