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Beliefs about learning and constructive processes in reading: Effects of a computer supported intentional learning environment.

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Abstract

Substantial evidence has accumulated showing that students' beliefs about learning are related to their academic achievement. CSILE (computer supported intentional learning environments) is intended to support an interplay of private and public reflection through its communal student generated database and commenting functions. The hypothesis for this study was that if collaborative knowledge building in CSILE changes the goal of school from a task orientation to a learning orientation it would also change children's approach to learning to a deeper active one. Elementary students in CSILE and non-CSILE classes were asked about their beliefs about school learning and were given a reading comprehension task. Results showed that from fall to spring CSILE students' conceptions of learning became more mastery oriented and they improved more in both problem solving and recall of central concepts.

Theoretical Framework

Substantial evidence has accumulated showing that students' beliefs about learning are significantly related to their academic achievement. A major contrast is that between a "shallow" conception of learning, which sees it as a matter of paying attention, doing assigned work, and memorizing, and a "deep" conception, which sees learning as dependent on thinking and understanding. Related evidence from studies of achievement motivation has shown that beliefs about learning and intelligence influence children's choices and initiation of tasks as well as the intensity and persistence with which they pursue them (Dweck, 1989). Children with learning goals select more challenging tasks and persist longer whereas children with performance goals tend to select undemanding tasks and withdraw when difficulties are encountered.

The contrast between approaches to learning becomes especially relevant in situations requiring learning of difficult concepts, concepts for which students have inadequate prior knowledge. As an example, a copy and delete strategy that children commonly use in summarizing and composing texts (Brown & Day, 1983; Brown, Jones, & Day, 1983; Scardamalia & Bereiter, 1986) is to look for single important points without evaluating the overall meaning of what is being read or written. Clearly, a focus on taking in or reporting new facts can lead to locally adequate understanding. However a surface approach is unlikely to lead to new insights into a domain. In contrast, studies of what successful students <u>do</u> when trying to learn complex new information have shown that successful learners focus on cognitive goals and a transformational approach to learning (e.g., Chi, Bassok, Lewis, Reimann, & Glaser, 1989).

CSILE (computer supported intentional learning environments) is a hypermedia system which is intended to support an interplay of private and public reflection through its communal student generated database and commenting functions. Articulating ideas in writing clearly facilitates memory and enables revision, but as well encourages students to formulate their ideas explicitly thereby making them objects of thought. Further, CSILE through its communal database and commenting functionality affords comparison of ideas. Notes and graphics in the shared database are accessible to other students - they can search for, retrieve, read, copy and comment on other students' ideas. Private conjectures are now available for public discussion. Gaps and contradictions in understanding which may have remained opaque to the learner become available as problems requiring explanation (Chi et al, 1989). As such, this cognitive technology (see Pea (1987) for a review of cognitive technologies) affords an opportunity for extended peer collaboration (e.g., Scardamalia & Bereiter, 1991; Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989). As the theory of collective argumentation (Miller, 1987) implies, the cognitive processes used to articulate ideas and beliefs in social interactions may then be available to the child for self reflection. Previous studies have shown that children in CSILE classes become more reflective about their own work and the work of classmates than do children in non-CSILE classes (Lamon, Abeyguarnadena, Cohen, Lee & Wasson, 1992; Scardamalia, Bereiter & Lamon, 1992).

The claim here is that collaborative knowledge building in CSILE changes the goal of school from a task orientation to a learning orientation and consequently changes children's approach to learning from a shallow passive one to a deeper active one. The hypothesis for this study was that if CSILE was achieving some success in orienting students toward active construction of knowledge, this should be reflected in a deeper conception of learning being held by CSILE students and as well a more active approach toward learning difficult concepts.

This report encompasses two studies aimed at revealing students' beliefs about learning and their understanding of scientific concepts presented in text. The first study involved a nine item three alternative forced-choice instrument constructed on the basis of statements that we had found in previous research to be significantly related to student beliefs about learning (e.g., Coleman, 1992). The questionnaire is shown in Appendix 1. The second study asked students to read a passage in order to solve a problem and answer recall questions. Students were given a text on either photosynthesis or evolution (texts were counterbalanced such that students who had read the evolution text in the fall were presented with the photosynthesis text in the spring) in order to solve an analogous problem. As an example, students who studied a text on evolution read about the change in the coloration of peppered moths from primarily white to primarily black in industrial England. The subsequent problem asked them to explain the emergence of long legged deer in an area populated by cheetahs. These texts and problems are difficult: students need to extract underlying concepts - concepts which are not taught in the curriculum.

Method

Subjects. One hundred and ten elementary students in two non-CSILE and three CSILE classes participated in these paper and pencil tasks at the request of their teachers. CSILE and non-CSILE classes are comparable in grade mixture, socio-economic level, and educational philosophy.

CSILE facilities. The standard CSILE installation has eight networked computers per classroom, connected to a file server, which maintains the communal database. The database consists of text and graphical notes, all produced by the students and accessible through database search procedures. Anyone can add a comment to a note or attach a graphic note subordinate to another graphic note, but only authors can edit or delete notes. CSILE can be used to support anything from very traditional schoolwork to student-initiated inquiry (Scardamalia & Bereiter, 1991; Lamon & Lee, 1992); nonetheless students themselves seem to extend and elaborate school tasks within CSILE even in contexts where teachers do not support collaboration (Scardamalia, Bereiter & Lamon, 1992).

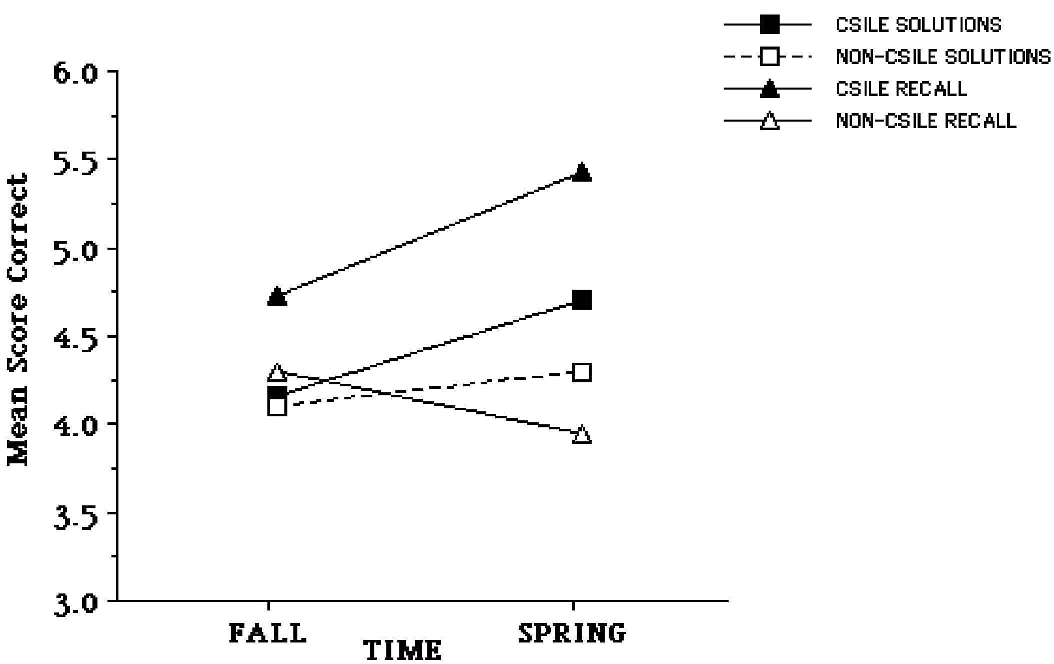
Procedure. Both the text comprehension and implicit learning theories questionnaire were administered in two separate sessions in the fall and in the spring. Students were tested in whole class sessions. For the text comprehension study, students first read the passage and then used the text to help solve the problem. Subsequently, texts and problems were removed and students were presented with recall questions. All phases of the study were self paced; almost all of the students finished within an hour. Questionnaires were completed about three weeks later.

Results

Rating scales were constructed for scoring problem solutions, summaries and recall questions. Rating criteria and examples for problem solving responses are shown in Appendix 2. Responses to the implicit learning theories questionnaire were scored as correct if the selection corresponded to a learning orientation (e.g., understand something I didn't know before) and as incorrect if they corresponded to a performance orientation (e.g., getting a good mark).

The data of primary interest are the changes in children's solutions to the problems and their recall of text information. In the fall, no differences emerged between CSILE and non-CSILE students' solutions, $F(1, 109) < 1$, MSe = 1.66 (M = 4.05 for non-CSILE students, M= 4.11 for

CSILE students). Most children's solutions either indicated a focus on less central elements)or revealed evidence of misconceptions (e.g., a Lamarckian view of evolution). These types of solutions suggest that students did not use the text to solve the problem. Nor was there any difference in recall as a function of CSILE, $\underline{F}(1, 109) < 1$, MSe = 4.56 (M = 4.25 and M = 4.66 for non-CSILE and CSILE students respectively). By the spring the pattern of results had changed considerably. Analysis of covariance showed that CSILE students' solutions were now significantly more accurate than were non-CSILE students, $\underline{F}(1, 108) = 4.14$, $p < .05$, MSe =1.06 (M = 4.25 and M = 4.68 for non-CSILE and CSILE students respectively). Analysis of covariance of recall scores showed a similar shift, $\underline{F}(1, 109) = 13.95$, $p < .001$ MSe = 4.16 (M =3.89 and M = 5.38 for non-CSILE and CSILE students respectively).



Problem solving and recall in the fall and spring as a function of class type (CSILE vs non-CSILE)

Analyses of variance for the fall implicit learning theories interview revealed that the mean proportion of learning oriented responses differed significantly as a function of years in CSILE, $\underline{t} = 2.21$, $p < .05$. Results in the spring showed that children in CSILE classes again chose significantly more learning oriented responses than did children in non-CSILE classes. As an example, 80% of children in CSILE classes said that they could tell that they had learned if they came to understand something that they didn't know before but only 56% of students in non-CSILE classes did so. Conversely, 40% of children in non-CSILE classes said they could tell if they had learned something if they got a good mark on a test but fewer than 15% of CSILE students assessed learning in terms of marks.

A second question of interest is whether a learning orientation is associated with increased comprehension in complex domains. Specifically, students with learning goals should be more apt to engage in active learning processes and so their solutions should address more information provided in the text but students with performance goals are more apt to engage in passive learning processes and hence rely more on prior knowledge. Of interest here is the relation between students' beliefs about learning as reported in their responses to the learning questionnaire and their solutions to the text based problem as well as the quality of their explanations. Correlational analyses showed that the relation between implicit learning theory responses and problem solving were significantly correlated although the pattern of correlations did not indicate a causal direction (fall implicit learning theory/ spring problem solving , $r = .31$, $p < .01$; spring implicit learning theory/fall problem solving, $r = .28$, $p < .01$).

Discussion

These data offer positive support for the idea that collaborative knowledge building in CSILE mediates children's beliefs about learning and that these children are significantly more likely to use information provided in a text to solve problems. CSILE students were more likely to report that learning is a matter of understanding and not simply getting all of the facts, that it is important to fit new information with what is already known and that learning is a matter of understanding increasingly complex information and not simply a matter of answering all of the questions. Further, children in CSILE classes showed a significant improvement in problem solving and recall of complex information.

The data also suggested that learning oriented responses are related to improved problem solving. Although results did not indicate a causal direction to the relation, demonstrating that knowledge building activities in CSILE classrooms changes both students' beliefs about learning and their ability to understand new concepts is a non-trivial finding in view of evidence suggesting that children's beliefs about learning influence their choices and initiation of tasks as well as the intensity and persistence with which they pursue them.

The findings reported here may have implications beyond the present study. Many cognitively based approaches for enhancing student reflection have adopted the metaphor of cognitive apprenticeship as a model (e.g., Collins et al, 1989; Resnick, 1987). The motivation behind both cognitive apprenticeship models and peer collaboration in CSILE is the supposition that reflective processes, including beliefs about the nature of learning, knowledge of one's own thought processes and knowing how to use that knowledge (Schoenfeld, 1989), in turn affect cognition in a number of ways. It is still an open question whether such metacognitive knowledge affects cognition in a causal way (e.g., Wellman, 1983). But see Keil (1991) for his interpretation of Brown as hypothesizing that metacognition may comprise a set of domain general processes acquired through specific experiences. Mapping the relation between reflection and learning is of interest for educational learning theories attempting to account for how learning can take place in situations for which the learner has inadequate prior knowledge.

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Appendix 1

IMPLICIT LEARNING THEORIES QUESTIONNAIRE

1) The most important thing in learning math is

a) to remember what the teacher has taught you.

b) to practice on lots of problems.

c) to understand the problems you work on.

2) The most important thing you can do when you are trying to learn science is

a) faithfully do the work the teacher tells you to do.

b) try to see how the explanations make sense.

c) try to remember everything you are supposed to know.

3) In order to learn the most you can from a book, you have to try to

a) read correctly what the book says.

b) remember what the book says.

c) think deeply about what the book says.

4) When you are learning something new, the most important thing to do is

a) to figure out how it fits or doesn't fit with what you already know.

b) to get all the facts you can about it.

c) to write down what you have learned so you won't forget it.

5) In school, the way you learn the most is by

a) listening to the teacher

b) working by yourself.

c) working with other students.

6) If you studied something like science or art really hard for a whole school year, at the end of the time, how much would you know about it?

a) I'd probably run out of things to study before the year was up.

b) I'd probably know some things, but there would still be a lot to learn.

c) I'd know almost as much as an expert in the area.

7) If you wanted to learn everything there is to know about something, say animals, how long would you have to study it?

a) Less than a year, if you study hard.

b) About one or two years.

c) Forever.

8) As you learn more and more about something

a) the questions get more and more complex.

b) the questions get easier and easier.

c) the questions all get answered.

9) After you have studied something for a while, how can you tell if you've learned anything?

a) If I still have a lot of questions, then I know I haven't leaned very much.

b) If I understand something that I didn't know before then I know that I've learned something.

c) If I get good marks on the test, then I know I've learned a lot.

Appendix 2

Rating Criteria and examples for Problem Solving

Scale - Quality of Problem Solutions

1. Does not understand the question

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"Yes I think the deer used his/her legs for capturing the animals to eat
and they use their legs for running away from hunters and other
creatures."
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"Yes I think that they had as much food as they needed because they had
their own food. If they had each other's food they wouldn't have eaten it
and they wouldn't have had the proper care."
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2. Irrelevant responses

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"Moths are very good to us because they are food for birds."
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"Plants are very good to us because they take away the carbon dioxide from
us and give us good air."
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3. Incorrect solutions

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"I have no idea why they developed longer legs, that is a good question? I
would think that the cheetahs and the deer would give off a special
chemical that would interact through the years, and cause the deer's
thinking to change which would cause their legs to grow longer."
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"No I don't think they provided as much food as necessary for the plant because if they grow green and unhealthy without sunlight then I don't think it would make a difference if they gave the plant water and food and I don't think the hamster would survive because I think the hamster would be too frightened and would jump all around and get so upset and tired and unhealthy and die."

4. Misconceptions

"Yes I do think that those deer developed longer legs to run faster. It was the same way with horses. They got bigger when the predators got bigger. It is a part of evolution."

"No I don't think that the plant got the right food because plants need sunlight to grow green healthy and strong they get their energy from the sun or else they grow a yellowish brown colour and look unhealthy. And for the hamster It would be okay but I think hamsters like sunlight too."

5. Parallel conceptions (co-existing ideas)

"No I think it grew longer legs just by chance.* this makes it easier to run but I think that the situation is the same as the moths who couldn't change colour to camouflage themselves. But it is fortunate for the deers to now be able to run with longer strides; enabling to cover more ground escape from the cheetahs.

* the legs could also start getting longer from all of the running."

"Yes and no because the hamster does not necessarily need light to live. But the plant would need light to make the food it needs. and the plant would go a lighter colour of green because of not being exposed to enough light to live."

6. Correct conceptions

"I think the deer developed longer legs, not because they had to escape from the cheetahs, but probably because there were lots of deer with short legs and a couple of deer with longer legs and the deer with the longer legs survived because they could outrun the cheetahs and so they multiplied and the deer with the shorter legs did not survive for the opposite reason."

"I think that they gave the hamster enough but the scientists did not give the plant one essential thing, they did not give it sunlight which the plant uses to make its own food (in its leaves)."