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Guest Editorial…

Tensions Faced by Mathematics Professional Developers

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I recently worked on a research project in which I was the facilitator of a middle school mathematics professional development course, InterMath Rational Numbers, and part of a research team examining InterMath through a National Science Foundation-funded project, Does It Work?: Building Methods for Understanding Effects of Professional Development (DiW). In my position as one of the InterMath facilitators for the DiW project, I took a leading role in tailoring the original InterMath syllabus to meet the needs of the DiW project and the participating teachers. While the course was a great experience for me, it also brought up several tensions that, I suspect, often exist in mathematics education at all levels. In particular, there were several goals in the course that did not appear to be in opposition, yet led to many tensions in my actual practice. After describing my experience I will pose several questions to the mathematics education community about the interwoven, yet sometimes conflicting, goals we often have for our classes.

Four common recommendations for effective professional development (PD) include a focus on mathematical content, the use of activities that actively engage teachers in learning, planning for sustained time to learn, and developing a community of learners (e.g., Garet et al., 2001; Guskey, 2003; Sowder, 2007). However, little has been written about the tensions that arise for the mathematics professional developer who is attempting to balance content coverage with elements of effective PD. I felt that the InterMath (IM) syllabus gave me the time and opportunity to balance all four PD recommendations. Hence, my goal was to be as true to the modified syllabus as possible. Nonetheless, as the weeks passed, the pressure to examine all of the content topics started to come into conflict with my desire to balance the other elements of effective PD. I wanted the course to be successful not only for the participants, but also for the DiW research project. This meant I wanted to ensure quality content coverage for the DiW research project, make the course engaging, and support the development of a community of learners for the teachers. In this commentary, I use literature and personal experience to describe the tensions between the different PD goals and pose questions to the mathematics education community for consideration about PD aimed at building teachers' mathematical content knowledge.

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Effective Professional Development

Many studies have shown the need to meet with teachers multiple times to have the greatest impact on teacher learning and change in teaching practice. Garet et al. (2001) found time span and contact hours were important features in PD because both of these measures had a positive influence on opportunities for active learning and focus on content knowledge. Garet et al. found "professional development is likely to be of higher quality if it is both sustained over time and involves a substantial number of hours" (p. 933). Additionally, Banilower, Heck, and Weiss (2007) found the effects of PD to be the greatest when contact hours were high. Their results suggested that if contact time was between 32 and 80 hours teachers would gain the most from the PD. Besides contact hours, this recommendation implies activities designed for teachers should be high quality (focusing on active engagement with content knowledge). Guskey (2003) noted, "although effective professional development clearly requires time, it also seems clear that such time must be well organized, carefully structured, and purposefully directed" (p. 12). Thus, the challenge for professional developers is to ensure that sufficient time is being spent on each mathematical concept. While the IM course included 40 contact hours, well within the recommended 32 to 80 hours, I still struggled with how to distribute the time allotted to various mathematical content.

An important guideline for PD is to focus on specific content (Guskey, 2003; Sowder, 2007). Garet et al. (2001) reported that PD focusing on content knowledge "is more likely to produce enhanced knowledge and skills" (p. 935). Research has also supported the notion that focusing on improving teachers' content knowledge in PD has the potential to positively impact student learning (Hill, Rowan, & Ball, 2005). Cohen and Hill (2000) found empirical evidence to support content knowledge as the focus of PD in changing teachers' practices, noting, "It seems to help to change mathematics teaching practices if teachers have even more concrete, topic-specific learning opportunities" (p. 312).

Rational numbers is an important topic in middle grades mathematics in the United States, and research has shown teachers' understandings of these concepts are generally not strong (e.g., Ma, 1999; Post, Harel, Behr, & Lesh, 1998). Because of this, the DiW team focused the IM course on this topic. The assumption was that an increase in teachers' mathematical knowledge for teaching would translate into a positive impact on their teaching practices and their students' understanding of mathematics. The team decided on three themes for IM: referent unit, drawn representations, and proportionality.[1] Thus, consistent with recommendations for effective PD, IM explicitly focused on mathematical content.

For the professional developer, focusing on content means planning activities where mathematics is the focus, and supporting and encouraging teachers as they engage in the mathematics that they teach. For example, Kazemi and Franke (2004) studied a group of teachers who used students' written work as a springboard for discussing their students' responses to a problem provided by the facilitator. The facilitator's role was to press teachers to focus on student strategies and propose strategies the teachers did not suggest. They observed that the facilitator was able to help guide the direction of the meetings and assist the group in maintaining a focus on students' mathematical work. My goal was to press the teachers to remain focused on mathematics and actively engaged in the selected mathematical tasks while also keeping them engaged on working to develop community.

The need for PD to help activate knowledge in the participants, not to deliver knowledge, was a common theme in Wilson and Berne's (1999) review of PD literature. Active learning in PD includes working together, sharing ideas and strategies, and becoming reflective practitioners. In IM, teachers worked in pairs and as a whole group on cognitively demanding tasks focused on rational numbers. By using these tasks, we were addressing many of the PD recommendations: having the teachers engage with mathematically demanding problems, work collaboratively, and do so over a sustained period of time. Professional developers "engage them [teachers] as learners in the area that their students will learn in but at a level that is more suitable to their own learning" (Wilson & Berne, 1999, p. 194). Thus the professional developer has to support teachers in acknowledging their lack of understanding on material they are responsible for teaching, while motivating them to engage with the mathematics they are to learn. Without teachers being willing to engage as learners, IM would have been a failure because the design of the course was dependent on the teachers working together on tasks with little to no direct instruction from me.

Borko and Putnam (1995) noted successful PD provides "opportunities for teachers to construct knowledge of subject matter and pedagogy in an environment that supports and encourages risk taking and reflection" (p. 59). This characteristic includes developing an intellectual space where teachers can make public their understandings, as well as misunderstandings. Community building activities are common experiences in PD that supports meaningful interactions between participants and the facilitator, and building community is an important component of effective PD. In Kazemi and Franke's (2004) study, the teachers began to develop norms about what it means to teach and learn from each other based on their examination of student work. This development of norms was related to the community building of the group and their active engagement in examining students' mathematical work. Active learning lends itself to creating a community of practice as teachers are given opportunities to explain, compare, and contrast mathematical strategies for solving tasks as a group.

Because of my passion for community development, this was important to me as I planned IM. The design of the modified syllabus for the IM Rational Numbers course was especially important because the pacing and tasks allowed me time and opportunity to build a community. For example, there was time at the beginning of the course for me to lead a discussion about the expectations participants had about IM, myself as the facilitator, and themselves as participants. In addition, I felt passionate about all the tasks and the sequencing of the concepts. When learners are producing high-quality materials and are engaged in mathematical discussion, the facilitator is,

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[1] *Referent unit referred to the whole for a given quantity. Drawn representations included array models, area models, single number lines, double number lines, tables, and graphs. These representations were intended to be used to reason about a given problem, not just as a picture of the solution. Proportionality referred to multiplicative reasoning in fraction and decimal operations as well as situations involving direct and inverse proportions.*

at least implicitly, working to build a community. I felt confident that the syllabus would allow for both adequate time on mathematically-focused activities and community building, hence balancing all four recommendations.

Tensions

As the facilitator I felt a constant tension between my intentions of increasing participant's mathematical content knowledge (the explicit goal of IM) and building a mathematical community of practice (my personal goal as facilitator). Balancing community building and pushing the participants' mathematical knowledge was a challenge. I also felt tremendous responsibility to keep the teachers satisfied with the experience in order to continue to motivate them to engage deeply with the mathematics together. For me, part of the satisfaction would be to continually relate what they were experiencing to their own classroom practices. This meant being explicit about how my actions could be replicated in a classroom of middle grades students. Finally, the pacing of the PD and my knowledge of teachers' understanding provided a tricky dilemma for me to navigate.

One of the principal ways I tried to build community was by fostering productive conversations as we debriefed our mathematical work on tasks in the whole group setting, but I rarely had enough time for all the tasks and conversations I had planned. Thus, I was faced with making decisions about doing more tasks to meet the goal of developing content knowledge versus doing fewer tasks and having longer conversations about them to meet my goal of building community. The tension between building the teachers' mathematical knowledge and building community was overwhelming at times and made me feel like I was unable to be successful on either front. In one of my journal entries I wrote, "There is so much that we needed to talk about and do but we didn't have time. I'm concerned because we move on to division of fractions next. I feel like I'm leaving many participants with holes in their knowledge."

Because of the time crunch and the tug I felt between debriefing the mathematics and debriefing our conversations, I never explicitly addressed my community building efforts with the participants. Although I praised the group at the conclusion of a good conversation, we never discussed what made those conversations special in terms of either building a community or developing mathematical knowledge. Despite my efforts to balance building content knowledge with building community, there were times when one goal dominated my decision-making in our class meetings.

This leads to another tension I faced about how explicit to be about what I was asking them to do as the facilitator and the success we were having in learning about rational numbers. Clearly, I struggled to do this related to community. But the time limits also impacted how often we could discuss how what they were experiencing could be implemented in their classrooms. This was important to me because I saw it as a component of active learning. For example, the National Council of Teachers of Mathematics (NCTM) has been promoting a vision of the ideal mathematics classroom as one where teachers "establish and nurture an environment conducive to learning mathematics through the decisions they make, the conversations they orchestrate, and the physical setting they create" (NCTM, 2000, p. 18). One goal of mine was to provide an example of learning in this environment. How explicit should I be about how I did this? In the end, there was little time during class to have these conversations. By not finding the time to discuss our own practices as a community, the teachers were unable to reflect as a group on the behaviors and actions that supported our development of a nurturing, mathematical environment. When working with the teachers in small groups, I would ask about their classrooms and students and suggest that what I was doing could be done in their classrooms. Reflection components were part of the course; teachers were asked to do a ticket out the door after each class meeting and were interviewed by a researcher each week about the course. Through these reflections, teachers did think about my role as the facilitator. For example, one teacher said, "She has the approach that you know the answers, there are no right or wrong answers. But everyone should be able to learn from each other. And she tries to make sure that she is not the center focal point, is the center focal point, that it is on us, the students" (King, Week 8). The teachers, however, rarely made connections between what they were experiencing and their own classrooms in the phone interviews or in our class discussions.

IM engaged teachers in exploring high cognitive demand tasks related to rational numbers, and at times these tasks pushed the participants to their mathematical limits, which was often uncomfortable. This discomfort was not surprising, as research has shown that exploring rational number concepts is often an uncomfortable enterprise (Armstrong & Bezuk, 1995; Ma, 1999). The discomfort had the potential to inhibit our work together because participants might have been reluctant to expose the gaps in their knowledge to their peers, particularly because those peers taught in the same district. The participants, however, worked through this discomfort and grew to expect it when working together in IM. For example, one task the teachers were asked to work on had a lower cognitive demand. The participants noticed the change in the nature of the task because they expressed concern that the task felt too easy, and they were sure they had missed something. The tension I then faced was determining whether to continue to follow the syllabus despite my growing awareness of teachers' misconceptions about rational numbers and their willingness to continue to engage deeply with the mathematics. This tension speaks to the recommendation for sustained time to learn. If I forged ahead, how would that affect the quality of our mathematical work? If I remained focused on the same content, would the teachers continue to be actively engaged in the material? This tension was complicated by the fact that the PD was being offered as part of a research project and the district had been promised a specific course. Thus, as a larger team, the decision was made to continue following the pace of our syllabus.

Concluding Remarks

Despite the tensions I felt as the facilitator, IM was a success. Not only did the teachers report being happy with the experience, but the increase in the average score on the pre-assessment and the post-assessment of their mathematical knowledge for teaching rational numbers was statistically significant. More specifically, nine participants had a significant increase in their scores. In addition to the quantitative data, there was qualitative evidence that teachers grew in their understanding of the three themes of IM—referent unit, drawn representations, and proportion—and that the class was able to form a community of practice. Further analysis is being conducted on other aspects of teacher learning in IM.

I was able to learn more about myself as an educator and about the challenges faced by facilitators as they attempt to focus on increasing mathematical knowledge and community building. The tensions faced by the professional developer who is balancing the development of mathematical knowledge and following guidelines for effective PD are not trivial. I would like to challenge the mathematics education research community to seriously consider the potential tensions faced by the mathematics educator who finds herself managing these dual, sometimes opposing, goals. I pose the following questions for consideration:

1. How does this tension influence the professional development experience?
2. What can we learn about teaching, in general, from our experiences as facilitators?
3. What can we learn about community building?
4. What does the facilitator learn through this experience? How does it impact how she conducts the PD?
5. How can these understandings be translated to classroom teachers' experiences?

As our understanding of PD grows (including learning of teachers, fidelity of programs, and essential features for effectiveness), we need to consider how the simple decision to facilitate the PD being examined influences all who are involved in the experience.

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