

Dealing With Changes and Challenges: Grade 5 Students' Experience With Knowledge Building Pedagogy in a Yearlong Science Inquiry

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Abstract: The goal of this study is to understand how grade 5 students as new knowledge builders adapt to the changes and address the challenges associated with Knowledge Building pedagogy to sustain their science inquiry over a school year. We observed the knowledge building process of a Grade 5 classroom that studied ecology, conducted in-depth semi-structured interview with nine students to gather detailed accounts of their personal experiences with science inquiry organized based on Knowledge Building pedagogy. Qualitative analysis of the interviews in relation to the classroom observations elaborates how the students experienced changes in their learning and their socio-emotional and cognitive responses to these changes. The findings show that the students addressed the challenges brought by the changes by exerting a series of cognitive efforts themselves and by gaining support from their knowledge building community.

Introduction

Education in the 21st century needs to prepare students for creative knowledge-intensive careers and collaborative practices. Various collaborative, inquiry-based learning programs have been developed to cultivate productive knowledge practices among students. Among the inquiry-based programs is the Knowledge Building pedagogy, which is aimed at restructuring classrooms as knowledge building communities in line with how creative knowledge practices operate in the real world (Scardamalia & Bereiter, 2014). Despite the advances made in understanding the socio-cultural and cognitive processes of collaborative inquiry and knowledge building (Bell & Linn, 2000; Hakkarainen, 2003; Hmelo-Silver, 2004; Roschelle, 1992; van Aalst, 2009), we, as a field, still have not found out how to bring sustained collaborative inquiry and knowledge building into broad classrooms to transform educational practices. The implementation of authentic inquiry and knowledge building requires teachers as well as their students to adapt to a new paradigm of learning that involves new learning goals, processes, social roles and norms, and environments. For example, students need to learn how to enact high-level agency and collective responsibility for co-managing the processes of inquiry (Scardamalia & Bereiter, 2014; Zhang et al., 2011). While existing research has investigated the progress made by various classrooms toward productive knowledge building practices (van Aalst & Truong, 2011; Zhang et al., 2007), it is unclear how students as new knowledge builders experience and respond to the dramatic changes to strive for effective knowledge building. The purpose of this study is to understand how students in a grade 5 classroom adapted to the changes and addressed the challenges associated with knowledge building to sustain their science inquiry over a school year.

Conducting science inquiry using Knowledge Building pedagogy represents a demanding challenge to teachers and students who are new to the pedagogy. Students are expected to take on new roles and handle learning differently to become effective knowledge builders who work together to develop collective understandings through sustained inquiry processes at both the individual and community level. Such transformation takes a gradual process through which students become more comfortable embracing changes and addressing challenges associated with Knowledge Building pedagogy. To better support the process of classroom change, we need to investigate the motivational and socioemotional aspects related to the ways students deal with the challenges and difficulties of knowledge building (cf. Miyake & Kirschner, 2014). When experiencing challenges, students have various emotions, which are associated with the ways they view themselves in relation to the nature and context of learning (Dweck, 2006). More positive responses to challenges involve seeing challenges as opportunities to learn and dealing with challenges through persistent efforts (Duckworth, Peterson, Matthews, & Kelly, 2007). Students need to make decisions at an individual level to adapt themselves to the new pedagogy that requires them to actively seek support and build knowledge as opposed to passively waiting to be guided and taught by their teacher.

What specific changes students experience, what these changes mean to students, and what efforts they pay to respond to the challenges when doing inquiry with Knowledge Building pedagogy are worth investigating. This study investigates the experience of a group of fifth-graders in their first year of knowledge building. We ask the following research questions: (a) How do students conceive of the new way of learning

through knowledge building? (b) What characterizes student experience as new knowledge builders? And (c) How do students deal with challenges to sustain and deepen their science inquiry over a school year?

Methodology

Classroom contexts

This study was conducted in a grade 5 classroom at a public school in Northeast US. This classroom had 24 students who were taught by a veteran teacher. The students studied ecology over a whole school year, with two science lessons each week. The ecology study was implemented based on Knowledge Building pedagogy supported by Knowledge Forum: an online collaborative environment (Scardamalia & Bereiter, 2014). The science inquiry began with focused research on crayfish and was then expanded to study different ecosystems. Students generated various interests and questions and formulated shared wondering areas as the focus of their inquiry. They generated ideas, conducted research using online and printed materials, and engaged in knowledge building conversations to share and build on one another's ideas for deeper understanding. On an ongoing basis, students contributed ideas to Knowledge Forum for continual discussion online.

Data sources and analyses

The data sources included classroom observations and interviews. The first author observed each science lesson and took detailed notes. At the end of the inquiry, we conducted a semi-structured interview with nine students randomly selected from those who had consented to be interviewed. The interview included nine questions focusing on the processes and experiences of inquiry. Follow-up questions were asked in each interview to have students explain their response in detail. The interviews lasted between 10 and 19 minutes each. All the interviews were video-recorded and transcribed verbatim.

We used qualitative inductive data analysis (Hatch, 2002; Strauss & Corbin, 1998) to analyze the interview data supported by our classroom observations. The first author read and re-read the interview transcriptions. Focusing on each of the research questions, a set of raw codes was developed and applied to the interview data. The raw codes were further reviewed and linked to develop salient themes. The themes and codes were described in Findings.

Findings

To understand how the students experienced and conceived of the changes in their classroom caused by the adoption of Knowledge Building pedagogy, we asked students to reflect on their journey of inquiry and their experience with this new way of learning in the interview. Qualitative coding of the students' responses resulted in five major codes that gave rise to two themes (Table 1). Students recognized that they were expected to take ownership over their science inquiry to generate inquiry directions and questions and plan and structure their inquiry processes. With this expectation, students noticed that they needed to take on new roles to find the information through research, to go beyond the information for deep understanding, and to build connections across the various ideas to understand how ecosystems work.

Table 1: New changes students experienced with Knowledge Building pedagogy

Themes	Codes	Examples
Learning as student-driven	Defining inquiry topics and questions	"choose what you wanted to learn about, instead of teacher saying, this is what you gonna learn about"
	Structuring inquiry processes	"there is a lot of resources I can work by"
Learning through deep inquiry	Conducting research	"having to find out all the answers for ourselves"
	Going deep	"had to figure out why this was the answer and how it worked"
	Building connections	"make... connections to many other things"

In the interview, the students were further asked to reflect on any exciting things or difficult moments they had experienced in the knowledge building process. Coding of their responses helped us to identify both their feelings/emotions as well as cognitive challenges (Table 2). As new knowledge builders, students

experienced different emotional reactions along their journey of science inquiry. On one hand, they showed enjoyment and excitement. On the other hand, they also experienced struggles to adapt to their new role as knowledge builders who needed to manage their inquiry interests and directions. Associated with the struggles are the specific cognitive challenges they encountered at different stages of their inquiry: to go deeper, to find helpful sources of information, and to deal with setbacks in thinking.

Table 2: Socio-emotional responses and cognitive challenges students experienced with Knowledge Building

Themes	Codes	Examples
Feelings about inquiry	Enjoyment	"It's actually very fun!"
	Struggle	"It would've helped if some of the questions I could have gotten answers to like easier, like if the teacher knew the answer to a question, she could tell us."
	Finding and changing interest	"I couldn't find anything else about tundra and so I decided that I switched topic because I was stuck in the tundra."
Cognitive challenges	"couldn't go any further"	"Sometimes I felt like everything I read was kind of just over and over again, the same exact thing."
	"hard to find information"	"can't find the information that we were trying to find."
	Setbacks in thinking	"my train of thought stopped"

In the interview, students further commented on what they did when they faced difficulties and challenges. Analysis of their comments revealed their active efforts and strategies along three themes: deep thinking, reflective monitoring and strategic focusing, and seeking collaborative support in their community to connect ideas and deepen inquiry. These comments aligned with our classroom observations, showing that the students exerted continual efforts both individually and as a community to solve problems, stretch their thinking, and achieve deeper understanding.

Table 3: Cognitive efforts students made to deepen inquiry with Knowledge Building

Themes	Codes	Examples
Deep thinking	Keep thinking and researching	"to think in a different way, at a different angle"
	"got more information"	"look at the websites, the extra information, the books, the videos"
Reflective monitoring and strategic focusing	Seeing the whole picture	"learn about other things about it to figure out how that affecting what you think is important"
	Tracking thinking	"Think about what you know, and think about what you don't know"
	Refocusing	"After I switch topics, I found a lot about coral reefs, so I did not get stuck during the coral reefs"
Collaborating to connect and deepen inquiry	Reaching out to other people	"get ideas from my friends and Mrs. O"
	"connecting ideas"	"connect your knowledge with other people and your thinking."
	Contributing to the community	"to take the most important things you kinda want to talk about what's happening more than the facts about it."

Discussion

Efforts to transform classroom practices using Knowledge Building pedagogy and other inquiry-based learning programs require deeper understandings of how students as new knowledge builders experience and respond to the dramatic changes. In this study, the participants understood that their learning was expected to be "student driven" for "deep inquiry," which were two major changes they faced in their science learning. The participants

reported enjoyment of their yearlong science learning experience. Meanwhile, they reported struggles to play their new roles and manage their inquiry interests and directions when they reflected on the beginning phase of their inquiry. The contrast of students' emotional responses between "struggle" and "enjoyment" indicates a sense of accomplishment after they adapted to the changes by dealing with the "cognitive challenges", by engaging in "deep thinking" and "reflective monitoring and strategic focusing," and by "collaborating" and reaching out to their KBC for inquiry support. To students, "reaching out to other people" and "connecting ideas" through face-to-face or online interactions were not the only ways they practiced to deepen inquiry. "Contributing to community" by generating and improving ideas in Knowledge Forum also fostered their cognitive effort and stretched their thinking. The community served as a supportive context to sustain the science inquiry of both individuals and the community as a whole.

Implications and next steps

The findings contribute to understanding how students experience and respond to the changes and challenges associated with Knowledge Building pedagogy. Transforming classroom practices using inquiry-based learning and knowledge building not only requires the efforts of researchers and teachers but also the persistent efforts of students to make sense of the changes, embrace challenges, and deploy proactive strategies to seek idea improvement despite difficulties. We are expanding this analysis to a larger group of students from several classrooms to understand the full range of changes and challenges students encounter. We will also do deeper analysis of students' specific actions to address the challenges in relation to knowledge advances achieved.

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