Methods for Analyzing Teacher Facilitation of Collaborative Learning in the Science Classroom

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Introduction

Understanding how instructional contexts assist or constrain collaboration within computer environments is important to CSCL research (Stahl, 2002). A key aspect of the classroom context is the facilitation that a teacher provides as groups of students collaborate as they work on complex problems, an important feature of design-based approaches. Collaborative discussions in the classroom are not always productive without teacher support. For example, Tabak and Resier (1997) suggested that during small group collaboration, teachers can help students attend to features within the computer environment, help students reflect on local construction of understanding, and assist students in adopting scientific ways of thinking about and explaining phenomenon. They also found that interleaving whole class discussions between small group sessions provided opportunities to extend local constructions into generalizable global understandings of important concepts and theories. Because some groups may have richer experiences than others, whole class discussions also provide opportunities for groups to publicly share their findings and insights.

But teachers, especially middle school science teachers with little or no inquiry teaching experience, face a myriad of challenges when enacting design-based curriculum. One challenge in particular relates to the strategies teachers choose as they facilitate whole class and small group discussions during synchronous collaboration using a computer tool. Because many teachers are themselves the product of traditional didactic science education, a tendency exists for teachers to teach in a manner similar to the way they were taught, emphasizing the acquisition of factual information through closed and authoritative question-and-answer sessions (Bartholomew, Osborne & Ratcliff, 2004). Research into teacher facilitation strategies has identified little distinction between strategies used during whole class and small group discussions (Dawes, 2004, Web, Nemer & Ing, 2006), or focus on procedural knowledge rather than on helping students draw inferences or synthesize ideas (Webb, et al., 2006). Student responses tend also to mirror teacher strategies when working collaboratively with their peers (Tharp & Gallimore, 1998). This didactic behavior is not conducive to fostering collaboration. One way to address this issue is to provide professional development opportunities for teachers.

This project proposes to use the synergistic relationship between research on knowledge-building communities and conceptual change to design teacher professional development. Iterative idea improvement is the centerpiece of Scardamalia & Bereiter's (2006) Knowledge-Building Communities. Seen as a shift away from students as learners or inquirers, knowledge building as an educational approach recognizes understanding as emergent, regards idea improvement as a result of community rather than individual achievement, values knowledge *of* over knowledge *about*, and stresses that classroom discourse emphasize collaborative problem solving rather than argumentation. If we accept symmetric knowledge advancement as expertise distributed within and between communities (Scardamalia, 2002), the participant structures created as students cycle between small group collaboration and whole class discussions form different communities. Thus, a second collaborative community exists during whole class discussion that provides a space for metadiscourse that uses the first-order discourse from collaborative groups as its subject (Scardamalia, 2002). Eliciting initial student ideas and constantly monitoring the status of student ideas is the focus of conceptual change. When teaching for conceptual change, Hewson, Beeth, & Thorley (1998) propose that (i) student ideas must become an explicit part of classroom discourse, (ii) students must be metacognitive as they think *with* and *about* their ideas, (iii) the status of competing ideas must be constantly monitored and (iv) when two or more ideas or explanations are considered for the same phenomenon, decisions must be made through justification on explicitly agreed upon standards of evidence. By explicitly incorporating the tenets of each into professional development, teachers can better understand how attending to students and their evolving ideas may lead to fundamental changes in their facilitation of classroom discussions, thus improving peer collaboration at both levels of community.

My proposed research compares teacher facilitation strategies during whole class and small group discussions before and after professional development experiences that emphasize student idea improvement within a knowledge building community and conceptual change. The intervention will address a common misconception of teachers new to inquiry teaching that students are responsible for ‘discovering’ or learning science from activity without teacher support, emphasize the importance of creating and maintaining a classroom culture that engenders collaboration, and focus teacher attention and practice on student ideas. While the major emphasis will be on fostering a knowledge building community at both the group and whole class level, conceptual change literature will be used to provide teachers with a mechanism or framework for moving their communities forward. Combining elements from the conceptual change model with knowledge building pedagogy emphasizes both the role of the teacher and students to explicitly identify initial ideas and to continuously monitor the status of ideas in an effort to advance the state of knowledge in the classroom community. Therefore, the research questions driving this proposal are:

1) What are the characteristics of teacher discourse strategies that foster student collaboration?
2) How does a teacher facilitate the formation of a knowledge building community in a class at both the group and whole class level?
3) How can teacher professional development activities foster the formation of a knowledge building community?

Context of Study

The CoMPASS Work & Energy curriculum consists of two components: design-based investigations and a hypertext software system called CoMPASS. The overarching design challenge is to design and build a machine composed of at least three different simple machines to help a person with a wrist injury easily lift heavy items. Mini-design challenges throughout the curriculum ask students to design and test six different simple machines. The second component of the unit, CoMPASS (Puntambekar, Stylianou, & Goldstein, 2003), is a hypertext system that integrates text and a concept map on a single page to produce a conceptual unit. Students navigate through CoMPASS either by selecting science concepts from the text or from the accompanying concept map. (See Figure 1.) After each selection, a new concept map is constructed that places the chosen concept in the center of the map. Concept relationships are indicated both by color and proximity to the central concept. Students conduct research on CoMPASS in groups after brainstorming questions about science concepts that they think will help them design a machine to successfully complete challenges. Groups also return to CoMPASS to connect the formal abstract scientific concepts and terminology to their concrete hands-on experiences.

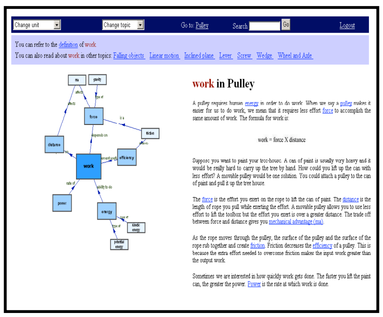

Figure 1. CoMPASS Screen

Student Collaboration

The CoMPASS inquiry cycle is composed of cycles of small group collaboration and whole class discussion and can be envisioned as being composed of three distinct phases. During the *introductory phase* students learn about the design challenge, brainstorm their initial ideas about the challenge and the science related to the challenge, become familiar with the equipment they will use, and make predictions. During the *research phase*, students collaboratively formulate questions that can be researched using the CoMPASS hypertext system that will help them successfully complete the challenge, conduct the research in small groups sharing a single computer, and then share the results of their research as part of a whole class discussion. During the *design challenge phase* students collaborate in groups to conduct the physical challenge, repeat the same or similar challenges using computer simulations, and then share group findings within a whole class discussion.

CoMPASS Inquiry Cycle

WC	Introducing the simple machine
WC	Brainstorming prior knowledge
GP	Familiarization with lab supplies
GP	Individual and group predictions
GP	Generating group questions
WC	Sharing group questions
GP	Research using CoMPASS
WC	Sharing CoMPASS research
GP	Conducting design challenge
WC	Sharing challenge results
GP	Analysis questions
WC	Reviewing analysis questions

Teacher Facilitation

Previous research (Knight, 2008) of teacher-student interactions during design-based CSCL revealed that: (i) teacher strategies were similar during whole class and small group work; (ii) teacher strategies rarely related group work to the overarching design challenge and instead were primarily task oriented and discrete; (iii) teachers experienced difficulty providing appropriate scaffolding by providing too much independence followed by episodes of "science telling" when student frustration and time became an issue; and (iv) with few exceptions, teachers rarely used student initial or evolving ideas as the basis for co-constructing knowledge and instead seemed to lead students to pre-determined outcomes based upon a pre-determined agenda. Teacher professional development that includes teaching explicitly for conceptual change and iterative idea improvement is proposed to address these findings.

Methodology

Data will consist of classroom video of enactments of the CoMPASS Work & Energy curriculum by four middle school teachers during the 2008-2009 and the 2009-2010 implementations. Pre-and post-test student data will also be considered for both years.

Data analysis will consist of quantitative analysis of student outcomes from testing and qualitative analysis of teacher strategies used during both whole class and small group collaborations. Results of the two implementations will be compared to determine the effect of the intervening professional development opportunities. An earlier study of teacher dialogic strategies (Knight, 2008) revealed a dilemma between extracting coding categories and maintaining fidelity to the richness and the context of the video being analyzed. The recent collection of articles appearing in *Video Research in the Learning Sciences* (Goldman, Pea, Barron, & Derry, 2007) will provide guidance for selecting additional methods for analyzing, interpreting, and reporting the results of my research that will be of the most value to the CSCL community.

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