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Working with Novice Teachers: Challenges for Professional Development

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This study examined the classroom practice and beliefs of two novice teachers, Anne and Rachel, during their first year of teaching and during the first year of their involvement in Project PRIME, a district-wide professional development project. The research also analysed the challenges faced by the novice teachers and the professional developer who worked with them. Using accounts of practice (Simon & Tzur, 1999), the professional developer interviewed and observed the two novice teachers throughout the school year and established a hypothetical learning trajectory to inform their professional development program. By the end of the first year, neither teacher's classroom practice reflected the reform goals of PRIME in relation to implementing worthwhile mathematical tasks, questioning or promoting students' thinking. However, their practice was observably different and so were their beliefs about teaching. Anne's practice was consistent with the literature's characterization of a novice teacher while Rachel's practice was more aligned with that of a veteran teacher. In spite of the fact that the professional developer used different kinds of coaching, collaborative teaching and feedback sessions, the professional development experience was problematic for different reasons, some of which were related to the different perspectives of the two novice teachers.

A number of studies have addressed the beliefs and classroom practices of novice teachers (Borko, Eisenhart, Brown, Underhill, Jones & Agard, 1992; Drake, 2000; Huberman, 1993; Leinhardt, 1989; Leinhardt & Greeno, 1986; Shealy, 1994; Shealy, 1995; Sherin & Drake 2000; Wilson, Shulman, & Richert, 1987). These studies define a *novice* teacher as one with less than 3 years of teaching experience and one whose teaching tends to focus on "survival" (Huberman, 1993) and establishing basic classroom routines (Sherin & Drake, 2000). In this research, we bring a different perspective by analyzing two novice teachers who brought contrasting backgrounds and experiences to their first year of teaching.

More specifically, our study asked the following questions: (a) What were the beliefs and classroom mathematical practices of two novice elementary teachers who were involved in the first-year of a district-wide professional development program? (b) What kinds of challenges and dilemmas did the novice teachers and the professional developer face as they participated in the professional development program?

Theoretical Orientation

The professional development program that served as the context for this study was Project PRIME [PRIME] (Thornton & Barrett, 2000). PRIME was a systemic effort that focused on enhancing the practice of elementary teachers who

were working in a mid-size urban school district with a high minority student population. The key elements of PRIME were improving teachers' pedagogy and providing on-site support to facilitate classroom-based implementation. More specifically, PRIME aimed at enhancing teachers' development of three integrated instructional strategies: (a) posing worthwhile mathematical tasks, (b) asking responsive and extending questions, and (c) listening to students' responses and promoting their thinking and engagement,

The *accounts of practice* methodology (Simon & Tzur, 1999) provided the theoretical infrastructure for the case-study analysis of the two novice teachers in this study. Simon and Tzur (1999) describe accounts of practice as an approach for understanding teachers' current practice and as a means of viewing their current practice in the context of professional development programs that embrace envisioned reforms. Research that uses accounts of practice has two key elements: (a) the development of a conceptual frame, and (b) the use of the conceptual frame to trace teachers' classroom practice. The conceptual frame should be based on research in mathematics education and the particular perspectives and concerns of the researchers as they relate to the professional development project. The conceptual frame or lens in our study was PRIME'S three integrated instructional strategies and we used this lens to examine and trace the classroom practice of the two novice teachers during the professional development program. Using accounts of practice also provided an opportunity to ascertain why the teachers taught the way they did.

Accounts of practice also incorporates the notion of a hypothetical learning trajectory (Simon, 1995). By hypothetical learning trajectory, Simon means that an envisaged learning sequence incorporating goals, activities, and conjectured learning process, is formulated for the teacher by the professional developer. More specifically, the researchers' conceptual frame and aspects of the teacher's practice observed by the researcher are used to generate possible directions for the teacher's ongoing development. In this study, hypothetical learning trajectories based on the PRIME strategies and the teachers' extant practices were used to inform the novice teachers' development.

The multifaceted nature of the accounts of practice methodology made it very appropriate for driving the collection of data to address the research questions for this study. With respect to the first research question, we were able to use the conceptual frame to trace and interpret the teachers' beliefs and classroom mathematical practices captured through videotape and interview. With respect to the second research question, the on-going processes of tracing teachers' beliefs and practice and developing hypothetical learning trajectories highlighted the dilemmas and challenges for both the teachers and the professional developer. As Simon and Tzur note, "When the same teacher's practice is described in a number of accounts generated over time, researchers can use the accounts to develop an empirically based understanding of mathematics teacher development" (p. 257).

Method

In accord with the "accounts of practice" methodology (Simon & Tzur, 1999), we used case-study analysis to examine the beliefs and classroom practices of two novice teachers during the first year of PRIME. We also distilled from the data corpus the dilemmas and challenges that arose for both the teachers and the professional developer.

Participants

The 2 novice teachers in this study were part of a pool of 337 teachers who agreed to participate in the 3 years of PRIME. These novice teachers, identified by pseudonyms, were also part of a random sample of 16 teachers selected for detailed case-study analysis. Both novice teachers were teaching Grade 1 classes. *Rachel,* a novice teacher in her first year of teaching, came into teacher education after having 20 years in the workforce doing a variety of jobs while raising a child. She taught for 1 year as a full-time teacher-aide prior to obtaining a teaching position. *Anne* had entered her teacher education program immediately following high school and was in her first year of teaching. The first-named author, referred to as the Professional Developer (PD), worked with the teachers and observed their classroom practice during the first school year of the PRIME.

Procedure

During the PRIME summer workshop, prior to the first year of the program, the two teachers undertook a 1-week program that focused on ways that geometric concepts can be built using tasks from *Investigations in Number, Data, and Space* (TERC, 1998). These TERC materials were provided for all teachers in PRIME and were intended to support and enhance their mathematics curriculum in the coming years.

Working in collaboration with the second-named author, the PD wrote accounts of the teachers' classroom practice and beliefs during the fall and spring semesters. These accounts served as the basis for generating hypothetical learning trajectories (HLTs); that is, determining a plan, identifying activities, and conjecturing the way the teacher development process might go. The researchers had also decided to use the Activity-Reflective-Cycle (Simon, Tzur, Heing, & Kinzel, 2000) to engage teachers in a sequence of activities intended to highlight the relationship between mathematical tasks (like those contained in the TERC materials) and children's subsequent understandings.

Data Sources and Analysis

Data were gathered from four sources: (a) video tapes of two teaching sessions for each teacher, one in the fall and one in the spring; (b) detailed field notes of six teaching sessions during the intervention; (c) field notes of interviews associated with the six teaching sessions in each semester (two groups of three consecutive days); and (d) samples of students' work. Using a modification of Miles and Huberman' three-part analysis (1994), we (the first two authors) used a double-coding procedure to analyze the video and field data in terms of the conceptual

frame: PRIME's three integrated instructional strategies. In the first-part of the analysis, we independently summarized and coded the data with respect to our conceptual frame. In the second part, we constructed data displays to compare and contrast the key practices and beliefs of the two teachers across the six sessions. We also constructed displays of the dilemmas and challenges that arose for the two teachers and the PD. The final part involved drawing conclusions and testing these conclusions against our original data corpus. The use of four sources of data and the generation of independent summaries and codes allowed for triangulation of the data in the sense that it enabled both confirming and alternative interpretations.

Results

The results are presented in three parts. The first part deals with the novice teachers' classroom practices, the second part with their beliefs, and the third part with the challenges and dilemmas experienced by the teachers and the professional developer.

Classroom Practices

Using the accounts of practice methodology and the three PRIME instructional strategies as a lens, the classroom practices of the two target teachers were analyzed during the first year of PRIME. The thick descriptors for Anne's and Rachel's classroom practice are presented in Table 1. In what follows we compare, contrast, and amplify the classroom practice of the two teachers.

With respect to *worthwhile mathematical tasks*, the outward manifestation of the teachers' practice was very similar: students did not experience the value of the worthwhile mathematical tasks that they used from the TERC (1998) resources. That is, the teachers' actions reduced or masked the cognitive load and the mathematical richness of the tasks. Having said that, the teachers worked in different ways. Anne gave her students the opportunity to solve and report their thinking on problems that were worthwhile. For example, near the end of the first year of the project, she posed this question: "Draw a cake in the shape of a rectangle and indicate how you and I could share it." The task was meaningful to the children, they seemed to understand that share implied *divide equally*, and the task had the potential to build understanding of mathematical concepts as well as to make connections between number and space. By way of contrast Rachel never allowed her students to engage in worthwhile tasks in the manner that was intended. She always embellished the task with a set of procedures that reduced or eliminated the problem-solving characteristics of the task. For example, near the end of the first year of the project she asked the children, " Which is longer than 2 inches, your fingernail or your hand?" Rather than let the children explore or even think about the task, Rachel immediately told them to look at their ruler, find 2 inches, and compare. Consequently the task was immediately reduced to a set of predetermined procedures.

Table 1
Novice teachers' classroom practices

PRIME Strategies	Anne	Rachel
Worthwhile mathematical tasks	Her tasks are worthwhile and she is willing to let the children engage in thinking about the task.	Her tasks are never presented as a problem for the children to solve; rather, tasks are always reformulated as a sequence of "well-known" procedures.
Questioning	Her questions ask children to describe their solutions but rather than delve into their thinking she avoids any kind of discussion that would lead to mathematical sense making.	Her questions focus on checking that children use the correct procedure; she often seeks a response from the whole class to reinforce the procedure.
Listening to and promoting students' thinking	She does not follow up on the children's written responses as she doesn't appear comfortable using and extending their thinking	She assesses responses according to whether or not they agree with her model; seldom seeks explanations as she sees the role of elaborating responses as her prerogative.

With respect to *questioning*, Anne's questioning reflected what Brousseau (1992) calls the *Jourdain* effect while Rachel's questioning reflected what Brousseau terms Topaze-like leading of the students (p. 20). By the Jourdain effect, Brousseau refers to a situation where the teacher avoids having a discussion about knowledge with the student and instead recognizes a response of the student that has been stripped of its meaning. In our situation, Anne started with open questions, encouraged students to convey their own thinking, but then avoided having any follow up discussion on the children's knowledge. The following dialogue in the cake-sharing example illustrates Anne's Jourdain approach.

> Anne: How could the cake be shared between you and me? Do it in you own way and be ready to tell me about it.
>
> [Anne walked around while the students solved the problem, but did not question any students. Her only interaction was to remind one student that a rectangle was long "like a square but long."]
>
> Anne [After about 3 minutes]: What are you looking for in this problem?
>
> Children [In unison]: Two equal parts
>
> Anne: And equal parts mean they're the…

Children [In unison]: Same

Anne: So, you cut it down the middle.

In spite of the fact that students had valid solutions with horizontal cuts, vertical cuts, and even cuts that were not down the middle, Anne did not pick up on these solutions in the dialogue. Even though she must have seen them she simply asked the students questions about equal parts when it was obvious that many of them had gone well beyond that level of understanding and had rich solutions to share.

Rachel epitomized Brousseau's Topaze-style. That is, she used an instructional approach in which the students' response to a question is determined in advance and the teacher negotiates the conditions under which the response is produced. The following dialogue for the fingernail–hand problem was typical of her questioning:

Rachel: Who can tell me? Which is longer than 2 inches, your fingernail or your hand?

Student1: Your fingernail

Rachel: What do you think? [pointing to another child]

Student 2: Your hand

Rachel: Your hand, that is correct. Why?

Rachel [without waiting for the children]: Because how big is an inch? Who can show me an inch?

Many children held their hands a foot apart, and were individually corrected. However, by now the original question had become submerged, marooned by a sea of subroutines. In essence, Rachel's questions were not predicated on doing problem solving but on checking the various subroutines she had prescribed in advance.

With respect to *listening to and promoting students' thinking*, both teachers ultimately assessed children's responses against their own established standard. Using a Jourdain style approach, Anne encouraged children to generate different representations but did not feel comfortable asking the children for explanations especially when a child was going in a direction different from her own solution. Rachel's Topaze-like strategy was clear from the outset: if the child's solution was correct (fitted her solution), she elaborated and explicated the student's solution; if the child's solution was incorrect, Rachel asked another child or represented her model without further discourse with the child.

In an overall sense Anne's classroom practice was often different from what she intended; that is, it was different from her professed intent to meet PRIME goals. By way of contrast Rachel's practice was consistent with "her" intent and she had already established the routines to meet her goals. Notwithstanding these differences, the end product of their classroom practice was much the same and was clearly inconsistent with the direction of the PRIME Project and the intent of the TERC (1998) resources.

Beliefs

The teachers' beliefs were identified during interviews with the PD that were undertaken as part of the accounts of practice methodology. Some of these beliefs arose in response to questions by the PD; others were volunteered by the teachers during discussion. The key beliefs identified for Anne and Rachel are listed in Table 2.

The beliefs of Anne and Rachel provide the essence of their classroom practice. Anne understands the key tenets of PRIME and is able to articulate them. She believes that children will produce different mathematical representations for problems and she thinks these representations may be helpful for instruction. However, she professes a lack of confidence in her own mathematics and this is reflected in her beliefs about children's mathematical thinking and her reluctance to use children's solutions to enable sense-making and the building of mathematical knowledge. By way of contrast, Rachel's beliefs seem to be more firmly held and her beliefs are consonant with her classroom practice. She is quite definite that children can't act mathematically on their own and as a consequence teachers must demonstrate the correct mathematical procedure and then ensure that children adopt the teacher's procedure. Rachel is steadfast in her belief that learning for "important" written tests and chapter tests will not occur through any other mechanism.

Table 2
Novice teachers' beliefs

Anne	Rachel
Children use different representations that may be helpful for instruction.	Children are not able to do mathematics independently of the teacher.
I have trouble constructing mathematical ideas; hence, my students will not be able to construct their own mathematics.	Children learn math when I demonstrate the procedure they are to imitate.
Children will produce different solutions and representations but the textbook solution is the ultimate authority.	Children should reproduce the teachers' model solution; multiple solutions are likely to confuse the children.

Interactions between the Professional Developer and Teachers

Several different types of PD-teacher interactions emerged during the interviews and the planning of hypothetical learning trajectories. The interactions are presented in Table 3.

The PD's inputs, described in Table 3, were part of the hypothetical learning trajectory that he formulated during the first year of PRIME. The response "encourages them to work with students' thinking," is an example of a goal in the learning trajectory. It represents the PD's judgment on what needed to happen for the teachers to adopt reform- teaching processes and in particular to gain control over the PRIME instructional strategies. In a similar way, the suggestion about collaborative lessons illustrates an activity in the hypothetical learning trajectory and reflects the PD's ongoing attempt to engage the teachers in activities that would facilitate their meeting the goals of PRIME.

Table 3
Interactions between the Teachers and Professional Developer

Professional Developer	Anne	Rachel
Observes that many students don't understand the strategies modeled by the teachers; encourages the teachers to work with students' thinking.	Responds positively because she is aware of the low performance of many students in her class; however, she has difficulty converting intent into practice.	Is skeptical about using students' thinking because this conflicts with her beliefs about children's abilities to work independently of the teacher and her concerns about children's capacity to deal with multiple solutions.
Suggests that they do collaborative lessons focusing on students' thinking.	Embraces this suggestion and is eager to work with him; however, she tends to be over-dependent and abrogates much of the teaching to the PD.	Goes along with PD's suggestion but finds it difficult to embrace a strategy where students talk about their mathematical thinking.
Asks whether the teachers are beginning to feel comfortable using strategies involving students' thinking and concrete materials.	Likes the idea of using teaching strategies involving students' thinking but has major concerns about actually doing it.	Agrees that this approach has some merit but her commitment to teacher-driven strategies remains strong.

The two novice teachers responded in very different ways to the goals of the PD's hypothetical learning trajectory. With respect to the goal that encouraged the teachers to work with *students' thinking*, Anne resonated with this suggestion. She revealed her concern with the performance of the lower-level students in her class and commented, "They come from really troubled home backgrounds in the neighborhoods. I want to find better ways of getting across to them in

mathematics." In spite of her desire and even commitment to utilize students' thinking, her practice was not congruent with her intent. As noted earlier Anne epitomized the Jourdain effect (Brousseau, 1992), in that she encouraged the students to think about problems in "their own way" but then avoided discussing the often rich thinking of the children. In fact, she generally focused on ideas or procedures that the children already knew. By way of contrast, Rachel was skeptical. She concurred with the PD's evaluation that a number of students in her class were not following her preferred strategies but she didn't really embrace his suggestion that "learning would be more effective if her teaching was closer to students' ways of thinking rather than imposing her own strategies on students' thinking." Even though the PD and Rachel talked about questioning that focuses on children's thinking and reasoning, there was no deep commitment and she quickly reverted to Topaze-leading (Brousseau, 1992) where she negotiated the conditions under which students' responses were produced. Hence, although the teachers' responses and commitment to students' thinking were in sharp contrast, the outcome in their classrooms was similar.

In response to this situation, the PD suggested that he and the teachers engage in collaborative teaching activities. He conjectured that collaborative teaching would work best if they worked on tasks from *Investigations in Number, Data, and Space* (TERC, 1998). Anne was enthusiastic and clearly valued the opportunity to work with the PD. For example, when they planned to have the children work on a game that involved comparing the sum of two given addends, Anne was ready to go. She had the game cards prepared and the background material read from the TERC materials. However, when they worked together on these collaborative lessons, Anne became very dependent on the PD and tended to withdraw from the dual role they had planned. It seemed that she did not want to participate in the teaching in case she "messed things up." In responding to this the PD wrote in his field notes, "I thought our collaborative teaching would bring out the beliefs that Anne has about the importance of children's thinking, however, she seems to lack confidence in her understanding of the TERC materials. This inhibits her taking ownership of the ideas in the material." Rachel was less enthusiastic. For example, when they came to the comparison game, she did not have the game cards ready and requested his help in explaining the background material as she admitted finding it "hard to read." Even though she was not fully sanguine about the collaborative approach, she agreed to guide the children through the game. After some initial clarification difficulties, the children played the game enthusiastically and Rachel and the PD were able to monitor children's thinking. However, in the reflections that she and the PD engaged in following the lesson, it was clear that Rachel's concerns about an approach based on students' thinking were deep-seated. In summing up her beliefs, she states, " The kids like the hands-on, and I am excited about some of the work of the weaker students. However, I need to give them lots of written work since the tests are all written. Talking about what is in their head is okay, but they are going to have to write it down."

Near the end of the first year of PRIME, the PD asked the two novice teachers whether they were beginning to feel comfortable using strategies involving students' thinking and concrete materials. Anne responded that she liked the idea

of using students' thinking but did not feel comfortable doing it. She says, "I am concerned that I may not understand what the child is thinking and may even tell a child that her solution is incorrect when it is just a different interpretation." She sums it up when she says, "I don't think I'm ready to take this step." Rachel admitted that teaching based on using children's strategies had some merit. She alluded to the successes of two of the weaker students and to the fact that using students' thinking helped them to better understand "what zero does in addition." However, she is torn by concerns about written rather than oral tests, her comfort with a teaching strategy where she models the correct procedure and the children practice that procedure, and feeling that hands-on work is review rather than the real business of teaching. In summing up she says it all, "There are PRIME lessons and there are regular lessons."

From the perspective of the professional developer there was a sense of frustration as he reflected on the classroom practice of and interactions with the two novice teachers. He sums it up by saying, "I have to find ways of promoting an emphasis on students' ways of thinking about mathematical ideas without asking Anne and Rachel to give up their 'trusted sense of structure' which, although different in each case, is difficult to overcome. I need to shift my way of working toward their comfort zones."

Conclusions and Discussion

This study examined the classroom practice and beliefs of two novice teachers during their first year of teaching and the first year of a professional development program that had been adopted by their school district. The research also identified the challenges faced by the novice teachers and the professional developer who worked with them.

The end product of each novice teacher's classroom practice was similar but they reached these states in different ways. From the perspective of the first two PRIME goals, Anne's classroom practice showed potential in that her mathematical tasks were often worthwhile and her initial questions opened up children's thinking. However, she lacked the confidence to use students' thinking to engage them in mathematical sense-making. In essence, Anne's practice was in direct contrast with her espoused beliefs that were consistent with PRIME instructional goals. In an overall sense, Anne's classroom teaching reflected that of a *novice* teacher in that her actions were consistent with the literature on novice teachers: specific goals not carried through (Sherin & Drake, 2000); frequent confusion caused by mis-sent signals (Leinhardt, 1989); struggles to listen to children's thinking (Fennema & Franke, 1992); dissonance between beliefs and practice (Cooney & Shealy, 1997); and lacking confidence in her own mathematics (Ball, 1990).

By way of contrast, Rachel's practice was deliberate and she was completely in control of an approach that seemed to be built on well-established routines, albeit routines that were not consistent with PRIME or reform directions in mathematics teaching. Rachel consistently reduced the cognitive load of worthwhile mathematical tasks, used Topaze-leading (Brousseau, 1992) when she questioned

students, and assessed students' responses according to their fit with her own predetermined standard. Nevertheless, Rachel's classroom teaching tended to reflect that of *veteran* teacher in that many of her actions were consistent with the veteran teachers literature: transparent system of goals (Leinhardt, 1989); detailed agenda and well established routines (Leinhardt & Greeno, 1986); minimal student confusion about what was required of them (Leinhardt, 1989); and beliefs that were consonant with practice (Cooney & Shealy, 1997). Consequently, even though Anne and Rachel were both *novice* teachers they brought very different beliefs and actions to instruction, and these differences proved to be an-going challenge for the professional developer.

From the perspective of the two novice teachers, the challenges and dilemmas associated with the professional development program were ongoing and difficult. Anne enjoyed being involved in the project, she liked working with the PD, but she felt anxious and insecure when she had to implement instruction that engaged children's thinking as a means of building conceptual understanding in mathematics. Consequently she became very dependent on the PD. Rachel was a more reluctant starter with respect to professional development activities. She had her own teaching agenda and routines in place and she really wanted to try them out in her first year of teaching. Because she believed that children could not work independently to build their own mathematics, the PD's suggestion that they focus on children's thinking as a means of informing instruction was never something she could embrace. Consequently she and the PD were often in stand-off mode, subtle but real.

For the PD, the professional development activity had its own frustrations. Although he carefully implemented the accounts of practice methodology (Simon & Tzur, 1999), he may have overestimated the similarities and underestimated the differences between the two novice teachers. For example, in formulating a hypothetical learning trajectory (Simon, 1995) for the two teachers, he established the same goals and activities for both: the goal was related to children's thinking and the *activities* were embodied in collaborative teaching. Although his conjectured development process for the two novice teachers was different–coaching Anne from where she was to where she wanted to go (Evered & Selman, 1989) and coaching Rachel by focusing on the content and pedagogy of the TERC lessons (Institute for Learning,1999)–this accommodation may not have been enough. An implication arising from the findings of this research, is that characterizations of novice teachers, while helpful, need to be used with caution when building professional development experiences.

In accord with the ongoing cycle associated with *accounts of practice* (Simon & Tzur, 1999), we are refining the hypothetical learning trajectory for both teachers as we move into the second year of PRIME. Although we still intend to have both teachers focus on children's learning as their key goal, the activities and conjectured learning processes for each will be different. For Anne, the thinking of the students was distracting, confusing, and even anxiety building. Hence, we believe that she needs to be guided to study and discuss pertinent examples from her students' solutions, statements and questions. While most of these discussions will occur in retrospect with the PD, we expect that these discussions will arm her

with the confidence to deal with students' thinking extempore. For Rachel, there is no evidence that she believes children are capable of building their own mathematical solutions. Hence we are intending to video tape the PD working with her class on open-ended problems that produce samples of children's work. Rachel and the PD will observe these videotapes together and analyze the children's work before any further attempt is made to have her adopt an approach to teaching that promotes mathematical sense making.

On the one hand the findings of this study provide strong evidence of the need to continually refine the hypothetical learning trajectory in a professional development program (Simon & Tzur, 1999). On the other, the evidence in this study is consistent with other profession development studies (e.g. Jones et al., 2000; Patty, 2002) in revealing that panaceas are not readily available to address the idiosyncrasies and complexities that teachers and professional developers face in enhancing student learning.

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