MATHEMATICS PROFESSIONAL DEVELOPMENT: EXAMINING FACILITATION AND DISCOURSE

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The authors present an analysis of facilitation across three cohorts of a phase-two professional development project. Four types of discourse are introduced and defined (correcting, eliciting, probing, and responsive). The analysis attends to implementation fidelity and facilitator moves in light of these four types of discourse. Conjectures about the impact of facilitation moves on implementation fidelity and discourse are explored, and implications for conducting professional development are considered.

Keywords: Teacher Education-Inservice/Professional Development, Classroom Discourse, Elementary School Education

Mapping the terrain of research in professional development, Borko (2004) considered three phases of research to examine professional development. Phase-one research focuses on an individual professional development program at a single site and investigates the relation between the program and participating teachers as learners. Phase-two continues to focus on one professional development program, but the program is now offered at multiple sites; such research attends to the relations between the program, the teachers, and the various facilitators of the professional development. Phase-three research focuses on comparing different professional development programs across multiple sites and facilitators, investigating relations among programs, teachers, facilitators and contexts. This papers reports on a phase-two research study that investigated various implementations of one professional development program - Project AIM (All Included in Mathematics).

Borko (2004) stated that professional development programs that could be enacted by multiple facilitators were ripe for the exploration of questions about similarities and differences across sites, with an eye toward generating knowledge about professional development and also refining the program's tasks and materials. She highlighted the importance of developing "well developed and clearly specified" (p. 9) programs that allow the field to move from conducting phase-one research to phase-two research. Such a move creates the necessity of investigating "the balance and tradeoffs between fidelity and adaptations" (p.12), but represents a fundamental step toward offering professional development at scale.

The issue of scale in professional development has received renewed attention with the release of the Common Core State Standards for Mathematics (CCSSM) (Sztajn, Marrongelle, Smith, & Melton, 2012). The national-level need for massive professional development to bring the CCSSM into classrooms represents a change of magnitude in the need for professional development capacity (Ball & Cohen, 1999), requiring knowledge about professional development facilitation that supports productive, rather than fatal, adaptations (Seago, 2007) of professional development programs.

Project AIM, the professional development that serves as the context for the present study, is part of a National Science Foundation-funded, 5-year research and development program. The tasks that comprise the 40-hour program were designed and tested in year 1, implemented in one site in year 2 as a pilot, then revised and scaled to multiple sites in year 3. The present study

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focuses on one session of the professional development program as implemented by three different facilitators in year 3. This research attends to whether the materials were implemented as intended. Given that attention to classroom discourse is a central tenet of Project AIM, this study also examines the professional discourse that took place among teachers at the various professional development sites. As we learned, implementing the program with fidelity did not warrant the promotion of teacher discourse as envisioned by the program designers because differences in facilitation moves led to variations in the emergences of professional development discourse.

In what follows, we first discuss the importance of discourse for mathematics learning both at the K-12 and at the professional development level. Based on the literature on discourse in general, and on the work of Hufferd-Ackles, Fuson, and Sherin (2004) in particular, we introduce our definitions of four types of discourse (correcting, eliciting, probing, and responsive), which were used both as a professional development tool for the project and as a lens to analyze the teachers' professional discourse in the context of the project. Next we discuss how issues of fidelity of implementation and integrity of enactment were considered in the study. Then, we define the context of the study and introduce the research participants. We describe the particular professional development session that served as the context for our research, the data collected and the analytical procedures. Finally, we share our findings about the implementation of the professional development program, the professional discourse of teachers in different professional development sites, and the facilitations moves that supported responsive discourse among teachers.

Research Context and Question

The notion that students learn from one another has been posited and investigated by a number of researchers (e.g., Vygotsky, 1978). More recent research in mathematics education confirms the importance of discourse and interaction for student understanding (Kazemi & Stipek, 2001; Yackel, Cobb, & Wood, 1991). However, this notion that knowledge is socially constructed is not limited to the mathematics classroom; it may be applied to mathematics teacher education and professional development as well. McCrory, Putnam, and Jansen (2008) assert that in professional communities "teachers learn through sustained discourse with other teachers, sharing their expertise and learning from the expertise of others, bringing professional development [and university training] closer to the real work of teaching" (pg. 157).

The professional development context of our research was designed to provide practicing elementary teachers opportunities for long-term, collaborative work with ready-to-use strategies that could be implemented in their mathematics classrooms to promote responsive discourse among students. Specifically, participants in Project AIM learn to identify four different types of mathematical discourse in the classroom. Drawing upon Hufferd-Ackles et al.'s (2004) theoretical framework for a "math-talk learning community," the four types of discourse defined in Project AIM classify both mathematical content and responsibility. For the purpose of this study, it is appropriate to share these in light of responsibility classifications. First, correcting discourse is characterized by the Teacher initiate-Student respond-Teacher evaluate pattern of discourse in which the teacher asks questions, a student responds, and the teacher listens to verify whether the answer is right or wrong. In eliciting discourse, the teacher transitions from focusing on correcting students' ideas, to eliciting students' sharing of their ideas and their thinking. This removal of the correcting aspect of the discourse intends to create a safe environment that supports students in communicating their explanations. In probing discourse, the teacher continues to maintain the positive nature of discussions, and purposefully uses

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questioning to press students for greater depth in sharing their thinking. Finally, responsive discourse involves a difference in responsibility within discussions. The teacher moves from being the sole authority for the quality of the content and the nature of the discourse, to helping students take increasing responsibility for them.

Recall that this paper reports on a phase-two research study that investigated various implementations of one professional development program. It attends to the central goal of phase-two research, which is "to determine whether a professional development program can be enacted with integrity (LeFevre, 2004) in different settings and by different professional development providers" (Borko, 2004, p. 9). We focused on fidelity of implementation as delineated by O'Donnell (2008) in her review of research as 1) adherence, 2) duration, and 3) participant responsiveness. Analysis of fidelity of implementation allowed us to better understand how facilitators interpreted the professional development materials. In particular, in this study, we address the following overarching research question: *How do elementary grades mathematics professional development facilitators interpret and use with elementary grade teachers a set of professional development materials developed to promote discourse in the classroom?*

Methodology

Participants and Setting

A 40-hour yearlong professional development in Project AIM (*Project Name*) was created with underlying assumptions that 1) students need to learn to participate in productive classroom discourse; and 2) knowledge of mathematics for teaching and how to promote classroom discussions are both necessary, but neither one alone is sufficient. During the first two years of this research and development project, elementary instructional math coaches were recruited from a large school district in the southeast United States. In year one, these coaches were participants of the professional development. The second year, elementary teachers were recruited from the same district and the coaches observed the professional development and served as a focus group for revisions of the materials. During the third year of Project AIM, the time of this current study, eight of the coaches were recruited to be facilitators of the professional development. Facilitators were paired and four new cohorts of second grade teachers were recruited. In all, nearly 80 second grade teachers representing 23 elementary schools in the district were selected based upon their guarantee that at least two teachers from each participating school would commit to the yearlong professional development. The number of teachers in the four cohorts ranged from 15 to 21.

The purpose of Project AIM is to promote mathematics discourse in the elementary school classroom by implementing strategies found in research from the literacy field. The project also includes development of crafted professional development materials along with research that includes documenting teachers' learning and implementation of ideas throughout the school year. A series of three-hour professional development sessions were designed to encourage teachers to analyze classroom video, engage in discourse-promoting activities, and plan for instruction. For the purposes of Project AIM, classroom discourse is defined as patterned ways of using language and other communication tools in the classroom. The professional development began with an intensive 3-day summer institute, during which teachers participated in 6 of the 13 total sessions of Project AIM. Session 3, the focus of this paper, occurred at the beginning of day 2 of the summer institute. To begin answering the above research question, we chose to focus initially on Session 3 because it included the Think Aloud, a strategy often used in literacy, and therefore already familiar to teachers.

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Overview of Session 3

In Session 3, participants were introduced to ways to support the implementation of responsive discourse in the classroom. The session included pedagogical discussions about instructional moves that allow students to talk about their mathematical ideas and the teacher to listen in support of learning. Specifically, Session 3 emphasized the launch phase that begins a lesson, and participants had the opportunity to learn about and reflect on one particular launch strategy, called Think Aloud, through the use of classroom video artifacts.

Data Collected

Our initial focus on a single session of the professional development, namely Session 3, also allowed us to look carefully across cohorts. However, facilitators in one of the cohorts shared leader responsibilities within Session 3. Therefore, it was decided to exclude them from the current study so that we could better compare the remaining three cohorts, which only utilized one facilitator as the leader of Session 3.

During the summer institute, when Session 3 occurred, entire sessions were video recorded. Graduate students, not part of Project AIM, served as videographers, one per cohort. Each cohort also had a project liaison in the room during the entire summer institute. One responsibility of the liaison was to provide a detailed observation log for each session. Other written data collected included observation notes from the facilitators who did not lead Session 3 as well as reflections from the facilitators who did lead the session.

Data Analysis

We were interested in reporting traditional implementation fidelity of the professional development materials as well as how facilitators engaged participants with activities and how their moves affected implementation and engagement.

Reporting implementation fidelity. The written plans for individual sessions of the professional development are divided into a few main segments. For each segment, the plans include a rationale/purpose, suggested times, a detailed list of activities, and a list of facilitation notes and main ideas for participants. For some segments, the plans also offer anticipated teacher responses for the facilitators to consider during their planning and preparation or during implementation of the session. Prior to analysis, the number of activities and main ideas for each segment of Session 3 were determined. Videos from each cohort were carefully viewed to determine the time allotted and number of activities implemented for each segment in Session 3. Additionally, the number of main ideas explicitly stated by facilitators during the session was noted. Liaison logs and observer notes were used to confirm such actions.

Discourse in session 3. We selected three focal activities in Session 3 to analyze how teachers interacted with one another and how the facilitator engaged them in whole group discussions. These three activities were identified at the beginning of Project AIM's third year as part of larger research and development goals for Project AIM as potentially rich sources for describing development of participants' mathematical knowledge for teaching and their understanding of responsive discourse during their engagement in the professional development. Three of those focal activities occurred during Session 3. The first was a whole group discussion of a video of a second grade teacher launching a lesson using the Think Aloud strategy with a comparison problem: "Jane and Ernie have some apples. Jane has 6 apples and Ernie has 9 applies. Who has more apples? How many more?" (Fuson, 2009, pg. 222). The second focal activity was a later whole group discussion on the teacher's use of the Think Aloud strategy in her launch. Prior to the second focal activity discussion, participants watched a second video, which included content from the first video as well as what happened in that classroom

immediately following the launch. Finally, the third focal activity in Session 3 was a whole group discussion of participants' reactions to the second grade teacher's written reflection on her use of Think Aloud to launch the mathematics lesson.

Videos of these focal activity discussions were analyzed for both interaction patterns and levels and types of discourse. Two researchers entered a cycle of video analysis and coding modification until agreement was reached. A revised coding scheme, which included four dimensions (correcting, eliciting, probing, and responsive) and two types (questioning and explaining), became the codebook used for video analysis. Reliability was established by the two coders working together until an 85% agreement had been reached, and a third researcher independently agreed with the codes applied to a particular video segment. Then, the two original coders continued coding additional video segments separately. For each cohort, videos for the three focal activity discussions in Session 3 were coded directly using Atlas TI and the quotations formed within the qualitative analysis software were used to look for further themes. Each participant and facilitator turn was coded separately and the time of talk was recorded. Wait times of five seconds or more were also coded. This line-by-line coding provided information about interactions within a cohort. The research team used color codes within an Excel spreadsheet to look for patterns. Each quotation was denoted by a separate row in the spreadsheet. Columns represented the four dimensions of discourse (correcting, eliciting, probing, and responsive). Then, colors were used to distinguish participant from facilitator (yellow and red respectively) and shades of individual colors specified questioning (light color) and explaining (dark color). (See Figure 1 for an example.)

Making conjectures about facilitator moves. Continued video analysis allowed us to make conjectures about why certain discourse types and discussion patterns emerged during whole group discussions. Aligned with the overall goal of Project AIM, which is promoting responsive discourse, it was noted when facilitators explicitly made comments shifting responsibility for discussions to participating teachers. We also attended to facilitators' physical placement in the room during different segments of Session 3, as their physical location within the group might influence the group's sense of who is responsible for generating and shaping discussions. These details, along with graphical representations of discussion patterns and discourse types, permitted us to make conjectures about how facilitators' moves during implementation of Session 3 impacted discourse among participants during the professional development.

Results

Reporting Implementation Fidelity

It was suggested in the lesson plan that 165 minutes be allowed for all activities in Session 3. Overall, we found that facilitators followed the timing recommendation for each segment fairly closely, which resulted in little overall time differences across cohorts for the professional development session. Each cohort went slightly over the suggested total of 165 minutes (between 1.5 and 7 minutes). We also found little difference across cohorts in the number of activities implemented by facilitators. All activities were listed in the detailed plan for Session 3, and facilitators consistently adhered to that plan, implementing the activities in the specified sequence (between 80% and 89%). All facilitators used an accompanying Power Point presentation to help guide their work in leading Session 3. The Power Point file for Session 3 included slides about most of the activities, which may have contributed to the consistent implementation of activities in sequence. Although the accompanying Power Point presentation for Session 3 included, for most segments, the activities in the order they were designed to be

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implemented, the slides did not present all of the main ideas. This factor may have had an impact on the number of main ideas that facilitators explicitly stated. For example, during the discussion of the launch video, the facilitator in Cohort 4 stated only those main ideas that were displayed on the slide for participants to read. This decision resulted in a much lower percentage of the main ideas (67%) being stated when compared to what occurred in Cohorts 2 and 3 (91% each).

Despite some differences between facilitators in the number of minutes used in Session 3, the number of activities, and the number of main ideas explicitly stated for participants, the facilitators were using the professional development materials largely as they were intended and were helping participants attend to most of the main ideas within the session.

Discourse in Session 3

Recall that while we reviewed Session 3 in its entirety for implementation fidelity, we focused on only the focal activities within Session 3 for our discourse analysis. Discourse for each of the focal activities was coded for type (correcting, eliciting, probing, or responsive) and dimension (questioning or explaining). Figure 1 below shows discourse coding for one focal activity in two of the cohorts. This example was selected to show how differently one focal

Questioning	Explaining	
		Participant
		Facilitator

Cohort A Session 3 (Think Aloud Reflection Whole Group Discussion				
Quote #	Correcting	Eliciting	Probing	Responsive
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				

Cohort C Session 3 (Think Aloud Reflection Whole Group Discussion				
Quote #	Correcting	Eliciting	Probing	Responsive
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Figure 1. Discourse Coding for One Focal Activity in Cohort A and Cohort C.

activity looked across cohorts, despite having nearly an equal number of distinct talk turns (13 and 14 in Cohorts A and C, respectively). The discussion in Cohort A began with the facilitator asking an eliciting question. This beginning was followed by an eliciting response from a participant and a longer, responsive conversation among the whole group of participants. The facilitator did not enter the dialogue again until the last talk turn when she took stock of the discussion and concluded the focal activity. In Cohort C, the discussion began with the facilitator explaining content and asking an eliciting question. When a participant responded with a short answer, the facilitator's quick reply at the correcting discourse level prompted another participant's correcting-level response. Answering the original question, a participant gave an eliciting remark, and the facilitator once again responded at the correcting level. Responsive discourse was present at the end and maintained for several talk turns, despite an eliciting question from the facilitator.

Apart from the first correcting statement by the facilitator in Cohort C, the two discussions highlighted in Figure 1 began and ended similarly. Both facilitators started the discussion with an eliciting question and ended with an eliciting explanation. What we found interesting were the

differences in what happened during the discussion. The nature of the focal activity discussions described above was not exceptional. Similar discourse patterns were found throughout Session 3. Facilitators in Cohorts A and B were more able to remove themselves from whole group discussions than the facilitator in Cohort C. As a result, participants in Cohorts A and B frequently took responsibility for the conversation. Thus, participants in those groups reached and maintained responsive discourse more often than participants in Cohort C.

Making Conjectures about Facilitator Moves – Considering Implementation Fidelity and Discourse Together

Table 1 provides a summary of adherence to main ideas of the session (percentage of main ideas explicitly shared during the activity), duration (+/- minutes over the suggested time denoted in the professional development materials), and time of facilitator talk (% of total minutes) for

Table 1. Summary of Focal Activities in Session 3.

		Cohort A	Cohort B	Cohort C
Focal Activity 1	**Activities**	100%	100%	75%
	Main Ideas	92%	92%	42%
	Duration	-4	+7	0
	Facilitator Talk	27%	19%	62%
Focal Activity 2	**Activities**	100%	100%	100%
	Main Ideas	100%	75%	100%
	Duration	+9	+2	+17
	Facilitator Talk	26%	31%	54%
Focal Activity 3	**Activities**	100%	100%	75%
	Main Ideas	100%	50%	50%
	Duration	-6	-1	-9
	Facilitator Talk	33%	34%	46%

each of the three focal activities in Session 3. We found that the back-and-forth nature of interactions between the facilitator and participants in Cohort C resulted in more facilitator talk time and less time operating at the responsive discourse level than in Cohorts A and B.

In our analysis of video, we also noted facilitators' physical placement during the session as well as explicit statements about responsive discourse shared with participants. Facilitators in Cohorts A and B tended to remove themselves from the center or front of the room. They would often stand to the side during whole group discussions. Once, the facilitator for Cohort B even sat in a chair outside the semi-circle of participants. We interpreted these physical moves as promoting the expectation that participants should use responsive discourse to share ideas and talk with one another. The facilitators in Cohorts A and B also reinforced this expectation with explicit directions for participants. They directed participants to "look at each other and respond to each other" (facilitator, Cohort A) and to "take control of the conversation" (facilitator, Cohort B). In contrast, the facilitator for Cohort C remained at the front of the room during whole group discussions and did not explicitly remind participants to talk to one another. We hypothesize that the facilitator's physical placement and explicit comments contributed to participants' opportunities for responsive discourse.

Types of discourse used by the facilitators may be another contributing factor for participants' ability to reach and maintain responsive discourse. From our analysis of three focal activities, it appears that responsive discourse may not occur (at least during the early stages of a long-term professional development effort) unless some scaffolding of the discourse occurs.

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Changes in responsibility occurred more naturally as the types of discourse also changed (from eliciting to probing to responsive). When correcting discourse occurred, the next talk turn was rarely responsive. In other words, once a discussion moved back to a correcting level, it took some time for responsive discourse to occur again, if at all (e.g., Figure 1).

Conclusion

In the professional development program, Project AIM, practicing elementary teachers learn pedagogical strategies to promote responsive discourse in their mathematics classrooms. Our results from this phase-two research study (Borko, 2004), which investigated implementations of the same session in three different cohorts, revealed that facilitators across the cohorts similarly adhered to professional development materials, implementing most of the activities and sharing most of the main ideas as described in the detailed session plan. However, facilitators' decisions about how to conduct whole group discussions, in particular, affected the opportunities for participants to engage in the responsive discourse in the professional development. Facilitators' physical placement in the group, explicit directions, and use of different types of discourse influenced the degree to which participants were able to take responsibility for conversations in the professional development.

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