The Role of Student Agency and Sustained Inquiry on Collaboration and Learning of Science Practices

Abstract: We redesigned a traditional inquiry-based science unit, creating a unit that incorporates student agency and sustained inquiry during science inquiry experiences. Using a quasi-experimental design, the two units were compared. Fourteen teachers in 5th grade classrooms in one school district in the Pacific Northwest participated. Data collected include an embedded inquiry assessment and video-recordings of student discourse. Preliminary findings show that students in the redesigned unit saw gains in both collaboration skills and scientific practices.

Major Issues Addressed

At present, many schools employ hands-on science curricula to help students become proficient in aspects of science inquiry and knowledge. However, our analysis suggests that for the most part these curricula do not engage students in what might be considered *authentic* science practice in the sense that students do not conduct *sustained, original inquiry* nor have *agency* in determining the course of their inquiry.

Research suggests that students can develop and pursue--with teacher scaffolding--their own program of research related to a complex problem (Chinn & Malhotra, 2002; Metz, 2004). Building on this work, we conjecture that students, when provided with the opportunity and appropriately supported to engage in authentic science, will be motivated and more likely to engage in sense-making and knowledge-building in the context of their work, and hence, more likely to acquire a deep understanding of science concepts and inquiry processes.

To evaluate these ideas, we examined collaborative learning processes (Herrenkohl & Guerra, 1998) and learning outcomes in elementary classrooms using two different hands on science units—one (of our own design) that offered students greater agency and opportunities for sustained, original inquiry, and one that involved a series of discrete investigations directed by the classroom teacher.

Potential Significance of Work

This research has the potential to contribute to our understanding of how student-driven, authentic science inquiry influences student engagement, discourse, and learning of science concepts and processes. It also has the potential to contribute to our understanding of effective design principles for science curricula.

Theoretical and Methodological Approach

Taking Science to School (Duschl, Schweingruber & Shouse, 2007) suggests that teaching "science as practice" involves "engaging children in designing and conducting investigations and answering complex questions" (p. 256). In inquiry science classrooms, students are purposefully engaging in scientific practices, grappling with important science ideas, and building conceptual understanding through meaningful discourse and activity. In contrast to this idealized depiction, current classroom practice more often involves a teacher giving students the questions and procedures for a series of discrete science investigations, and students' scientific work involves conducting these investigations and interpreting the results. In these classrooms, students' work is largely procedural, and lacks personalization and consequence (other than a grade).

In the present study, we compared a "traditional" science inquiry unit to a unit reformulated to embody more authentic science inquiry practices. Both units addressed similar concepts and skills, involved student collaboration, and were "hands on." The cornerstones of the "authentic" unit were student-choice/agency and student-guided collaborative investigations related to an over-arching problem (Vye, Schwartz, Barron, Bransford, Zech & CTGV, 1998). Namely, small teams of students were challenged to design and conduct a series of investigations that would inform their design of a habitat for isopods. We hypothesized that students in the Isopod Habitat unit would participate more productively in inquiry practices—that is, show greater evidence of sense making and knowledge-building over time--and be relatively more proficient at science inquiry practices.

The study involves a quasi-experimental design. Demographically matched schools were randomly assigned to either a comparison (i.e., traditional unit) or intervention (i.e., isopod habitat unit) group. A total of fourteen 5th grade teachers in one school district in the Pacific Northwest participated for 12 weeks each. Eight teachers and 122 students participated in the Isopod Habitat unit; 6 teachers and 72 students participated in the Comparison unit.

Data sources presented in this paper will include: a) students' performance on an embedded inquiry assessment that was conducted during week 10 in both the Comparison and Isopod Habitat classes; and b) videos of students' designing two investigations (during the first and last quarters of the unit).

In the embedded inquiry assessment, students in both conditions were asked to generate their own

research ideas including an investigative question, a prediction, and an explanation for their prediction. They conducted the study, interpreted their findings, and then were asked to decide upon and justify a good follow-up study. Two coders "blind" to treatment condition scored students' responses.

For the purposes of this paper, we have selected one group from each of 2 classes in both the Comparison and Isopod Habitat conditions (for a total of 4 student groups). For the Comparison classes we selected the 2 expert teachers who had provided students with an opportunity to design a study. Similarly for the Isopod Habitat classes, we selected 2 teachers whom we thought had implemented the unit with special fidelity. The groups were chosen based on the completeness of the video records.

For each of the 4 student groups, we selected videos of their design work early and late in the unit. This affords us the opportunity to examine the extent to which students' discourse changed over time as well as a comparative perspective on discourse processes under conditions of greater/lesser agency and sustained thinking. The video records were transcribed for discourse analysis.

Preliminary Findings, Conclusions and Implications

As illustrated in Figure 1, results from HLM analysis of items comprising the embedded inquiry assessment indicate that Isopod Habitat Challenge students performed significantly better than Comparison students in the following areas: generating a quality investigative *question* ($p < .0005$), *prediction* ($p < .1$) and, design for *follow-up study* ($p < .05$). This association cannot be considered causal, since the assignment procedure was not random. However, in these analyses, differences in baseline achievement are not a likely explanation for the estimated effects, since students' previous year's achievement scores on the Washington Assessment of Student Learning (WASL) standardized tests were used to control for prior achievement.

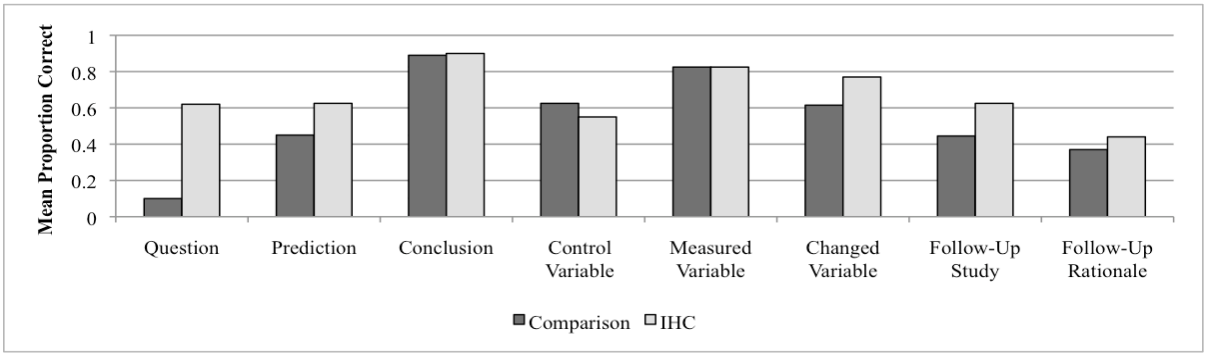

Figure 1. Performance on Embedded Inquiry Assessment

The discourse analyses are on-going; however, preliminary analysis indicates that Isopod Habitat students show greater evidence of knowledge-building over time. More students contributed during discussions, and there were more knowledge-building interactions between students. Lengths of exchanges were longer, and the Isopod Habitat students used greater precision in their language. In addition, engagement was markedly higher for the Isopod Habitat students. Preliminary findings indicate the value of building sustained inquiry and student agency into scientific inquiry experiences.

References

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