2010

Examining Sociocultural Contexts of Classrooms to Foster Student Mathematical Discourse and Learning

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Mathematics learning and teaching are optimized in classrooms when reform-oriented culture (ROC) is present. This report presents a case study that illustrates how ROC manifested and influenced mathematical Discourses in one sixth-grade classroom. The data was drawn from a study that addressed the question: How do classroom interactions influence mathematical Discourses? The study used interpretive methodology for analysis. One finding was that classroom boundary interactions either enhanced or hindered mathematical Discourses dependent upon sociocultural context alignments. An implication of this research is when "effective" learning and/or teaching strategies are identified, "effective" implementation may require paying close attention to sociocultural context alignment.

Introduction

In the past, mathematics education reform has been articulated in terms of content (NCTM, 2000), curriculum and assessment (NCTM, 1989), and teaching (NCTM, 1991); and in each of these standards documents are descriptions of sociocultural elements of mathematics classrooms and advice for transitioning classrooms from traditional to reform-oriented culture (ROC). For this study, sociocultural elements include all classroom interactions related to learning and teaching. The purpose of this investigation was to examine classroom interactions closely using a perspective that would offer insights into how mathematical Discourses (more than talk, engagement, and participation) influenced learning and teaching. This report offers a glimpse into a study (Grant, 2009) that examined how classroom interactions influenced mathematical Discourses related to learning and teaching.

The research study took place in a large urban Midwestern school district in the United States. The participants were from three sixth-grade mathematics classrooms from two different schools from within the school district and included teachers, students, and Mathematics Coaching Program (MCP, Erchick & Brosnan, 2005) instructional coaches. The study examined interactions from each classroom and then compared the three classrooms to illuminate the findings to address the research question: How do classroom interactions influence Discourses related to mathematics learning and teaching?

Methodology

The overarching method for the investigation was case study including comparative case study analysis (Stark & Torrance, 2005). Data sources for this study included videotaped mathematics instruction (~1,350 minutes), survey responses from teachers and students, and audiotaped interviews with teachers and coaches. NVivo 8 (QSR International, 2008) qualitative analysis software was used to support the data analysis.

The theoretical model used in this study was inspired by relational perspectives developed by Cobb and several colleagues (2002) The mathematics teaching and classroom practice literature (e.g., Franke, Kazemi, & Battey, 2007) suggested that classroom learning requires social and cultural interactions. A significant problem for the investigation was determining what

Brosnan, P., Erchick, D. B., & Flevares, L. (Eds.). (2010). Proceedings of the 32nd annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education. Columbus, OH: The Ohio State University.

sociocultural elements to target when studying mathematics classroom interactions. The theoretical model used in this study addressed this issue and focused the observation and analysis using three key constructs – classroom culture (social norms and practices), Discourse (more than talk, participation, engagement, and community), and relationships (that support opportunity for learning). These constructs were prominent in both the relational perspectives of Cobb and colleagues and the mathematics teaching and classroom practice literature.

The theoretical model offered a point of view that was beneficial for interpreting or making sense of the complexities of interactions that occur in a mathematics classroom (Yackel & Cobb, 1996). This theoretical model and the classroom practice literature led to defining a hierarchically organized set of codes that were used to focus the classroom observation and analysis on specific sociocultural elements of the mathematics classrooms targeted in the study.

Data analysis included both descriptive statistics and interpretive analysis (Erickson, 1986). The theoretical model was used serially – each of the three theoretical constructs in turn was used as a lens to code all of the data from each classroom (i.e., the hierarchically organized codes were assigned to specific data). In other words, all data were reviewed and coded at least three times, one pass for each construct. Then descriptive statistics were generated to describe the data and analysis quantitatively – categories with the highest density coding by construct were identified, then inferences were made and those sufficiently warranted by the data across all constructs led to claims and findings.

The study presented three case studies, one for each classroom, and a cross case analysis by construct was done to further elucidate the findings. This paper presents one of the findings that emerged from the study, but was limited in scope in an effort to be concise. The case study and analysis in this paper is from one classroom (Eva) and focused on only one construct (classroom culture).

The classroom culture construct focuses on social norms and processes related to interactions within mathematics classrooms; examples of the hierarchy and codes follow: a) cultural influencer – teacher expectations; b) mathematical process – connections; c) sociomathematical norm – student explaining; and d) social norm – listening.

Findings

One of the major findings from the study was that some classroom interactions enhance while others hinder mathematical Discourses related to learning and teaching; and the sociocultural contexts within the classroom appear to determine whether Discourse emerges or not. These types of classroom interactions that depend on sociocultural contexts are called boundary interactions. Several examples of boundary interactions are described within the case study.

The following case study and discussion are presented to demonstrate how boundary interactions manifest in practice. Three examples of classroom interactions are presented. The sociocultural context alignment in each situation described in the case enhanced the mathematical Discourse. The discussion that follows the case suggests alternative sociocultural context alignments for the boundary interactions that would likely hinder the mathematical Discourse. The alternative sociocultural context alignments were inspired by data from the study.

Eva's Mathematics Classroom

Eva taught sixth-grade mathematics for 90 minutes three times each day during this investigation. During the observation period, all of the mathematics topics in Eva's classroom

were related to fractions. Eva's class included a diverse group of students. The class was comprised of slightly more males (12) than females (8), a diverse representation by race or ethnicity included a balance of Black (8) and White (8) students, and there were biracial (2) and other (2) racial or ethnic students. On average, there were 20 students present on each of the observation days.

Eva described this class as a good class, but not her best. During the initial pre-observation interview, Eva described her instructional style as one that was "organized" and "structured" (Feb. 20, 2009). Observation data validated her description; instruction followed a pattern. First, students completed bell work (two or three problems related to the previous day's mathematics) as Eva circulated the room observing student work, answering questions, and taking notes (sometimes written) of who did what and how. Next, Eva reviewed the bell work in a whole-class format that included students' explaining taking 30-45 minutes of the 90-minute instructional period. Then, students engaged in activities, usually in small cooperative groups of two to four followed by students' sharing solution strategies. During the last 5 to 10 minutes of class, Eva articulated a summary review of the days' mathematics or presented new mathematical ideas. This instructional pattern was consistent with little variation on the observation days.

Given Eva's admission of being structured and organized, it was not surprising that the normal desk configuration in her classroom was straight rows facing front. Each day I observed her classroom, prior to children entering the room, she spent time straightening the rows and preparing supplies for children's ready access or for easy distribution at the appropriate time during instruction. However, when she wanted students to work cooperatively, students reorganize desks to accommodate the collaboration and Eva's oversight ensured a timely transition. At an appropriate time following cooperative activity or before leaving Eva's classroom, students returned desks to their original positions.

Classroom Interactions on the Boundary

In Eva's classroom, there were several instances when classroom culture enhanced Discourses and other instances when it served to hinder them. Classroom interactions that hindered Discourses included: a) fact or procedural reproduction; b) low-level questioning; and c) negative social norms. Conversely, classroom interactions that enhanced Discourses included: a) mathematical connections; b) student explaining; and c) listening and respect. Additionally, there were boundary interactions – classroom interactions that sometimes enhanced and at other times hindered Discourses depended on related sociocultural contexts such as: a) collaborative sense making; b) communications; and c) teacher explaining (see Table 1 column 1). These sociocultural contexts were boundary interactions in Eva's classroom, but I cannot conclude they would manifest as boundary interactions in other classrooms.

Boundary interactions listed in Table 1 enhanced mathematical Discourses when sociocultural contexts aligned with enhancers such as those in column two. Conversely, boundary interactions hindered the mathematical Discourses when sociocultural contexts aligned with saboteurs such as those in column three. For example, in Eva's classroom for the boundary interaction teacher explaining (column one) the mathematical Discourse was enhanced when the sociocultural context alignment supported students' sharing ideas (column two). Conversely, for the boundary interaction, collaborative sense making (column one) the mathematical Discourse was hindered when the sociocultural context alignment included students tasks without choices (column three).

Table 1. Boundary Interactions with Examples of Sociocultural Context Alignments from the Classroom Culture Construct

Boundary Interactions	Discourse Enhancers	Discourse Saboteurs
collaborative sense-making communications teacher explaining	tasks with choices students' sharing ideas students' comparing mathematical approaches	tasks without choices no opportunities for sharing ideas prescribed solutions only

Table 1is not an exhaustive representation of boundary interactions and sociocultural context alignments that enhanced or hindered Discourses in Eva's classroom. These boundary interactions and sociocultural context alignments may be valid for other mathematics classrooms, but more research with a broader scope is needed before such conclusions can be made.

There were glimpses of reform-oriented culture (ROC) within Eva's classroom. One example of ROC occurred when two students' perceived they had an opportunity to share an authentic idea based upon their independent thinking. These two boys had each autonomously thought about comparing fractions conceptually instead of using one of the procedural approaches that had been the focus for instruction over the last several days. The students were asked to compare three fractions $\frac{3}{4}$, $\frac{3}{5}$, and $\frac{3}{12}$ and order them from least to greatest. The following classroom snapshot is a descriptive vignette that summarizes the interaction processes.

Classroom Snapshot 1 – Listening and Revoicing

Eva began the class discussion of the bell work by inviting two boys to share their thinking. Eva discovered the two boy's approach as she circulated the room assessing student work and understanding. The boys explained their thinking and approach without Eva interrupting or correcting errors in their explanations. At the end of each explanation and throughout the mathematical Discourse related to the bell work, Eva congratulated each boy. She revoiced what each boy had explained after both explanations were done.

In this vignette, the boundary interaction is communication and the sociocultural context alignment that enhanced the Discourse is students sharing ideas. Eva created the opportunity for student sharing. The two boys' articulated rationale was that each fraction had the same numerator and different denominators, thus all that was needed was to compare the relative sizes of the pieces by using the denominators. The students' sharing led to a broader class discussion and analysis than perhaps would have otherwise emerged had the Discourse been limited to comparing fractions using only the two procedural approaches the class had been practicing. The ensuing Discourse included students' generalizations about relationship between the magnitudes of denominators and the size of the pieces and the importance of assuming all fractions were based on an equivalent whole.

A second example of a boundary interaction is collaborative sense making and the sociocultural context alignment that enhanced the Discourse is a task with choices. The instructional segment started with Eva asking students how to show $\frac{7}{10}$ using a pictorial representation of a fraction bar. Several students contributed and described what to do as Eva drew on an overhead projector. Eva asked, "So, I've got $\frac{7}{10}$ but I have 100 squares. How would I divide this up?" and the following interaction ensued:

Classroom Snapshot 2 – Developing fraction representations
Eva: [waits ~10 seconds, repeats the question several times as she waits, and more students raise their hands] Student A1?
A1: You can make boxes of ten.
Student: no [shouting out]
Eva: So, I'd have to make boxes of ten.You're right. What do I know about the boxes of ten Student A1?
A1: Um
Eva: They need to all look how?
A1: The same.
Eva: They all need to look the same. A1, So, could I go like 1, 2, 3, 4, 5 and could I make my boxes of ten like this? [drawing 5 X 2 rectangular arrays on the overhead displayed grid paper]
A1: Yeah
Eva: You bet I could. How else could I make them? Student A2?
A2: You could take one like, one set of ten, like a row [gesturing with her hands as she speaks] and color it in.
A3: What if you took one bar [10 of the 100-square grid] and colored in 7?

The task called for students to create a pictorial representation of a fraction and yielded two different approaches and an interesting question (Line 12). This student's question was a clarifying question that enhanced the Discourse by encouraging more collaborative sense making to emerge after the initial task was completed. The fraction being represented, $\frac{7}{10}$, could have been easily done using a row of 10 blocks; however, the nature of the task, representing the fraction on a 10X10 grid likely encouraged the student to seek clarity. Nonetheless, students' collaborative sense making Discourse was enhanced because the student's question led to the class having to consider whether the proposed pictorial representation met the criteria of the original task. Using Bloom's taxonomy, the original task was a knowledge question, but the student's question was an evaluation question; the Discourse was enhanced.

The third and final example of a boundary interaction is teacher explaining (as implicit telling) and the sociocultural context alignment that enhanced the Discourse is student comparing mathematical approaches.

Classroom Snapshot 3 – Reflecting and Evaluating a Mathematical Procedure
Eva: by 4's
Students: 4, 8, 12, … [Counting by 4's up to 48].
[Students are unenthusiastic, and lose synch. Eva writes on the overhead sighs, and then runs out of space]
Eva: Do we have to count like this? Seriously guys, what would be the easiest way to do this? We'll be counting forever. What's an easier way to do this Student A?
Student A: You know how we put the numbers at the bottom and circle them? Instead of going through the whole thing.
Eva: OK. OK. Student G?
Student G: Factor tree
Eva: Guys? Factor tree. Awesome. I would say factor tree. You're probably gonna spend less time than if you do it the other way. Let's try it? Let's try factor tree.

Eva appeared to have contrived a situation that caused students to reflect and evaluate the efficiency of a mathematical approach by commenting about running out of space for writing and showing great exasperation during the execution of the mathematical procedure. Her theatrics (Lines 3 & 4), which were not in character for her, were interpreted as teacher explaining, but not telling. She asked in Line 4 if there was a better way to find the least common multiple than counting ALL of the multiples of a number. In fact, Eva asked the question multiple times. This approach had been observed as a way to focus students' attention and to generate wait time for thinking. The result was several students raised their hands to offer ideas, which evidenced several students' compared mathematical approaches and enhanced the Discourse related to learning and teaching.

Discussion

In the case study, examples of how boundary interactions when coupled with sociocultural context alignments enhanced mathematical Discourses related to learning and teaching. In this section, we will examine how those Discourses might have been hindered by Discourse saboteurs. Consider the first example in Classroom Snapshot 1, the process was described in the vignette, Discourse might have been different had Eva not created opportunities for the two boys to share their ideas for comparing the three fractions. Would the class have had the opportunity to reflect on the size of denominators when the numerators are the same? Additionally, the Discourse included thinking about the importance of the whole and the relationship it plays when comparing fractions. How helpful might it have been for a student harboring a misconception about fractional comparisons to hear three different explanations for comparing fractions conceptually followed by a comparison done procedurally?

In Classroom Snapshot 2, collaborative sense making was the boundary interaction. However, how might the Discourse have differed had Eva simply dismissed the student's proposed representation as not correct? That is, offered a task with no choice. Instead, the task was designed to accommodate "What if" questions and students were encouraged to decide whether the representation was appropriate given the task; the task afforded choices. Consider task options that are presented as choices that in practice are not. For example, suppose Eva had provided several representations for students to select the one that was correct. The cognitive rigor of the task must be considered if collaborative sense making is desired. The task that was the focus for this example was not especially rigorous for a sixth-grade class, but the pedagogical approach of valuing and using all students' input enhanced the Discourse.

In Classroom Snapshot 3, teacher explaining was the boundary interaction, even though the teacher explanation or telling was implicit. How might the Discourse been different had Eva explained explicitly that they needed to use a different approach? She could have simply told the students that what they were doing was inefficient and they could get the solution faster by using one of the procedural approaches they had been practicing, i.e., offered a prescribed solution. When Eva created wait time by asking and re-asking questions, had she not, would the same number of students raised their hands to offer their ideas about the question? Additionally, how effective are mathematical Discourses when students choose not to participate?

Eva's teaching actions appeared to be more aligned with developing integrated mathematical knowledge than sharing correct answers. Her sociocultural perspective was aligned toward reform-oriented culture (ROC), which led her to encourage students to share their authentic thinking and ideas. Eva invited and encouraged students to act this way as evidenced by the opportunities she afforded them during instruction independent of whether or not she finished

her instructional goals for the day. This type of instructional perspective manifested in the emergence sociocultural context alignments that enhanced Discourses toward mathematical inquiry and sharing of ideas, ROC. The classroom culture in Eva's classroom often led to multiple student approaches for finding correct solutions and mathematical connections; restated, using a traveling metaphor, the journey was valued as much as the destination in Eva's classroom.

One implication for practice from this study is if expected outcomes fall short for new learning and/or teaching strategies, something to consider examining is the sociocultural context alignment. That is, reflect on classroom interactions and consider adjusting related sociocultural contexts such as creating opportunities for student explaining or revising the task for increased student autonomy before concluding that the new strategy was ineffective.

Conclusions

If a goal of reform is to usher in effective mathematical Discourses related to learning and teaching, then those focused on support and implementation must not lose sight of ROC and reflecting on the alignment of sociocultural contexts that enhance or hinder boundary interactions. Simply stated, ROC is about creating opportunities and space within instructional settings for students to be both learners and teachers as their authentic ideas emerge. However, sociocultural contexts must be appropriately aligned to enable authentic mathematical utterances from students as the norm rather than the exception.

Some reform-oriented learning and teaching strategies appear to be promising, but they often emerge independent of consideration for sociocultural contexts extant in today's classrooms. As educators, we must forego rigid plans focused on curriculum coverage and/or strategy implementation, and look for opportunities to allow ROC to emerge and infiltrate classrooms. As supporters of teachers engaged in reform implementation, we must be cognizant of and prepared to help teachers transform ROC stifling classroom cultures. As researchers, we must further define and articulate sociocultural nuances related to recommended reform-oriented learning and teaching strategies to support the emergence of ROC within classrooms.

References

Cobb, P., & Hodge, L. L. (2002). A Relational Perspective on Issues of Cultural Diversity and Equity as They Play Out in the Mathematics Classroom. *Mathematical Thinking & Learning, 4*(2/3), 249-284.

Erchick, D. B., & Brosnan, P. (2005). Mathematics Coaching Program Home Page. Retrieved April 23, 2009, from http://mcp-coaching.osu.edu/Pages/index.aspx

Erickson, F. (1986). Qualitative Methods in Research on Teaching. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (3rd ed., pp. 119-161). New York: Macmillan.

Franke, M. L., Kazemi, E., & Battey, D. (2007). Understanding Teaching and Classroom Practice in Mathematics. In F. K. Lester (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning: A project of the National Council of Teachers of Mathematics* (Vol. 1, pp. 225-256). Charlotte, NC: Information Age Publishing.

Grant, M. R. (2009). *Examining classroom interactions and mathematical Discourses.* Unpublished Ph.D., The Ohio State University, United States -- Ohio.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). *Professional Standards for Teaching Mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. Reston, VA: Author.

QSR International. (2008). NVivo 8. Doncaster, Victoria, Australia

Stark, S., & Torrance, H. (2005). Case Study. In B. Somekh & Lewin, C. (Eds.), *Research Methods in the Social Sciences* (pp. 33-40). London: Sage.

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal*, *27*(4), 1-16. Retrieved from http://vnweb.hwwilsonweb.com.proxy.lib.ohio-state.edu/hww/results/results_common.jhtml;hwwilsonid=IXTMVLKWJ5GNXQA3DINCFF4ADUNGIIV0