TEACHER LEARNING IN MATHEMATICS TEACHER STUDY GROUPS

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Abstract: In this paper I explore the challenges and possibilities for teacher learning in study groups by examining the typical discourse generated in one particular group. Special attention was paid to the teachers’ talk when doing mathematics together and when talking about their teaching practices and students’ work. When doing mathematics together, the examined group’s talk can be described as exploratory talk, that is talk characterized by speakers seeking and showing intellectual involvement; public disclosure of disagreements and confusion; and talk that is generative and collaborative. In contrast, the teachers’ talk about their teaching and students’ work can be categorized as expository talk, which can be characterized by the use of monologues; speakers seeking and giving approval; and the non-analytical or unproblematic narration of events. These are features of study group talk that seem important to attend to and study as these affect the participants’ learning opportunities and impact the design and leadership of teacher groups.

Introduction

The notion of school-based study groups is a departure from traditional approaches to the professional development of teachers. Rather than attempting to “sell” the reform-minded ideas about mathematics teaching and learning, teacher study groups are designed as forums for critically examining and experimenting with standards-based mathematics teaching. This departure from traditional professional development activities stems from the negligible impact they have had on helping teachers realize the more ambitious goals of teaching and learning embedded in the mathematics reform documents. It has also grown out of the realization that professional development that seeks to engage teachers with “what is hard” about teaching and learning needs to happen in critical and reflective learning communities (Ball & Cohen, 1999) and that teacher learning needs to be “activated” rather than delivered (Wilson & Berne, 1999).

Recent years have seen an emerging consensus in the research literature on teacher learning about the “essential principles” of effective professional development. Putnam and Borko (2000), for example, have named the following as essential features to include in professional development opportunities for teachers: 1. Teachers should be treated as active learners who construct their own understanding. 2. Teachers should be empowered and treated as professionals. 3. Teacher education must be situated in classroom practice. 4. Teacher educators should treat teachers as they expect teachers to treat students. Wilson and Berne (1999) generated a similar list stating the typical features of successful professional development as work that: 1. Is ongoing; 2. Is school based and embedded in teacher work; 3. Is collaborative; 4. Focuses on students’ learning; 5. Recognizes teachers as professionals and adult learners; 6. Provides adequate time and follow-up support; 7. Is accessible and inclusive. It is however important to realize that “we know as little about what teachers learn in these kinds of forums as we do about what teachers learn in traditional staff development and in-service” (Wilson and Berne, 1999, p. 176). And, as Ball (1996) notes, “determining how to design provocative experiences for teacher learning and for engagement with what is hard about the reforms, while still honoring teachers as professionals, is a more complex matter than many may recognize.” (p. 502).

Following on the reform-minded ideas for professional learning my colleagues and I have been working with four elementary schools that have close ties to our institution’s elementary teacher preparation program. Each of us is both an instructor in the teacher preparation program and a study group leader in one of the participating schools. The idea is that by working with the teachers that mentor our students, prospective teachers will have access to teachers who are reflecting, studying, and innovating their teaching practice. The aim of our project, therefore, is twofold: (1) to strengthen our partner schools’ teaching of mathematics; and (2) to strengthen the field-based component of our teacher preparation program. In this paper, however, I will focus on the insights, questions, and tentative conclusions I have drawn from my work as a study group leader in one of the teacher study groups of this project. More specifically, my aim is to address the following questions: (1) What opportunities for learning do teacher study groups afford the participants, and (2) How do different study group activities affect the nature and substance of these learning opportunities?

Data Sources and Analysis

The study group I will focus on is composed of seven K-4 teachers. The group meets once every 3 weeks for 2.5 hours during school hours. Meetings began in the spring of 2001 and will continue until the spring of 2003. Six
of the teachers are female, and only one of them is male. Two of the teachers have been teaching for over 20 years, two of the teachers have 7-10 years of teaching experience, and three of them are in their 2nd or 3rd year of teaching. All of the grade levels are represented in the group. During these meetings we have engaged in several professional development activities including (a) discussions of selected readings, (b) engage in mathematical problem solving ourselves, (c) analyze students’ work, (d) observe and discuss someone’s teaching, etc. These activities have generated multiple sets of data, which have been recorded and collected. Teacher educators’ project and planning meetings, for instance, have been audio taped. The teacher study group sessions have also been recorded, with both audio and videotapes. Teachers have been observed and video taped teaching in their classrooms. Written data from the students, from the teachers’ notebooks, and the teacher educators’ journals are also available for analysis.

One of the main foci of our teacher study groups is to engage teachers in the exploration of mathematics through problems that challenge and extend their own understanding. There are obvious reasons for focusing teachers’ professional development on doing mathematics. Teachers need to understand the subject matter they teach (Ball & Cohen, 1999; Ma, 1999). Otherwise, they are confined to a practice of showing and telling that does not allow students to figure things out on their own. The analysis of students’ mathematical work is also another important focus of our teacher study groups. Understanding what students say, do, and write is an important aspect of teaching that values, respects, and encourages students’ thinking. We draw from the professional development ideas and materials of CGI (Fennema et al, 1996) and DMI (Schifter et al’ 1999a,b) to structure the study groups’ discussions about students’ thinking. We also structure conversations around the participants’ own students’ work on problems the teachers have first worked and discussed in their respective study groups and then tried out with their students.

In this paper I will focus the analysis on the kinds of conversation that take place in a typical study group meeting. In a typical meeting, the study group leader poses a rich mathematical problem to the teachers. These problems are chosen with many of the NCTM’s (1991) criteria for worthwhile tasks, as such as problems that generate opportunities for mathematical discussion and exploration of mathematical ideas. In addition, the study group math problems are chosen or constructed so that they are accessible for different levels of mathematical sophistication and that are adaptable to different elementary grade levels (K-5). The structure of a typical study group meeting is akin to Simon’s (1994) “learning cycles” for mathematics teacher education. In our case, the study groups have four learning cycles—Solving, Posing, Interpreting, and Reflecting. The solving and posing phases occur when the teachers solve a particular mathematics problem together and discuss and analyze their solutions and ways of posing the problem to their students. The interpreting and reflecting phases, in turn, occur after the teachers have tried their version of the problem in their own classrooms and come to the study group meeting prepared to share classroom stories along with insights into their students’ thinking and their teaching practice.

A major assumption driving the analysis of the data is that opportunities for teacher learning and change in a community of learners, such as in teacher study groups, depend a great deal on the participants’ willingness to share their ideas and to examine their own and their peers’ ideas critically. Hence, particular attention is paid to participants’ disagreements and challenges of each other’s ideas, as well as to the participants’ talk that reveal uncertainty, surprise, and confusion. These elements have long been considered instrumental to the personal construction of knowledge and to a community’s generation of knowledge. This kind of professional talk, however, is not without some serious challenges. Chazan and Ball (1999), for example, have suggested that most discussions about teaching in all circles tend to be too judgmental to support analytical and constructive conversations about practice. Similarly, Pfeiffer and Featherstone (1995) have noted: “when teachers talk about their work, most are quite facile in talking about teaching without revealing the struggles and uncertainties inherent to the practice.” Lord (1994) also contends that in order for teacher groups to become a setting for teacher learning, teachers must be prepared to openly and publicly disagree with and about practice and to engage in a “critical collegueship” which he defines as “an alternative professional stance where teachers move beyond sharing and supporting one another through the change process to confronting practice—the teachers’ own and that of his or her colleagues.”

In order to make sense of this data I have drawn from the situated learning perspectives, such as Wenger’s (1998) “communities of practice,” and the emergent “situative perspective” in cognitive science (Putnam & Borko, 2000), which also emphasizes the social nature of cognition. In addition, because the nature of learning in study groups is discourse-based, several discourse analysis frames such as, “turn-taking”, “participant’s involvement,” “politeness,” “disagreements” and “concensus” (Cazden, 1988; Tannen, 1989; 1993) are used to uncover conversational patterns and explore Lord’s notion of “critical colleagueship” or whether and when do teachers openly and publicly disagree with one another.

Results

A survey of the participants’ assessment of the study group meetings revealed that at least in the teachers’
minds, teacher study groups provide them with multiple opportunities for professional learning. Teachers have reported learning and enjoying the experience. The main attraction and learning opportunity, they have said, comes from being able to work across grade levels, which they say has given them opportunities to learn about curricular issues, students’ understandings, and teaching struggles at the different grade levels. They have also reported that working on mathematics problems together and then trying them with their students to later report back to the group on what happened and what they learned from the experience has not only further their own understanding, but also has affected their teaching practices. When asked how the study group work were helping them, teachers for example wrote:

I've really enjoyed the opportunity to get together and talk/share with other teachers about mathematics. I've seen myself look more critically at how I talk or ask questions to the class during a math lesson. I also have seen myself grow in the area of challenging my students… not being afraid to give them an open-ended story problem (Special Education Teacher).

I find myself pushing my students to think beyond more. Instead of stopping at solving a problem one way, we talk about alternatives. We also do more thinking/talking about connections to other problems (Second Grade Teacher).

Features of Study Group Talk
A closer look at the discourse generated in the study groups have revealed important differences in the pattern of the group’s talk when teachers are engaged in the doing of mathematics and when they talk about their own teaching and students’ work. Each of these activities generates distinct conversational patterns of talk and involvement by the participants. These unique forms of talk and participation provide both challenges and possibilities for teacher learning. When doing mathematics, for instance, the teacher group’s talk in this study tends to be very interactive and collaborative with participants interrupting and disagreeing with one another, freely and unprompted. Yet, when the focus of the conversation shifts towards their practice and students’ work, the conversation tends to take on a different character. This talk is less interactive and collaborative, as one speaker would speak at a time uninterrupted and in a monologue style. These findings are elaborated next.

In terms of the structural features of the teachers’ discourse around their own doing of mathematics, it is interesting to note the very public and explicit disagreements that are uttered. The speakers, for instance, explicitly object to another person’s solution using “but,” “no,” and “I don’t think so.” In addition, the teachers’ talk seems more like exploratory talk rather than a polished exposition of ideas. That is to say that the group seems to be figuring things out together and extending perhaps even revising their ideas as they talk. The focus of such conversations is on the analysis of everyone’s solutions rather than on simply reaching or agreeing on the right answer. Furthermore, teachers use phrases that indicate uncertainty and exploration of ideas such as “what if,” “maybe,” “what about” and “I’m not sure.”

The group’s involvement is another prominent characteristic of this talk. The number of speaking turns and the multiple speakers on the same topic are some evidence of this. In addition, there are several instances in the transcripts where the speaker and listeners show involvement (Tannen, 1989). There are multiple instances of speakers using phrases that suggest they were seeking or showing involvement and understanding such as: “does that make sense?,” “you know what I mean?,” “what did you say?, “okay I see what you’re saying.” Another example of involvement is when the participants finish each other’s sentences. In addition multiple instances of “repetition” were uncovered in the transcripts, which is another indicator of involvement. Repetition is a conversational strategy used by speakers in order to check for understanding or better understand what has been said.

In contrast, when the conversation is focused on the teachers’ teaching practice and students’ work, the structure of the conversation changes. The turn taking pattern is different. When sharing their practice, each teacher takes uninterrupted turns and presents with varying levels of detail and analysis what they had done and what their students thought and did in relation to the math problem everyone has tried. Also, interesting is the fact that no one except for the group leader actually asks questions to the speaker. It is also important to note that the teachers in the focus study group have shown a genuine excitement and interest in their students’ work regardless of whether the work is correct or incorrect. Their talk therefore tends to be non-evaluative and somewhat celebratory of the students' work, but it also tends to be more descriptive rather than analytic of the mathematical work. Another interesting feature of the conversation is a lack of explicit disagreements; there are no “but” or “no” spoken, even when differences of opinion are expressed. Very explicitly spoken, however, are phrases that imply certainty such as: “probably,” “definitely,” and “must have.” Teachers also use repetition of certain key phrases such as “I think,”
“in my opinion,” and “my students.” For instance, when a teacher was asked what might happen in her classroom, she responded by referencing the fact that she had taught both first and second graders before she stated her response. With such conclusive statements that make reference to their expertise, number of years teaching, or their opinion, teachers seem to position themselves as the ultimate authority on what they think and on their students. It is therefore hard to imagine anyone disagreeing or arguing with anything that anyone says.

Another interesting aspect of the teachers’ talk about their practice and students’ work is the amount of details that the teachers are able to recall and report. Some teachers, for instance, have been able to report the chronology of students’ contributions or reproduce what the students say with great accuracy. Still others use “reconstructed dialogue” (Tannen, 1989) in their narrations. The reconstructed dialogues may or may not represent actual dialogue but serve to involve and engage the audience in one’s story. It is therefore interesting and puzzling that although some elements for potentially collaborative conversations are present, the teachers’ talk about their practice have tended to be anything but collaborative. This is surprising because as Tannen suggests “details create images, images create scenes, and scenes spark emotions, making possible both understanding and involvement” (p. 135).

However, Tannen also suggests that a speaker or writer may use details and images to lead hearers and readers to draw the conclusion favored by the speaker or writer. She also cautions that, “one can fabricate details to make a false story sound true, or pile on details about irrelevant topics to de-fuse, diffuse, or avoid a relevant topic” (p. 161). In these teachers’ case, then, the provision of detail and images can be thought of as a strategy to involve the listeners in order to help them draw the same conclusions the speaker reached and not necessarily as a way to engage listeners in further analysis of the described experience.

Opportunities for Learning

The two kinds of group talk I have discussed also provide multiple learning opportunities to the participants. When doing mathematics together, the participants have opportunities to: explain their thinking, make sense of someone else’s explanation, offer counter-explanations of problems, and participate in discussions about the meaning of problems or mathematical ideas. During the sharing of their students’ work, in turn, the participants have opportunities to: make observations about children’s work and ideas; contrast what children said and did with what participants anticipated they would do or say; consider differences between children’s and adults perceptions of the problem; develop conjectures about alternate approaches to presenting problems or about follow-up activities or problems. These are aspects of professional learning that are considered to be important to the teaching of mathematics as discussed by the National Council of Teachers of Mathematics (2000; 1991); the National Research Council (2001); and the Conference Board of the Mathematical Sciences (2001).

These opportunities for learning depend a great deal on the selection of tasks used in the study groups as they allow different kinds of content and processes to be explored and yield different possible mathematical learning outcomes. In all of the examined transcripts, the problems used have engaged the teachers in explaining and clarifying their own mathematical thinking, and in listening to others’ explanations and ways of solving. Participating in these two activities have afforded teachers the opportunity to expand their repertoire of possible solutions or approaches to particular problems. This can be inferred from the analysis of the group’s discourse when teachers use expressions of surprise after hearing somebody else’s solution, indicating that a particular approach or solution is new to them. Another indicator or source of evidence can be found when teachers are compelled to repeat somebody else’s solution word by word, which is a conversational strategy many use in order to better understand what has been said. One other example that supports the notion that conversations around their own doing of mathematics can serve to expand teachers’ repertoire of solutions to problems can be seen when teachers disagree with another’s solution and try to convince each other that their solutions is or is not mathematically sound.

When discussing ways of posing the same problem to their K-4 students and what might happen in their classrooms, the teachers’ conversations have revealed multiple opportunities for professional learning. The teachers’ attempts to anticipate what their students might think and how they would “nudge” them towards seeing other solutions beyond their own often led to further analysis of the problem and how it is different from the “typical” math problems they would pose in their classrooms or previous problems the group had tried. In one such conversation, for instance, the first grade teacher said that “unless I really read this over” pointing to the last sentence in the problem, her students would automatically want to prove one of the two kids in the problem right, because that is what math problems tend to ask them to do. This led to a discussion about: “do you want it to even say that (prove that both kids could be right) or would you want it have it say “which one is right?” This suggests that engaging teachers in discussions about how they might pose problems to students can provide opportunities to analyze math problems from different vantage points—the wording, structure, demands, challenging aspects, etc. across the different grade levels.

In terms of opportunities for learning when sharing and listening to each other’s accounts, teachers have
multiple opportunities to extend their pedagogical content knowledge, and their knowledge of students’ mathematical thinking. By listening to others’ accounts, the listening teachers have opportunities to learn about the speaking teachers’ practice. This opportunity depends a great deal on how much of their practice the reporting teacher is willing or able to reveal. From listening to others’ accounts, participants can learn that the reporting teacher, for example, had “read the problem” to her students, or that she decided against bringing actual manipulatives because she “didn’t want to have predetermined solutions for them.” Teachers’ report on what happened in their classroom also provided opportunities for learning about the different solutions and ways of thinking from students in classes that were different from their own and how the reporting teacher had made sense of them. It is, however, unclear and harder to determine how the reporting of their insights, in turn, helped extend of challenge anything that the reporting teachers may have already learned. The opportunity for extended learning in this situation, therefore, depends a great deal on the reporter’s willingness to publicly problematize their teaching practice and their students’ work. It also depends a great deal on the availability of records of practice for everyone to examine and also on the study group leader’s mediation and interjections.

One of such interjections that have proven very fruitful often happens when the group leader moves the conversation from a reporting to a reflective mode by asking the participants, for example, to talk about “what was hard about doing this problem with students?” In this reflection mode the participants would often reveal more about their pedagogical thinking and the problematic aspects of their teaching that were not revealed when they reported on their teaching and their students’ work. One teacher, for instance, who in the reporting/analysis phase sounded self-assured and her practice sounded straightforward, revealed the tensions she experienced when deciding when it was time to move on.

I struggled with the chunk of time that you talked about too. We had 6 different pictures and solutions all over the board and when I finally cut it off I still had 4 or 5 kids with their hands up wanting to say something more and come up to the board. I mean I wanted to get some other things done in math and we had already spent I think 25 minutes on it. You know between the pre-discussion and giving them the problem and having them start talking about it, and giving them some paper to draw on and then all the different answers and getting them to the board, it was really hard. Although I don’t’ think I would have gotten some of the interesting thoughts in the end if I didn’t give them extra time to process but it was hard to give up the time and keep going and still wonder if I should have continued on going. (Second Grade Teacher)

To summarize, in the solving cycle teachers have opportunities to engage in the doing of mathematics. This work affords them opportunities to (a) explore and discuss their own mathematical solutions and approaches to proving or refuting (b) identify and expand their knowledge and beliefs about particular mathematical content and approaches to learning it, and (c) evaluate the problem’s potential for supporting students’ learning. The posing cycle provides teachers the opportunity to: (a) explore the contextual, mathematical, and linguistic demands of the problems, (b) anticipate and prepare for students’ difficulties, and (c) design versions of the same problem to try out with students in different grade levels. In the interpreting cycle teachers: (a) explore students’ mathematical work across grade levels, (b) identify insights they have gained about teaching and about students’ mathematical work and understanding, and (c) develop analytical frames to interpret teaching and students’ learning. The reflecting cycle, in turn, provided teachers the opportunity to (a) explore what they and their students might have learned, (b) identify effective practices and aspects of their current practice that they may wish to examine further or change, and (c) map possible plan for follow up and investigation into their teaching and students’ learning.

Insights, Questions, and Issues

An important insight from this study is the differences between the two types of talk explored in this study and the learning that each can afford. Teachers' problem solving discourse can be categorized as exploratory talk, that is talk that is characterized by speakers seeking and showing intellectual involvement; explicit disagreements and public disclosure of uncertainties and confusion; and talk that is generative, interactive, and collaborative. In contrast, the teachers’ talk about their teaching and students’ work can be categorized as expository talk, which can be characterized by the use of monologues; speakers seeking and giving approval; and non-analytical or unproblematic narration of events. These are features of study group talk that seem important to pay attention to and study. Another important insight relates to the opportunities for learning that these two forms of talk afford the participants. When the conversation is focused on their own mathematical problem solving and the structure of the talk is exploratory the participants have opportunities to explore and analyze mathematical ideas and expand their repertoire of solutions and approaches to particular problems. When the discussion focuses on their teaching practice
or students' work and the talk is expository, the participants have opportunities to expand their repertoire of students' solutions and strategies and to glance at each other’s teaching moves and pedagogical reasoning.

After this analysis it has become clear that engaging teachers in discussions about their own mathematical ideas is likely to provoke a more generative and collaborative talk than conversations that focus on teachers' practice or their students' work. The more collaborative form of teacher talk happened more “naturally” and without much intervention from the study group leader when participants engaged in, and discussed their own, problem solving activity. This has turned out to be somewhat surprising. I, for one, would have thought that talking about mathematics would be more intimidating to elementary school teachers who are known to have a weak mathematical background and sometimes negative dispositions towards the subject. There are, however, different plausible explanations of what I have described. It is possible that for elementary school teachers admitting mathematical ignorance is not as threatening as admitting dissatisfaction or problems with one’s teaching (whereas the contrary might be true for secondary school teachers). They may not find it threatening to their professional status or self-worth. Paulos (1988) has noted that the great majority of Americans openly say they are not a “math person” or were “never good at math.”

Another plausible reason is that teachers are more likely to have been engaged in mathematical discourse than they would be used to talking about their teaching practice with colleagues. It is therefore a resource that they bring with them to the teacher study groups. Yet another explanation is the power of a “shared experience” in promoting and sustaining collaborative discussions. Having just solved a problem and talking about it is much easier to handle as a participant and as a facilitator than a conversation that focuses on each participant’s individualized experience from a few days ago. The point here is that for the uninitiated participant (and leader) of study groups, doing problem solving seems to be a fruitful setting to begin to engage in the kinds of discussions that might lead to the “critical colleagueship” orientation Lord advocates, and to the adoption of patterns of discourse that are more analytical rather than simply descriptive or evaluative of one’s and others’ teaching and students’ work.

By the same token, the analysis of the conversations centered in and around practice and students’ work seemed to be less amenable and open to collaborative talk. The form of the teachers’ talk I have called “expository” tended to keep participants away from becoming involved and from asking questions or challenging the speakers’ interpretations. The lengthy and intricate stories the participants told while vivid and memorable in many respects were not conducive to interactive and analytical discussion. The study group leader’s interventions then are the most crucial in this setting. Modeling the kinds of questions that would further the group’s collective insight, asking participants to comment on each others’ accounts, and asking participants to comment on analytical questions such as what sense or insights they gain from listening to each other or what they found hard or problematic were some of the interventions that seemed to generate more revealing and collaborative discussion. It is however important to point out that teachers’ expository talk also provided multiple opportunities for learning to the participants. Absent from that kind of talk, however, were opportunities for the teacher reporter to hear others’ perspectives, challenges, and questions about their interpretations and narrations of their classrooms and students’ work.

References
Conference Board of the Mathematical Sciences (CBMS 2001). The Mathematical Education of Teachers.
Mathematical Association of America & American Mathematical Society.


