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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Permalink

<https://escholarship.org/uc/item/1xr4j3tt>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 29(29)

ISSN

1069-7977

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Publication Date

2007

Peer reviewed

Can Tutored Problem Solving Be Improved By Learning from Examples?

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Keywords: Cognitive Tutor; Worked-Out Examples

Theoretical Background

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.

While problem solving supported by Cognitive Tutors has been shown to be successful in fostering initial acquisition of cognitive skills, it seems sub-optimal when focusing the learner on the domain principles to be learned. One instructional idea to further improve the focus on principles can be taken 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 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.

It is expected 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

A pilot study showed that both the regular Cognitive Tutor and the example-enriched version yielded the same learning and transfer effects. Interestingly, other recent studies investigating the use of examples in the Cognitive Tutor environment showed similar outcomes (e.g., Ringenberg & VanLehn, 2006).

A possible explanation could be that the Cognitive Tutor itself contains a high amount of help which diminishes the possible benefits of examples to be found. We are currently running a study which compares the regular Tutor and the example-enriched version with an "untutored" version of each. This study might reveal that when using a Cognitive Tutor which resembles problem solving as used in the literature on examples might replicate the findings in that literature.

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Acknowledgements

This work was supported in part by the Pittsburgh Science of Learning Center which is funded by the National Science Foundation award number SBE-0354420.