Scaffolding a Critical Lens of Generative AI for Lesson Planning

Alesia Mickle Moldavan and Bailey Nafziger (Georgia Southern University)

Mathematics education has long recognized both the affordances and tensions of knowledge-generating tools, such as calculators and apps, that aid computations and provide answers. Technologies leveraging generative Artificial Intelligence (AI) machine learning approaches offer similar possibilities with enhanced capabilities, improving the quality of mathematics education by augmenting conventional teaching and learning methods. According to the National Council of Teachers of Mathematics position statement on Artificial Intelligence and Mathematics Teaching (2024), “AI has the potential to adjust application-based problems to student interest and identify the sense students have made even in their incorrect answers” (para. 3). The utilization of AI in mathematics education and other fields can help teachers and students explore its application and roles, such as intelligent tutors or lab assistants. Furthermore, analyzing AI use can inform its impact on students’ thinking and the immediate feedback it provides during learning (Holmes et al., 2019). This report details how preservice teachers (PSTs) used AI in lesson planning during elementary mathematics and science methods courses. We provide a context for AI use and discuss the lessons learned, guiding ethical implications and recommendations. We share this experience to build awareness of AI’s benefits and emphasize the critical perspective necessary for using AI tools appropriately and ethically.

AI Use in Teacher Education

AI is transforming the learning experiences of students in our methods courses, particularly those that require PSTs to design personalized learning based on student performance data, develop lesson plans that engage students with complex mathematical concepts through differentiated supports, and provide assessment feedback with targeted interventions. AI holds significant potential at the PST level. Likewise, teacher educators can also benefit from AI assistance. Nevertheless, the roles of teacher educators and PSTs remain essential to connect prior knowledge with newly acquired content and to maintain a critical perspective when integrating AI into educational practices. For instance, AI can be used to analyze student performance datasets; however, it is imperative to reflect on the historical privileges that influence these datasets, including assessments that predominately represent white, Westernized, and colonized perspectives, which often disenfranchise marginalized groups. Therefore, users must know AI tools’ risks and ethical implications (International Society for Technology in Education, 2024). Additionally, they must be equipped to prepare students to use AI tools appropriately to foster conceptual understanding and critical consciousness.

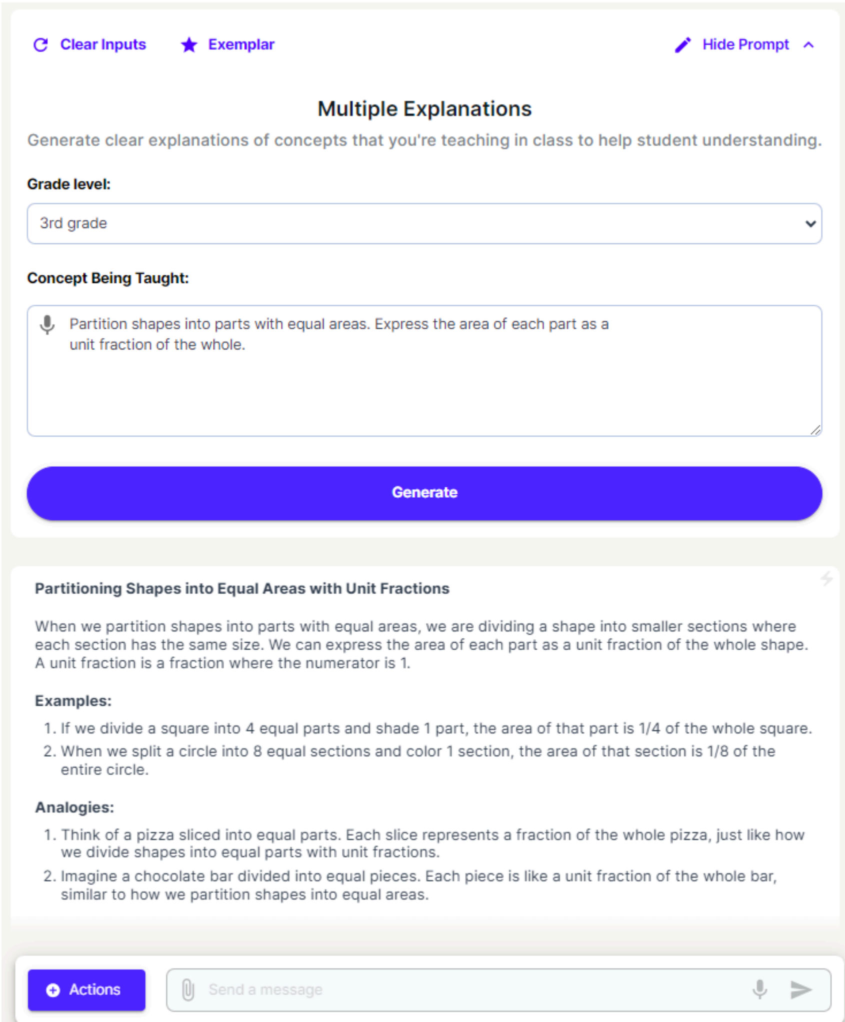
Our Context

Our teacher education program supports AI integration to enhance instructional initiatives within the classroom. We incorporated AI into our elementary mathematics and science methods courses, enabling PSTs to explore how AI can help efficiently design creative and effective lesson plans. PSTs take our content-focused methods courses simultaneously so they could engage in parallel experiences using AI to develop content-specific lessons. To guide this work, various AI tools were explored to aid in creating lesson plans that address content standards, misconceptions, vocabulary, assessment rubrics, student interests, and accommodations.

In particular, we selected MagicSchoolAI (https://app.magicschool.ai/tools) to develop inquiry-based lesson plans in our courses. MagicSchoolAI offers drop-down menus for specific grade levels and provides prompts to assist in scaffolding prompt engineering for those new to AI. The platform includes a variety of tools designed to support users in exploring AI's possibilities, such as Standards Unpacker, Multiple Explanations, Common Misconceptions, Rubric Generator, Student Work Feedback, Math Story Word Problems, DOK Questions, Math Spiral Review, Real World Connections, Make it Relevant!, and Conceptual Understanding.

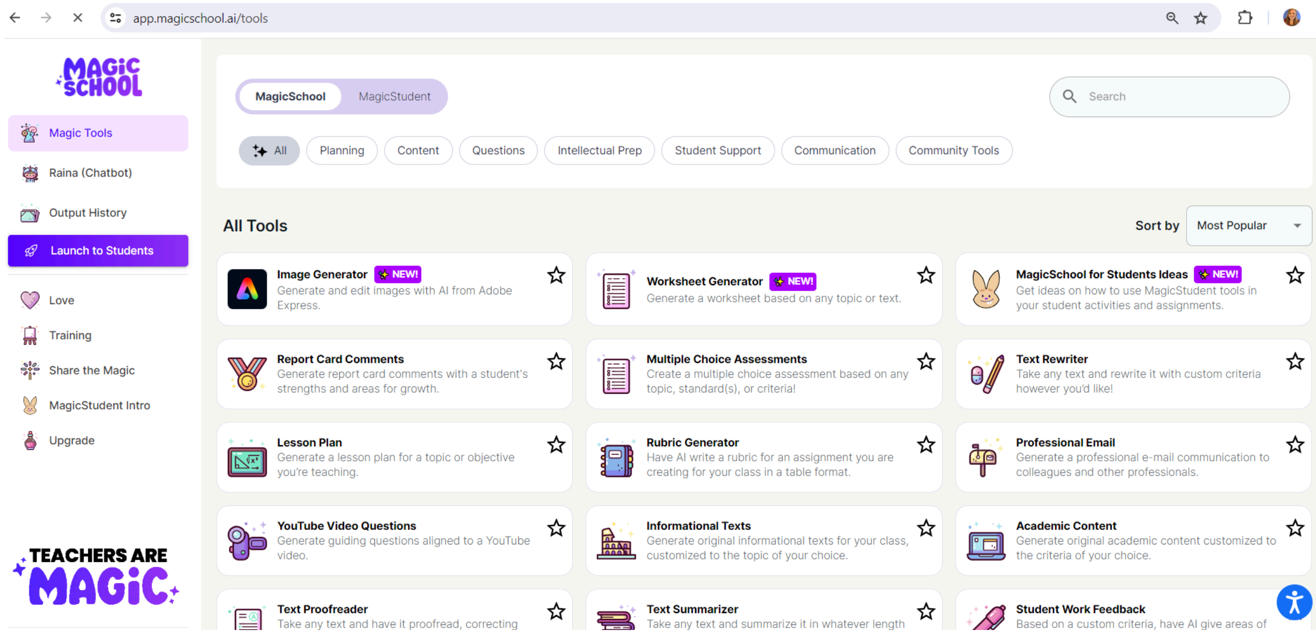
For lesson planning assignments, PSTs used MagicSchoolAI to build their content background using a tool called "Multiple Explanations," which allows users to input the grade level and concept (or standard) and receive detailed explanations of the content (see Figure 1). The PSTs were provided with a paragraph explanation, examples of real-world applications, and analogies to help them understand abstract concepts. They copied and pasted this information into their brainstorming notes. Next, the PSTs were asked to evaluate the given information and challenge it with supporting evidence. They had to indicate if they agreed, disagreed, or had lingering questions about the AI-generated output. Their reflections on the content guided additional research to validate their findings, as they were asked to support their findings with additional evidence from at least two reputable sources, such as their course textbook, assigned readings, and other peer-reviewed journal articles. This part of the assignment helped the PSTs develop a critical lens, recognizing the limitations of AI-generated information. It also encouraged them to engage in critical thinking and sensemaking related to teaching practices.

Figure 1.
MagicSchoolAI's Multiple Explanations



Next, the PSTs were instructed to use the "Common Misconceptions" to identify common yet incorrect ideas that could impact lesson delivery. They were required to critique the listed misconceptions and explain why such misconceptions existed, using supporting information from other sources. Although these were the only tools we explicitly required our PSTs to use, they also found value in using other tools available through MagicSchoolAI (see Figure 2). For instance, PSTs used the "Standards Unpacker" to help break down a standard into skills, knowledge, and concepts. The tool also addresses learning targets and provides examples of instructional and assessment strategies. Thus, various MagicSchoolAI tools helped the PSTs efficiently plan, differentiate, accommodate, communicate, and assess student work. However, it is important to note, and for PSTs to identify, that such efficiency can come at a cost.

Figure 2.
MagicSchoolAI's Magic Tools



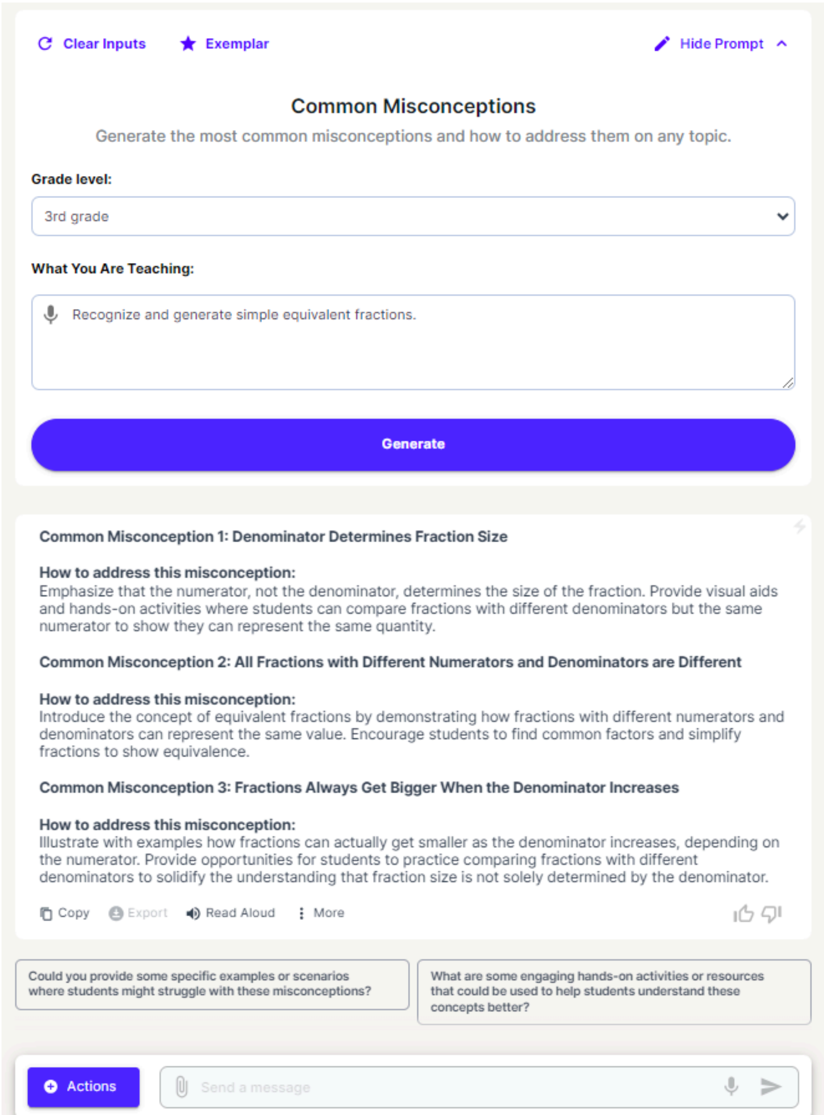
Lessons Learned Guiding Ethical Implications and Recommendations

When asked to reflect on the process of using AI to guide lesson planning, most of our PSTs recognized that AI can both benefit and hinder educators. While AI can assist teachers in becoming more creative planners, it also poses the risk of perpetuating inaccurate information. Additional research highlights more complex risks, such as prolonging systematic bias and discrimination (Akgyn & Greenhow, 2022). AI tools have been trained primarily on English Language texts, which may embed cultural biases and values (Rettberg, 2022). For instance, a teacher using AI to provide feedback on written assignments might unknowingly "silence their [students'] unique, culturally relevant ways of thinking" (Trust et al., 2023, p. 8). These significant risks necessitate that users consistently approach AI with a critical perspective.

PSTs were responsible for critically reflecting on AI-generated information. They were required to agree or disagree with the provided output and suggest recommendations for others on evaluating AI information, including asking critical questions and verifying answers with reputable external sources. For instance, some PSTs analyzed the "Common Misconceptions" output in their mathematics methods course when entering common third-grade misconceptions about recognizing and generating simple equivalent fractions.

One PST's AI-generated output (see Figure 3) indicated that a common student misconception is that the denominator determines the fraction size. When guided by the note on ways to address this misconception, it appeared that fractions with different denominators but the same numerator can be used to represent the same quantity. The PST wondered how 3/4 and 3/6 can be used to show equivalency. Upon further research, the PST challenged the statement and noted that it would only be true if the numerators were zero. For instance, 0/4 = 0/6 = 0. Thus, the PST noted how the AI-generated output should clarify its statement with the mention of zero and encourage users to use their professional judgment to review the content for accuracy.

Figure 3.
MagicSchoolAI's Common Misconceptions



In another PST's AI-generated output, a student misconception was identified: multiplying the numerator and denominator by a scale factor changes the value of the fraction. The PST challenged this misconception because, for example, multiplying 3/7 by a scale factor of 5 yields 15/35, which the PST viewed as a new fraction because of the different values in the numerator and denominator. Another PST critiqued their peer's interpretation of the misconception, explaining that multiplying the same number in the numerator and denominator is multiplying the fraction by 5/5 = 1, so the value of the fraction does not change. Thus, 15/35 is an equivalent fraction to 3/7. This analysis allowed the PSTs to reflect on common misconceptions they might have had, learn about additional misconceptions, and mathematically justify claims like the interpretation of “changes the value.” It also underscores the necessity for PSTs to possess the mathematical knowledge required to evaluate AI-generated output, as a solid conceptual understanding is essential for accurately using or challenging the information to inform their instructional decision-making.

Similarly, in the science methods course, some PSTs questioned pedagogical tactics, such as what is a hands-on activity to teach luster. Others formulated questions to deepen their content knowledge, like why a freshwater fish might not readily adapt in the ocean. Many questions were robust, but some lacked depth (e.g., what are the basic needs of plants?). None critically assessed the epistemology behind the AI-generated output. For example, they did not ask how the question was answered, why it is considered accurate, the criteria used to evaluate the truth claims, the assumptions made about the data, or whose perspectives might be excluded. It is crucial to allocate time for helping PSTs critique AI responses by developing critical questions to inform pedagogical choices, enrich content knowledge, and promote equitable teaching practices that recognize students’ cultural and linguistic assets. Increasing PSTs’ capacity to think critically will improve their ability to reflect, evaluate, and use AI responses to expedite and enhance the lesson-planning process and develop their content-specific teaching competencies.

Critical thinking skills can be cultivated through deliberate and explicit integration into course curricula (Edwards, 2017). In future iterations of our assignments, we will provide more prompts to help PSTs better understand the ethical considerations inherent in using AI for lesson planning. Building on recommendations from Krutka et al. (2022), these prompts will ask PSTs to reflect on their conduct while using AI tools, assess how their use of AI fosters or hinders learning, critically evaluate suggested pedagogical activities and their potential implications for all learners, and analyze content to discern underlying epistemological assumptions.

Our initial efforts to support PSTs in exploring AI emphasized validating AI-generated output with additional research. However, it is evident that these efforts only scratched the surface. As technology evolves, there is a growing need to continually refine and expect higher levels of critical thinking for evaluating available tools. This means deliberately integrating AI tools and reflective prompts into our educational practices and assignments. Thus, teachers must be prepared to intentionally incorporate these prompts into their classrooms, enabling students to thrive in a technologically transforming world that continuously shifts how we think and learn.

References

Akgunm, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics, 2*(3), 431–440. https://doi.org/10.1007/s43681-021-00096-7

Edwards, L. C. (2017). The craft of infusing critical thinking skills: A mixed-method research on implementation and student outcome. *Journal on Centers for Teaching and Learning, 9,* 47–72.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning.* Center for Curriculum Redesign.

International Society for Technology in Education. (2024). *Artificial intelligence in education*. https://iste.org/ai

Krutka, D. G., Heath, M. K., & Smits, R. M. (2022). Towards a civics of technology. *Journal of Technology and Teacher Education, 30*(2), 229–237. https://www.learntechlib.org/primary/p/221182/

National Council of Teachers of Mathematics. (2024). *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/

Rettberg, J. (2022, December 6). *ChatGPT is multilingual but monocultural, and it's learning your values*. https://jilltxt.net/right-now-chatgpt-is-multilingual-but-monocultural-but-its-learning-your-values/

Trust, T., Whalen, J., & Mouza, C. (2023). Editorial: ChatGPT: Challenges, opportunities, and implications for teacher education. *Contemporary Issues in Technology and Teacher Education, 23*(1), 1–23.