Assessing and Supporting Remote Collaborative Problem Solving

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Introduction

We define cognitive mentoring as joint problem solving involving a more-knowledgeable colleague (mentor) and less-knowledgeable peer (learner) in the context of an authentic task. Schlager, Poirier, and Means (1996) identify several highly iterative mentoring stages (problem definition, problem diagnosis, execution, evaluation, reflection) each involving a number of specific processes (e.g., demonstration, scaffolding) that participants execute. *Distant Mentor* (DM; Schlager, Means, O'day, & Poirier, 1994) was developed to facilitate and examine cognitive mentoring at a distance in the field of engineering. DM allows people in different locations working in a networked UNIX environment to jointly interact with a circuit board manufacturing simulation while maintaining a conversation over the network-based audio channel. DM supports both natural language and point-and-click gestures to query, rewind, and step through the simulation for information needed to diagnose the cause of manufacturing problems, and provides a history of prior queries and answers for easy review. Using the system, we examined questions such as: How does the aid of a mentor improve the speed and quality of subjects' solutions? Does DM afford any advantages over a mode of distant collaboration that is used commonly today—the telephone and FAX machine?

Method

Twelve undergraduates from San Jose State 's Industrial and Systems Engineering Department were recruited as subjects, and two department graduates (with related teaching and work experience) were recruited as mentors. Subjects and mentors received training on DM, and mentors worked with at least two pilot subjects prior to the study.

Subjects worked alone or with one of the mentors (located in a separate room) to solve two (increasingly difficult) problems. Three conditions were employed: 1) *Solo*: Subjects used DM to solve problems independently, without the aid of a mentor. 2) *DM*: Subjects solved problems with the help of a mentor, using the full collaborative capability of DM. 3) *FAX*: Subjects had access to the mentor via an audio channel but could only send *snapshots* of the current DM screen to the mentor as needed. In each problem, the simulation was run with one or more parameters changed from the "normal" run, on which all machines were working properly and all boards had the same priority. Hence, the boards finished in a different order, and the subject was asked to diagnose the cause. Complete problem solutions contained 2-4 subparts, and the parameters were varied to ensure that mentors did not know the solution in advance.

Sessions were videotaped, transcribed, and coded into our cognitive mentoring stages. We assessed effects of condition on several measures, including solution time, mentoring time and stages, and solution completeness. See Schlager, Means, and Schank (in prep) for a more detailed discussion of these (and additional) analyses and observations.

Results

Mean solution time was 83 minutes for Solo subjects, while DM and FAX subjects solved the problems significantly faster (36 & 40 minutes, respectively; $p<.05$). DM subjects solved all problems completely, while FAX subjects solved significantly fewer (only 50%) of the problems completely ($p<.05$). Solo subjects solved 63% of the problems completely. Overall, problem diagnosis represented the largest percentage of mentor-learner interactions (44%), followed by execution (26%), problem definition (15%), reflection (13%), and evaluation (2%); no effects of condition on these stages were observed.

Discussion

DM appears to afford significant advantages over both individual and collaborative telephone/FAX problem solving. We attribute the reduced problem-solving time for mentored (compared to unmentored) subjects to the help provided by the mentor. Although DM and FAX groups spent a similar amount of time in each mentoring stage, joint interaction with the simulation apparently improves the effectiveness of this time in terms of solution quality. In a post-hoc test of overall problem solving productivity, we summed the mentoring and total solution time and found a significant savings (34%) for DM subjects (only) over the Solo group, demonstrating that the overall time savings more than offset the investment of the mentor's time. These results suggest that investment in network-based cognitive mentoring could significantly improve both productivity and quality of distributed teamwork. Our current (and future) work assesses mentor styles and effects, field implementation issues, and other multi-user collaborative environments.

References

Schlager, M, Poirier, C., & Means, B. (1996). Mentors in the classroom: Bringing the world outside in. In H. McLellan (Ed.), *Situated learning perspectives*. Englewood Cliffs, NJ: Educational Technology Pubs., 243-261.

Schlager, M., Means, B., O'day, V., & Poirier, C. (1994). *Enhancing skills through distant mentoring*. (Technical Report). Menlo Park: SRI International.

Schlager, M., Means, B., & Schank, P. (in prep). *Facilitating collaborative problem solving with Distant Mentor*. (Technical Report). Menlo Park: SRI International.