Does Learning from Examples Improve Tutored Problem Solving?

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Theoretical Background

Our research focuses particularly on the intermediate stage of skill acquisition in which the primary instructional aim is to gain understanding and to close knowledge gaps. One very successful instructional approach which tries to optimize cognitive skill acquisition is the use of Cognitive Tutors (e.g., Koedinger, Anderson, Hadley, & Mark, 1997). These computer-based tutors provide individualized support for learning by doing by selecting appropriate problems to-be-solved, by providing feedback and problem-solving hints, and by on-line assessment of the student's learning progress.

Although problem solving supported by Cognitive Tutors has been shown to be successful in fostering initial acquisition of cognitive skills, this approach does not seem to be optimal with respect to focusing the learner on the domain principles to be learned. One instructional idea to further improve the focus on principles in Cognitive Tutors can be taken from cognitive load theory research (e.g., Sweller, van Merriënboer, & Paas, 1998) or more specifically from the instructional model of example-based learning by Renkl (2005). The basic idea is to reduce problem-solving demands by providing worked-out solutions in the intermediate stage, when the primary instructional goal is to gain understanding. Thereby, more of the learners' limited processing capacity (i.e., working memory capacity) can be devoted to understanding the domain principles and their application in problem solving, especially when worked-out examples are combined with self-explanation prompts.

We expect that the effectiveness of a Cognitive Tutor unit will be further enhanced when it presents faded worked-out examples to learners in the beginning of each curricular section. When studying worked-out examples, more of the learners' limited processing capacity can be devoted to an effort to understand solution steps in terms of the application of domain principles. Assuring that learners have a basic understanding before they start to solve problems should help them to deal with the problem-solving demands by referring to already-understood principles instead of shallow strategies. The use of principles during problem solving not only enables learners to deepen their knowledge, by successfully applying it to new problems, but will also cause them to notice gaps in their understanding of the principles when they reach an impasse. Cognitive Tutors can then help to repair the knowledge gaps.

Experiments

Our main hypothesis states that the "example-enriched" version leads to more effective self-explanation activity, as determined by the analysis of the learner's input to the prompts.

This research question has been investigated in a preparatory lab experiment (in March 2006) and a follow-up field experiment in a Geometry Cognitive Tutor is scheduled to run in summer 2006.

References

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