Applying a Framework for Conceptual Change in the Science Classroom: Studies of Knowledge Integration

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Abstract

Using Linn's (1992) theoretical framework of conceptual change, known as Scaffolded Knowledge Integration (SKI), in a classroom context, we explore two cognitive processes that are important to conceptual change in the science classroom: asking critical questions of evidence and searching for evidence to support design or scientific argument. Separate studies were performed for each of these processes, in order to isolate the effect of their treatment. Subjects were eighth-grade students who worked on special projects designed for the Knowledge Integration Environment (Linn, M. C., Bell, P., & Hsi, S., in press). Results suggest that these kinds of student activities and scaffolding derived from the SKI framework are indeed conducive to enhanced student learning. Students who received projects in which SKI components played a stronger role (in the form of specially designed curriculum and software tools) showed clear superiority in the questions they posed about scientific evidence as well as in their use of evidence in a design task.

Conceptual change in the science classroom is a complex cognitive and social process -- one that is affected by many factors: the student's knowledge of domain material; the nature of the instruction provided; the student's values and attitudes about school and learning; social interactions within the classroom; etc. Our framework for conceptual change in the science classroom must therefore include cognitive, social and epistemological components. A long history of research in the Computer as Learning Partner project (Linn, 1992) has culminated in the identification of four major components to the framework: a) identify new goals for science learning, b) make student thinking visible, c) encourage autonomous learning, and d) provide social supports. Learning how to ask questions has been identified as one of the most important cognitive skills for students to acquire on the road to becoming autonomous life-long learners (Palinscar and Brown, 1984; Collins, Brown and Newman, 1990; see Rosenshine, Meister and Chapman, 1996, for a thorough review of this research).

A Collaborative Search Page (CSP), designed using the SKI framework, provided a repository for classroom knowledge that successfully filtered information for students that had trouble independently locating Internet sites to support design decisions. The CSP does not simply help students formulate queries; rather, it helps them redefine the nature of the problem by a) modeling successful approaches used by other students, b) providing a range of alternatives that are submitted by other students who deemed them relevant, and c) encouraging reflection during the process of finding information to support design decisions. The specific design problem studied here, creating an energy efficient house for the desert, required the integration and application of scientific principles that were learned throughout a semester of computer-based laboratory work.

In a separate but related critiquing activity, students who received guidance consistent with the SKI framework were able to ask questions that were rated nearly a standard deviation better than those of students receiving the superficial guidance in relation to specificity, relevance, and productivity of questions ($F(2, 109) = 15.01$; $p < 0.0001$).

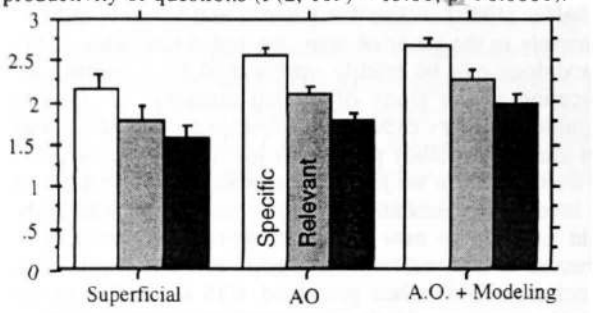

Figure 1. Categories of guidance versus generated questions.

Perhaps the most interesting thing about these results is: once the students left their respective "evidence cover page" (where the advance organization (AO) and modeling information was supplied) and went out to the actual Web sites, there was *no difference whatsoever* between the treatments for the three conditions. Simply by providing the appropriate guidance in advance, we could positively affect students' ability to ask critical questions of evidence.

The SKI framework combines the most recent and prominent contributions from the cognitive literature on conceptual change with important insights from the education community. According to this framework: no single model, but a repertoire of conceptual models should be encouraged; intermediate and qualitative conceptual models should be the preference in curriculum; students should be encouraged to work autonomously within their own conceptual repertoire; and finally, social components of learning, a prominent factor in collaborative learning environments, should be encouraged. The two cognitive processes studied by this research -- question generation and searching for evidence -- are both vital to the process of acquiring science knowledge. Our research has shown how both of these processes can be dramatically enhanced, within the even broader context of a sound pedagogy, by applying this framework to the design of tools and curriculum. More detailed information about the research along with the references and related publications is available at **http://www.kie.berkeley.edu** under "Publications".