Productive Knowledge Building Discourse Through Student-Generated Questions

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Abstract: Working on students' authentic problems is emphasized in Knowledge Building theory and pedagogy, as it is perceived that a failure to deal with such problems may result in a failure of knowledge building. This study is focused on questions students asked in a knowledge building environment, in order to examine how issues students cared enough about to pose as questions help knowledge building succeed. Comparing question threads (threads started with questions) and non-question threads (threads that did not start with questions), we noticed that problems posted by students engaged the community in a sustainable and progressive discourse, which is central to collaborative knowledge building. Moreover, the quality analysis of the data revealed that the threads starting with questions were more likely to end up with productive threads compared to the non-question threads.

Introduction

Knowledge Building is an idea-centered pedagogy where students create knowledge through engaging in complex socio-cognitive interactions as epistemic agents (Scardamalia & Bereiter, 2006a). Knowledge Building is based on 12 foundational principles, such as *community knowledge, collective responsibility*, *idea diversity*, and *improvable ideas* (Scardamalia, 2002; Scardamalia & Bereiter, 2006a). As a principles-based pedagogy, knowledge building classrooms are "profoundly different from even the best of traditional and modern classrooms" (Scardamalia, 2002, p. 77). Engaging students in *real ideas, authentic problems* (Scardamalia, 2002), which is one of the critical principles of Knowledge Building, means focusing on ideas that students themselves come up with, and the questions that they actually care about—not what others decide are engaging. Students in knowledge building classrooms are given high levels of agency, so that they actively mine the world around them for interesting issues and challenges. In pursuing *real ideas/authentic problems* that arise from their efforts to understand the world, students engage in sustained creative work with ideas through *knowledge building discourse* (Scardamalia & Bereiter, 2006a) -- another Knowledge Building principle. *Knowledge building discourse* is central to collaborative knowledge creation, because learners construct their knowledge, express their opinions, values and feelings through discourse (Bereiter & Scardamalia, 1993; Tsoukas, 2009). Engaging in sustainable knowledge building discourse will help students dig down the issues, which is part of idea improvement (Scardamalia & Bereiter, 2006b). Therefore, the more students are engaged in knowledge building discourse, the higher the chance of knowledge building success. It is perceived that questions are propulsions that push the dialogue forward (Resendes, 2014); *factual questions* (who, what, where, and when) are required for explanation-seeking dialogue as they increase the coherence of theories, and *explanatory questions* (why/how something works) push the dialogue forward in new and promising directions (Resendes, 2014). This exploratory study investigates the extent to which students introduce their authentic questions in their knowledge building discourse, how the peers pursue these peers-generated questions to reach a deeper understanding of the world, and how these contributions impact collective idea improvement.

Method and data analysis

The dataset used for this study is comprised of the online discourse of one class of Grade 4 students exploring "rocks and minerals." Student dialogue consists of 262 notes generated by 20 students over the course of 4 months and archived on Knowledge Forum®-- a knowledge building environment built specifically to support collaborative production and refinement of the community's knowledge (Scardamalia, 2004). This study employs the "ways of contributing" framework, which was developed to code students' types of contributions to knowledge building discourse (Chuy et al., 2011). This framework was chosen because it offers a systematic inventory of ways of contributing that can shed light on how knowledge building discourse moves toward knowledge objectives. This framework categorizes students' contributions into six main categories (e.g., questioning, theorizing, obtaining information) and 24 subcategories (e.g., proposing an explanation, improving an explanation, synthesizing information from resources).

For this analysis, student contributions were also assessed according to their role in discussion threads. In this study, a thread is defined as a set of connected notes, or even a single isolated note. This definition is compatible with Hewitt and Teplovs's (1999) and Hewitt's (2005) description of a discussion thread, which considered one single disconnected note as a thread. In Knowledge Forum, students are able to post individual notes into the discussion space, and are also able to create 'build-on' notes, which are contributions that link directly onto an existing note. Build-on notes are indicated by an arrow that connects the two notes on the screen. In the dataset for this work, there were a total of 91 online discussion threads. The discussion threads were first categorized into two categories: I) threads starting with students' questions, and II) threads starting with non-question notes. Among these 91 threads, 68 threads were *question threads* (threads started with questions), while 23 threads were *non-question threads* (did not start with a question). Applying the ways of contributing scheme, two raters coded all the notes and achieved an agreement rate of 99.57%. The result of the coding of the notes was then used to categorize threads starting with questions. Based on the results of the coding, 33 threads were identified as *factual-question* threads (threads started with factual question--e.g. what is a rock?), and 37 threads were identified as *explanatory-question* threads (threads started with explanatory question-- e.g. how are rocks made?). Two threads were identified as starting with both factual and explanatory questions (e.g. where did Lava come from? and how it was formed?) In order to answer the research questions, ANOVA analysis and qualitative analysis were conducted. The ANOVA analysis was conducted in order to examine if and how the length of these three types of threads differ. The length of threads is an indicator of sustainable discourses and can indicate the potential of a discourse to be productive, as the depth of inquiry in a short thread is usually limited (Law, Yuen, Wong, & Leng, 2011, p. 64). However, it is very important to realize if the discourse is really moving toward a knowledge objective, despite thread length (Bereiter, Scardamalia, Cassells, & Hewitt, 1997). Therefore, qualitative analysis was conducted in order to qualitatively examine which types of the threads demonstrated idea improvement. Chen, Resendes, Chai, and Hong (2017) employed the ways of contributing schema, and distinguished productive and non-productive threads using the *improving an explanation* subcategory of the *theorizing* category. If a contribution was found to be *improving an explanation,* it was helping to move the discussion towards a knowledge goal and increasing the explanatory coherence of collective ideas (Thagard, 1989, 2007). If any note in a thread fell under the *improving an explanation* subcategory, that thread was considered a "productive" thread, otherwise, it was considered non-productive. We employed Chen and colleagues' method to identify which threads are productive.

Results

Sustainability of threads

Results show that almost 78% of the non-question threads did not have any responses, while only 30% of the factual-question threads and 24% of the exploratory-question threads had no responses. These isolated discussion threads form threads with size 1. Moreover, almost 9% of the non-question threads had one response (threads with size 2), while almost 36% of the factual-question threads and 19% of the exploratory-question threads had one response (Figure 1).

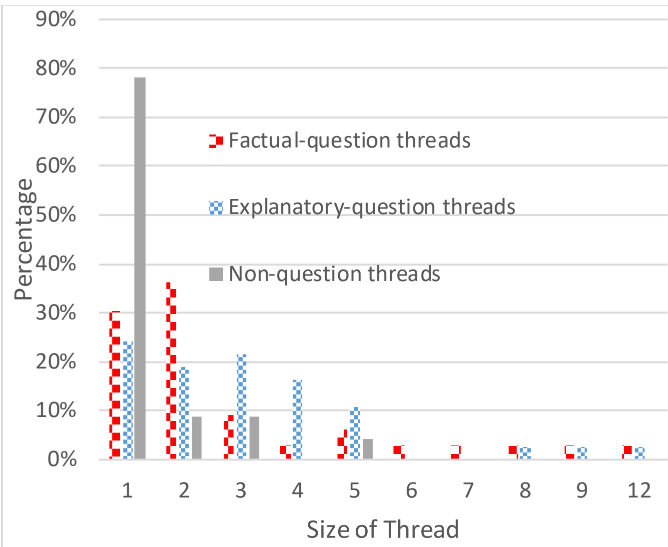

Figure 1. Comparing the size of the threads.

As Figure 1 demonstrates, the maximum size of a non-question thread is 5, while the maximum size of a question thread (either factual or exploratory) is 12. Therefore, the results show that compared to non-question threads, threads starting with factual questions and exploratory questions tended to be more sustainable--a quality which can potentially push discourse toward other types of contributions, resulting in productive discourses.

As Table 1 shows, the ANOVA analysis revealed that the size of the factual-question threads and explanatory-question threads do not differ significantly. However, the size of both factual-question threads and explanatory-question threads differ significantly with the size of non-question threads; non-question threads have significantly fewer responses compared with the other two types of threads that started with questions.

Table 1: ANOVA analysis of the size of the three types of threads

(I) Types of notes that lead threads	(J) Types of notes that lead threads	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Non-question	Factual	1.565*	.610	.032	.11	3.02
	Explanatory	1.808*	.597	.009	.39	3.23
Factual	Explanatory	.243	.538	.894	-1.04	1.53

Productivity of threads

The results of the productivity analysis show that among all the 91 existing threads, 11 threads were identified as productive threads, while the other 80 threads were coded as non-productive threads. Among these 11 productive threads, five threads (45.5%) were coded as explanatory-question threads and four threads (36.4%) were identified as factual-question threads. Only two threads (18.1%) were coded as non-question threads. Below you can see an example of a productive knowledge building thread. (Typos in students' notes have been revised).

> [Note A] *How are rocks made?*
>
> > [Note B] *My theory is that rocks are made by magma drying and being compacted.*
> >
> > [Note C] *My theory is that sand is in the sea starts to form in a number of years and finally it [a rock] forms.*
> >
> > [Note D] *Some rocks are made by sand hardened sand.*
> >
> > > [Note E] *My theory is that wherever the rock is found is probably where it is made.*
> > >
> > > [Note F] *The rock that I brought in is made out of pure hardened sand*
> >
> > [Note G] *There were a whole lot of volcano and the ash came and lava so the lava cooled and you have your rock.*
> >
> > [Note H] *Rocks are made by minerals coming together over many millions of years.*

In the above thread, the thread starts with an Explanatory Question [Note A]. Based on the coding, Note B and Note C are considered as improving an existing theory of the community, Note E is coded as proposing a theory, and Note G and Note H are coded as supporting a theory. As there are two notes in this thread that are coded as "improving a theory" notes, this thread is considered as a productive thread.

The thread shown below is an example of a non-productive thread (size 2) that does not show evidence of knowledge advancement:

> [Note A] *Some scientists think that the thing that exploded was remains of an old universe what if that universe had life the old life from the old life particles C.*
>
> > [Note B] *i think that's true BUT, what does c mean?*

Discussion and conclusion

The results of the analysis show that threads not starting with students' questions were not sustainable enough to move the discourse toward a knowledge objective. On the other hand, questions (either factual or explanatory), made students' discourses more sustainable, which is a favorable phenomenon for Knowledge Building. The results of the productivity analysis show that, in this case, the chance of having productive dialogue in threads starting with questions is higher than the chance of having productive threads in non-question threads. As presented above, there were nine question-driven threads that were coded as productive, while there were only two non-question threads that were coded as productive threads. Therefore, only 18% of the 11 existing productive threads started with non-question notes, while 82% of the all productive threads of the community were threads that started with students' questions.

As described before, the length of the "factual question" and "explanatory question" threads did not differ significantly. Moreover, we identified five productive threads starting with explanatory questions, while four other productive threads started with factual questions. These findings do not show any significant difference between factual questions and explanatory questions, in terms of their effects on improving the community knowledge. In fact, the results suggest that giving students sustained opportunities to pose original questions may help them engage in sustainable discourses that may result in productive discussions.

These findings indicate that computer supported knowledge building environments provide the opportunity for students to express their puzzlements in order to mine the world around them. On the other hand, these questions encouraged peers to engage in sustainable discourse to dig down the issues and finally generate/improve theories. As a result, dealing with students-generated questions which they really care about helps knowledge building succeed by engaging the community in sustainable and productive discourses. Replicating the study with a richer dataset from different grade levels will be the focus of our next investigation, in order to examine if the same phenomenon occurs.

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