When to Collaborate: Individual and Group Exploration of a Hypertext Environment within an Inquiry Science Classroom

Garrett W. Smith, Sarah A. Sullivan, Sadhana Puntambekar
Department of Educational Psychology, University of Wisconsin-Madison, Madison, WI
Email: gwsmith@wisc.edu, sasullivan2@wisc.edu, puntambekar@education.wisc.edu

Abstract: The use of a hypertext environment within an inquiry science curriculum is explored, comparing two conditions of group collaboration: one in which students explore the environment individually prior to a group discussion, and one in which students use the hypertext as a group while discussing the content. Student discourse is analyzed to compare the efficacy of the two conditions and the influence of classroom context on these learning conditions is discussed.

Introduction

Collaborative learning is an important part of inquiry science classrooms. In an inquiry environment, learners can benefit from the ability to discuss ideas and negotiate deeper meaning with other learners (Olson and Loucks-Horsley 2000). Though small group collaboration may be beneficial for learners, it is not always successful (e.g., Barron 2003). There are many factors that influence collaborative learning, including group composition, the nature of the task, and the nature of the environment itself. Collaborative learning is also influenced by the affordances of the tools, the context in which they are used, the role of the teacher as a facilitator of class discussions (Puntambekar and Young 2003), as well as *when* the tools are used in the learning process (Koschmann 1996). The exploratory study described in this paper attempts to explore the issue: *when* should students collaborate? Should students use a tool individually first and then discuss ideas in groups, or discuss their ideas while mutually engaged with the tool? We explored this issue within the context of using a hypertext system, which students used as a resource during inquiry-based science learning. This issue is especially relevant because, on the one hand, the hypertext system could offer points of shared reference for collaboration, which in turn could support the co-construction of knowledge among learners (Lipponen 2002) and lead to richer discussions of the content. On the other hand, as a technology tool not specifically designed to foster collaboration, the affordances of the hypertext environment might not meet the pre-conditions for successful collaboration (Stahl 2007). Furthermore, reading text in general is largely an individual activity. For these reasons, we examined student learning with hypertext in both an individual and a group condition. We also explored how the classroom context, such as the nature of the task and the role of the teacher, influenced how students interacted with each other and the tool.

Methods

The study was conducted in a 6^{th} grade science classroom (N=16), consisting of four small groups of four students each. Students used the CoMPASS hypertext system (Puntambekar 2006) on a notebook computer as part of a project-based inquiry science curriculum to learn about physics concepts related to simple machines. The CoMPASS hypertext system is designed to complement students' hands-on investigations by providing text that describes the concepts, as well as navigable concept maps, which mirror the conceptual structure in the domain of physics.

In this study, we describe student and teacher discourse while students used CoMPASS to help them complete four design challenges: the inclined plane, lever, wheel and axle, and pulley challenges. For each challenge, students were told to find the best way to use the simple machine to reduce the force needed to complete a given task. For this study, student groups completed two challenges in each of two conditions. In the *individual* condition, students explored CoMPASS individually for both the inclined plane and pulley challenges. During this time, students used the hypertext to research information for their challenge, and *then* met in their small groups of four students to discuss what they had learned. In the *group* condition, students explored CoMPASS *with* their small groups to research information for the lever and wheel and axle challenges. For all design challenges, students were given 15 to 20 minutes for exploration of CoMPASS, with an additional 10 minutes of group discussion for the *individual* exploration condition, resulting in approximately 160 minutes of audio and 150 pages of transcripts.

Transcripts of group discourse for the four student groups were used to investigate the kinds of talk that occurred during the two conditions. For the individual condition, the discourse during the group discussion *after* individual exploration was analyzed; for the group condition, we analyzed the discourse of the group discussion *while* groups explored the hypertext environment together. We coded the group discourse using a rubric, consisting of five categories: 1) *off-topic* conversation included discourse unrelated to the material; 2) *group dynamics* included socially-oriented discourse such as instances of group conflict; 3) *task-oriented* discourse included talk pertaining to task management and hypertext navigation; 4) *fact-oriented* discourse consisted of students sharing facts learned in CoMPASS, without elaborating on the information or its relation to their challenge; 5) *deeper understanding* discourse included scientific discussions of the relationships between concepts, connecting concepts to the challenge, providing examples of physics concepts, making predictions about potential challenge solutions, and deeper questions or explanations of the underlying physics concepts. Each utterance was coded using the rubric, with inter-rater reliability between the first two authors of 85%.

Results

To compare discourse in the two conditions, we calculated the percentage of utterances in each discourse category out of the total utterances for each group, and computed the means and standard deviations of each condition across the four student groups. There were several differences in the types of discourse between the *group* and *individual* exploration conditions (see Figure 1). For the individual exploration condition, group discourse after using the hypertext individually was far more *fact-oriented* (*M*=53.3%, *SD*=19.2) than in the group exploration condition (*M*=18.7%, *SD*=11.4). However, much of this talk consisted of students simply taking turns reporting basic information (i.e. definitions and formulas) they found during their individual exploration of CoMPASS, including incorrect or incomplete facts. There was also more *deeper understanding* talk for the individual exploration condition (*M*=6.6%, *SD*=0.09) than in the group condition (*M*=2.2%, *SD*=0.02), though much of this talk was connecting the concepts to the challenge, rather than demonstrating a truly deep understanding of the science.

During the group exploration condition, student discourse was on average more *off-topic* (*M*=37.0%, *SD*=17.0) than when exploring CoMPASS individually first (*M*=16.4%, *SD*=13.9), and more time was spent on *task-oriented* discussions (*M*=27.7%, *SD*=14.4) than for the individual exploration condition (*M*=13.5%, *SD*=8.8), though much of this difference could be attributed to the presence of navigation talk in the group exploration condition. There was essentially no difference in the frequency of *group dynamics*-related discourse between the group exploration (*M*=14.4%, *SD*=6.8) and individual exploration (*M*=12.2%, *SD*=19.6) conditions.

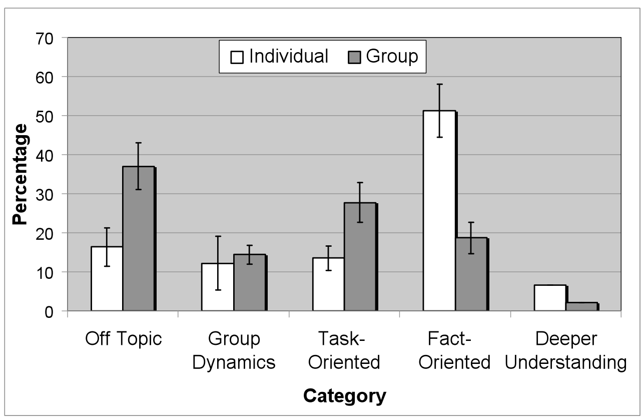

Figure 1. Percentage of group discourse category by exploration condition (with standard error bars).

Students' overarching goal for researching and discussing information from CoMPASS was to develop an understanding of the science concepts and relate them to their design challenge. However, the teacher did not always frame their research on CoMPASS and group discussions in a way that made this goal apparent. For example, after students used CoMPASS individually and were to have group discussions, the teacher directed that students' sentences should begin with "I learned that…" Students discourse therefore focused on simply reading from their notebooks everything they had written down; they were more focused on how much information they had recorded and could report to their group than on understanding the science, as illustrated in the following excerpt:

> [Student 4]: Um I learned that a stair is an inclined plane.
> [Student 3]: Me too. And I have the, the types of inclined planes. Er, eh, inclined planes...
> [Student 1]: Okay. I learned…
> [Student 3]: Wait, what did (Student 4) say?
> [Student 2]: Types of inclined planes, inclined planes…
> [Student 1]: I learned that work equals force times distance.
> [Student 3]: Okay what was yours (Student 4)? Sorry.

Further, direction and facilitation by the teacher was not much different when students navigated in the group condition. Students were still focused on simply writing down facts that they had found to answer specific questions. This kind of discourse was reinforced by the teacher as illustrated by the following excerpt:

> [Teacher]: You're first finishing answering all of your questions.
> [Student 2]: We did that.
> [Teacher]: Then you're just continuing to research levers writing down important information on page twenty-four, write down that key information on page twenty-four.

Discussion

This exploratory study was conducted to compare group and individual exploration of a hypertext environment. Group discourse after individual exploration was largely focused on reporting basic facts found within the hypertext, with students often reporting incomplete or incorrect facts. Having students come together to share information that they learned individually did not lead to successful collaboration. For group exploration, there was more *off-topic* behavior, which may be attributable to the fact that only one group member was able to control the navigation. Simply having the hypertext available as a shared reference for collaboration did not in itself lead to richer discussions. Given the lack of talk focused on deep understanding of the science, neither condition seemed ideal.

This overall lack of depth in both conditions could perhaps be attributed to the nature of the task, as framed by the teacher. The students were mainly concerned with writing down and reporting basic facts, rather than developing a deeper understanding of the concepts and making connections to their design challenges. The way the teacher framed the task may have changed the task from an authentic, ill-defined, divergent task to a more constructed, well-defined, convergent task (Kirschner 2002). This suggests that the teacher should frame the task in a way to support collaborative inquiry, regardless of when the collaboration takes place. It also suggests that successful learning in an inquiry classroom may require a shift in how both the teacher and students think about scientific inquiry, especially those with no prior experience with collaborative learning in an inquiry environment.

Our original question of *when* to collaborate is not a simple one with a clear answer. Based on the results of this study, we suggest that future research is needed investigating the organization of collaborative activities in inquiry environments. Such research can include combining individual and group exploration, altering the group structure and the nature of the task, characterizing the teacher's role in collaborative inquiry, and exploring technologies designed specifically for collaboration.

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