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Investigating Task Complexity and Generativity on the Learning Effect of Delayed Instruction

Huang Junsong David and Sasha Raj Lawrence

KEY IMPLICATIONS

- Task complexity (e.g., from two- to two-variable mathematical problems versus from two- to three-variable problems) and generativity (e.g., generating analogous problems versus evaluating given analogous problems) influence the learning and transfer effects of delayed instruction (i.e., preparatory activity followed by direct instruction).
- When adopting delayed instruction as a teaching method, teachers could adapt task complexity and task generativity, to enhance students' learning.
- Preparatory activities with a higher degree of freedom of generation coupled with a high level of task complexity, as well as a low degree of freedom of generation with a low level of task complexity, are two effective choices for teachers to consider. Preparatory tasks with a higher level of complexity may have better learning outcomes if the tasks have higher generativity, while less complex tasks could lead to better learning outcomes if the tasks involve lower generativity.

BACKGROUND

Studies on Preparation for Future Learning (PFL) (Schwartz & Martin, 2004) and Productive Failure (PF) (Kapur, 2008, 2016) have shown the advantages of problem-solving prior to instruction (delayed instruction). Allowing students to attempt problem-solving on their own, followed by instruction, affords a better learning outcome than when students are taught at the start. However, the understanding of delayed instruction has been limited to solving problems as the preparatory task.

FOCUS OF STUDY

The study aimed to investigate whether delayed instruction affects learning outcomes with non-problem solving tasks. Through investigating generative tasks (Grabowski, 2004) that do not involve problem-solving, the study assessed the effects of task complexity and generativity. It explored if a more complex and generative task is better for students' learning and transfer, and what constitutes a desirable level of complexity of the generative task.

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KEY FINDINGS

The task complexity in Study 1 is low. Students in the teacher-generated analogies (TGA) condition significantly outperformed those in the student-generated analogies (SGA) condition in the immediate post-test on transfer. This suggests that when the task complexity is low, a less generative task is advantageous.

The task complexity in Study 2 is high. Students in the SGA condition significantly outperformed those in the TGA condition in the immediate post-test on transfer. This suggests that when the task complexity is high, a more generative task leads to better learning and transfer outcomes.

Therefore, the characteristics of a generative task (i.e., complexity and generativity) influence learning and transfer from subsequent instruction.

SIGNIFICANCE OF FINDINGS

These findings begin to delineate the boundary conditions of delayed instruction. Preparatory tasks that are relatively complex combined with a high degree of freedom of generation during preparation, as well as tasks with a low complexity combined with a low degree of freedom of generation, are two possible instructional contexts that optimize the transfer effects of delayed instruction.

The findings also generalize the PF design principle from solving complex problems to working on complex tasks that allow for sufficient degrees of freedom in generation.

For PF to be effective, our work suggests that designing the preparatory task to be generative alone is not sufficient. The preparatory task needs to be sufficiently generative as well as complex.

PARTICIPANTS

Students from two secondary schools in Singapore participated in the study. Study 1 involved 101 Grade 8 students from an autonomous co-educational school and Study 2 involved 52 Grade 7 students from an independent single-gender school.

RESEARCH DESIGN

Two studies were conducted. In each study, Students Generating Analogies (SGA) were compared with students evaluating Teacher Generated Analogies (TGA). Students were randomly assigned to one of the two conditions.

In Study 1, Grade 8 students in the SGA condition (n=52) independently generated two-variable algebraic word problems from a given two-variable algebraic word problem. In the TGA condition (n=49), students compared and contrasted pairs of two-variable algebraic word problems given by the teacher.

In Study 2, Grade 7 students in the SGA condition (n=25) independently generated three-variable word problems from a given two-variable word problem. In the TGA condition (n=27), students compared and contrasted pairs of two- and three-variable word problems given by the teacher.

For both studies, the participants received instructions on how to formulate algebraic equations for two-variable word problems. Post-tests were conducted on formulating algebraic equations for word problems involving two, three and four variables.

Task generativity was deemed higher for SGA (i.e., students generate) than TGA (i.e., students evaluate), and task complexity was deemed higher for Study 2 (from two- to three-variable problems) than for Study 1 (from two- to two-variable problems).

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About the authors

David HUANG and Sasha RAJ LAWRENCE are with the National Institute of Education, Singapore.

Contact David at junsong.huang@nie.edu.sg for more information about the project.

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