

THE STRUGGLES OF A COMMUNITY OF MATHEMATICS TEACHERS: DEVELOPING A COMMUNITY OF PRACTICE [1]

Cristina Gómez

The University of Alabama

The purpose of this study was to understand how participants in a professional development program initiated, developed, and supported a learning community focused on students' understanding. The analysis focuses on teachers' activity as they participated in a community of practice and how that participation promoted (or restricted) their learning and therefore their students' learning. The components that characterize a community of practice are 1) mutual engagement, 2) a joint enterprise, and 3) a shared repertoire. The study took place in a bilingual (English-Spanish) high school in a large district in the Midwest, with a high percentage of Latino/a students, and situated in an urban setting. The study shows how the community was transformed by the practices and resources available to the members.

INTRODUCTION

Mathematics teachers' participation in communities of practice has been identified as a promising strategy for professional development. Studies focused on school organization have found strong relationships among teachers' participation in professional communities, innovative practices, and student learning (Adajian, 1995; Lee, Smith, & Croninger, 1997; Louis, Marks & Kruse, 1996). Mathematics teachers who participate in communities of practice are more willing to change their practices and their learning becomes generative (Franke, Carpenter, Levi, & Fennema, 1988; Stein & Brown, 1997).

While studies have found that teacher' participation in communities of practice is one significant element for supporting teacher change, we do not know how those communities are constructed and supported. In many studies, the communities were already organized or, in some cases, the communities emerged from the reform process in ways that are not clear. Regardless, communities are important in supporting both mathematics teachers' and their students' learning.

OVERVIEW OF THE STUDY

This study was part of a larger study that took place during a two-year period. The goal of the larger study was to examine how the focus on student understanding affects different systems at school. The hypothesis was that when teachers have knowledge about how students reason, they are able to interpret patterns in students' thinking and they are responsive to student understanding in the classroom (Carpenter, Fennema, Peterson, & Carey, 1998). This knowledge would also help teachers to select and construct meaningful tasks that highlight the development of student' algebraic thinking. At the same time, this knowledge would give teachers tools to promote discourse in which students are allowed to express their opinions, defend their solutions, question other's ideas, and reorganize their own thinking.

The purpose of this study was to understand how participants in a professional development program initiate, develop, and support a learning community focused on students' understanding. The analysis focuses on teachers' activities as they participate in a community of practice (Wenger, 1998) and how that participation promotes (or restricts) their learning and therefore their students' learning. The three dimensions characterizing a community of practice are 1) mutual engagement, 2) negotiation of a joint enterprise, and 3) development of a shared repertoire. This study seeks to describe how a specific design for professional development serves the different requirements for learning defined on a framework in which communities of practice and participation in those communities are the fundamental unit of analysis. Such a conceptual framework emphasizes the negotiation of meaning and the building of identities, which take place during the development of practice (Wenger, 1998).

THE CONTEXT

The concern for minority students' achievement in schools in the United States is well known. Many Latino students attend overcrowded schools, live in economically distressed areas, and face prejudice and stereotypes in their daily lives (Secada, et al., 1998). The city where this study took place had been making efforts for improving minority student opportunities. The school, Urban High School, faced strong pressure from the school district to improve student achievement and to get more students to pass the graduation test required by the school district. The school district agreed five years before the beginning of the study, to require algebra for all ninth-graders.

Urban High School offers a bilingual program for its 57% of Latino and Latina students. Close to 66% of students received free lunch (1997-1998). The school had 1500 students, and it was considered the most diverse school in the district with 19% of African-American, 10% white, and 7% Asian. Like any other inner city high school in the United States, Urban High School had many problems to confront. Teen pregnancy, truancy, and gangs were the most prominent.

The mathematics department at Urban High School had twelve teachers where five of them were bilingual. Four bilingual teachers volunteered to participate in the program. They were looking for mechanisms to get subject-colleagues support and to get a common understanding of the challenges they faced due to the changes in the school structure. The school was in the process of reconstruction due to poor student achievement and failing performance. The idea of "schools within schools" (or families) was being utilized since 1996-1997 when the new principal was hired. The family structure encouraged teachers to change their academic organization. Instead of traditional departments, the school was organized into families by areas—business, art, geography, science, and computers. Students belonged to a family and took most of their classes together. The mathematics department still existed but its function was not clear. While many teachers belonged to families and shared experiences with these teachers, others did not belong to a family and did not have an opportunity to talk to other teachers. The department was mostly a remnant from the previous structure and its function was mainly informative.

Participants

The teachers are Fernanda, Celina, Gustavo and Armando. They all identified themselves as Latino; three of them were Mexican-American and one Spanish-American. They lived in the neighborhood and participated in activities with the community. They were bilingual and received bachelor's degrees in mathematics or mathematics education. Urban High is the only school they had taught. Armando and Celina belonged to the arts and science family respectively. Fernanda and Gustavo did not belong to a family.

During the first year we observed five classrooms, two from Celina and one from each one of the other teachers. During the second year we observed two classrooms, one from Gustavo and one from Armando. One hundred and sixty students attended these classes during these two years. The demographic characteristics of these classes were very similar. In Celina' and Armando's classes, the students were mostly 9th and 10th graders. In Gustavo's and Fernanda's, they were mostly 11th and 12th graders. The age varied from 14 to 18 years old and the time living in the United States varied from one month to all their lives. Most of the students were bilingual. Ten percent of the students were born in the United States, 60% were born in Mexico, 27% were born in Puerto Rico and the remaining 3% of the students were born in other Central or South American countries. Sixty-two percent of the students in these classes were female and 38% male.

THE COMMUNITY OF PRACTICE

Different researchers have shown the importance of communities, usually in the form of academic departments, in secondary schools (Gutierrez, 1996; Adajain, 1995; Siskin, 1994). But, what happens when teachers do not find places and opportunities in the school for creating these communities? With efforts from different directions in changing school structure and improving students' learning, it is difficult for teachers to come together and find the cohesiveness necessary to maintain groups together. At Urban High School neither the families nor the department had the structure for community. These teachers spent most of their time in their rooms, where they had lunch, tutored students, had parent conferences, and planned their classes. These teachers fit what Hargreaves (1993) described as "isolation, individualism, and privatism" as model of teachers' work. Different from what Siskin (1994) said, at Urban High School the department structure had not given teachers opportunities for collaborative efforts, for creating a strong identity, or for having norms and shared values. The family structure had not given them that support either.

The community engaged in two kinds of practices—the general meetings and the reflection meetings—aligning efforts to understand students' thinking and creating images to communicate and share knowledge. The next section describes how this community defined the three components of the framework during the two years.

Mutual engagement

Because engagement refers to the ability to take part on meaningful activities of the community, in interactions with other participants, in the production of tools and artifacts and in the whole process of community building, it is necessary to look at the planned

activities, the way those activities allowed different participants to be involved in, and the way the activities were structured to guarantee an uninterrupted succession of events in which the participants would be engaged. For this group of people the general meetings were opportunities to talk, interact, and engage in doing things together. Sharing their experiences in the classroom, designing a test, and critiquing the school curriculum gave every participant opportunity for mutual engagement. The reflection meetings provided the opportunity to reflect about specific aspects of each teacher's practice. Using observations of students' strategies and responses in class, the researchers focused the conversations around the meaning of those observations and the way this information could be used by the teachers to plan following classes. These conversations with critical friends were also opportunities to get to know the teachers in a more personal way.

One of the first activities the community engaged in was the sharing activity. It was proposed by the teachers during the second meeting as a way to maintain contact with others and keep some coherence between mathematics courses at Urban High School. During the fourth meeting three of the teachers presented some of the experiences they had designed for their classes. Another activity the group engaged in was the discussion about curriculum. Because the group of teachers had decided it was important to have some coherence in the curriculum at the school, the teachers decided to discuss what the purpose of algebra would be and what would be the best way to organize the courses at school to reach the goals they had defined. Fernanda expressed her concerns about coherence in the curriculum at school and the effect of this lack of consistency in students' achievement. She promoted the idea of discussing the coherence of the curriculum at Urban High School in order to help her understand what content was important for her courses and how much emphasis was adequate on certain topics for getting students ready for the next course.

The design of the test was an opportunity for the teachers to participate in the research process. The researchers used the classroom observations as a way to get some knowledge about what the teachers considered important for the content of the algebra course and using these ideas to design a first draft for the test that was shared and discussed with the teachers. Engaging in looking at student work and analyzing possible student responses in different situations proved to be a successful task for this group. Teachers' knowledge of their students and researchers' knowledge about theories of learning provided opportunities for complementary contributions. The results from the test gave teachers information about what their students knew. The gap between teachers' expectations and test results created an opportunity to reflect about the main ideas of the algebra class. The teachers saw the need to make changes in their practices and give students more opportunities to explain their thinking. Having the possibility of talking about students' different strategies and levels of development of understanding gave teachers a new insight into students' learning. Teachers began to focus on the big ideas of algebra and on developing strategies to help students understand those ideas.

On the one hand, the activities the community was engaged in during the study offered to all participants opportunities for using their knowledge about their students, for making decisions about curricular issues, for evaluating the situation of bilingual students at Urban

High, and for creating tools, specifically the test, to get a better understanding of student's thinking. On the other hand, the teachers took responsibility for selecting the activities they considered worthwhile. Even though the researchers were interested in carrying out activities more related with looking into student understanding, the teachers were concerned about other issues they needed to deal with before, e.g. the discussion about curriculum.

Negotiation of a joint enterprise

The negotiation of a joint enterprise refers to the ability to coordinate perspectives and actions to a common goal. It is necessary to understand the enterprise of the community, to take responsibility, and to contribute to the process of pursuing it. The practice of this group of teachers and researchers reflected an attempt to create a context in which to advance in their understanding of student thinking. The teachers struggled to satisfy the restrictions from the school and the district, and they worried about their students' future. The teachers negotiated the enterprise with the other member of the community. The members were engaged together in the joint enterprise of understanding student's thinking. This does not mean all participants agreed on everything, had the same dilemmas, or found the same answers. But they found a way of working together, negotiating the goals, and recognizing the effects of it in their practice.

This process of negotiation also entailed the development of relations of mutual accountability. In this case, accountability included not only trying things out in the classrooms, but also sharing experiences, expressing concerns, and making sense of their practices. The need for coordinating a perspective on what all participants meant by student' understanding, for example, made the processes of coordination and communication dynamic, open-ended, and generative. This community developed in a larger context, which shaped and influenced its practice. The practice of this community was part of an historical development and it was influenced by the institutions to which the members were part of. Resources and constrains, from the school as well as from the university, were negotiated by the community in the process of defining its enterprise.

Other aspects related to coordination include the research methods used by the group and the ways for communicating that were followed during the study. Most of the processes for gathering data were defined by the researchers and agreed to by the teachers. Some of those processes included giving tests to students, participating in interviews, and collecting permission forms. Some other issues were negotiated with the teachers. Setting the interviews with the students is one example of how the teachers helped the researchers to make use of the resources available and even proposed alternative solutions.

One of the conflicts the group had from the beginning was the lack of time for the teachers to meet and do things together. Other than time during the general meetings, there were very few opportunities for teachers to even see each other during the day at school. This fact restricted opportunities to engage in discussions or even in planning activities for their courses and to reach their goal of getting some coherence in the curriculum. This conflict could not be resolved during the first year. Even though the group found different alternatives like meeting on Saturdays, using the banking days, and meeting after school,

there were always other issues that conflicted with the schedule and made difficult to find time to meet.

Development of a shared repertoire

The development of a shared repertoire refers to the creative process of generating new ways of looking at the activities the community is engaged in. In order to belong to a community of practice, participants must be engaged in activities and have aligned processes. Participants must interpret events, locate themselves in the world, and explore other possibilities. The process of pursuing the enterprise creates resources for negotiating meaning. In this case, the use of specific terms such as “students understanding” or “informal assessment”, routines such as discussing scheduling issues, tools such as the test, stories such as those shared by the teachers, and actions such as discussing the school curriculum were examples of the repertoire of the community. This repertoire was developed during the process of mutual engagement. Each one had its own history, its well-established interpretation, and it could be re-used in new situations.

Another important piece of the repertoire was the shared positive beliefs and high expectations about Latino students. All participants expressed an honest concern for their students. They believed their students’ Latino heritage was worthy of respect, and they believed all students were capable of success. This set of beliefs was critical for getting the group together and, even when other meanings were negotiated, they were almost “underlying principles” for the community.

During the joint process of pursuing the enterprise the community creates resources for negotiating meaning. In this community, certain terms, routines, stories, and concepts took on specific usage. Two clear examples were the concept of “student understanding” and the “rate of change test” as an artifact. During the first year, the ambiguity of the term “student understanding” made the process of communication difficult. The teachers were confident their students had complete understanding of the algebraic concepts. For them, being able to complete homework or not asking questions during the class were evidence of understanding. At the same time, they believed covering all the topics from the book would give students an understanding of all the concepts necessary to understand future topics. During the general meetings the concept of understanding as being able to see things related or connected to other things was brought by the researchers and adopted by the community after a process of negotiation.

The rate of change test was one of the artifacts that emerged as part of the engagement of the participants and allowed the convergence and stabilization of meanings. The test was developed based on researchers observation of teachers’ classrooms and using teachers’ insights about its relevance to their practice. Looking at strategies students used to solve these problems, instead of looking at performance, served as a resource to talk about understanding. Based on the test results from the first year, the teachers wanted to talk about the big ideas and ways to promote student participation in the classroom during the second year. The gap between teachers’ expectations and the evidence from the test created a conflict the teachers struggled to resolve.

The community focused its attention and efforts to the development of meanings that mattered to the participants. For the researchers it was important to understand the impact of talking about students' understanding with these teachers. For the teachers it was important to look at their practice from a new perspective and pay attention to students thinking.

IMPLICATIONS

Membership in the community benefited the participant teachers in different and personal ways. From a social perspective, learning is fundamentally experiential and social. It depends on the opportunities to contribute to the practices of the community (engagement), on the connection to the frameworks that determine the social effectiveness of the actions (alignment), and on the processes of orientation, reflection, and exploration of identities and practices (imagination). In this way, the learning in the community presented here took place because of the practices, norms, and images the teachers and researchers constructed together over the two years.

In this group Isabel could be considered as an experienced teacher, while Fernanda and Armando were just passing the critical initial stage of their professional lives, and Gustavo was a new teacher with just one and one-half year of experience at the beginning of the study. On one hand, the two teachers in the extremes, Isabel and Gustavo, were the most engaged participants and benefited the most from the community by taking into their classroom what they learned within the community. On the other hand, the other two teachers, Fernanda and Armando, represent the larger group of traditional teachers who find the ideas of reform difficult and even threatening. Many teachers will listen and participate marginally in the activities with some attempting some changes despite finding the experiences intimidating and risky while others neglect to translate the experiences to their classrooms entirely.

The study contributes to research in professional development in two ways, (1) understanding how a community of practice emerges and (2) validating the relevance of the content on professional development programs. The framework used helped to describe the different stages of the community and the way the group matured over time. Looking at the facilities available for each component during the process of community formation has given a detail description of what activities the participants were engaged in, what goals they negotiated, and what tools they produced during these activities for reaching the goals. The description brings to the front the importance of the content in the development of the community.

The second contribution to the research literature is the relevance of the content in professional development programs. The changes observed from the first year to the second year, show how important is the content of the conversation in a professional development program. Only when student understanding was the real focus of conversations and the community had tools to talk about it, did the teachers engage in more meaningful activities. The focus of the discussion was always highly related with the mathematical content, specifically with student development of algebraic reasoning.

NOTES

1. The research reported herein was supported in part by a grant from the U.S. Department of Education, Office of Educational Research and Improvement, to the NCISLA in Mathematics and Science (R305A60007-98). The opinions expressed herein do not necessarily reflect the position, policy, or endorsement of the supporting agencies.

REFERENCES

- Adajian, L. (1995). Teachers' professional community and the teaching of mathematics. Unpublished doctoral dissertation. University of Wisconsin-Madison.
- Carpenter, T. Fennema, E., Peterson, P., & Carey, D. (1988). Teachers' pedagogical content knowledge of students' problem solving in elementary mathematics. *Journal of Research in Mathematics Education*, 19, 385-401.
- Franke, M., Carpenter, T., Levi, L., & Fennema, E. (1998, April). Capturing teacher' generative change: a follow-up study of teachers' professional development in mathematics. Paper presented at the annual meeting of the AERA, San Diego.
- Gutierrez, R. (1996). Practices, beliefs and cultures of high school mathematics departments: understanding their influence on student advancement. *Journal of Curriculum Studies*, vol 28, no. 5, 495-529.
- Hargreaves, A. (1993). Individualism and individuality. In J. W. Little & M.W. McLaughlin (Eds), *Teachers' work*, New York, Teachers College Press, pp.51-76.
- Lee, V., Smith, J., & Croninger, R. (1997). How high school organization influences the equitable distribution of learning in mathematics and science. *Sociology of education*, 70, 128-150.
- Louis, K., Marks, H., & Kruse, S. (1996). Teachers' professional community in restructuring schools. *American Educational Research Journal*, 33(4), 757-798.
- Secada, W., Chavez-Chavez, R., Garcia, E., Muñoz, C., Oakes, J., Santiago-Santiago, I., Slavin, R. (1998). No more excuses: The final report of the Hispanic dropout project.
- Siskin, L. (1994). *Realms of knowledge: academic departments in secondary schools*. The Falmer press. Bristol, PA.
- Stein, M., & Brown, C. (1997). Teacher learning in social context: Integrating collaborative and institutional processes with the study of teacher change. In E. Fennema & B. Nelson (Eds.), *Mathematics teachers in transition* (pp. 155-192). Mahwah, NJ: Erlbaum.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York: Cambridge University Press.