The Impact of AI Tools on Metacognition and Study Skills

Emma Eastman
Boise State University

Brinley Stringer
Boise State university

Keywords: Artificial Intelligence, Metacognition, Study Skills, Introductory Math

The growing use of Artificial Intelligence (AI) tools by students in mathematics education presents both opportunities and concerns related to student learning. AI tools provide students with personalized learning experiences and instant feedback, but overreliance on these tools can undermine critical thinking skills and create opportunities for academic misconduct (Alasadi & Baiz, 2023; Lo, 2023; Yoon et al., 2024). Essential for addressing the concerns posed by AI tools are students' metacognitive skills and their adherence to academic integrity, both of which play critical roles in effective and ethical learning. Metacognition refers to one's knowledge of and ability to monitor, control, and regulate one's own thinking and learning processes and allows students to understand and regulate their thinking processes, leading to improved problem-solving skills and deeper learning (Desoete & De Craene, 2019; Flavell, 1979; Velzen & H, 2016). Academic integrity entails acting honestly, transparently, and responsibly in all academic activities, which is essential for fostering genuine learning (Riedesel et al., 2012; Seaton, 2019). The central question guiding this study is: **How do AI tools impact students' metacognitive awareness and study skills in introductory mathematics courses?**

Methods

This study will take place at Timberline University (TU), a mid-sized public university located in an urban area in the Mountain West region of the United States, serving approximately 27,000 undergraduate and graduate students. It focuses on students and faculty from six introductory mathematics courses, ranging from developmental math to precalculus. These courses are part of an award-winning program within TU's Mathematics Department, known for its innovative practices and strong student success rates. As part of the initial intervention efforts, instructors will have weekly discussions with their students about how to effectively and responsibly use AI tools.

Data sources for this research include pre- and post-semester student surveys assessing AI tool use and learning behaviors and student focus groups exploring study habits and AI usage. A qualitative survey will be sent to math instructors teaching these courses to explore their perspectives on AI's impact on student learning and academic practices. The data will be analyzed using a mixed methods approach to explore trends in AI use, metacognitive development, learning behaviors, and academic integrity. The pre- and post-semester surveys will be compared to assess changes in students' AI tool use, metacognitive awareness, and study behaviors following the initial interventions. The qualitative survey and focus group data will undergo thematic analysis to identify recurring patterns in students' AI use, learning strategies, metacognitive reflections, and perceptions of academic responsibility. Additionally institutional data will be used to contextualize the self-reported behaviors within broader academic trends.

Data collection for this study is ongoing during the Fall 2025 semester. We anticipate findings will reveal trends in how students engage with AI tools in relation to their metacognitive development and adherence to academic integrity. In addition, this study will contribute to the development of practices and guidelines regarding AI tools that enable both faculty and students to foster metacognitive awareness and support academic integrity.

References

Alasadi, E. A., & Baiz, C. R. (2023). Generative AI in Education and Research: Opportunities, Concerns, and Solutions. Journal of Chemical Education, 100(8), 2965–2971. https://doi.org/10.1021/acs.jchemed.3c00323

Desoete, A., & De Craene, B. (2019). Metacognition and mathematics education: An overview. ZDM, 51(4), 565–575. https://doi.org/10.1007/s11858-019-01060-w

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Lo, C. K. (2023). What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature. Education Sciences, 13(4), 410. https://doi.org/10.3390/educsci13040410

Riedesel, C. P., Clear, A. L., Cross, G. W., Hughes, J. M., Simon, & Walker, H. M. (2012). Academic integrity policies in a computing education context. Proceedings of the Final Reports on Innovation and Technology in Computer Science Education 2012 Working Groups, 1–15. https://doi.org/10.1145/2426636.2426638

Seaton, K. A. (2019). Laying groundwork for an understanding of academic integrity in mathematics tasks. International Journal of Mathematical Education in Science and Technology, 50(7), 1063–1072. https://doi.org/10.1080/0020739X.2019.1640399

Velzen, V., & H, J. (2016). Eleventh-Grade High School Students' Accounts of Mathematical Metacognitive Knowledge: Explicitness and Systematicity. International Journal of Science and Mathematics Education, 14(2), 319–333. https://doi.org/10.1007/s10763-015-9689-3

Yoon, H., Hwang, J., Lee, K., Roh, K. H., & Kwon, O. N. (2024). Students' use of generative artificial intelligence for proving mathematical statements. ZDM – Mathematics Education, 56(7), 1531–1551. https://doi.org/10.1007/s11858-024-01629-0