MATHEMATICS PROFESSIONAL DEVELOPMENT RESEARCHERS AS STAKEHOLDERS

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ABSTRACT

In this paper I argue that since the publication of *The Reflective Practitioner* (Schön, 1983), mathematics professional development researchers have focused on bringing teachers' knowledge to the foreground, leaving behind the value of their own research community's knowledge. I revisit Schön's criticism of the technical rationality and use examples from my own practice in mathematics professional development to suggest that instead of continuing to reject technical rationality, mathematics professional development researchers should consider a revised version of it to move the field forward: one that values both teachers' and researchers' knowledge.

KEY WORDS

Mathematics education; Professional development; Technical rationality.

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INTRODUCTION

This paper addresses a major current challenge for mathematics education researchers: to demonstrate the unique contribution of their research knowledge to discussions about K-12 mathematics. I take for shared that the ultimate goal of mathematics education research is to contribute to the improvement of K-12 mathematics for all children. However, I believe there is no shortage of situations designed to bring together stakeholders in K-12 mathematics that do *not* include mathematics education researchers. Parents, mathematics teachers, mathematics specialists, school administrators, professional development providers, mathematicians, engineers, scientists and others come together to discuss K-12 mathematics without considering that perhaps a mathematics education researcher should be included or is missing in the conversation. These stakeholders do not necessarily acknowledge the potentially unique contributions mathematics education researchers can make.

The situation just described is more complex in the case of mathematics *professional development* researchers, that is, the subset of members of the larger mathematics education research community who have teacher professional development as their research foci. As researchers in a newer field within mathematics education, mathematics professional development researchers have yet to organize and present their growing body of research-based knowledge in a coherent standardized way (Sztajn, 2011) that highlights its contributions. The discussion in the field still focuses on issues of rigour (e.g., NRC, 2002; Simon, 2004) when only attending to both rigour and relevance will position mathematics professional development researchers as stakeholders.

Further, as I will argue, mathematics professional development researchers have put their efforts in the past decades into making the case that teachers are key stakeholders in mathematics professional development research (Kieran, Krainer & Shaugnhessy, 2013). This effort has deviated attention from the goal of making mathematics professional development researchers stakeholders in K-12 mathematics.

Whereas I understand and respect colleagues who may not want to become stakeholders in K-12 mathematics because they believe the current system needs to be reconsidered from a more critical stance, I suggest the field needs to come together to establish that mathematics professional development research results are fundamental for K-12 mathematics. More important, mathematics professional development researchers make a unique contribution to discussions about the field that others cannot make.

Thus, in this paper, I position myself as a mathematics professional development researcher who is interested in establishing the value of research-based, scientific knowledge for K-12 mathematics. I contend that in discarding the technical rationality, Schön (1983) separated relevance from rigour and placed relevance with practitioners' knowledge whereas researchers' knowledge, at best, accounted for rigour. Therefore, since *The Reflective Practitioner* (Schön, 1983), mathematics professional development researchers have focused their attention on bringing teachers' knowledge to the foreground, leaving behind the value of their own research community's knowledge.

In what follows, I first revisit Schön's (1983) criticism of the technical rationality. I contend that, although *The Reflective Practitioner* was important because it made researchers attend to other professional rationalities including teachers' knowledge, researchers are inexorably connected to the scientific knowledge. I then attend to researchers' and teachers' knowledge to compare and contrast two professional development programs in which I have worked. The first took place in the early 2000s and was focused on establishing teachers as knowers (Sztajn, Hackenberg, White & Allexshat-Snider, 2007). The second took place in 2010 and focused on teachers and researchers as boundary crossers between researchers' and teachers' knowledge (Sztajn, Wilson, Edgington & Myers, in press). I use these examples to suggest that instead of rejecting the technical rationality, mathematics professional development researchers embrace a revised version of it to move the field forward.

REVISITING *THE REFLECTIVE PRACTITIONER*

The crisis of professionalism is the theme that sets the stage for Schön's (1983) discussion of *The Reflective Practitioner*. Considering the various challenges that the 1970s and early 1980s posed to the 1960s' glorification of professionals, Schön claimed «In 1982, there is no profession which would celebrate itself» (p. 11). He argued that the professional claim to knowledge monopoly was questioned when professionals could no longer make their knowledge fit the inherently unstable nature of problems of practice. He noted that:

> [Leading professionals and educators] are disturbed because they have no satisfactory way of describing or accounting for the artful competence which practitioners sometimes reveal in what they do. They find it unsettling to be unable to make sense of these processes in terms of the model of professional knowledge which they have largely taken for granted (p. 19).

For Schön, questioning professional knowledge meant questioning the technical rationality that defined professional activity as the instrumental application of scientific theories and techniques to solving problems of practice. Although professionals can adapt their knowledge to the problems at hand, the technical rationality suggested they practiced «rigourously technical problem solving based on specialized scientific knowledge» (p. 22). Therefore, professionals used a knowledge base that was not only specialized but also scientific and standardized, and carried out solutions from one problem to the next as the application of general theories and principles.

Contrary to the notion of technical rationality, Schön argued that the problems of practice escaped scientific categories and presented themselves as unique and unstable. Therefore, competent practice could not be accomplished solely through the use of techniques derived from applied research. Schön proposed:

> Let us then reconsider the question of professional knowledge, let us stand the question on its head. If the model of Technical Rationality is incomplete,

> in that it fails to account for practical competence in «divergent» situations, so much the worse for the model. Let us search instead for an epistemology of practice implicit in the artistic, intuitive processes which some practitioners do bring to situations of uncertainty, instability, uniqueness, and value conflict (p. 49).

Changing the focus of attention from professionals to practitioners, he noted that competent practitioners recognize phenomena they cannot describe, make judgments based on quality for which there are no criteria, and apply skills for which there are no prescribed procedures. Further, competent practitioners turned thoughts into action and attended to the knowing that was implicit in the action. Schön concluded:

> Once we put aside the model of Technical Rationality, which leads us to think of intelligent practice as an application of knowledge to instrumental decisions, there is nothing strange about the idea that a kind of knowing is inherent in intelligent action. Common sense admits the category of know-how, and it does not stretch common sense very much to say that the know-how is in action (p. 49).

The Reflective Practitioner presented reflection-in-action as the way to account for how practitioners are knowledgeable in practice. Schön proposed that knowing is tacit and knowledge is implicit in the action of practice. Later, Schön (1987) explained the difference between reflecting on action and reflecting-in-action. The former (on action) occurs when, after the fact, one thinks back on accomplished practice to examine how knowing-in-action contributed to the outcomes of the situation. The latter (in action) occurs when unexpected situations arise and thinking reshapes practice as the practice is being carried out. Schön proposed that reflection in action questioned assumptions about the structure of knowing-in-action. Further, reflection-in-action led to on-the-spot experiment and thinking that affected what was being done. However, Schön noted that it was the careful reflection *on* previous reflections-in-action that began what he called «a dialogue of thinking and doing» (p. 31) through which one became skilful and acquired the artistry of practice.

Thirty years after its publication, *The Reflective Practitioner* continues to influence mathematics professional development researchers (e.g., Krainer, 2011). Schön's work directed attention to tacit knowledge in the practice of teaching and questioned the assumption that expert teaching was based on research knowledge. He called for a re-examination of the relation between educational research and teaching practice and a reconsideration of the value of research-based knowledge in relation to other forms of knowledge that exist in teaching. Schön helped establish that teachers had knowledge and their practice could not be reduced to an application of scientific knowledge.

The importance of establishing the value of teachers' knowledge was Schön's fundamental contribution and that continues to be important. The debate that followed, however, was whether this knowledge should replace research knowledge in improving mathematics teaching and learning. A review of the work spearheaded by *The Reflective Practitioner* is beyond the scope of this paper. However, in what follows, I briefly discuss the work of Munby (1989) and Eraut (1995). I borrow from these authors to disagree with the interpretation that bringing teachers' knowledge to the forefront eliminated the space for scientific knowledge in teaching.

Although Munby was a follower of Schön's work and Eraut was a strong critic, both argued that Schön did *not* call for the elimination of research knowledge in professional practice and did *not* suggest that research knowledge had no value for teachers. Rather, both Munby and Eraut proposed that although different, knowledge emerging from both scientific inquiry and reflection-in-action had a place in teaching and professional development. Their interpretation of *The Reflective Practitioner* called for increased attention to the knowledge generated through reflection-in-action, but not for a new hegemony of this knowledge at the expense of scientific knowledge.

Offering Language

Munby (1989) directly responded to criticisms that *The Reflective Practitioner* separated practitioners from the products of science and isolated technical rationality from reflective practice. He explained that he did not interpret Schön to be claiming that reflection-in-action was «the sole source of professional knowledge» (p. 6). Munby characterized Schön's contributions as highlighting the exaggerated emphasis that had been placed on formal knowledge at the expense of practical knowledge. He pointed out that knowledge from practice had gone unrecognized because it was not perceived as rigourous within scientific traditions. Thus, for Munby, what Schön did was to offer the field language to recognize and attend to overlooked elements of learning from teaching.

Munby (1989) attended to the concept of reflection-in-action as opposed to knowledge-in-action, as Schön's major contribution. He explained that in Schön's work, the focus of attention was on the meaning of «in-action» and not on the meaning of «reflection.» Munby considered fundamental the concept that teachers gained knowledge as they were teaching, that is, in the practice of teaching. However, Munby also considered that Schon's concept of reflection-on-action was powerful. Through this process, practitioners could attend to research knowledge as they «undoubtedly use the knowledge of technical rationality in their work» (p. 6). Thus, it was both through reflection-in-action during practice, and afterwards, reflection-on-action that could include scientific knowledge, that teachers' developed expertise.

Knowledge Generation

Eraut (1995) criticized Schön's work for being unclear and inconsistent in its analysis of knowledge. He recognized that there had been disagreements as to whether Schön's alternative epistemology was meant to replace or complement the technical rationality. He criticized Schön's work for oscillating between a radical rejection and an accommodatory stance toward scientific knowledge.

> A generous interpreter of Schön might argue that he is not discarding research-based professional knowledge but challenging inflated views of its practical significance. In particular, he is attacking the ideological exclusivity of a paradigm in which only knowledge supported by 'rigourous' empirical research is accorded any validity (Eraut, 1995, p. 10).

More interested in the discussion of innovation within professional knowledge instead of classification of types of knowledge, Eraut (1995) proposed that reflection-in-action was a process for knowledge generation and not a new kind of knowledge. He characterized knowing-in-action as being used in routine situations, whereas reflection-in-action was triggered by recognising that the situation being faced was in some respect unusual. However, Eraut was concerned with the time period for this reflection-in-action, and noted that such reflection, for teachers, was different than for other professionals, given the speed, amount, and uniqueness of the interactions teachers face daily in their classrooms.

RECENT DEBATES

Similarly to the argument I will make in the remainder of this paper, researchers in various fields have recently returned to Schön's work to suggest that, despite the prevalence of reflective practice in the education of professionals, development of professional knowledge does not require the abandonment of technical rationality. Kinsella (2007) examined the contributions of Schön and Dewey and suggested that, in the field of nursing, the common interpretation of reflective practice as a «theory that sets up a dichotomy between technical rationality and an epistemology of practice» (p. 109) was an oversimplification. Kotzee (2012) noted that in continuing education, reflective practice had become mainstream but lacked attention to social aspects of learning and of practice. This attention to social aspects necessitated a review of reflective practice. In architectural education, Webster (2008) examined how Schön's ideas had become the dominant theory of practice and acknowledged the important contribution Schön made in establishing that professionals developed tacit knowledge through experience and reflection. However, she highlighted the role other theories of knowledge play in the development of architectural learning and suggested that those who value Schön's contributions should also recognize «the 'partial' nature» (Webster, 2008, p. 72) of his contributions. In line with these current re-examinations of the role of the *The Reflective Practitioner* in professional education, I consider the role of Schön's ideas in mathematics professional development.

MATHEMATICS PROFESSIONAL DEVELOPMENT AND *THE REFLECTIVE PRACTITIONER*

Stimulated by *The Reflective Practitioner*, the discussion about the nature of teachers' knowledge impacted mathematics professional development. Within the technical rationality, professional development was characterized by the transmission of research-based knowledge to teachers. This view of professional development, however, had to change when Schön established that there was another type of knowledge in teaching and this knowledge came from teaching practice itself. And, even though teachers' knowledge was not to replace researchers' knowledge, teachers needed new mechanisms to access their knowledge from practice, which required a different model for professional development. Thus, following Schön's work, mathematics professional development researchers turned their attention to knowledge coming from teaching and renewed discussion about what was needed to educate mathematics teachers.

One influential interpretation of the criticism of the technical rationality in teacher education that impacted mathematics professional development came from Cochran-Smith and Lytle (1999). These authors questioned the assumption that teachers who knew more taught better and claimed that «radically different views» (p. 249) existed for what it meant to know more and to teach better. These views were based on different conceptions of professional practice and teacher learning. Cochran-Smith and Lytle proposed three categories of knowledge, two of which related directly to Schön's work: knowledge-for-practice and knowledge-in-practice.

Knowledge-for-practice hinged on the idea that knowing more subject matter, educational theory, pedagogy, instructional strategies, etc., leads to more effective practice. In this case, the knowledge needed for teaching came from formal knowledge composed of theories and research findings that established a knowledge base. Skilled practitioners, therefore, had deep knowledge acquired from research that produced this knowledge outside the classroom. Knowledge-in-practice placed its emphasis on knowledge-in-action, which Cochran-Smith and Lytle (1999) explained as «what very competent teachers know as it is expressed or embedded *in* the artistry of practice, *in* teachers' reflections on practice, *in* teachers' practical inquiries, and/or *in* teachers' narrative accounts of practice» (p. 262, emphasis in the original). Skilled practitioners acquired this knowledge through experience and deliberate reflection into practice (in and on action) that made explicit the tacit knowledge that existed in the action of competent teachers.

The distinction between knowledge-for-practice and knowledge-in-practice separated professional development into settings that transmitted research knowledge and settings that engaged teachers in examining and reflecting on practice. Emerging research in the 1990s showed that teachers who worked together as colleagues to examine their teaching found themselves better prepared to teach (Little, 1990) and teachers who de-privatized their practice strengthened their pedagogical preparation (Louis, Kruse & Marks, 1996). This research heightened the call for researchers to attend to the need to build communities among teachers (Wilson & Berne, 1999). Reviewing the literature on mathematics professional development, Sowder (2007) listed the development of professional communities, establishment of professional development schools, and implementation of lesson studies as some of the approaches that emerged to promote knowledge-in-practice.

It is also important to note that this shift of mathematics professional development researchers' attention to communities and teachers' examining their teaching practice happened at the time when mathematics education at large was engaged in a «social turn» (Lerman, 2000), shifting from a more constructivist perspective that attended to the individual acquisition of knowledge to a focus on the social origins of knowledge from a socio-cultural perspective.

This shift brought attention to learning as participation in communities of practices (Lave & Wenger, 1991), which aligned with some of the ideas promoted under the search for teacher knowledge-in-practice. Together, the concepts of knowledge-in-practice and communities of practice strengthened the teacher's role and valued the teacher's knowledge. For example, examining a variety of project that reconceptualized the relationship between researchers' and teachers' knowledge in mathematics professional development research, Kieran, Krainer and Shaughnessy (2013) highlighted the importance of settings designed to harness teachers' expertise and build from collaboration among teachers.

In summary, by the end of the 1990s, mathematics professional development research was engaged in an important movement to value teachers' knowledge and examine the role this knowledge played in mathematics teaching and professional development. Teachers were placed at the centre of mathematics professional development, and mathematics professional development researchers turned their attention to examining how teachers organize in learning communities to promote teacher participation and knowledge exchange in ways that leveraged and valued teachers as knowers. At that point, as interpreted in mathematics professional development research, *The Reflective Practitioner* supported a shift that led to the predominance of teachers' knowledge over researchers' knowledge.

My claim in this paper is that in turning their attention to studying teachers' knowledge and communities, mathematics professional development researchers helped establish the importance of teachers as stakeholders. However, unfortunately, in the process of supporting teachers, while diminishing the attention given to the role of researchers as stakeholders. Therefore, renewed attention to researchers' knowledge is timely.

To support my claim, in what follows, I share two examples from my own practice in mathematics professional development research. In analysing the first project, I discuss how attention to teachers and their knowledge became fundamental in mathematics professional development research and made the role of research knowledge in professional development less clear. This first project is, in many ways similar to other mathematics professional development research projects of its time (2000s), allowed me to critically examine the field while criticizing my own work.

In examining the second project (2010s), I propose one way in which mathematics professional development researchers can continue to promote teachers' knowledge while also recognizing the importance of researchers' knowledge. The analysis of the second project highlights a venue to think about mathematics professional development in relation to teachers' communities, but in interaction with the researchers' communities, making *both* mathematics teachers and mathematics professional development researchers stakeholders in K-12 mathematics.

TWO EXAMPLES FROM MY OWN PRACTICE

In turning my attention to two projects, I share professional reflections about my work as a mathematics professional development researcher. I bring forth and discuss successes and tensions experienced in navigating between researchers' and teachers' knowledge in mathematics professional development. Although I cannot claim that others share my experiences, I expect that other mathematics professional development researchers have worked in similar situations. Highlighting similarities across the projects, I call attention to their school-based design, that is, both projects took place at the participating teachers' schools and all teachers from the partner elementary school in each project were invited to participate.

In both cases, mathematics professional development researchers met with teachers at the school and the school principals supported the professional development, making it a part of the school activities. In different ways, teachers' voices were important in both projects. Also, in both projects, members of the mathematics professional development research group had worked with some of the teachers at the school in various capacities for about one year prior to the beginning of the project. Thus, when each project started, researchers and teachers already knew each other.

The descriptions that follow are not meant to be exhaustive. They are based on the language used in each project's publications to allow for analysis of how the two research teams conceived the work of each project at the time it was carried out. The description of the first project was compiled from Sztajn, Allexsaht-Snider, White and Hackenberg (2004); White, Sztajn, Allexsaht-Snider and Hackenberg (2004); Sztajn, Hackenberg, White and Allexshat-Snider (2007); and Sztajn, White, Hackenberg and Allexsaht-Snider (2010). The description of the second project came from Sztajn, Wilson, Edgington and Confrey (2011); Sztajn, Confrey, Wilson and Edgington (2012); Sztajn, Wilson, Decuir-Gunby and Edgington (2012); Wilson, Sztajn, and Edgington (2012); and Sztajn, Wilson, Edgington and Meyers (in press).

Although both projects included multiple years of collaboration with the partner school and participating teachers, the focus of the description is on the first year in which mathematics professional development researchers and mathematics teachers at the partner schools engaged in professional development activities. The presentation of the projects is followed by a discussion about the role of researchers' and teachers' knowledge in each project, and the topic of researchers as stakeholders is revisited in the conclusion of the paper.

THE SUPPORT AND IDEAS FOR PLANNING AND SHARING PROJECT (SIPS)[1]

Project SIPS was a partnership with an urban elementary school in the South of the United States, where 90% of the children qualified for free or reduced-price lunch. In its school district, this school had the highest percentage of Hispanic children at the time (39%), although the school population was mostly African American (51%). In an initial project survey, twenty of the twenty-two teachers who participated (91%) in the project said they had not completed any professional development program or graduate courses in the previous five years in which recent research on children's learning of mathematics was discussed.

1 Supported through an Eisenhower Teacher Quality Grant.

Describing SIPS

Project SIPS was designed to help teachers improve the quality of their mathematics instruction by building a supportive mathematics education community within their school. In its first year, the main goal was to build such a community, creating a space for teachers to engage in reflections about their mathematics instruction. The mathematics professional development research team worked with the school administration to provide teachers with time to meet and discuss mathematics teaching and learning at their schools. As these conversations evolved, based on what teachers highlighted as their needs, mathematics professional development researchers provided teachers with vocabulary and ideas to think and talk about student learning. Thus, with teachers' input and recommendations, SIPS was designed to infuse the emerging mathematics education community with activities that focused on instruction; but it also increased teachers' mathematical content and pedagogical knowledge.

During the first year of SIPS, teachers participated in two types of SIPS meetings: work sessions and faculty meetings. SIPS work sessions took place at the school during school hours and teachers met within grade-level groups. Each group met for a half-day of activities every other month, and substitute teachers were hired to allow for teacher participation. Each work session addressed children's learning of those mathematics topics selected by teachers as critical to the grade-level. For example, one 2^{nd} grade work session focused on place value and subtraction. During the work sessions, teachers explored their knowledge of and teaching strategies for the mathematical topic in focus. They discussed the work of their students, were introduced to research-based ideas for teaching those particular mathematics topics and co-planned lessons to implement in their classrooms.

The after-school mathematics faculty meetings were attended by the whole school staff and, whenever possible, by school administrators. These meetings were devoted to building and maintaining a mathematics education community within the school. During these meetings, teachers had the opportunity to share what they were doing in their mathematics classrooms with their colleagues across grade levels. They also solved some mathematics problem together and discussed their visions for mathematics teaching and learning at their school.

As a research project, SIPS aimed at understanding «the complex world of lived experience from the point of view of those who lived it» (Schwandt, 1994,

p. 118). From a qualitative research standpoint, SIPS researchers attempted to «elucidate the process of meaning construction and clarify what and how meanings are embodied in the language and actions of social actors» (p.118). Thus, in its research component, SIPS was interested in unveiling teachers' perceptions about the development of trust within the mathematics education community.

In answering the question what factors in Project SIPS supported the development of trust among mathematics professional development researchers and mathematics elementary teachers as the community was formed, the project research showed that teachers valued the mathematics professional development researchers' flexibility, respect for teachers' knowledge and awareness of school realities as important to developing trust. Teachers also appreciated the time SIPS provided for them to meet and the practical activities they developed to implement in their classrooms.

Examining SIPS

With a focus on teachers' knowledge, Project SIPS was designed to promote teachers working together and support them in examining their mathematics teaching. In line with the attention given at the time to the teachers' knowledge-in-action and knowledge-in-practice, the project highlighted the importance of teachers talking to each other and analysing their practice. Most of project SIPS time was spent in collectively planning for and sharing of mathematics instruction, with a focus on topics teachers deemed important.

Working together with teachers in a community of learners, SIPS researchers brought suggestions for classroom activities for discussion with the community, and, in the context of discussing such activities, they shared research knowledge on student mathematics learning. Thus, researchers' knowledge was not at the forefront of the SIPS community conversations – classroom practice was. Further, research knowledge only emerged as part of the conversation of the community when teachers saw a need for it.

In project writings, teachers and researchers were called «school-based educators» and «university-based educators,» respectively. These names were purposefully selected to represent the proximity of teachers and researchers in the project, indicating that in the SIPS community, all participated together as educators interested in mathematics teaching and learning. Although teachers and researchers obviously brought different contribution to the SIPS community, mathematics classroom practices was what brought them together.

Mathematics professional development researchers in Project SIPS, nonetheless, also had a goal of promoting change in mathematics instruction at the partner school through teacher learning of research on children's mathematics. This goal was not at the forefront of the project or at the centre of the SIPS community. Elsewhere (Sztajn, 2008) I discussed the dilemmas of being a researcher in such a community and trying to build trust and promote research when not all members of the community shared the goal of learning research results to transform practice.

The Learning Trajectory Based Instruction Project (LTBI)[2]

The LTBI project was a partnership with one elementary school in a midsize urban area in the southeast of the United States. The school had approximately 600 students: 35% Caucasian, 29% Hispanic, 25% African American, 7% Asian, and 4% other; 54% of the children qualified for free or reduced-price lunch. Teachers at the partner school volunteered to participate in the project and all professional development meetings were conducted at the school, at hours deemed convenient by teachers, researchers and school administrators. Of the 24 teachers who started the professional development in July 2010, 22 completed the program one year later. The initial group of teachers included six kindergarten teachers, three grade 1, five grade 2, three grade 3, two grade 4, and one grade 5 teacher. Four teachers taught multiple grade levels.

Describing LTBI

The LTBI Project was designed to share research-based knowledge on student mathematics learning with teachers and, in the process, investigate how teachers came to learn about and use this knowledge in practice. In its first year, the main goal of the project was to examine teacher learning of the students' learning trajectories, with learning trajectories being defined as «a researcher-conjectured, empirically-supported description of the ordered network of constructs a student encounters through instruction (i.e. activities, tasks, tools, forms of interaction and methods of evaluation), in order to move from informal ideas, through successive refinements of representa-

2 Supported through a National Science Foundation REESE grant.

tion, articulation, and reflection, towards increasingly complex concepts over time» (Confrey, Maloney, Nguyen, Mojica & Myers, 2009, p. 347).

The LTBI professional development was designed for a 12-month period beginning with a 30-hour summer institute in which teachers learned about one particular learning trajectory. Following the institute, teachers and mathematics professional development researchers met regularly throughout the school year, after school hours, to continue to build teachers' knowledge of the trajectory and discuss their classroom implementations of instruction that used the trajectory.

The model of instruction emphasized in the professional development highlighted the importance of open instructional tasks to elicit students' mathematical thinking, together with a set of pedagogical practices that allowed teachers to build on this thinking to promote mathematical discourse in the classroom. Although teachers learned about the learning trajectory and the model of instruction promoted in the project throughout the duration of the project, the summer professional learning tasks were designed to support teacher learning of the learning trajectory, whereas during the rest of the year, the professional development focused more on the learning trajectory-based instructional model. The two components of the professional development totalled 60 hours of face-to-face, whole group interactions over one school year.

As a research project, LTBI used a design experiment research methodology to investigate teacher learning of students' learning trajectories. Research questions focused on teacher learning, including both questions about teachers' participation in the professional development and teachers' acquisition of the learning trajectory itself. For example, an initial conjecture in the project stated that as teachers learned about the trajectory, they gained specialized language that brought their participation closer to the centre of their professional community and strengthened their positioning and voice in the discourse of the group.

However, very early in the ongoing data analysis, teachers' discourse indicated the prevalence of language that talked about students as being «high» or «low,» for example, or not being able to complete a task because it did not align with their «experiences outside school.» This use of language to explain students' mathematical work led researchers to attend – not only to the ways in which teachers positioned *themselves* in the community - but also to the ways in which teachers positioned *students* in their discourse within this community. Further, it led to investigations of the ways in which knowledge of trajectory disrupted teachers' discourse about students.

Examining LTBI

With a focus on research-based knowledge, LTBI was designed to share recent knowledge about student mathematical learning with teachers and investigate how teachers come to learn and use this knowledge. Thus, in many ways, the project shared features of the Technical Rationality and knowledge-for-practice. However, LTBI was also designed to strongly build on teachers' interests as the partnership between teachers and researchers in the project was built with teachers' input with attention to their questions about learning trajectories as new ways to represent student learning in mathematics. Research knowledge was at the centre of the LTBI professional development community, and the project investigation focused on how teachers appropriated this knowledge.

The roles of researchers and teachers in the LTBI professional development community were clearly different. Researchers organized the professional development sessions with the goal of supporting teacher learning of the trajectory. Teachers knew researchers were interested in their use of the trajectory in their classrooms and felt they were teaching the researchers about classroom constraints and the realities of implementation.

In conceiving and designing for this relationship, LTBI mathematics professional development researchers conceptualized the LTBI community as a temporary boundary encounter (Wenger, 1998) among researchers and mathematics teachers. In such encounter, boundary practices emerged that brought the group together to work on shared goals. Further, mathematics professional development researchers designed for these boundary practices by creating professional learning tasks around boundary objects, that is, objects form the researchers' or the teachers' community that created shared knowledge across the two communities. Among such objects, for example, were sample of students' work and various representation of the learning trajectory.

Looking across SIPS and LTBI

In contrasting SIPS and LTBI, both similarities and differences are important. Because LTBI followed SIPS and since the projects were about 10 years apart, changes in LTBI reflect tensions experienced in SIPS, combined with the maturity gained in conducting investigations within the emerging field of the mathematics professional development research. By understanding these similarities and differences, one can support the claim that it is important to attend to teachers' knowledge while also maintaining mathematics professional development researchers as stakeholders in K-12 mathematics.

By design, LTBI built on features that supported the successes of the community-building experiences from project SIPS. The trusting and caring relationship (Sztajn, 2008) established between researchers and teachers, which was at the centre of SIPS, continued to be important in LTBI. Teachers' knowledge-in-practice, which was central for SIPS, continued to be respected in LTBI, and teachers engaged in a variety of discussions focused on their own knowledge.

These discussions positioned teachers as expert in the professional development community. Both projects included teachers across grade levels at one partner school and allowed for conversations about mathematics teaching and learning within the school as a whole. Teachers from different grade levels got to discuss and gain a better grasp of K-5 mathematics instructional goals and teaching strategies, acquiring a better-aligned perspective of their collective work in mathematics teaching.

These fundamental similarities were an important motive of teacher engagement and satisfaction in both projects. Yet LTBI was also designed to address the tensions perceived by researchers in project SIPS. One of these was allowing researchers to have a stronger voice in the project. Whereas SIPS was built around process goals only, focusing on teachers' knowledge and the development of a teacher-based community, LTBI included both content and process goals (Simon, 2008), focusing on both the teachers' and researchers' knowledge and the development of a boundary community across teaching and research. In LTBI, research-based knowledge was more openly shared with teachers during professional development, because sharing knowledge was one of the goals of professional development. One of the LTBI's explicit aims was for teachers to learn about the learning trajectory, which was always front and centre in the project because it brought research-based knowledge into the community.

LTBI reclaimed the role of researchers as knowers and stakeholders in professional development, while allowing the teachers to maintain the voices and positions they had acquired as knowers. LTBI accepted the importance of both research-based and practice-based knowledge, and looked for ways in which both knowledge-types could interact. This approach was more in line with the notion supported by both Munby (1989) and Eraut (1995) that knowledge-in-action was to be respected without eliminating the importance of research knowledge. Thus, LTBI professional development did not have to choose a focus on knowledge-for-practice *or* knowledge-in-practice; rather, it attended to the intersection between the two.

Revisiting the Technical Rationality: Teachers and Researchers as Stakeholders

In this paper, I claimed that mathematics education researchers are facing the challenge of demonstrating the unique contribution they make to discussions about K-12 mathematics, and that this challenge is more acute for mathematics professional development researchers because they are a newer subset of the larger research community. I noted that in the recent past mathematics professional development researchers made an effort to establish that teachers are key stakeholders in mathematics professional development. This effort made significant gains in supporting teachers, but also hindered the concept of mathematics professional development researchers as stakeholders in K-12 mathematics. I traced the effort to attend to and strengthen teachers' knowledge to the concept of knowledge-in-action and the increased attention to practitioners as knowers. I related the attention to teachers as knowers to the concept of knowledge-for-practice and knowledge-in-practice used in the professional development literature.

Sharing my own experiences, I presented two research projects: one with process goals focused on establishing a teacher community in a partner school, the other maintaining the process goals but adding a clear content goal of teaching teachers about students' learning trajectories. I described and examined each project, later comparing and contrasting their similarities and differences. I noted that by working with teachers in a boundary community, researchers' knowledge could have a stronger role in the project with a content goal while also respecting teachers' knowledge.

Thus, I showed one venue for mathematics professional development researchers to continue to value teachers' knowledge and return to an increased attention to researchers' knowledge. I contend that highlighting research knowledge in mathematics professional development and clearly articulating the contributions of research for teaching is a possible route to establishing that mathematics professional development researchers are, indeed, stakeholders in K-12 mathematics.

I conclude this paper calling for mathematics professional development researchers to embrace a revised version of the technical rationality that highlights the importance of both knowledge from practice *and* knowledge from research. Without recognizing the former, there is no understanding of what teaching entails. However, without valuing the latter, there is no connection between teaching and innovations from various areas. Thus, more productive than attending to whether a project is about researchers' or teachers' knowledge, or whether it is about knowledge-for-practice versus knowledge-in-practice, is focusing on the connections between the types of knowledge and the ways in which knowledge-for-practice becomes knowledge-in-practice and vice-versa. In our work, we have addressed this connection by examining the concept of boundary encounters (Wenger, 1998).

A revised technical rationality highlights the value of teachers' knowledge – a fundamental contribution of Schön's workwhile also maintaining the importance of knowledge from research. A revised technical rationality allows mathematics professional development researchers to bring rigour and relevance – separated in *The Reflective Practitioner* –, which suggested that only practice was relevant – together once again. A revised technical rationality establishes that both mathematics education researchers and mathematics teachers are key stakeholders in K-12 mathematics.

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