SHAPING MATHEMATICS CLASSROOM DISCOURSE: RELATING PROFESSIONAL DEVELOPMENT AND CLASSROOM PRACTICE

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Professional development that furthers teachers' understanding of mathematics classroom discourse offers possibilities to improve students' learning of mathematics. It is not clear, however, how teachers relate such professional development experiences to their own classroom practice. In this paper, I discuss the features of mathematics classroom discourse that were most salient for teachers in relation to their classroom practice as they engaged in professional development focused on secondary mathematics classroom discourse.

BACKGROUND

Providing students with opportunities to engage in mathematical argumentation and conceptual explanations improves students' learning (Chapin, O'Connor, & Anderson, 2009). Despite documented benefits of students engaging in such rich discourse, most mathematics classroom discourse follows a pattern in which students take only brief turns in discussion followed by evaluation or feedback from the teacher (Cazden, 2001). Consequently, there is a need for professional development (PD) that supports teachers to become purposeful about engaging students in mathematical explanations, argumentation, and justification. Identifying what teachers learn from any PD, however, is a complex task. The purpose of this paper is to share findings from an investigation into what teachers learned from a particular case of the Mathematics Discourse in Secondary Classrooms (MDISC) PD program (Herbel-Eisenmann, Steele, & Cirillo, 2013). Specifically, I discuss one aspect of the findings which addresses the following question: *What features of mathematics classroom discourse are most salient for teachers related to their classroom practice as they engage in PD focused on secondary mathematics classroom discourse?*

ANALYTICAL FRAMEWORK

Two bodies of literature informed this study, literature that examines: (a) particular features and practices associated with enhancing mathematics classroom discourse for students, and (b) influences on teachers' learning from PD. From this literature, I generated an analytic framework for instructional practices and concepts that teachers might learn from engaging in PD focused on mathematics classroom discourse. This framework is comprised of the following four categories of practices, which have been shown to influence students learning of mathematics, including: (a) shaping classroom

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discourse, (b) shaping classroom social norms, (c) making student thinking visible, and (d) promoting mathematics during classroom discussion. Here I briefly describe the features of these categories and later I outline how this framework forms the basis of analysis for this study and the ways in which the MDISC PD experience addresses these categories.

Shaping Classroom Discourse

Teachers' instructional moves can shape classroom discourse patterns in order to support the mathematical thinking and learning of their students (Chapin et al., 2009; Stein, Engle, Smith & Hughes, 2008; Wood, 1999). Teachers' may purposefully shift classroom discourse for many reasons, including efforts to assess students' understanding, or to help students to more meaningfully engage with each other's reasoning (Cobb et al., 2001; Nathan & Knuth, 2003; Stein et al., 2008; Staples & Truxaw, 2010). Teachers' recognition of the ways in which they shape discourse in their classrooms is an important step towards enacting these types of instructional practices.

Shaping Classroom Social Norms

Students' participation within the classroom is heavily influenced by the social expectations and contexts of that classroom (i.e., Yackel & Cobb, 1996). Based on their prior experiences, students in secondary mathematics classrooms may not be inclined to openly share their in-progress ideas and solution strategies. The moves teachers make to support students to share their solution strategies can establish new social norms in the classroom regarding expectations that students should explain their reasoning (Forman, Larreamendy-Joerns, Stein, & Brown, 1998; Herbel-Eisenmann & Cirillo, 2009; Stein et al., 2008). Similarly, teachers' efforts in close listening, engaging with students' thinking, and pressing students to engage with each other's reasoning indicate to students that relevant mathematics discourse is valued in their classroom. As teachers become more aware of their control over the social norms present in their classrooms, they are able to purposefully shape those norms.

Making Student Thinking Visible

Classroom discourse can provide a mechanism by which individual student's thinking and reasoning can be made visible to both the teacher and to other students. Therefore, classroom discourse can provide a source of data for formative assessment that teachers can use to monitor students' understanding of mathematical concepts. Teachers who are learning about mathematics classroom discourse will likely engage in practices that help make student thinking visible. These include, (a) making students' reasoning a part of classroom discourse (Stein et al., 2008), (b) sharing ideas students generated independently as a part of whole class discussion, and (c) pressing students to clarify and justify their reasoning (Cobb et al., 2001; Staples & Truxaw, 2010).

Promoting Mathematics During Discussion

Teachers can support student learning by foregrounding the mathematics in classroom discourse, such that mathematical ideas at the heart of teachers' lessons remain prominent throughout the instruction (Stein et al., 2008). This can be accomplished through practices such as (a) revoicing (Forman et al., 1998) or highlighting a particular aspect of a student's contribution in order to connect to more advanced mathematical ideas (Herbel-Eisenmann, Steele, & Cirillo, 2013; Nathan & Knuth, 2003) and (b) focusing on the mathematical content of the discourse through purposefully developed symbolic records of students' contributions (Cobb, et al., 2001).

Relating the MDISC Professional Development Goals to the Literature

The MDISC PD curriculum is a set of practice-based, case-based materials. The materials are organized around five constellations of activities anchored by a mathematical task and a narrative or video case of a teacher engaging students in work on the task. The materials introduce six Teacher Discourse Moves (TDMs) as tools for teachers in developing their discourse practices (see Herbel-Eisenmann et al., 2013 for more detail). I examined the content of the MDISC PD in light of the aforementioned analytic framework. Each activity within the MDISC materials provides multiple opportunities for teachers to engage with a number of these ideas. For example, *Activity 1.5: Examining Whole-Class Discussion as a Context for Communicating Mathematics* provides teachers the opportunity to examine transcript excerpts of a whole-class mathematics discussion to explore (a) the ways in which students participate in a whole group context, (b) the ways in which students' opportunities to engage in mathematical practices are influenced by their participation in the classroom discourse, and (c) the ways in which classroom discourse can position mathematics. Although I use *Activity 1.5* as an example, all activities in the materials follow a similar pattern of providing teachers with multiple opportunities to engage with practices across the analytic framework.

METHOD

The setting for this study was a yearlong pilot of the MDISC PD materials with four mathematics teachers at a suburban middle school in the Midwest. The group was comprised of two seventh grade teachers, referred to here as Stephanie and John, and two eighth grade teachers, Nick and Brenda. The teaching experience within the group ranged from Stephanie having no prior full-time teaching experience to Brenda and John having taught mathematics for over 20 years. None of the participants had previously engaged in PD focused on mathematics classroom discourse. They became aware of the project through recommendations from their colleagues in the mathematics department at the high school in the same school district. All four participants also expressed a strong learning disposition and desire to improve their practice. Both the facilitator of this pilot and the author worked as developers for the MDISC materials.

Data Collection and Analysis

This paper is informed by data collected from the PD study group sessions, observations of teachers' classroom, and individual interviews. The study group met approximately once each month for six hours each session, with the exception of the second and sixth sessions, which occurred after school and for only two hours each. The distribution of the sessions and data collection is represented in Figure 1.

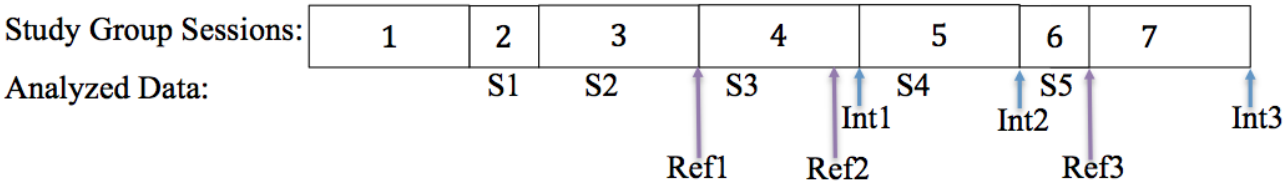

Figure 1: Schedule of study group sessions and data collection

I attended, videorecorded, and took detailed field notes of all study group sessions. Using my field notes from the entire set of study group sessions, I identified any segments of conversation during which the primary focus was on the teachers' own classroom practice (marked S1-S5 in Figure 1). I also observed three lessons selected by participants, during which I video recorded and took field notes. Additionally, I communicated with the teachers prior to each observation to gather data about their goals for the lesson, and immediately following each observation I asked teachers to reflect on their teaching episode. Subsequently, about one week later, I engaged the teachers in a semi-structured follow-up interview. The data used for the analysis presented in this paper comes from the semi-structured interviews, not the classroom observations (marked Int1-Int3 in Figure 1). Additionally, I collected three written reflections from the participants (marked Ref1-Ref2 in Figure 1). The data from these reflections were used for triangulation purposes, rather than as a primary source. The nature of the interview protocol and related methods will be discussed in more detail in the presentation of this paper.

To analyse the data, I first transcribed all study group session segments, written reflections, and teacher interviews and then imported the transcriptions into the qualitative analysis software NVIVO. Then, I used a modified grounded theory approach (Strauss & Corbin, 1998) to identify the ideas related to mathematics classroom discourse most salient to teachers in their discussions of their own classroom practice. Using open-coding, I categorized teachers' statements related to their own classroom practice and to classroom discourse. I then re-examined these data, specifically looking for statements that included references to the four categories of the analytic framework described above. Through this process, I developed the coding scheme in Table 1, with code definitions and subcategories refined through a constant comparative method.

Category	Code Definition
Shaping Classroom Discourse	**General Moves Related to Discourse.** Teacher discusses moves they made in order to shape their classroom discourse.
	Specific TDM Terms. Teacher explicitly referenced one of the six TDMs terms from the materials: Asking, Creating, Inviting, Probing, Revoicing, and Waiting.
	Use of TDMs Without Term. Teacher discussed moves that fit the descriptions of the six TDMs described by the PD materials, without explicitly referencing the terminology specified in the materials.
Shaping Social Norms	**Teacher Shapes Social Norms.** Teacher discussed the ways in which they influence, both purposefully and implicitly, the social norms of their classroom.
	Attention to Social Norms. Teacher described implicit or explicit social norms present in their classroom without acknowledging his/her role in shaping those social norms. This code applies to the teachers' statements describing existing norms or those they wish to change.
Making Student Thinking Visible	**Students' Non-verbal Evidence.** Teacher discussed evidence of students' thinking that were non-verbal. This code applies to statements about students' written work or gestures
	Inference About Student Thinking. Teacher discussed students' thinking without specifically attending to verbal or non-verbal evidence.
	Assessing Via Specific Student Discourse. Teacher referenced assessing students' understanding of mathematical concepts via students' specific statements, written or non-verbal.
Promoting Mathematics	**Promoting Mathematics Content During Discussion.** Teacher explicitly described bringing out mathematical ideas during classroom discussions (i.e. functions, equations).

Table 1: Coding Categories

I synthesized the similarities I observed across the teachers and across the data sources to identify the themes most salient in what the teachers talked about in relation to their classroom practice. Although the teachers discussed a wide range of ideas, I selected representative examples focused on the features of classroom discourse that appeared most consistently across the group and across the data set.

RESULTS

Overall, my findings suggest that as the teachers engaged in the MDISC PD, the themes that were salient regarding their classroom practice represent elements of all four categories of the analytical framework: (a) shaping classroom discourse, (b)

shaping social norms, (c) making student thinking visible, and (d) promoting mathematics during discussions. The data revealed that the features of mathematics classroom discourse that teachers discussed most consistently related their role in shaping the discourse in their classrooms. Consequently, this paper specifically focuses on the salient themes from the category *shaping classroom discourse*.

Shaping Classroom Discourse: Seeing the Need to Move Towards More Open Discourse Patterns

As an early step towards purposefully shaping discourse within their classrooms, the teachers acknowledged the ways in which they controlled the discourse within the classrooms. The teachers expressed a desire to allow for more natural interactions between students, in which students communicated productively with each other about mathematics. Building upon the teachers' understanding of their role in shaping discourse, they discussed the impact their interactions had on their students' discourse. Reflecting on the video of the first lesson observation John noted,

> The thing that struck me in the first half…was the amount of very traditional interactions. You know, prompt, response, feedback, prompt, response, feedback, – consistently. [The students gave] very factual answers. [It was] very [teacher] centered…I don't know if I'm dumbing things down, without realizing it even, by trying to put it in little tiny steps for them, because that's the way that I see things… So, by making it so explicit, does that help them? (Int1)

In this instance, John reflected on whether or not his interactions with students allowed them flexibility to share and develop the mathematical concepts. This is characteristic of a theme that I observed throughout the data; the teachers worked towards a goal of more open discourse patterns. As a part of this effort, teachers described their use of questioning practices. Reflecting on the video recording of the second lesson I observed, Nick described his concerted efforts to ask more open-ended questions as follows:

> When I was asking kids to explain something, I wasn't asking them yes or no questions. It was more open-ended. You know, "What did you get for your solution? And talk us through the steps." And I saw more of that, which I was happy about. But I still saw that it was a lot of the teacher-guided questions. (Int2)

In this statement, Nick both identified his own growth in terms of his efforts to ask more open-ended questions and acknowledged that he had further to go before he met his goals. As a group, the teachers' discussion of their classroom practice in both interviews and study group sessions demonstrated a combination of (a) an increased awareness of the ways in which their teaching moves affected the discourse patterns in their classroom and (b) a desire to support more natural student-to-student interactions with less central control attributed to the teacher.

During the third professional development session, teachers were introduced to the IRE pattern of discourse (Mehan, 1979). During subsequent study group discussions and interviews, all of the teachers noted their tendencies to follow the IRE pattern as

part of their reflection on video recordings of their instruction. John's quote above illustrates this type of reflection. Later, during the fifth study group session, John described his efforts to limit his evaluation of students' responses, he said, "We were doing this thing yesterday and I hadn't been saying nice job, good work, or whatever. And a kid gave an answer and I said, "Great answer!" [hesitates] "I meant, *another* great answer!" (S4). John recognized that his "nice job" comments affected how his students responded; they waited for him to validate their answers, as is typical in IRE patterns. Acknowledging their tendency to fall into the IRE pattern marked a point of comparison for the teachers between the discourse they wanted to have in their classrooms and the sorts of interactions they were presently experiencing.

Although the teachers struggled to change the discourse patterns in their classrooms, as they developed an understanding of the sorts of interactions they wanted to support they began to catch themselves engaging in unproductive discourse patterns, and thus began to make changes towards their goals. Specifically, the teachers began making a variety of efforts to move the classes towards more open-ended discourse patterns, including modifying mathematical tasks and using the specific Teacher Discourse Moves suggested by the PD.

DISCUSSION

These findings highlight the features of mathematics classroom discourse that were most important to the teachers in relation to the classroom practice as they engaged in the MDISC PD. Additionally, these findings show the ways in which teachers described how they learned from their engagement with the ideas of the professional development in the context of their own classrooms. Reflecting on the PD experience John said,

> [The MDISC professional development experience] is an opportunity to improve what we're trying to do and to look at yourself in a little different light…You see things and you go, 'Oh no!' but we have to confront the image we have of ourselves and what's actually going on in our classrooms and what the reality is. (Int3)

Spurred by his recognition of the contrast between what he encountered in the study group sessions and his classroom experiences, John described his desire for change. John's quote highlights a group commitment to continue learning as they worked to connect the ideas discussed in the PD to their use of those ideas in the reality of their teaching. Throughout the PD, teachers had opportunities to engage with multifaceted theoretical ideas related to mathematics classroom discourse. These findings reinforce the notion that teachers can and will make sense of information from PD in complex and meaningful ways that are connected to their classroom experiences (Herbel-Eisenman, Drake, & Cirillo, 2009). If professional developers are thoughtful about enacting the recommendations from the field for high-quality PD, rather than devoting energy to developing assessments of what teachers learn from PD, these findings suggest research should focus on the ways teachers conceptualize and engage the professional development content through their discussion of their classroom

practice as alternative means to assess the impact of PD. By prioritizing teachers' perspectives and valuing what they find most salient, this study offers possibilities for how we can begin to bridge the gap between teachers' learning from professional development and sustained change in classroom practice.

References

Cazden, C. B. (2001). *Classroom discourse: The language of teaching and learning* (2nd ed.). Portsmouth, NH: Heinemann.

Chapin, S. H., O'Connor, C., & Anderson, N. C. (2009). *Classroom discussions: Using math talk to help students learn (*2nd ed.). Sausalito, CA: Math Solutions Publications.

Cobb, P., Stephan, M., McClain, K., & Gravemeijer, K. (2001). Participating in classroom mathematical practices. *The Journal of the Learning Sciences*, *10*(1-2), 113-163.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychology*, *31*(3/4), 175-190.

Forman, E. A., Larreamendy-Joerns, J., Stein, M. K., & Brown, C. A. (1998). "You're going to have to find out which and prove it": Collective argumentation in a mathematics classroom. *Learning and Instruction*, *8*(6), 527-548.

Herbel-Eisenmann, B. A., & Cirillo, M. (2009). *Promoting purposeful discourse: Teacher research in mathematics classrooms.* Reston, VA: National Council of Teachers of Mathematics.

Herbel-Eisenmann, B. A., Drake, C., & Cirillo, M. (2009). "Muddying the clear waters": Teachers' take-up of the linguistic idea of revoicing. *Teaching and Teacher Education: An International Journal of Research and Studies*, *25*(2), 268-277.

Herbel-Eisenmann, B. A., Steele, M. D., & Cirillo, M. (2013). (Developing) teacher discourse moves: A framework for professional development. *Mathematics Teacher Educator*, *1*(2), 181-196.

Mehan, H. (1979). *Learning lessons*. Cambridge, MA: Harvard University.

Nathan, M. J., & Knuth, E. J. (2003). A study of whole classroom mathematical discourse and teacher change. *Cognition and Instruction*, *21*(2), 175-207.

Staples, M. E., & Truxaw, M. P. (2010). The mathematics learning discourse project: Fostering higher order thinking and academic language in urban mathematics classrooms. *Journal of Urban Mathematics Education*, *3*(1), 27-56.

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and Learning*, *10*(4), 313-340.

Strauss, A. L., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). New York: Cambridge University Press.

Wood, T. (1999). Creating a context for argument in mathematics class. *Journal for Research in Mathematics Education*, *30*(2), 171-191.