Analogical Transfer in Mathematics

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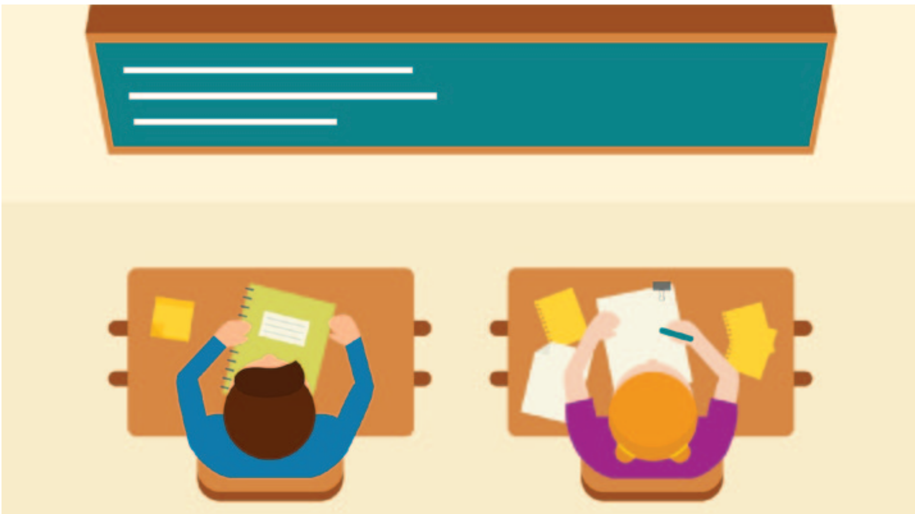

Within the classroom, efforts are continuously placed into preparing our students to overcome tasks and challenges that they may face in the future in both education and the real world. However, it is unlikely that we can prepare them for every single situation possible. As such, we look to analogical transfer—the transfer of knowledge from a well-known source to another—as a possible technique to address this gap. If students have a good understanding of the source, and of how to transfer and apply the knowledge to a new set of problem, this process can help them deal with tasks and challenges that are beyond the classroom boundaries.

Analogical Transfer to Aid Learning

This study examined Analogical Encoding (AE) and Generating Analogues (GA), which promote analogical transfer. AE involves explicitly comparing the relational structures of two problems, thereby discovering their relational similarities, so as to transfer knowledge from one to another. GA involves generating analogues (e.g., the water current as an analogue to the electricity current) as a way to activate and differentiate prior knowledge for subsequent instruction and analogical transfer.

Within our study, we also assessed isomorphic (e.g., two- versus two-variable) and non-isomorphic (e.g., two- vs. three-variable) word problems. Non-isomorphic problems are more complex and demand more cognitive resources as they have only partial mappings, or similarities, in relational structures.

These transfer mechanisms were examined with the backdrop of delayed instruction—the theory that students who solve problems before receiving instruction (i.e., delayed instruction) attain better learning outcomes compared to after receiving instruction. This theory stems from research on *Preparation for Future Learning and Productive Failure.*

The Study

Using a delayed instruction setting, the 2x2 study compared AE and GA for their learning and transfer effects when students independently work on isomorphic (Study 1) and non-isomorphic (Study 2) problems.

The task difficulty in Study 1 was low. Students were assigned to AE2-2 (comparing two-variable problems) or GA2-2 (generating two-variable problems from a given two-variable problem), prior to instruction. The task difficulty in Study 2 was high. Students were assigned to AE2-3 (comparing pairs of two- and three-variable problems) or GA2-3 (generating three-variable problems from a given two-variable problem). All the conditions were followed by instruction on formulating algebraic equations for two-variable problems. A post-test to test analogical transfer was then conducted on formulating algebraic equations for problems that involved different numbers of variables.

For Study 1, the AE2-2 outperformed the GA2-2 condition, whereas for Study 2 it was the opposite; GA2-3 condition outperformed the AE2-3 condition. In other words, when the task difficulty was lower (Study 1, isomorphic), evaluation was a better learning strategy than generation. When the task difficulty was higher (Study 2, non-isomorphic), generation was a better learning strategy than evaluation.

Implications for the Classroom

Task difficulty (two- vs. three-variable problems, isomorphic vs. non-isomorphic) and generativity (generating analogies vs. evaluating given analogies) influence delayed instruction. When adopting delayed instruction as a teaching tool, preparatory activities with a high level of task difficulty could be coupled with a higher degree of freedom of generation. Those with a low level of task difficulty could be coupled with a lower degree of freedom of generation.

Further data analysis will be conducted to better understand students' conceptual understanding and cognitive processes enacted.

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