Incorporating Vicarious Learning Environments with Discourse Scaffolds into Physics Classrooms

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Abstract. The current study investigated the role of discourse scaffolds embedded into vicarious learning environments in classroom learning. In the current study, one of three vicarious learning conditions with varying levels of discourse scaffolds preceded standard instruction on seven classroom days. An explanation condition included deep questions, course content and explanations. In a question condition the explanations were deleted. A monologue condition contained only course content. The explanation condition participants showed significantly greater learning gains for daily sessions. Results are discussed in terms of presenting vicarious explanations and their role in classroom instruction.

Keywords. Vicarious learning, Discourse Scaffolds, Classroom research, Physics

In today’s classroom there is an increased demand to cover more material for more students while at the same time maintaining the same or higher levels of quality. Vicarious learning procedures in the classroom could provide a method for teachers to produce high quality material for their students to observe while freeing up the teachers resources to handle more individualized instruction or focusing on deeper understanding of materials for the overall classroom. The following studies provide the first validation steps for implementing vicarious learning within the classroom.

Computer-based vicarious learning environments include those in which the learners see and/or hear content for which they are not the addressees and cannot physically interacting with the source of the content they are attempting to master. Vicarious learning was observed in humans by Bandura [2] while modeling aggressive behavior for children. Although Bandura’s work on vicarious learning was associated more within the context of behavioral psychology, recent work in education research has focused on cognitive processes and knowledge construction in computer–based environments [7].

These non-interactive multimedia environments that use auditory narration and images to improve learning have been referred to as a vicarious learning environment (See [7] for review). A primary mechanism required for learning within these environments is that the learner stay cognitively active during the learning process [3]. When a learner is cognitively active, they presumably are attending to the material and while processing the material are producing inferences about the material as well as linking new material to previous knowledge. However, it is important to provide

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enough scaffolding or support in the material for the learner to be able to produce the correct links and inferences ([1]; [12]).

**Discourse scaffolds** [11] are elements of classroom dialogue traditionally used by teachers to guide and evaluate novice learners [10]. While the concept originated out of traditional classroom research, a well designed discourse scaffold used in an observed dialogue would be one potential way to provide needed support for learners in vicarious learning environments. A question – answer dialog is one example of a discourse scaffold that has been shown to be effective in both the traditional sense of discourse scaffolds [11] and in the non-interactive vicarious learning environments ([5]; [7]). The learners in the vicarious learning situation would be analogous to other students in the class who got to observe the teacher and student interaction.

Another potential discourse scaffold is self-explanation. Inducing students to provide self explanations has been show to improve comprehension and deeper understand of the material in such areas as physics problem solving [4], and history [13]. Vicarious exposure to self-explanations, including paraphrasing newly introduced information, increases students’ understanding of difficult science texts when used in conjunction with the SERT program that prompts and assists learners in providing explanations [9]. Using multimedia presentations, the current studies have aimed to contrast the effect of deep-level reasoning questions and deep-level reasoning questions along with self-explanations on knowledge construction in high school Physics classrooms.

**Current Study: A Test of discourse scaffolds in high school Physics classrooms**

In this classroom study, 150 high school students were presented course content on Newtonian physics. Five physics classes at an inner-city public high school were studied for a total of nine days in which the students were taught course content with multimedia presentations. The conceptual information of two units of the curriculum on basic forces and Newton’s first law and a second on Newton’s second and third laws, were taught. Students within classrooms were randomly assigned to one of three computerized conditions: a monologue condition in which only course content was presented, a question-only condition where each sentence presenting course content was preceded by a deep-level reasoning question, or a condition in which each sentence containing course content was preceded by a deep-level reasoning question and followed by an explanation of the material. These computerized conditions involved multimedia environments in which a virtual tutor and tutee discussed the day’s course content. Videos for each day lasted approximately 15-20 minutes. After the first 20 minutes, the class was returned to the teacher who taught the remainder of the class period covering problem solving and worked examples on the material.

On the first day of the study, students were given one version of the Force Concept Inventory [8] as a pretest. During days 2 through 8, students received computerized versions of their classroom instruction in one of three conditions using a laptop computer located on the student’s desk. Each day of instruction students received two versions of a 10-item (4-foil) multiple choice test covering that day’s content. The two versions of the test were counterbalanced as pretests and posttests across learners to assess daily changes in knowledge in that particular domain. Students completed a second version of the Force Concept Inventory as a posttest on the final day.
Posttest data from the multiple choice tests that were used to evaluate average daily learning gains across the seven daily sessions (Day 2 through Day 8), using pretest scores as covariates, were submitted to 3 (experimental condition: explanation vs. questions vs. monologue) x 2 (class type: standard vs. honors) ANCOVA. This analysis yielded significant effects of experimental condition, \( F(2,136) = 4.49, p < .01 \), and class type, \( F(1,136) = 7.64, \ p < .01 \). Learners in the explanation condition significantly outperformed those in both the monologue (\( p < .01 \)) and question (\( p < .05 \)) conditions. Learners in the explanation condition showed average pretest-to-posttest learning gains of 23 percent, while those in the monologue and question conditions showed gains of 18 and 17 percent, respectively. The honors students showed significantly greater gains (24 percent) than the standard students (15 percent).

The results of this study seem to support prior research indicating that vicarious presentation of deep-level reasoning questions promotes learning when integrated into course content. Additionally, vicarious deep-level reasoning questions may be more effective when followed by vicarious explanations of the content being presented. We have recently completed a laboratory study in physics and a replication study with younger 8th grade students. At the writing of this paper the results of these two studies are still pending. While further research is needed, this study provides evidence that vicarious presentations of deep-level reasoning questions, combined with additional scaffolding, are effective components of knowledge construction in multimedia environments when integrated into classroom settings.

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