ESTABLISHING A PROESSIONAL LEARNING COMMUNITY AMONG MIDDLE SCHOOL MATHEMATICS TEACHERS

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The paper examines how community was established in a professional development institute that focused on algebra content knowledge for middle school mathematics teachers. This qualitative study was framed within a situative perspective. We analyzed multiple data sources to identify the ways in which community was established. Results indicate that giving tasks that provided access to all participants on the first day allowed active participation from all participants and characteristics of community emerged. Characteristics that were evidenced in triangulated data indicate that explaining and clarifying ideas, building off of others' ideas, admitting weaknesses, giving praise to others, and laughing were indicators that community was being established.

BACKGROUND AND FOCUS STATEMENT

Professional development models are receiving renewed attention in mathematics education. Researchers are examining a variety of methods to identify characteristics of models that provide promise for improving classroom teaching and student achievement. Research suggests that one feature of successful professional development models is the ability to create community (Cobb, McClain, Lamberg, and Dean, 2003; Franke & Kazemi, 2001; Grossman, Wineburg, & Woolworth, 2001; Stein, Silver, & Smith, 1998).

Learning within a community of teachers is a simple idea yet establishing a successful community that results in teacher change and student achievement is a complex endeavor. First and foremost, the teachers need to share in the commitment to intellectual development and refinements in practice (Elmore, Peterson, & McCartney, 1996). Other features of professional development programs that support community development include: creating a safe environment for teachers to grapple with difficult content and pedagogical issues, developing sustained relationships among teachers in the community, encouraging participants to listen carefully to each others ideas and perspectives, equally distributing social and intellectual work within the community, and fostering a commitment to helping others within the group learn and develop both intellectually and in their teaching practice (Wenger, 1996; Grossman, Wineburg, & Woolworth, 2001.)

The most developed models of teacher community within professional development programs originated in elementary school mathematics (Carpenter, Fennema, & Franke, 1996; Schifter, 1996; Franke & Kazemi, 2001). These models of professional development focus on in-depth understanding of the elementary curriculum from a student thinking and learning perspective. At the heart of these models is the assumption that teachers teach concepts that they themselves have not mastered. Teacher learning is defined as understanding elementary mathematical concepts and curriculum. Elementary teachers often do not possess extensive mathematical knowledge, and one of the reasons for community is to mitigate teachers' negative affect around difficult subject matter (Schifter, 1996). Teaching communities within professional development models differ between grade level and subject matter (Grossman, Wineburg, & Woolworth, 2001). There is a difference between professional development communities in the elementary school in that elementary school teachers are not expected to be subject area experts whereas in high school communities many teachers have degrees in mathematics and sometimes advanced degrees. However, professional development communities in the middle school are unique in that that they are made up of high school licensed teachers as well as elementary school licensed teachers. A middle school mathematics community makes a unique community in that it adds different strengths and weaknesses to the professional development. This paper describes how community evolved within a summer institute for middle school teachers on conceptualizing algebra.

THEORETICAL FRAMEWORK

We drew upon a situative perspective to design both the professional development institute and the research investigation (Greeno, Collins, & Resnick, 1996; Putnam & Borko, 2000). From the situative perspective, a critical aspect of professional development is the development of community. We draw on the work of Lave, Wenger, and Grossman, Wineburg, & Woolworth to define community. Lave (1996) defines community of practice as relations across people, and activity over time and in relation with other communities of practice. Grossman, Wineburg, and Woolworth capture the notion of professional teacher community by indicating necessary speech and action enacted within the group. A professional teacher community is characterized by: [or "develops through" 1) the formation of group identity and norms of interaction, 2) the navigation of differences among group members, 3) negotiating the essential tensions between the goals of improving professional practice and fostering intellectual development, and 4) communal responsibility for individual growth. (Grossman, Wineburg, & Woolworth, 2001). Fundamental indicators of learning within the situative perspective are identifying changes in participation in the social practices of a community (Greeno, 2003; Lave, 1996). Therefore, professional development created with community as a central characteristic create an environment that considers participation, social negotiation, and collective learning. Social negotiation including the regulation of social interactions and group norms is an ongoing practice. Originally a few key individuals may do most of this regulation however roles in leadership will shift overtime.

From the situative perspective, the evolution of teacher professional development communities can be documented by observations of changes in leadership and shifts in participation (Rogoff, 1997). Indicators of group equity and maturation can be identified by the degree to which discussion brokering is distributed among individuals and the degree to which it is shared rather than monopolized by one or two people. Members of the teacher community must believe in the right to express themselves honestly without fear of censure (Grossman, Wineburg, & Woolworth, 2001). Documenting how this evolution takes place is different from professional development to professional development. Yet, as members transform their role within the community the person they are becoming crucially and fundamentally shapes what they know (Lave, 1996, p. 157) and indicators of growth can be identified. Genuine communities make demands on their members as membership comes with responsibilities. These demands can also be outlined as markers of maturation. More specifically, in a teacher community-a core responsibility is to help other teachers learn by encouraging them to contribute to large group discussion, pressing others to clarify their thoughts, eliciting the ideas of others, and providing resources for others' learning.

METHOD

The Professional Development Institute

The summer algebra course was part of the "Supporting the Transition from Arithmetic to Algebraic Reasoning" (STAAR) project. STAAR is an NSF-funded, 5-year project, conducted collaboratively between 3 major universities. The aims of the project are to study algebra teaching and learning at the middle school level, focusing both on students and teachers. The general scope of the summer algebra course was jointly developed by members of the STAAR team and based on two years work from three tiers of the project. The course was grounded in emerging theories about how students develop algebraic reasoning identified by Tier 1, how teachers teach algebraic concepts identified by Tier 2 and the professional development described here was to help teachers foster the transition from arithmetic to algebra designed by Tier 3. There was a general consensus among the team that middle school teachers might benefit from extended learning opportunities centered upon the teaching of algebraic reasoning. The two-week STAAR summer algebra course was held in July 2003 at a university campus setting. The three-credit graduate level course was offered through the Continuing Education program in the University's School of Education. According to Putnam & Borko (2000), such a setting appears to be "particularly powerful… for teachers to develop new relationships to subject matter and new insights about individual students' learning" (pg. 7).

Course Goals

Increasing teachers' content knowledge was the central goal of the course. The aim was to challenge teachers' own content knowledge as they engaged in rich explorations of many of the algebraic concepts that they are likely to teach in their own classrooms. Creating a teacher community or network was another goal of the summer course. Developing a sense of community among the teachers in the course was deemed very important. The course encouraged teachers to work together by seating teachers in small groups, assigning mathematical problems and encouraging teachers to work on them together.

A third goal was to have teachers experience learning in a classroom based on "reform" ideals. A fourth goal was to increase teachers' awareness of students' algebraic thinking by examining student work, discussing student thinking, and reading current literature. A fifth goal was to influence teachers' beliefs about algebra and pedagogy. In particular, the course was designed to help participating teachers see the value in developing algebraic reasoning skills through problem solving, group work, sharing a variety of solution methods, etc. This presentation focuses on the second goal, tracing how the professional teaching community evolved within the algebra summer course.

Participants

Sixteen mathematics teachers participated in the course. They were all inservice teachers from a variety of school districts in the state, mostly teaching at the middle school level. Although there was a range of experience among the teachers in the class (from 0-15 years), the majority had relatively little experience teaching middle school algebra. The course was team taught by two mathematics educators. One of the instructors had mathematics teaching experience at the middle school level while the other taught at the secondary level. Both also had experience teaching university courses and mathematics professional development courses.

Data Collection

An extensive set of data were collected both to describe the teaching and learning that occurred within the context of the summer course, and to track changes in the participants' knowledge and beliefs. Two video cameras were used throughout the course to document the activities of the instructors and the students. During whole-class activities, one camera was focused on the instructor(s) and the other on the students. When students worked in small groups, the cameras were trained on separate groups of students. In addition, extensive daily notes were kept by several members of the research team. Multiple measures were used to assess teachers' mathematical abilities and beliefs before and after the course. These measures included written mathematics assessments, face-to-face (or telephone) interviews about their beliefs regarding algebra teaching and learning, and a written statement about their mathematics experiences. The participants also kept extensive documentation of their work and reflections during the course. The course instructors were interviewed on a daily basis about their reflections on the class sessions. They also kept records of all instructional plans, handouts, and assignments.

The conversations that occurred throughout the professional development course, captured on videotape, are a main source of data to document how community evolved. In addition, field notes, interviews with both of the instructors and teachers, teacher daily reflections and instructor interviews provide important data for triangulation, confirming and disconfirming evidence. If a group grows toward community you should be able to hear it and see it in the venues (PD, online) in which they met. Claims should be supported by evidence from the interactions of the members.

Analysis

The coding framework implemented in this study uses two categories of codes. The first category includes 13 high inference analytic codes, for which the unit of analysis was whole discourse events. The second category includes 14 low inference analytic codes; which are applied to smaller chunks of data examined line by line (See Table 1.). As an initial step in data analysis, one researcher viewed the entire set of video recordings, created a chronological record of activities within the professional development institute along with a brief summary of each activity. At the same time, she identified activities during which issues related to the evolution of community were particularly evident. A second researcher analyzed these sections using the coding framework. A third researcher went through the data sets to achieve inter rater reliability in the coding of the data. Interrater reliability was accepted data was coded with 90% agreement. When coding of data was complete, researchers went through the data set and clustered codes. Themes were determined from the clustered data set. Again we went through the data set to find confirming and disconfirming evidence using triangulated data for the themes that emerged.

Code	High Inference	Code	Low Inference
TR	Sharing specific tools, representations, and artifacts	SW	Sharing a weakness or misunderstanding
SS	Shared stories, inside jokes, laughter-	SP	Sharing ideas and ways of thinking
RT	Reoccurring themes in language or in solving problems	CI	Challenging each others ideas
IC	Participants performed both individually and collectively to make sense of problems	CT	Instructor(s) gave tasks that required cooperative skills

Table 1: Sample of Select Analytic codes

RESULTS AND CONCLUSIONS

Preliminary results suggest the following themes emerged from the data set that help to characterize the evolution of community within the summer algebra institute. First, the grouping of participants was a planned strategy for community building. Instructors specifically grouped participants by personality to stimulate community development over the course of the institute. For example, the instructors' goals were to place participants that did not have prior experiences with each other together so that students made new relationships on the first day. These decisions were based on prior relationships with the participants and knowledge from institute interviews (Instructor Interview Day 1, July, 2003).

Second, it appeared that using tasks that provided access to all participants was important in the co-involvement of the whole group as they solved problems. Problems used on the first day appeared to be puzzle like tasks with multiple levels of access. All participants could solve the "sidewalk problem." This task had students cut a rectangular section of a sidewalk and find the minimum and maximum pieces that could be made. All participants could make representations of the different problems involved. Conversations focused around finding the minimum and maximum in which all group members participated, generalizing results, and writing algebraic expressions to represent the problem. This problem led participants to clarify and explain what they knew and did not know, be persistence in problem solving, admit when they did not understand the thinking or the content that others used, giving praise, and laughing. The sidewalk problem is a series of problems that was used most of the first day. The students worked in small groups where they individually solved the problem as well as collaboratively. Intermittently they would share parts with the whole class before they moved forward. Data analysis indicates that clarifying and explaining, building off of each others ideas, persistence, admitting weaknesses and laughing together were all characteristics that appear to be the ways in which community initially began to evolve. The following excerpt provides an example of one group presenting their results near the end of the day.

[Ken, the reporter, gets up to come to the overhead Mary, Mindy, and Allen get up as well.]

Mary: This is a team effort.

Allen: you might need us.

Kris: You guys don't have to come up.

Mary: Cover that part [of the overhead] up.

Ken: You have seen this before maybe [showing a table they made to represent the problem]. We started with the number of lines, then the minimum number, and the maximum number.

[agreement from teammates]

Ken: [jokingly asks] Can I go on? [directed to his teammates responses]

Mia: This was Ken's idea [pointing to the next column on the chart] before lunch. He noticed that something was going on with the number of intersections. Like how many intersections did you have and the resulting number of pieces.

Allen: This is kind of going off of what the last group introduced that the intersections had to increase by 1, 2, 3, etc. This was the actual number of intersections so these should line up.

Mary: [goes to the screen of the overhead] So this would be the 1, 2, 3, 4, as she points to different intersections that were aligned with the previous groups chart. But also, Mia and I were like these numbers look familiar and Mia remembered they were all triangular numbers and I was like whatever but after she showed me why I was okay I get it.

Ken: This brings up for those of us who paid attention during high school math. [sarcastic saying he did not know triangular numbers previously.] [lots of laughing and references made to other summer content courses.] Oh yeah! Pascal's Triangle! Who is Pascal? I thought that was a chip.

Mary: [nodding her head in agreement]

Ken: And then they came up with this thing which is really pretty awesome if you notice these numbers [circles 1, 6, 10, 15] if you look at the number of intersections you will notice they are the same.

Mary: Allen tell them what you came up with at this point.

Allen: The column over here is exactly what the last group said this is where it increases over 1,2,3,4,5,6,-then the next column is the number of intersections so that is where it increases and where this formula came in [pointing to the overhead and explaining the similarities] We tried to figure out how to get from these numbers [number of intersections] to the maximum.

Ken: So we came up with n is the number of lines which is how we all did it. Then n + 1 is the minimum-most of us came up with that. Then we took that [(n + 1)/2] + 1 would be the maximum which is basically what you can do with the triangles somehow.

Mary: Yeah.

Allen: It is the intersections and you are adding to..

Ken: It's still a little foggy to me…

This excerpt provides a window into the first day of the algebra institute. You heard participants explaining and clarifying their ideas, building off of the previous group's presentation, admitted weakness, giving praise, and laughing and having a good time. On the second day, the tasks that the instructors gave and the pedagogical focus encouraged participants to establish and gain deeper trust in the relationships with first a partner and then the other participants as they grappled with their own content knowledge including understandings, misunderstandings, and the intricate underlying relationships between the conceptual ideas of algebra. This led to in-depth dialogues among participants in which characteristics such as clarifying mathematical ideas, making sense of multiple solution strategies, struggling with a difficult problem, and sharing of weakness or misunderstandings were identified more often. Each of these characteristics emerged as themes to help explain how community was established in the professional development institute. This work adds to the literature base on effective ways to establish community within professional development.

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