Modeling Justification and Reflection in Case-Based Learning Environments

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Abstract: Two studies examining the role of modeling of performance and refection in case-based learning environments were conducted. In the first study, modeling and prompting of performance accounted for the number of criteria addressed in learners' arguments and the coherence of their arguments. In the second study, modeling of performance plus reflection enhanced coherence and the number of reflective statements included in justifications.

Introduction

Constructivist learning environments are typically case-based, providing authentic, context-rich, information-rich, situated experiences. Examples of case-based learning is provided by anchored instruction (CTGV, 1992; CTGV, 1990; CTGV, 1993), which provides authentic and generative learning environments in which students generate subgoals to meet the challenges afforded by the case. Students use mathematics in order to solve problems.

The rationale for embedding learning in authentic cases is that learning is indexed by the experience and activities in the cases (Brown, Collins and Duguid, 1989) . For students to use tools in a way that they are used in real life, students must "enter the community and its culture," just like a craft apprentice learning skills from a master. In cognitive apprenticeships, emphasis is placed on teaching students to learn how experts solve problems and carry out tasks, a process of "learning-through-experience" (Collins, Brown, & Newman, 1989).

A major problem with situated, case-based learning environments is that they require independent learning skills that have not been acquired or practiced by most learners. Exercising control and accepting responsibility for learning are not commonly required activities among learners. Therefore, it is necessary to support those processes while learners are engaged by these environments.

Constructivist approaches to learning emphasize support strategies such as modeling, coaching, scaffolding, articulation, reflection, and exploration. Of these, the most prominent is modeling of the desired performance by a skilled performer. Support for modeling comes from multiple perspectives. For instance, Bandura (1977) noted that by providing subjects with modeling, performance guidance, corrective feedback, and self-directed mastery, we can foster learners' skill development and self-efficacy. With cognitive modeling, the teacher can expose learners to the expert's overt and covert cognitive processes used to solve real-world problems. Modeling is normally accomplished by having a skilled performer think-aloud, that is, verbalize their reasoning while performing the procedures involved in a task. By experiencing teacher's cognitive processes, students are more able to adopt the expert's mode of thinking (Gorrell & Capron, 1990).

The effectiveness of cognitive modeling has been demonstrated in many research studies in vastly different domains over a span of decades. Bruch (1978) reported two experiments supporting cognitive modeling treatments. Denney (1975) investigated using cognitive modeling as a way to enhancing children's problem solving efficiency in a task of asking interrogative questions. Three kinds of strategies were studied in the study: Cognitive modeling, watching people ask questions and self-rehearsal of key strategies. Older children benefited from all treatments, but cognitive modeling was the strategy was found to be most useful by all children. In mathematics, students with difficulties also benefited from cognitive modeling and guided performance. Making the covert problem solving process observable for the learners by giving exemplary modeling and explanation of internal processing process proved to be an effective way to scaffold students' performance (Schunk, 1981; Welkowitz & Calkins, 1984).

Research conducted by Englert and Raphael (1988) indicated that cognitive modeling and coaching are also effective strategies to teach expository writing. With their Cognitive Strategy Instruction in Writing Program (CSIW), they taught special education students writing strategies through the use of think-alouds that model underlying writing process. Evaluation results indicate positive results for using these strategies in teaching writing. Cognitive modeling in these studies is typically accomplished through think-aloud protocols. Students observe the covert and internal cognitive processes of the models by watching models' performance and listening to their speech that explains the processes and strategies used.

Although modeling is the most commonly recommended support strategy for computer-supported, case-based learning environments, little if any research has been conducted. In these environments, we believe that it is possible to reveal the model's cognitive processes by providing an explanatory description of the process as learners study the learning environment. In these studies, we explored experimental implementations of modeling in a computer-supported, case-based learning environment. The task that we chose to model was argumentation/justification of decision-making, since it reflects learners' understanding and internal organization of knowledge. So, in the present studies, the instructional outcome was the ability to construct justifications for decisions and actions. In order to make sound argumentation, students not only need to assimilate the thinking process of the experts, but also need to articulate their own reasoning and thinking in a way that the expert would do. Cognitive modeling here serves both as model of reasoning processes and also a model of desired performance.

Experiment 1

Purpose

The first study sought to establish the effectiveness of a modeling strategy by comparing embedded task modeling to a treatment which prompted the learner for certain performance.

Instructional Materials

The instructional treatments were embedded in a computer-based environment that supported a required assignment in a restaurant management course. It consisted of three separate restaurant cases requiring the learners to recommend menu changes and to select equipment for purchase and then to justify their decisions based upon the relevant information from the case. Each case was a restaurant that was being remodeled or restructured. Students had constant access to and control of a variety of information in each case, such as the location of the restaurant, the requirements and expectations of the restaurant owner, the new menu structure and menu analysis, and a database of specifications of different pieces of equipment to choose from. They also could access a glossary of difficult terms and use a built-in calculator. Learners were informed that their task was to write a report identifying the equipment that they would select along with a justification for their decisions. These decisions and justifications were recorded by the program. There were 12 criteria that each student could think about while writing their justifications.

Treatment 1: Modeling Group. When students were in report writing mode, the modeling treatment provided the student with a similar case scenario alongside the report writing window. Students could examine the expert consultant's decisions on which pieces of equipment to purchase as well as the rationales and justifications provided to support the decisions. The expert's rationale addressed each of the decision making criteria.

Treatment 2: Prompting Group. Students in prompting group had access to the same information and functions afforded the modeling group. The only difference in the materials was that in report writing mode, in the opposing window, students were shown questions that prompted them to consider the critical and relevant facts and the criteria when they are about to write the scenario. Sample questions are: "Have you gathered all the relevant facts from the case? " and "Can another piece of equipment perform this function equally well or better?"

Students in both treatments could go back to the case scenarios and equipment specification database from the report writing section while writing their reports in order to obtain information to support their justifications. The alternative treatments were provided only when the students were in the report writing section.

Treatment 3: Control Group. Students in control group studied the core materials only without any modeling or prompting provided while they were writing their reports.

Participants

Fifty-five college students from two classes in the School of Restaurant and Hotel Management of a large eastern university comprised the sample. Sample students ranged from the third to the fifth semester in college. Students were randomly assigned to three groups by their instructor. There were 17 students in the modeling group, 17 students in coaching group and 21 students in the control group. None of the students had any previous knowledge of the content.

Procedure

The three groups of students used the software as an assignment in their junior level course. All versions of courseware were stored on a university file server so that students had access to them at all times. To help students to retrieve the correct, assigned version of courseware, the three different versions were assigned different names and icons. Students finished the assignment in a one-week period and saved experimental data on floppy disks. The courseware saved version information, students ID, and their reports. After completing the experiment, data were collected by gathering data files recorded on students' disks.

Instruments

Two researchers scored students' justifications for all three scenarios on two scales. For each rater, the first scale to assessed how many criteria were addressed in each scenario. This scale had 12 points that reflected the 12 criteria to be considered. The number of criteria addresses in each case by each student was summed. The second scale assessed how integrated and coherent the essays were with regard to the use of given information and the underlying reasoning process. This scale had 10 points and each student had 3 coherence scores for the 3 scenarios. The average coherence score was also calculated for each student. In judging the answers, the researchers were more concerned with how well the students justified their decisions than with which piece of equipment they decided to purchase.

The inter-rater reliability for the average criteria scores was 0.75 and .77 for the average coherence scores. In the data analysis, the average of two rater's coherence and criteria scores were used.

Results

An ANOVA revealed a statistically significant main effect for coherence scores, F=46.49, p<.01. A Tukey post hoc test indicated that students performed significantly better in both modeling and prompting groups compared with the control group. However, there was no statistically significant difference in coherence scores between modeling and coaching groups (Table 1).

Table 1: Performance scores for Experiment 1

Treatment	N	Coherence	Criteria Used
Coaching	17	8.15	10.2
Modeling	17	8.21	9.9
Control	21	6.06	10.1

No differences in the number of criteria used were found. We concluded that both modeling and prompting were equally effective in supporting the writing of coherent, well-justified decisions.

Experiment 2

Since modeling and prompting both showed equivalent advantages for scaffolding the argumentation of the learners, and since the prompting represented a fairly weak form of coaching, study 2 focused on the nature of modeling activities. This study compared the immediate effects and transferability of modeling the performance required of the learners as well as modeling the reflective thinking involved by the expert. Effective modeling should demonstrate not only the process (reflection in action) but also the thought processes supporting that action (reflection on action). So, in one treatment, the expert modeled the required argumentation to justify the decisions, and in the second also reflected the thinking that she was using while engaged in that activity. That reflectivity should improve the transferability of the knowledge constructed by the learner (Schon, 1988).

Instructional Materials

The instructional materials used in Experiment 2 used the same cases and structure as those in Experiment 1. Again, each case represented a restaurant under improvement. Students had control of same information in each case. Likewise, the task was to write a report justifying their decisions on what kind of equipment to buy for each case and any other recommended changes. The primary differences in the treatment materials were that the control group was eliminated (since Experiment 1 showed a powerful performance effect for modeling) and all of the supports were removed from the third case, so that it could be used as a near transfer activity. Also, the nature of the treatments was altered to focus on characteristics of modeling performance. As with the first study, students in both treatments could return to the case scenarios and equipment specification database from the report writing section at any time. Modeling was made available to the treatment groups while the students were writing their reports.

Treatment 1: Modeling Performance. In addition to the core instructional materials, the modeling treatment provided students with a model of the consultant's responses to a similar scenario justifying purchases. The modeling scenario was presented in a pop-up field and provided a mode for what a good justification was. This modeling was made available to the students while they were writing their own decisions and rationales.

Treatment 2: Modeling Performance and Reflection. The instructional materials for this treatment were identical to those in the modeling treatment except that hot words were added to the expert's justification while modeling the desired performance. Learners clicked on those words and received a message in a pop-up window (in the form of a speech balloon that was attached to a character of the consultant at the bottom of the screen) which included the consultant's reflections on the decisions that she was making. These reflections included 7 predictions, 5 mental images, 1 inference, 4 fix-up strategies, and 7 confusing points.

Participants

Thirty college students from a 300-level course in the School of Restaurant and Hotel Management at a large eastern university comprised the sample. Sample students ranged from the third to the sixth semester in college. Students were randomly assigned to the two groups by their instructor.

Procedure

Three groups of students used the software as an assignment for their class. Both versions of courseware were stored on a university file server so that students had access to them at any time. As in Experiment 1, the two versions were given different names and icons. Students completed the assignment during a two-week period and saved the experimental data on floppy disks. The courseware saved version information, students ID and their reports. After finishing the program, data were collected by gathering data files recorded on students' disks.

Instruments

Students' written protocols were printed out from the disks. Each case protocol was assessed for the surface pattern of the argument, the perspective assumed by the student (restaurant owner or independent consultant, as in the reflective treatment), the number of recommended purchases, the number of arguments supporting each decision, the number of non-equipment recommendations, the number of times that competing options were acknowledged by the student, and the number of personal reflections (where students speculated on their decisions or personal knowledge).

Results

A number of differences in student performances occurred. Students in the modeling + reflection group assumed the role of independent consultant more frequently than did the students in the modeling only group (X^2=9.28, df=1). Interestingly, the modeling only group presented more conflicting options during both the modeling (t=2.89, p=.01) and transfer (t=187, p=.07). During the transfer case, the modeling + reflection group, provided more arguments (M=13.5) than the modeling only group (M=9.1, t=-2.15, p=.04). Finally, during the modeling portion of the treatment, the modeling + reflection group produced more arguments per recommendation (M=6.0) than the modeling only group (M=4.0, t=-1.74, p=.09).

These data indicated that the modeled performance was reflected in all students' performance. The reflective thoughts of the consultative expert affected the argumentation and level of reflectiveness of those students receiving those reflective thoughts. Modeling reflection helped these learners test hypotheses and beliefs and create more complex arguments. The modeling only learners were not as able to resolve conflicting arguments.

Discussion

In these studies, the ability of learners to write well-written, coherent, and well-supported justifications of their decisions while interacting with a case-based learning environment in restaurant management was assessed. Ability was a function of the number of criteria addressed in their justifications, the coherence and organization of their arguments, and in the second study, the number of actions, supporting arguments, non-equipment recommendations, competing options, and personal reflections. In the first study, the fact that all of the 12 criteria were taught explicitly in effect made the learners' criteria scores a measure of recall of rules. That students in all three groups performed equally well on this recall task is consistent with the findings of most research on constructivist environments. Coherence scores indicated how students analyzed the problem situation, applied the knowledge introduced in the courseware, and integrated and synthesized their solutions to the problem. Argumentation and articulation reflected higher level of thinking process and real life problem solving skills that would be needed in their profession. By writing purchasing suggestions and rationales, they were trying to assimilate the language of the community of practice.

In the second study, adding reflective thinking to the modeling treatment appeared to affect the thinking of the learners. Their responses were more reflective and better supported. Modeling reflective behavior in case-based learning environments appears to be reflected in student performance. When students saw the experts modeling reflection more frequently, they provided more reflective statements in their justifications.

Conclusions

In case based learning environment, complex performances can be effectively modeled with commensurate effects on student performance. Reasoning and thinking process can also be modeled, although the effects are more diffuse and certainly more difficult to assess. Reasoning processes are perhaps better scaffolded in the design of the environment than modeled by an expert. Additional studies to test that belief are planned.

References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychology Review, 84*(2) 191-215.

Brown, J. S., Collins, A., & Duguid, S. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Bruch, M. A. (1978). Type of cognitive modeling, imitation of modeled tactics, and modification of test anxiety. *Cognitive Therapy and Research, 2*(2), 147-164

CTGV (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher, 9*(6), 2-10.

CTGV (1992). The Jasper Series as an Example of anchored instruction: theory, program description and assessment data. *Educational psychologist, 27*(3), 291-315.

CTGV (1993). Anchored instruction revisited. *Educational technology, 33*(3), 52-70.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction, essays in honor of Robert Glaser* (pp. 453-493). Hillsdale, N.J.: L. Erlbaum Associates.

Denney, D. R. (1975). The effect of exemplary and cognitive models and self-rehearsal on children's interrogative strategies. *Journal of experimental Child Psychology, 19,*, 476-483.

Duffy, T. M., & Jonassen, D. H. (1992). Constructivism: New implications for instructional technology. In T. M. Englert, C. S., & Raphael, T. E. (1988). Constructing well-formed prose: Process, Structure, and Metacognitive knowledge. *Exceptional Children, 54*(6), 513-520.

Gorrell, J. & Capron. E. (1990). Cognitive modeling and self-efficacy: Effects on preservice teachers' learning of teaching strategies. *Journal of Teacher Education, 41*(2), 15-22.

Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology, 73*(1), 93-105.

Welkowitz, L.A., & Calkins, R. P. (1984). Effects of cognitive and exemplar modeling on field dependence-independence. *Perceptual and Motor Skills, 58,* 439-442.