Reflective Structuration of Knowledge Building Practices in Grade 5 Science: A Two-Year Design-Based Research

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Abstract: This study was conducted in two Grade 5 classes (A and B) taught by the same teacher in two successive school years. Each year students studied human body systems over a whole school year using Knowledge Forum (KF). Both classes worked with an idea-centered, principle-based framework of knowledge building; students in class B (year 2) particularly engaged in reflective structuration to co-construct structures of inquiry as their work unfolded. Qualitative analyses of rich classroom data elaborated the reflective structuration process in class B. The analyses of student online discourse showed that compared to class A in year 1, class B made more purposeful and sustained contributions to understanding various human body systems and developed more sophisticated explanations.

Introduction

Despite the advances made in understanding the social and cognitive interactions in collaborative inquiry and knowledge building, the field of computer supported collaborative learning (CSCL) still faces the challenge of how to bring sustained inquiry and collaborative knowledge building to classrooms so as to transform educational practices (Stahl & Hesse, 2009; cf. NRC, 2012). Beyond understanding the specific social and cognitive processes of idea development, research on knowledge building and collaborative learning needs a social practices perspective, to incorporate a larger focus on the social practices enacted by students and their teacher to sustain and channel their cognitive and social moves for long-term productivity (Hakkarainen, 2009; Stahl & Hesse, 2009). In real-world knowledge building practices, participants continually build on and advance the knowledge assets of their community by generating and identifying promising ideas and improving the ideas through sustained inquiry and discourse; by formulating deeper problems as solutions are developed; and by assuming leadership and responsibility at the highest levels instead of relying on the leader to tell them what to do (Amar, 2002; Dunbar, 1997; Sawyer, 2007). They do not simply enact repeated procedures but continually create and adapt their social practices as their knowledge is advanced (Knorr Cetina, 2001, Zhang et al., 2009). To address the dynamic nature of social practices for knowledge building in classrooms, a principle-based, as opposed to procedure-based approach to inquiry is needed (Scardamalia, 2002). Drawing upon the Knowledge Building pedagogy (Scardamalia & Bereiter, 2006), a renowned inquiry-based program to cultivate authentic knowledge-creating practices, we explored how students and teachers worked with a set of principles to co-design their classroom practices and chart the unfolding course of inquiry (Zhang et al., 2011). This line of research has led to the discovery of an important socio-epistemic mechanism enabling sustained practices of knowledge building: reflective structuration by which knowledge building communities co-construct, adapt, and use collective structures to guide their collaborative deepening work on ideas (Zhang, 2012).

Different from many other inquiry-based learning programs (e.g. project-based learning) in which students are required to work on predefined tasks/problems using step-by-step procedures and scripts, Knowledge Building adopts an idea-centered and principle-based approach to classroom design. Guided by a set of knowledge building principles (e.g. epistemic agency, authentic problems and real ideas, improvable ideas, collective cognitive responsibility) (Scardamalia, 2002; Zhang et al., 2011), students and their teachers co-construct and reconstruct the flow of inquiry as their work proceeds. A conceptual as well as practical challenge arises pertaining to how the idea-centered, open-ended actions/interactions are translated into coherent, supportive, long-term classroom practices without extensive teacher pre-scripting.

We identify reflective structuration as a potential solution to this challenge, and elaborate this concept based on social practice theories (Giddens, 1984; Sewell, 1992). The key to understanding how knowledge building as a social practice can be possibly sustained lies in the dynamic relationship between human agency and social structures that presuppose each other. Social practices become organized and sustained over time because of their relatively stable structures. Such structures both constrain and enable human agency. Actors appropriate existing structures which are historically formed in their institutional contexts, use the structures to plan and guide their ongoing actions, and reflexively monitor what is going on. The actors' agency is reflected in their capability to reinterpret, modify, reorganize, and recreate the structures, influencing future practices by themselves and by other members (Sewell, 1992). In line with the social practice theories, our empirical analysis of productive

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knowledge building communities revealed that members engage in dual-level construction driven by their agency: as members contribute content-specific questions and ideas to build knowledge, they co-construct collective structures of knowledge practices to guide and support their collaboration and contribution (Tao et al., 2015, 2016). The collective structures serve as shared frames of knowledge building activities signifying structural properties of inquiry, including the epistemic objects/issues to be investigated as the focus of unfolding strands of practices (epistemic structure) (Knorr Cetina, 2001), productive ways to conduct research and discourse (pragmatic structure), and who should work with whom in what roles (participatory structure) (Zhang, 2012). Students use such co-constructed structures to monitor and regulate their joint inquiry and position their roles and contributions.

Our prior exploratory studies have analyzed how students generated and adapted epistemic and pragmatic structures to guide their knowledge building (Tao et al., 2015, 2016; Zhang et al., 2015). The current study further examines the processes and impacts of reflective structuration more systematically through a two-year design-based study, with students in year 2 engaging in reflective structuration more intentionally to frame/reframe shared areas/objects of inquiry for unfolding inquiry practices. Our research questions ask: How did the teacher and her students implement reflective structuration? Did the reflective structuration design in year 2 leverage sustained knowledge building practices among students? To what extent, and in what ways?

Method

Classroom contexts and designs

This design-based research was carried out in two Grade 5 classrooms (A and B) taught by the same teacher in two school years, with 21 students (10-to-11-year-old) in each year. In both classrooms, students investigated human body systems over a whole school year following Knowledge Building pedagogy supported by Knowledge Forum (KF), an online collaborative knowledge building platform (Scardamalia & Bereiter, 2006). Knowledge building practices in both classrooms unfolded based on student-generated questions and ideas without pre-set procedures. Specifically, students engaged in individual and small group reading, whole class face-to-face conversations, individual and small group modeling and demonstrations, student-directed presentations, and so on. Major ideas, questions, and findings generated through various inquiry activities were contributed to KF for continual discourse. While both classes worked with an idea-centered, principle-based framework of knowledge building; students in class B (year 2) particularly engaged in reflective structuration to co-construct collective structures to frame/reframe shared objects of inquiry as the focus of their unfolding strands of knowledge building practices. The detailed processes of reflective structuration are analyzed and elaborated in Results.

Data sources and analyses

To elaborate the implementation of reflective structuration, we conducted qualitative analyses of rich classroom data, including classroom observation notes, the teacher's reflection journals, student-generated classroom artifacts, and classroom videos. To examine students' knowledge building practices in each year, we analyzed their online knowledge building discourse. First, we compared the areas (objects) of inquiry addressed in the online discourse by the two classrooms and coded students' online contributions using a five-category coding scheme created to capture productive discourse patterns (*questioning, theorizing, evidence, referring resources, and connecting and integrating*) (Zhang et al., 2011). Each note coded as "theorizing" was further rated based on a 4-point scale: *1-pre-scientific, 2-hybrid, 3-basically scientific, and 4-scientific* (Zhang et al., 2007).

Results

Reflective structuration of knowledge building practices

Qualitative analyses identified the reflective processes in classroom B related to the co-generation and adaption of epistemic structures. These include: (a) co-formulating collective wonderings (e.g. how does the brain work) based on individual interests and questions; (b) deep search, framing, and collective mapping of interrelated areas of inquiry as the shared focus of the community; and (c) individual and small-group reflection on specialized inquiry aided by the collective map of inquiry objects. The teacher engaged in ongoing noticing and envisioning of idea progress related to the inquiry areas in her reflective journals to co-engage with her students in the unfolding inquiry. Specifically, the inquiry began with ten out-door games, which triggered students' initial questions about human body. Emergent groups formed after the kids categorized individual questions. As the inquiry went deeper, students began to move on to new areas. After two months of inquiry, students reflected on his/her previous inquiry, current work, and future research. Five new areas proposed by them were furthered discussed and rephrased in a whole class discussion. As new questions and areas were proposed, the community

decided to reflect on the areas of inquiry. Students started with a review of individual inquiry trajectory and connections among the specific issues of inquiry. Based on this reflection, the whole class worked together to identify new areas of inquiry based on interconnected issues. The epistemic structures thus evolved from a list of collective wondering areas to a collective map of connected areas/objects. With the support of this collective map, student continued inquiry in more specialized areas.

The impacts of reflective structuration on online knowledge building discourse

Each epistemic area of inquiry emerged from reflective interactions became a shared focus of inquiry in the classroom and online. In class A, students and the teacher co-identified five areas of inquiry as a list of overarching goals. In class B, students co-framed similar overarching goals in the beginning. However, through continual reflection on their ongoing research and unfolding directions, students in class B kept searching for progressive and connected directions of inquiry. Figure 1 shows the areas (objects) of inquriy identified by the two classes and the number of online notes written about each area. Class B made more systematic contributions to addressing a broader set of human body topics.

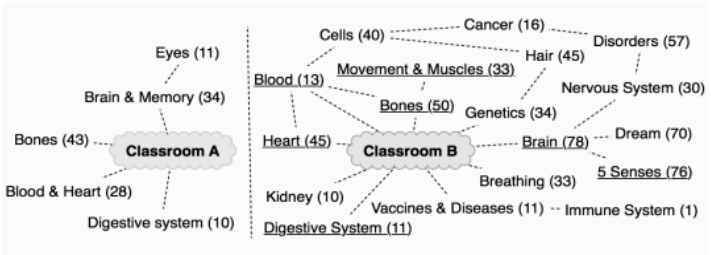

Figure 1. Areas of inquiry and the number of online contributions in each area in class A (left) and B (right).

Quantitative analysis of the KF notes shows that students in class B wrote more notes than those in class A on average (24 notes per students for class A and 36 for class B). We further coded the KF notes based on patterns of discourse contributions, focusing on the contributions that addressed a common set of five inquiry areas shared between the two classes. As Figure 2 shows, compared with class A, class B made more purposeful contributions involving asking questions, developing theories/explanations to answer their questions, integrating different ideas.

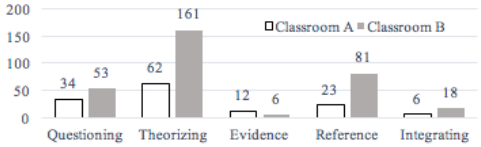

Figure 2. Contributions to shared objects of inquiry from class A and B.

The understandings related to each area of inquiry were further coded based on scientific sophistication to examine the extent to which students' explanations align with a scientific framework of human body systems. Through sustained and purposeful knowledge building work supported by collective structures, students in class B (M=3.41, SD=0.17) were able to develop a higher level of scientific sophistication of ideas in shared areas of inquiry than class A (M=2.70; SD=0.37); t (8)=3.91, p=0.01.

Discussion

This design-based study investigated reflective structuration as a way to sustain knowledge building practices in Grade 5 science classrooms. First, we documented the implementation of reflective structuration in class B. The collective inquiry areas emerged and evolved through several reflective cycles: formulating an initial list of five big "juicy" questions based on diverse individual interests and questions, expanding the list to a network of inquiry areas to include new epistemic objects (e.g. *dreams, nervous system, cancers,* and *cells*) emerged from student ongoing discourse and continual searching for interconnected areas of inquiry. The collective areas of inquiry were co-constructed and continually adapted by the community through metacognitive conversations in reflection of members' diverse input and progress. These collective goals were represented and highlighted using classroom artifacts (e.g. collective question list, and a collective map of all objects of inquiry) to guide student's attention and participation. Second, the analyses of online discourse of the two classes illustrated the impacts of reflective structuration on students' sustained and productive engagement in knowledge building. Both classrooms used the initial wondering list to organize their continual discourse online. Through continual reflection on undergoing

inquiry and emergent deeper questions, students in class B kept searching for progressive and interrelated issues of inquiry to adapt existing framing of shared focus, leading to more productive and sustianed knowledge building discourse and more sophisticated scientific ideas online.

The adaptive structuration perspective provides a framework to understand and support sustained knowledge practices driven by distributed student interactions without extensive pre-scripting. Leveraging their knowledge building actions and discourse to advance collective knowledge, members in a community co-construct adaptive collective structures, which help frame what they do as a whole community and further inform individual participation and reflection. Further advancements of collaborative learning environments need to provide opportunities and supports for students to co-construct/reconstruct structures of knowledge practices and make the structures visible to students. We recently designed a timeline-based structuration tool: Idea Thread Mapper (ITM) (Zhang et al., 2015) to support student co-construction of collective structures as they engage in ongoing knowledge building discourse. Deeper understandings of how students co-construct and use collective structures to support knowledge building will shed light on the pathways towards transforming educational practices.

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