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Seeing the Invisible: Exploring the Use of Spatial Reasoning in Mathematics Problem-Solving Beyond Geometry at the Secondary School Level

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Spatial reasoning has been widely studied and strongly associated with students' mathematics achievement, particularly in geometry and early grades. This recent study focuses on the use of spatial reasoning in mathematical problem-solving beyond geometry, referring to tasks in the algebra domain. To explore this, an algebra test (related to spatial reasoning) was administered to 6 eighth-grade students from 3 secondary schools in Depok City, Indonesia, followed by semi-structured interviews.

The findings showed that the students use spatial reasoning to understand the problem context, model the problem in representations, and plan problem-solving strategies. Spatial reasoning supported problem comprehension and strategic planning (Sorby et al., 2022), but procedural skills remained crucial for accurate problem solving. In particular, spatial reasoning may assist students in understanding the problem situation by transforming verbal and symbolic information into relational representation (Duffy et al., 2024) that can be visualized and mentally manipulated before students write equations, functions, or mathematical symbols.

Utilizing spatial reasoning appears to support students in constructing mental models of the problem situation to represent relationships among objects, positions, shapes, and orientations. Once the spatial structure is established, students can identify relevant quantities and the relationships among them, and then represent these relationships in appropriate mathematical symbols, variables, and expressions. Moreover, spatial reasoning may allow students to anticipate possible subsequent solution steps through selecting and integrating visual and mathematical strategies, thereby making problem-solving more effective.

The findings suggest that students may use spatial reasoning to support three problem-solving processes: understanding the problem context, modelling the problem, and planning a solution strategy. In addition, students who develop spatial reasoning tend to understand the problem and plan strategies more effectively. However, this does not necessarily guarantee correct mathematical solutions. Further studies need to integrate spatial reasoning with students' mathematical procedural skills in interventions to explore new approaches to mathematics problem solving beyond geometry.

References

Duffy, G., Sorby, S., & Bowe, B. (2024). Exploring the role of spatial ability in the mental representation of word problems in mathematics. *Frontiers in Education*, *9*, Article 1346474. https://doi.org/10.3389/feduc.2024.1346474

Sorby, S. A., Duffy, G., & Yoon, S. Y. (2022). Math instrument development for examining the relationship between spatial and mathematical problem-solving skills. *Education Sciences*, *12*(11), Article 828. https://doi.org/10.3390/educsci12110828

For more information, please refer to the following paper presented at the 48th Annual Conference of MERGA in July 2026.

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