Tracking the Flow of Discussion Topics in an Inquiry Science Unit

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Abstract: Inquiry-based curricula may leverage distributed knowledge by interleaving individual, small-group, and whole class activities. We tracked topics across multiple activities to study how topics are distributed and consolidated in a science unit. Embedded prompts guided students' discussion toward key topics, while the teacher helped students take greater responsibility for managing whole class discussions over time. These findings demonstrate how embedded prompts and teacher facilitation can scaffold knowledge sharing across individual, small-group, and whole class levels.

Introduction

In inquiry-based curricula, students may build knowledge by interacting with people, tools, and technology over time (Pea, 1993; Hmelo-Silver et al., 2007). Cyclical processes of generating questions, researching concepts, and developing explanations help students to externalize, negotiate, and revise their thinking at the individual, small group, and whole class levels (Hmelo-Silver et al., 2007; Wertsch, 1984; Tabak & Reiser, 1997; Mercer et al., 2004). Interleaving individual and collaborative activities helps students to explore their own inquiry while developing deeper understandings than they could on their own, especially when teachers help students to connect their distributed knowledge (Mercer et al., 2004; Woodruff & Meyer, 1997; Tabak & Reiser, 1997).

To understand the distribution and consolidation of curricular topics during an inquiry-based science unit, we tracked how students discussed topics when using individual notebooks, researching in small groups, and participating in whole class discussions. We focused on e-textbook sessions that included cycles of generating questions, researching content, and sharing findings with the class. In particular, we examined how embedded inquiry prompts in the notebooks shaped students' research, and how teacher facilitation encouraged students' sharing in whole class discussions. Our research question was: *how do curricular topics move across individual, small group, and whole class levels over time, as supported by embedded inquiry prompts and teacher facilitation?* This question has implications for how students leverage others' research as topics flow from individual artifacts to a collective knowledge base in an inquiry classroom.

Methods

We selected three groups of students working in groups of four (N = 12) in an eighth-grade public school classroom, located in a small Midwestern U.S. city. As part of a larger study, students participated in *Make Your Own Compost*, an eight-week science unit that challenged students to design an ideal compost. To inform their designs, students participated in research sessions with an e-textbook (VidyaMap) at three points in the unit, which we selected for study. VidyaMap displays content about biology topics and the relationships between those topics. To help students navigate toward content about compost, we embedded inquiry prompts in students' notebooks to guide question generation about topics that might improve their designs (e.g., abiotic factors). Students then discussed their questions and research as small groups and the whole class. Collaborative activities (e.g., small group and whole class discussions) created opportunities for students to share, negotiate, and revise their understanding.

To analyze how topics moved across individual, group, and class levels, we tracked the presence of topics in students' individual notebooks (120 pages), small-group discussions (90 minutes), whole class discussions (129 minutes), and log data from VidyaMap (176 records). We included topics when they were part of a statement or question involving reasoning (for notebooks and discussion) or were viewed for a minimum of 10 seconds (for log data). Next, we created matrices of each topic discussed by each student, group, and the whole class. We then identified patterns across levels, which we considered to be salient topics for the class. We also looked at how the teacher engaged in class dialogue with students by generating Markov models for teacher and student turns of talk during the three whole class discussions.

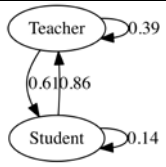
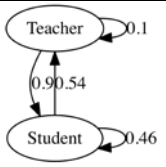
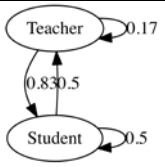
Findings

First, we discuss how embedded inquiry prompts guided student's discussions. The prompt for Session 1 (What factors help decomposers break down matter?) resulted in individual notes about moisture and temperature, which were also discussed by small groups and the whole class. Groups added biotic factors, carbon, compost, ecosystems, and water to their research. In the whole class discussion, students emphasized temperature (15.1%

of turns) and abiotic factors (10.6%). Undiscussed topics in individual notes included air and oxygen. Next, the prompt for Session 2 (Where does the energy for life come from?) resulted in individual notes about plants, producers, and sunlight, which were also discussed by small groups and the whole class. Groups also researched energy and photosynthesis. In the whole class discussion, students emphasized conservation of energy and matter (36.1% of turns) and producers (27.8%). Undiscussed topics in individual notes included air and oxygen. Last, the prompt for Session 3 (What is an ecosystem?) resulted in individual notes about abiotic factors, biotic factors, compost, consumers, decomposers, ecosystems, and producers; these were also discussed by small groups and the whole class. Groups focused on compost and ecosystems in their research. In the whole class discussion, students emphasized dependence in food webs (70.9% of turns) as they discussed consumers, decomposers, producers, energy, plants, and soil. Undiscussed topics in individual notes included biodiversity, oxygen, and water.

Next, the Markov models of whole class discussions (Table 1) showed a decrease in teacher talk over time. The probability of a student following up after another student was 14% in Session 1, but this significantly increased to 46% in Session 2 (z = -8.0995, $p < 0.001$) and 50% in Session 3 (z = -9.1975, $p < 0.001$). Correspondingly, the probability of the teacher following up after a student decreased from 86% in Session 1 to 54% in Session 2 and 50% in Session 3. Overall, the teacher limited his interjections into student talk over time, indicating that students took on greater responsibility for managing their whole class discussions.

Table 1: Markov models of turns of talk during whole class discussions

Session 1	Session 2	Session 3
		

Conclusion

Inquiry-based curricula may encourage students to access different resources and consolidate their knowledge as a class. In an effort to understand this process, we tracked how curricular topics moved across individual, small-group, and whole class levels during students' research sessions with an e-textbook in a science unit. We found that embedding inquiry prompts in individual notebooks helped guide students' inquiry toward important topics for understanding and improving their compost designs. Students also took on greater responsibility for managing their class discussions over time as the teacher facilitated increasingly student-centric discussions about topics related to the embedded prompts. This study creates an opportunity for further research about how embedded prompts, teacher facilitation, and e-textbook content can serve as synergistic scaffolds in a middle-school inquiry science unit.

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