Building Knowledge within Classroom Mathematics Discussions

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Over the past decade, a growing trend has been to center instruction around student learning, rather than teacher performance. Such instruction often elicits student participation through various classroom activities: answering questions; solving problems; having students do board work; working on collaborative tasks in groups or pairs; making and testing conjectures; presenting ideas, proofs, and solutions; and debating. Through these and other classroom activities, students are expected to engage in the learning process, participate in mathematical thinking, and contribute to classroom discourse.

The presence of these instructional forms in the classroom does not always indicate quality instruction or guarantee quality student involvement. Cursory classroom observations might not reveal students' mathematical thinking or engagement. For example, working in groups, carrying on discussions, or answering questions does not necessarily mean that they are engaged in mathematical thought. We would need to know: What is the nature of the group's task? What are they discussing? How thought provoking are the questions? and What is the nature of students' responses?

In general, determining the quality of student involvement and their role in building classroom knowledge requires us to answer deeper questions about the discourse: How are learners contributing to the discussion? What is the nature of those contributions? What role are they playing in the discussion? and What significance and impact do their contributions have on the developing content? Addressing these questions for discussions in the mathematics classroom setting is the aim of this paper.

Within a different context and social group, I was recently able to address these exact questions, while developing an analytical framework. While studying discussions among practicing teachers who participated in a professional development program, Belnap and Withers developed an analytical framework for identifying the origin of a discussion's content and how each individual contributed to that knowledge (Belnap & Withers, 2010).

This framework is based on a view of discourse that integrates aspects of various learning perspectives: constructivism (Cobb, 1994; Cobb & Yackel, 1996; Ernest, 1996; Sfard, 1998; Zevenbergen, 1996), the social perspective (Cobb, 1994; Cobb & Yackel, 1996; Lerman, 1998, 2000; Sfard, 1998), socioconstructivism (Lerman, 1998, 2000; Cobb & Yackel, 1996; Cobb, Jaworski, & Presmeg, 1996), and agency (Walter & Gerson, 2007). This view is that discourse involves the mutual construction of both individual and social knowledge; it is a social activity shaped by participants' involvement. At the same time, participants willfully act and construct their own knowledge from their involvement in the discourse.

From this perspective, the discussion's text represents a form of social knowledge constructed by the willful actions of its contributors. Stemming from social linguistics and the work of Nassaji and Wells (2000), Wells (1996), the framework Belnap and Withers developed both grew from and illuminates this idea. It describes how each individual's contribution links to the contributions of other participants, building the conversation's content (Belnap & Withers, 2010; Belnap, 2010).

As detailed in Belnap (2010), when individuals take turns in a discussion, they make willful contributions to the growing text, making *moves*. In building the discussion's content, each move has a function, determined by its *action* (i.e. how it affects the growing text) and its *target* (i.e. any content receiving the action).

Based on function, there are 13 different move (or function) categories, clustered into five main groups or types: *anchoring, valuing, altering, requesting,* and *contentless* moves. *Anchoring moves* present new ideas, opening potential lines of discussion. *Valuing moves* address the value, validity, or correctness of existing contributions, focusing on assessing, supporting, refuting, or otherwise affecting the credibility of prior contributions. *Altering moves* develop the content of existing contributions by adding to, modifying, or clarifying it. *Requesting moves* (including, but not limited to questions) solicit content. Finally, *contentless moves* either do not directly develop a discussion's content or are counted as such.

This framework provides a means of ascertaining the discussion's content structure. Each move's action and target describes a linkage between moves. Using these linkages to chain moves together breaks the discussion into *fibers*, each representing the development of a single idea.

Using this framework allowed me to see both the structure and individual contributions' roles in content development. Identifying fibers allowed me to distinguish separate ideas or topics in complex conversations, facilitating the identification of productive conversations (i.e. those relevant to the purpose of the PD program). The distinctions among moves provided a means of identifying substantive contributions to the conversation; by counting this information for individual participants and contrasting the results, I ascertained the extent and nature of their involvement.

As a particular example, using this framework allowed me to determine information about participant involvement, individual conversational roles, and discussion characteristics in a recent analysis of one professional development session. Specific data and details are provided in Belnap (2010).

The framework provided an overview of participant involvement in the session. I found that all participants took an active role in developing the discussion's content. Each participant initiated some conversational fibers. All listened to and built off of the ideas of others. Finally, they each made efforts to explain and support their own and others' contributions.

On a more specific level, the framework revealed the nature and extent of individual involvement. I found that the facilitator's involvement mainly consisted of initiating and soliciting content; the extent of this involvement was limited, as he often took a back seat, avoiding direct control of the content, and allowing it to develop at the participants' discretion. Other participants took an active role in the conversation, with no one clear discussion leader. One (while not dominating the conversation) did play a leading role,

initiating conversational fibers, conveying information, evaluating/refuting contributions, and integrating and building ideas, all more so than any other participant. By contrast, two participants seemed to hold back and contribute much less.

In addition to individual involvement, by revealing the conversation's composition, the framework provided the means of characterizing the discussion overall. The discussion could be characterized by conveyance, slight developing, and justifying a wide variety of ideas and opinions, with almost no discussion, change, and deliberation of ideas. A common pattern was that a conversational fiber consisted of an initial idea, justification with some addition of ideas or details, and then a topic shift. Little time was spent deeply investigating the many ideas initiated. Most content arose from spontaneous comments. There was a profound lack of inquiry and little disagreement and resolution of differences.

It is plausible that this framework can be used to answer similar questions and provide similar information regarding mathematical classroom discussions; this is the goal of this study. At the same time, differences in these contexts (the mathematics classroom verses a professional development program for teachers) are great, including: strongly rooted cultural norms, roles, responsibilities, and expectations; differences in the nature of the discussed content; and typical goals and objectives for the two contexts. With such strong differences, it is plausible that the framework may need to be modified to accurately reflect the content development of mathematical conversations.

Based on discussion and feedback from members of the research community, I am conducting a pilot study, to see how the framework can describe content development in a mathematics classroom. To do this, I have purposively selected a mathematics teacher who is well known for effectively engaging students in investigative tasks, orchestrating student centered classroom discussion, and establishing classroom discourse in which students listen to and respond to each other.

To test the analytical framework using typical qualitative methods. I will video tape an hour long class and apply the framework to the coding of the class' transcript, looking for contributions whose function may not be described well by the framework, modifying and reconceptualizing the move categories as necessary to account for these differences. Once I have completed analysis of the class, I will discuss the results with another researcher to gain an outside perspective and find concepts and ideas that may be missed, adjusting the framework as necessary. Next, to test the modified framework, I will apply the framework to the transcript of a second class to see if the framework accurately describes the discussion. Finally, I will analyze the resulting data to determine the extent to which the framework facilitates answering the questions posed earlier: How are learners contributing to the discussion? What is the nature of those contributions? What role are the students playing in the discussion? and What significance and impact do their contributions have on the developing content?

Data collection is currently beginning and preliminary results will be reached during December 2010 and January 2011. This paper and presentation will focus on discussing these preliminary results, examining potential information they give about the mathematics classroom, and beginning to contrast this with other frameworks that examine classroom discourse. As a preliminary presentation, participant discussion will also center on feedback, ideas, observations, and additional viewpoints on these same three issues. In particular, I will pose questions for discussion such as: What useful information can this framework pro-

vide for us as researchers? What interesting research questions could be answered utilizing this framework? How may this framework relate to other analytical or theoretical work? and What details may I have overlooked?

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