Using Eye-Tracking Software to Examine the Relation Between Spatial Reasoning and Mathematical Problem-Solving Behaviour

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Spatial reasoning is the ability to visualise and manipulate spatial images in the mind and is a strong predictor of mathematical achievement. Research has demonstrated that spatial reasoning skills can be improved through practice, and that improvements in spatial skills lead to corresponding improvements in mathematics (see Hawes et al., 2022 for review). Although this relation has been well established, transfer does not occur in every instance, with different types of mathematical problems benefitting more from improvements in spatial skills and others not demonstrating any transfer (e.g., Adams et al., 2023). Although this is unsurprising given the multifaceted nature of both spatial skills and mathematics, current research methods do not allow for explicit identification of how spatial skills support performance on mathematics tasks (Resnick & Adams, 2024). For this reason, new methodologies are needed to better explore this complex relation. The use of eye-tracking software is a recent, but increasingly popular approach in mathematics education to examine individuals' strategic behaviour when solving problems (e.g., Boels, 2025). This technology has the potential to shed light on the specific ways in which individuals might apply spatial skills when solving mathematics problems.

We examined undergraduate students' (n=43) strategic behaviour using eye-tracking software to capture real-time visual-attentional patterns when solving different spatial and mathematics tasks, and asked them to report the strategic approach they used to arrive at their answer. Spatial tasks included mental rotation and perspective-taking. Mathematics tasks included word problems, missing term problems, and questions involving the interpretation of pictorial representations. Individuals also completed measures of visuospatial working memory and executive function skills to explore how these related to specific strategic behaviors.

This presentation will explore these connections, such as how differences in spatial skills influence time spent interpreting written spatial information, and how visuospatial working memory aligns with efficient symbol scanning in missing-term problems. We will also discuss the implications for how to better leverage spatial skills to support students' success in mathematics.

References

Adams, J., Resnick, I., & Lowrie, T. (2023). Supporting senior high-school students' measurement and geometry performance: Does spatial training transfer to mathematics achievement? *Mathematics Education Research Journal*. https://doi.org/10.1007/s13394-022-00416-y

Boels, L., Bakker, A., Van Dooren, W., & Drijvers, P. (2025). Secondary school students' strategies when interpreting histograms and case-value plots: An eye-tracking study. *Educational Studies in Mathematics*, *118*(3), 479–503. https://doi.org/10.1007/s10649-024-10351-3

Hawes, Z., Gilligan-Lee, K. A., & Mix, K. S. (2022). Effects of spatial training on mathematics performance: A meta-analysis. *Developmental Psychology*, *58*(1), 112–137. (2022-25661-002). https://doi.org/10.1037/dev0001281

Resnick, R., & Adams, J. (2024). Spatial Reasoning Interventions and Transfer to Geometry: What we Know about Mechanism. In A. G. Rodrigues, T. Lowrie, & F. Emprin (Eds.). *Proceedings of the Twenty-Sixth ICMI Study: Advances in Geometry Education*. IREM de Reims.

(2026). In N. Berger, M. Thompson, J. Ley & C. Wilsmore (Eds.), *Beyond boundaries: Strengthening futures in mathematics education. Proceedings of the 48th annual conference of the Mathematics Education Research Group of Australasia, Sydney* (p. 479). MERGA.