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ABSTRACT

This paper presents a comparative analysis of three teacher educators using a curriculum--Developing Mathematical Ideas--designed to serve elementary school teachers in an inquiry group setting. The aim of the study was to examine the processes and demands of supporting teachers' learning and their efforts to reform their practices. Data collection involved observations of the 3-hour sessions, follow-up interviews with facilitators, and field notes. Analyses revealed that the central demand of supporting teachers' learning through inquiry involved navigating through what was called openings in the curriculum. These openings took the form of unanticipated questions, challenges, observations, or actions by participating teachers and required facilitators to make on-the-spot judgements about how to guide the discourse. Examination of the teacher educators' processes for navigating these openings revealed that they used a set of three activities in determining how to respond. Analysis of facilitators' activities further illuminates the work involved in supporting teachers' learning and offers implications for the type of support needed by teacher educators engaged in this work. (Contains 40 references.) (SM)

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What An Innovative Curriculum for Teachers Reveals About Supporting Teachers' Professional Learning[1]

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Researchers agree that achieving the fundamental changes called for by current reforms in mathematics education requires new learning on the part of teachers. To meet this challenge, a tremendous variety of teacher-enhancement projects, representing a range of perspectives and approaches to supporting teachers' learning, currently exists across the country. This paper presents a comparative analysis of three teacher educators using a curriculum—Developing Mathematical Ideas (DMI)—designed to serve elementary school teachers in an inquiry group setting. The aim of the study was to examine the process and demands of supporting teachers' learning and their efforts to reform their practices. Analyses revealed that the central demand of supporting teachers' learning through inquiry involved navigating through what we have called *openings in the curriculum*. These openings took the form of unanticipated questions, challenges, observations, or actions by participating teachers, and required facilitators to make on-the-spot judgments about how to guide the discourse. Examinations of the teacher educators' processes for navigating these openings revealed that they used a set of three activities in determining how to respond. Analysis of facilitators' activities further illuminates the work involved in supporting teachers' learning, and offers implications for the type of support needed by teacher educators engaged in this work.

The images of mathematics teaching and learning envisioned by the current reform movement are foreign to most teachers. As a result, reforming mathematics education requires substantial new learning on the part of teachers (Ball, 1997; Simon, 1997). To encourage this learning, professional development opportunities for teachers must also change (Cohen & Barnes, 1993; Heaton, 1994; Sykes, 1996). In recent years, the growing body of research on teacher learning and change has provided insights into the kinds of learning that are likely to support significant shifts in mathematics teaching. Many researchers agree that teachers need opportunities to develop deep understandings of mathematics and of students' mathematical thinking and development (Ball, 1993; Schifter, 1998). We have learned that teachers' pedagogical deci-

sions are closely connected to their beliefs about students, learning, and the aims of education (Fennema, Carpenter, & Franke, 1996; Thompson, 1992). Finally, considerable evidence suggests that the kind of learning that supports fundamental change in teaching occurs over a long period of time, with extensive support and multiple opportunities to experiment and reflect (Loucks-Horsley, 1997; Nelson, 1997).

There is less agreement, however, about how to foster and support this kind of learning (Ball, 1997). There is currently a tremendous variety of teacher-enhancement projects across the country, representing a range of perspectives and approaches to promoting teacher learning and change (Loucks-Horsley, 1997). This study examines one of these. We looked at three teacher educators' uses of an innovative teacher development curriculum. The aim of our research was to study the process and demands of fostering learning that supports teachers' efforts to reform their practices.

The Curriculum and the Challenge It Offers

Developing Mathematical Ideas (DMI) is a curriculum intended for use with elementary teachers in an inquiry group setting. The materials are designed to use teacher-written cases of students' mathematical thinking, group discussions, and mathematical investigations to provide opportunities for teachers to simultaneously examine central mathematical ideas and students' thinking about them (Schifter, Bastable, & Russell, 1999).

The curriculum approaches teacher development by asking teachers to explore mathematics. It assumes that, through examining their own and children's understandings of mathematical structures and relationships underlying the elementary curriculum, teachers will learn mathematics in new ways and reconsider what it means to learn and know mathematics. The DMI developers expect that the new insights teachers gain from these mathematical explorations will prompt them to rethink what it means to teach mathematics. To a large extent, this approach is in concert with Ball's (1997) call for professional development to foster a stance of critique and inquiry, rather than one of answers.

Currently, the DMI curriculum includes two modules, "Building a System of Tens" and "Making Meaning of Operations." Through a sequence of eight 3-hour sessions, each module chronicles the development of children's mathematical understandings as they move from kindergarten into the middle grades. In preparation for each session, participants read teacher-narrated cases of classroom episodes, illustrating student thinking and work. In addition to reading and discussing cases, teachers explore mathematics for themselves, share and discuss samples of their own students' work and understandings, view videotapes of mathematics classrooms, and write their own cases.

The DMI curriculum guides facilitators' work by providing activities, readings, and a structure for each meeting. It also includes reflective journal entries of a fictitious DMI instructor as she guides a group of teachers through the modules. Each entry provides an image of how the facilitator interprets and reflects on the interactions of participants. Research on K–12 teachers using reform-oriented curricula, however, suggests that implementing an innovative curriculum is *not* simply a matter of picking it up and using it (Cohen, 1990; Heaton, 1994; Remillard, 1996). It involves interpreting new and unfamiliar ideas about teaching and learning. Thus, implementing an innovative curriculum for teacher development is likely to involve at least two layers of complexity: the first layer involves working with unfamiliar ideas about children's mathematical learning; the second layer involves finding one's way through new approaches to teachers' learning. For this reason the DMI curriculum provided a productive site to examine the following two-part question: What is involved for facilitators as they (a) use an innovative teacher development curriculum and (b) support the kinds of teacher learning opportunities compatible with reform ideas in mathematics education?

What We Know about Curriculum and Reform in Mathematics Education

The preceding question is related to existing research on reform-inspired teaching and teachers' use of curriculum materials. Nevertheless, there is little research that examines such ques-

tions when the teacher is a teacher educator and students are practicing teachers. In fact, research on how teachers interact with and use curriculum materials is relatively new. Previously, textbooks and curricula were viewed as accurate representations of classroom curriculum (Walker, 1976). Implicit in this perspective was a view of the teacher as a conduit for curriculum, not a user or shaper of it. Observations of teachers using the "teacher-proof" materials of the 1950s and 1960s suggested that many teachers did not use the new curriculum materials as the authors had intended. Stake and Easley (1978) described adaptations to inquiry-based curriculum that reflected teachers' notions about teaching and the nature of the subject matter. Sarason (1982) observed teachers' struggles to understand the "New Mathematics" materials, noting a clash between their beliefs about mathematics and the ideals represented in the materials. Studies such as these illustrated the substantial role that teachers play in shaping the curriculum experienced by students.

Researchers have since examined teaching and teachers' use of curriculum guides, seeking further insight into teacher-text relationships. Researchers who have examined the beliefs underlying teachers' use of curriculum materials have concluded that a variety of factors tend to influence teachers' decisions, including their knowledge of and views about mathematics (Graybeal & Stodolsky, 1987; Thompson, 1984), their perceptions of the text (Bush, 1986; Duffy, Roehler, & Putnam, 1987; Remillard 1991; Woodward & Elliot, 1990), their perceptions of external pressures (Floden, Porter, Schmidt, Freeman, & Schwille, 1980; Kuhs & Freeman, 1979), and their ideas about the purpose of school and the nature of learning (Donovan, 1983; Stephens, 1982).

From another perspective, researchers have argued that placing the teacher-text relationship at the center of analyses of teaching oversimplifies teachers' curricular decisions. For example, in a study of elementary teachers, Sosniak and Stodolsky (1993) found that teachers did not see textbooks and teachers' guides as "blueprints" or "driving forces," but as "props in the service of managing larger agendas" (p. 271). By capturing the role of the text in relation to teachers' varied responsibilities, these findings suggest a need for understanding teachers' larger curricular agendas and the role the curriculum guide plays in them.

Research on what Doyle (1993) called the "curriculum process" considers teachers' larger agendas by focusing on how they enact curriculum in their classrooms. This research focuses less on the teacher-text relationship and more on the teacher-curriculum relationship. It often includes how teachers draw on resources like curriculum guides, but assumes that this process necessarily involves interpreting the meanings and intents of these resources (Doyle, 1993; Golden, 1988; Lemke, 1990; Snyder, Bolin, & Zumwalt, 1992). Implicit in studies of teachers' curriculum processes is a view that the *enacted curriculum* is more than what is captured in official policy documents or textbooks. It is the events teachers and students experience in the classroom (Clandinin & Connelly, 1992; Gehrke, Knapp, & Sirotnik, 1992). From this perspective, studying teachers' use of innovative curriculum resources involves trying to understand teachers' processes of constructing the enacted curriculum and the role that resources play in it. With this in mind, our research examined the curriculum enacted by teacher educators in professional development settings and how they used the DMI curriculum in the process.

Our research questions were also influenced by recent research that examines the work of teaching in today's reform context. As several scholars have pointed out, the current calls for reform envision a model of teaching that is significantly more complex than the traditional image of the all-knowing guide who corrects students and monitors their practice (e.g., Ball, 1997; Remillard, 1999; Simon, 1997; Steffe, 1990). Reform-inspired goals for all students that include mathematical thinking, problem solving, and communication require teachers to engage simultaneously in a number of inquiry-oriented activities. Through ongoing observation and analysis of students' performances, teachers build models of students' mathematical understandings and generate hypotheses regarding how their learning might progress (Simon). They take actions based on these hypotheses, but must continually modify their models and subsequent plans. In a sense, they must both direct and follow the activities of students. Simon aptly characterizes the

teacher as "function[ing] within the tension among his or her current goals for student learning and commitment to respond to the mathematics of the student" (p. 80).

We assume that the work of teacher educators in this reform context is equally complex. Not only must they help teachers engage in learning about teaching that is unfamiliar and highly complex, they must take into account new ideas about how teachers are likely to learn. The DMI curriculum proposes one hypothesis about teacher learning—by examining their own and children's understandings of mathematics, teachers will learn mathematics in new ways and rethink their teaching of it. Our aim in this research was to examine facilitators' work supporting this learning with the DMI curriculum.

Methods and Context

To examine the work involved in supporting teachers' learning, we studied three teacher educators using the DMI curriculum. Practicing qualitative, interpretive methods, we examined the role, activities, and thinking of each facilitator while using these materials. The three research sites varied across several dimensions. However, they were similar in that each facilitator was a first-time user of the DMI curriculum during its pilot year.

The Three Contexts

Marilyn[2], a middle school teacher, was new to teacher development work. She facilitated the DMI seminar through an agreement between her school district and a local college. She offered the seminar to teachers in her district as a two-credit mathematics course. Four participants enrolled in the course: three veteran elementary school teachers and one middle school teacher with two years' teaching experience. Participants met weekly for three hours over the course of the spring term.

Jennifer was a veteran teacher educator. A former elementary school teacher, she served as the curriculum specialist of her district for 13 years and sponsored and facilitated a wide range of teacher-enhancement projects. Jennifer offered the DMI seminar to a group of 30 teachers who had been meeting monthly to discuss the piloting of an innovative elementary mathematics curriculum. She hoped that teachers' experiences with the DMI curriculum would support their work with the new materials. The experience of teachers in this group ranged from 7 to 13 years of service. The group met once each month for six months, devoting mornings to the DMI curriculum and afternoons to issues related to the pilot project.

Connie, a mathematics teacher educator in a university setting and an experienced middle school teacher, used the DMI materials in a continuing education master's degree course offered through her institution. The course met once a week for one semester. Drawn from several of the school districts surrounding the university, the participants were practicing teachers with experience ranging from 1 to 30 years. A few of the participants were recent graduates of the university and former students in Connie's mathematics methods course. The seminar began with 30 students, but enrollment dwindled to 15 by the end of the semester. Connie brought to her use of the DMI materials an array of experiences facilitating professional development activities for practicing teachers.

Data Collection and Analysis

We collected data on each seminar through observations of the 3-hour sessions and follow-up interviews with the facilitators, which were audiotaped and transcribed. Our field notes supplemented the transcriptions of the observation sessions. Interview and observation instruments developed recursively as the investigation proceeded. Each analysis contributed to defining and refining future points in the process of collecting data, allowing us to trace the evolution of ideas and patterns across each teacher educator's work.

We analyzed the data using within-case and cross-case inductive methods of analysis (Patton, 1990). The cross-case analysis involved iterations of comparative examinations of each teacher educator's work, seeking themes and patterns, followed by additional checks with each case to confirm validity. The analysis revealed patterns in the teacher educators' experiences facilitating the seminar discussions and activities as well as relevant contrasts. We discuss these in the following sections.

Results: Openings in the Curriculum

Our analysis revealed that, despite the differences among facilitators and the seminar contexts, the three teacher educators confronted unanticipated and at times awkward points in the conversations through which they had to navigate. These instances were prompted most often by participants' questions, observations, challenges, or resistant stands on issues that were important to them. We have labeled these instances *openings in the curriculum* because they required facilitators to make judgments, often on-the-spot decisions, about how to guide the discourse. Initially we viewed these openings as interruptions in the natural flow of the sessions because they often felt clumsy or precarious to these first-time facilitators. Through our analysis, we came to view these breaks as potentially rich spaces in the curriculum because they presented opportunities for facilitators to foster learning by capitalizing on mathematical or pedagogical issues as they arose. As we discuss later, openings reflect tensions inherent in the type of teacher development work envisioned by the DMI creators. They are the natural consequence of interactions between what participants bring to the seminars and the kinds of learning opportunities proposed by the DMI curriculum.

In the sections that follow we describe openings that stood out in the data. We selected these four examples because they challenged facilitators in ways that made the process of navigating through them particularly visible. Yet, the four openings discussed here are not the only types of openings we observed. As we worked to understand what openings in the curriculum involved, we began to identify openings that were substantially more transparent than the four examples which follow. The apparent invisibility of these openings was often due to the seamless way they were navigated by facilitators.

Searching for Pedagogical Guidance

The first type of opening we describe occurred as participants in the seminars turned conversations away from the DMI agenda at hand and toward questions about mathematics pedagogy. The content of these conversations often suggested that participants believed that facilitators advocated a particular pedagogical approach about which they had questions. These queries forged openings in the curriculum that called on the facilitator to respond.

Connie confronted this type of opening often. Participating teachers regularly sought specific advice from her about their teaching. These solicitations occurred during class sessions, but also arose as conversations "on the side." In fact, the first instance arose early in the first meeting. In preparation for the session of Module One, participants read the assigned set of cases on children's algorithms for adding and subtracting 2-digit numbers and brought examples of three students' work. Connie instructed the teachers to group themselves according to the grade they taught and discuss the work samples. After moving around the room and giving the groups a few minutes to get started, Connie sat down with the five 1st-grade teachers and listened to their conversation.

Almost immediately Lucille, one of the teachers, began to solicit Connie's advice about her teaching. Lucille's face was strained and her voice determined. She explained that she showed her students how to use counters to add together two numbers. "Am I overshadowing them by showing them how to do this?" she asked, pointing to the example of student work which showed number sentences like "2 + 3," and corresponding drawings of 2 circles and 3 circles.

Connie paused for a moment and then asked several questions: "What kinds of responses have you had from your students when you give them problems like these? How many problems do you give them? How much do you let them struggle to figure out their own strategies? What kinds of strategies do you see?"

Lucille's response was puzzled and sincere. "Don't you have to teach them?" she asked. "We teach them the basic things and then I see them use strategies." She reminded Connie that her students had been in 1st grade for just a few weeks. Connie listened and nodded as Lucille explained her concerns. Connie then looked at the other four teachers in the group, who were listening, and reminded them to be sure that everyone got a chance to share the work they had brought. She then quickly slipped to another group. Lucille and other teachers attempted to draw Connie into similar conversations throughout the semi-

nar (Observation, 9/10/96).

In a conversation after class, Connie referred to these interactions as moments when her "biggest fears came true" (Interview, 9/10/96). "I would sit down, they would revert away from the discussion of what they were sharing to talking about curriculum and hitting me with questions." She found these questions frustrating because they seemed to be skeptical responses to the pedagogy in the cases and sidestep the mathematics or students' engagement with the content.

Marilyn and Jennifer struggled with similar openings in the curriculum. Jennifer generally chose not to respond directly to questions aimed at probing her views about good pedagogy. Instead, she often waited for participants to respond, which many were inclined to do. If no one responded, Jennifer directed the group on to the next focus question, suggesting that participants postpone their inquiries and focus first on learning what they could about students' engagement with the mathematical ideas.

In navigating openings created by participants' pursuits of pedagogical guidance, all three facilitators resisted making specific recommendations or assertions about teaching approaches. They did so for a variety of reasons. They all shared the view that it was not the facilitator's role to promote particular approaches to teaching; they believed the facilitator should provide opportunities for participants to construct their own ideas about teaching. Connie explained, "I deliberately tried not to give advice." When teachers persisted, she took a more explicit approach in defining her role, which she described in an interview:

> I said, "You know, I want us to continue to ask this question every week, and talk deliberately about what you are thinking. If I told you what I wanted you to do, that wouldn't really make any impact, and what I'd really like you to do is see where your beliefs and conceptions are moving to. But, I do want us to continue to talk about it each week, and I'd be happy to be a sounding board." (9/10/96)

The facilitators' ideas about the central purpose of the seminar also influenced their decisions to avoid responding to these questions or challenges. Both Connie and Jennifer believed that the purpose of the DMI curriculum was to engage teachers in inquiry about mathematics and students' thinking. Jennifer explicitly suggested that participants postpone their pedagogical questions and focus on the issues in the cases. As she described it, her "biggest challenge is figuring out how to get to those who think they already understand all this [the mathematics]" (Interview, 6/7/97).

The facilitators also avoided challenging these solicitations, particularly the confrontational ones, because they hoped to avoid conflict. They worked hard to create a supportive and congenial atmosphere in which participants respected the views of others. Because they felt that confrontational questions or statements would threaten the atmosphere they had created, they chose to avoid them. For example, Marilyn resisted taking a pedagogical stance when challenged by a participant because she considered that her role was to help others feel comfortable in the seminar. She believed that taking a stance counter to one voiced by a participant had the potential to foster disagreement within the group, and she worried that this conflict would be counterproductive to the goal of inquiry. Thus she responded by agreeing with the participants about the preponderance of barriers to change in teaching.

This type of opening in the curriculum seemed to be motivated by participants' searches for pedagogical suggestions and guidance. The participants enrolled in what they understood to be a professional development seminar. The DMI seminar, however, was unlike the workshops they had attended in the past. Traditionally, teacher development activities take a how-to approach, providing teachers with a selection of activities and lessons they can use in their classrooms (Little, 1993; Sparks & Loucks-Horsley, 1990). This approach to professional development is based on "a discourse of answers" and "a confident stance of certainty" (Ball, 1997). In contrast, the DMI curriculum assumed that genuine and productive teacher learning should begin with inquiry into mathematics and children's mathematical ideas. Thus openings prompted by teachers' searching for pedagogical guidance illustrates a tension between what participants were familiar with and

looked for in professional development and the stance of the DMI curriculum.

Taking a Prescriptive Stance

A second type of opening in the curriculum also occurred when the discourse turned toward pedagogical practices. As participants grew comfortable with one another, some occasionally expressed questions or ideas about what or how they were teaching in their own classrooms. During some of these instances, other participants offered prescriptive advice. Speaking with great authority, these participants told others what to do or gave advice about what worked for them. The facilitators we studied were uncomfortable with these situations because they did not want discussions of pedagogy to revert to quick fixes or how-to steps.

Jennifer found herself struggling with this type of opening when a participant offered advice that had the potential to undermine the focus of a discussion of rules to compare decimal numbers. In an interview, Jennifer confided that she "hoped that participants would work on the idea that comparing the value of decimal numbers and memorizing rules were not synonymous" (6/8/97). She believed that the case the participants had read illustrated that, although the rules had a place in mathematics learning, "they may not be the starting point for student learning." At the same time she knew that most of the teachers had not thought about what it meant to understand decimal numbers.

Jennifer began the case investigation by asking participants whether the students in the case understood decimals. Several participants answered that they thought the students probably didn't understand decimals very well or they would have been able to state a rule for comparing them. Another participant was less sure. She explained that she would have liked to read the students' notebooks in order to assess their confusion. She pointed out, "But the students seemed to think that they did understand how to compare numbers smaller than one. Stating it in a rule was less important to them." After several minutes of conversation about students' understanding of decimals, Jennifer added another question, "What do you think the student who said 'We don't need a rule' understood about comparing numbers?"

To push the participants to examine their ideas about rules more closely, Jennifer asked them to construct the rules they might use to compare decimal numbers. As they proceeded, several participants began to voice questions about learning rules and how they related to students' understandings of decimals. For example, one participant explained that she could see the difficulty students might have in connecting numbers such as .38 to the value of 38 hundredths or approximately 4/10 because the emphasis on rules led students to consider decimals digit by digit. Jennifer listened with interest; the participants seemed to be circling around the issues she hoped would emerge. Then a single comment derailed the conversation. Marvin, a fifth-grade teacher, stated very directly and with authority, "I have tried lots of things, but the only thing that works with kids is having them memorize the rules, especially when they have numbers with lots of zeros." He explained further that he had tried other approaches to teaching children to compare decimals including using manipulatives, but only had success when he showed students how to "insert the correct number of zeros and compare the numbers digit by digit." He then challenged the group to show him another way that worked. This was a powerful challenge. The group grew quiet. No one chose to respond (Observation, 6/8/97).

Afterward Jennifer expressed frustration and disappointment with this discussion. She admitted that she just didn't know what to say. She felt that both what Marvin said and how he said it shut down the discussion and potential learning opportunities for others. She noted, "You could even feel how the atmosphere changed in the room. It seemed that even though there were probably those that disagreed, it would have been really hard to say so. I just didn't know how or what to offer to the group or to this person. I just let it go" (Interview, 6/8/97).

Jennifer was particularly disappointed about this incident because she had carefully planned goals for the session's explorations. She had wanted participants to explore the rules for whole numbers and to consider why they didn't work across the decimal point. She hoped this would prompt them to think about what under-

standings students might employ in comparing numbers with decimals. At the same time Jennifer confided that, since her understanding of rational numbers was fragile, she was not sure about the answers to these questions herself. She attributed her uneasiness about how to respond to Marvin to her lack of confidence in her own understanding of decimals. She described her perspective with the quip, "Another learning moment goes by" (Interview, 6/8/97).

Connie faced similar openings, although none that felt so confrontational. In her sessions, some teachers—usually those with only a few years of experience—openly expressed questions or doubts they had about their teaching, and other, more experienced teachers offered specific advice. The responding teachers described approaches that worked best for them in terms of imperatives, while the younger teachers took copious notes. For example, during a discussion on place value, one teacher observed that a number of her students struggled with place value. This comment prompted a flood of suggestions and advice. Teachers described specific activities or mnemonics that worked for them. During these exchanges, Connie did not join the conversation, question the participants, paraphrase, or summarize what she heard. Although these strategies were typically part of her facilitating repertoire, she did not use them to extend these conversations. Generally she allowed these exchanges to run their course and then tried to move the group on to the next question or issue.

In Marilyn's seminar one participant consistently challenged what he viewed as the favored pedagogical stance with claims such as these: "I would never do this in my class because I wouldn't have time"; "My students would not respond like that"; or "We have tests to get students ready for." These statements tended to halt the inquiry of the seminar. Marilyn appeared challenged by the comments and often responded by focusing on the comments or obstacles raised by the participant.

All three facilitators found participants' prescriptive offerings and the discourse that followed awkward because they did not promote the kind of critique and inquiry about mathematics, teaching, or student learning that they hoped to cultivate in the seminar. Furthermore, they were concerned that by supporting comments such as these they would promote stratification within the group, implying that some participants knew more than others. At the same time the facilitators hesitated to shut down the conversations too abruptly or to challenge the specifics of the advice for fear that such moves could communicate disregard of these experienced teachers' knowledge. So they tiptoed through these instances, neither supporting nor challenging the advice offered.

This type of opening is similar to the opening discussed previously in that they both result from mismatches between what teachers have come to expect from professional development and what they encounter in the DMI seminar. Familiar with the discourse of answers prevalent among professional development opportunities, participants expected to give advice as well as receive it. Thus it is not surprising that the discussion occasionally lapsed into exchanges of advice. In these openings, facilitators struggled with ways to acknowledge the expertise that teachers brought with them while maintaining a stance of critique and inquiry. They were convinced that establishing a safe, supportive, and open environment was key to fostering the level of inquiry sought by the DMI curriculum, yet they were unsure about how to maintain an open environment in these circumstances. This kind of opening illustrates a tension between the facilitator's desire to validate or build on participants' knowledge and her need to maintain a stance of inquiry and critique.

Invitations to Explore Mathematical Ideas

The third opening occurred frequently for all three facilitators. This opening involved the challenges arising from exploration of mathematical ideas. The prevalence of these openings is natural since the DMI curriculum focuses on exploring the conceptual underpinnings of the elementary mathematics curriculum. The mathematical ideas are richly complex and interrelated, and yet unfamiliar to many elementary school teachers. Most teachers participating in the DMI seminars learned mathematics as a set of rules to follow, not as ideas that made sense, and their understandings were fragile. Even those who felt familiar with the math-

ematics found themselves seeing new relationships and patterns. The explorations they engaged in took participating teachers onto new mathematical ground. As a result, teachers frequently expressed surprise, inspiration, insight, confusion, frustration, and curiosity about the mathematical ideas they encountered which undergirded the facts and procedures they had once memorized. Faced with these reactions, the facilitator needed to decide how to respond. At times the facilitators themselves proceeded into new mathematical terrain even as they faced these decisions. In the following example, Marilyn's decision to push participants to examine a mathematical relationship more deeply was prompted by both new conceptual insights she gained and changes in her view of the facilitator's role.

During an activity focusing on 2-digit multiplication, Marilyn asked her group to create representations of 16 x 18 with diagrams using base-10 blocks, Cuisenaire rods, and unifix cubes. As Marilyn worked on the problem, she began to notice a mathematical connection she had never made before. In a somewhat surprised tone, she exclaimed to others, "Multiplying 2-digit numbers in the form of an array looks a whole lot like multiplying binomial factors (x+a)(x+b). This is the first time I have actually put multiplication and algebra together." The room fell silent for a few moments, after which Marilyn commented:

> You know, it seems that somehow, somewhere along the way, I have overlooked the idea that simple 2-digit multiplication underlies the more complicated idea of binomial expansion. It occurs to me now that I have been working with middle school children for all these years and never really made that connection.

The participants in the group stopped to listen to Marilyn. She continued:

> You know, it may have been useful to have students use arrays to multiply 2-digit numbers in eighth grade and then draw on this experience to learn about multiplying binomials. This never occurred to me. It would be a way to relate something new to something that many students may already know and be able to do.

While talking to the group about her new insights, Marilyn studied their faces to assess whether they saw the same connection and whether it was important to them. She asked, "Is anyone else seeing this?" No one acknowledged that they were. Marilyn hesitated for a moment and then began to show the other participants her diagram and explain the connection she had made. She illustrated the rectangular array she had constructed for multiplying 16 x 18 and beside it another array illustrating the multiplication of (x+a)(x+b). After several minutes of explanation the participants remained mostly puzzled.

As Marilyn pressed on, several related questions and observations arose from the group. Looking carefully at Marilyn's drawing of 16 x 18, one participant noticed that the arrangement of rods represented the partial products of the conventional multiplication algorithm. The drawing included a 10 x 10 square representing 100, a set of 6 and a set of 8 long rods representing 6 tens and 8 tens, and 48 small squares representing 48. Other participants' questions focused on the associative and distributive properties. As Marilyn waited and watched the conversation evolve, she seemed pleased that participants were asking questions. She decided not to push the relationship to algebra any further (Observation, 4/15/97).

In an interview that followed, Marilyn explained her decision to open the discussion about what she noticed. "I really saw for the first time why kids have so much trouble understanding algebra. In that moment I knew that I had taken my own understanding of algebra for granted. I wanted others to see this." This inspiration, however, was not her only reason. She was also reassessing her role as facilitator. She explained, "In the beginning of the seminar, I relied on the materials to stimulate the conversations. I saw my role as the organizer. I also wanted to make everyone comfortable. But, over time, my views began to change." Marilyn explained that she began to realize that "in walking the cake walk where you try to be so careful that no one's feelings get hurt, the agenda often got lost. Really, nothing got challenged, no one was willing to risk putting themselves out there" (Interview, 4/15/97).

For Marilyn, this new perspective on her role as facilitator represented a significant shift. Earlier in the seminar she was less likely to initiate a

discussion about a complex mathematical idea. Instead, she wanted to keep the waters smooth and thus tended to avert any sort of challenge or discomfort. She avoided pressing participants to explore mathematical ideas so that no one would feel put on the spot or forced to risk revealing what they did not understand. Yet, over time, Marilyn had grown increasingly dissatisfied with the conversations in the seminar. Inspired by the mathematical connection she made, she saw an opening that she thought was worth the risk and decided to push participants in that direction. Although she knew that participants did not fully grasp the connection she made, she thought the discussion was significantly more ambitious than those the group had earlier in the seminar. She was impressed with both the observations participants made and the connections they drew between the base-10 model and the partial products of the multiplication algorithm. "In the case of one participant," Marilyn speculated, "I think this may have been the first time to ever see a physical model of the traditional [multiplication] algorithm" (Interview, 4/15/98).

Each facilitator that we observed confronted questions about whether and how to support participants' mathematical explorations and learning. In many of these instances, the facilitator made the decision to pursue the particular mathematical idea, as Marilyn did. Connie was particularly inclined to follow up on mathematical questions and observations that arose. Jennifer tended to probe many of the mathematical discussions with general statements, such as "I know there is something more to this" and "Let's keep looking." For example, in a discussion about adding 2-digit numbers, a participant questioned what the teacher-author of a case was referring to when she wrote "I wonder if, in the transformation of the 8 and 9 to a 10 and a 7, she [the student] maintains their equality?" When no one responded, Jennifer said, "Well, let's keep asking that question." In an interview, she explained that she often responded this way during the mathematical discussions because she felt that she herself did not know where to go with the discussion or how to get there. Yet, she had confidence that several of the participants knew a great deal more mathematics, and she knew that if she persisted, someone in the group would move in a productive direction (Observation & Interview, 6/8/97).

We also observed a number of instances in which the facilitators chose not to follow mathematical leads. Connie made that choice during a discussion of children's work with base-10 materials. Several participants raised questions about students' understanding of place value and the role played by the study of other bases. In response, other participants offered observations and perspectives about the base-10 system with little or no evidence to support their claims. Some of the claims seemed to be based on partial, superficial knowledge. For example, one teacher claimed that base-10 was chosen for the conventional system because of the patterns inherent in a system based on 10. Connie listened and nodded. At that moment she did not interject specific questions or challenges, and the conversation moved swiftly to a new issue (Observation, 9/24/96).

Later Connie described her thoughts during this discussion. She noted that the conversation was moving quickly, which made interjecting difficult. She recalled being troubled by many of the assumptions reflected in participants' comments, explaining, "I thought, 'They have so many varied ideas of what base-10 is.'" She offered two reasons for not pursing that issue at that moment: "I didn't have a ready-available task to pose to them, nor did I think that was the place to do that. It wouldn't have helped me in the goals I had for the class." She explained that in other situations she might have provided a task in a later session to encourage participants to examine their ideas about place value. She knew she would not do this, however, because she wanted to follow the agenda offered in the curriculum. Given the focus of the curriculum, she suspected that the same questions would reemerge and "We can say, remember this conversation." While Connie seemed comfortable with the decision she had made during the session, in retrospect she described the instance as "pretty frustrating" (Interview, 9/24/96).

Connie was not the only facilitator who found openings related to mathematical ideas frustrating. Invitations to explore mathematical ideas emerged frequently and all three facilitators

struggled with whether and how to respond. In some instances the facilitator backed off completely to avoid putting participants on the spot. At other times she chose to move forward with the agenda of the curriculum rather than pursue an emerging mathematical issue.

Openings that offer invitations to explore mathematical ideas illustrate the complexity involved for facilitators when taking on mathematical inquiries and managing the tensions involved in deciding how far to push participants, oneself, and the agenda of the curriculum. In these openings facilitators were trying to figure out how to push participants mathematically without putting them on the spot. Even more complicated still, some facilitators may be trying to unpack the mathematics embedded in the DMI curriculum for the first time.

Discussing Videotaped Episodes

As we mentioned, the DMI curriculum uses teacher-composed cases to structure participants' explorations of mathematical ideas and children's learning of those ideas. Periodically the curriculum includes videotaped episodes of children's work and thinking. Unlike the written cases, the videotapes do not use descriptive language to structure participants' "reading" of the events. Instead, they present complete portraits of students' and teachers' words and actions, as well as the context in which each event occurred.

While providing participants with living images of students' mathematical thinking, we found that videotapes also opened the discourse in ways that the written cases did not. These openings occurred when participants noted and raised questions about aspects of the videotapes that seemed extraneous to the focus questions corresponding to the tape. We speculate that these openings highlight noteworthy differences between facilitating conversations about written and videotaped cases.

The most striking example occurred during Connie's use of videotapes during a session devoted to preparing participants to interview a child. To begin this work, Connie showed a videotaped interview with a young child about numeration. The DMI guide suggested that facilitators show the tape twice: first to have participants focus on the child's knowledge; and second, to attend to the types of questions the interviewer asked.

After the first showing of the tape, Connie asked, "What did you notice going on in the tape?" Several participants offered observations about what the child was able to do and what he struggled with. One participant expressed some surprise that the child could write numbers but had difficulty recognizing the number once he had written it. Connie, pausing for a moment, suggested that perhaps "He was not yet fluent in those kinds of ideas." Immediately, several participants offered alternative, less-cognitively oriented explanations for the child's struggles. "He was out of his comfort zone in the interview," one teacher suggested. Another added, "A child that age really has a minute attention span." A third explained, "He wasn't comfortable anymore; then he started to bounce all over, not only because he was uncomfortable, but because he was tired and it took more concentration."

Without responding to these explanations, Connie called on another participant who seemed anxious to comment. "Is there any reason why she didn't praise him? When he was right, why not say that is correct? Instead, she said, 'Oh, that's interesting.'"

"I wondered the same thing," another participant added, "I just wanted to praise him."

A third participant said, "I also know it helps to praise kids because if you keep looking at them they think they got it wrong. Then they will always look at you and try to change the answer."

At this point Connie paused. It was evident from her expression that this was not the discussion she had anticipated. She explained, "I think she [the teacher in the tape] wanted him to work out where he was before she influenced him."

"But you want the kids to be reassured in their answers that they are right, don't you?" asked another participant.

The discussion proceeded for several more minutes. Participants asked questions and offered opinions about praise and dealing with incorrect answers. Connie responded with questions. She asked whether the interviewer's

stance influenced the child's answers. She asked participants to consider how other actions the interviewer took—a nod, the general neutral stance—influenced the process and the results of the interview. Then she directed the conversation back to the child's mathematical knowledge (Observation, 9/24/96).

In an interview following the session, Connie explained that she allowed the praise discussion to proceed, even though she "wanted to get back to the mathematics." She said, "I do believe that our behavior, a teacher's choice of behaving, does influence children's math. I wanted them to think deliberately about praise in relationship to what it does to mathematics." Connie also expressed concern that she had short changed the mathematical discussion by allowing the praise conversation to go on so long (Interview, 9/24/96).

Several weeks later Connie showed participants a videotape of a child's unusual approach to solving a 2-digit subtraction problem. She wanted participants to see an example of a strategy they had read about in an article that highlighted related research findings. To her surprise, they did not see the connection she expected. Participants commented on what Connie felt were "trivial issues," such as how the student had written the problem on the page and the child's facial expressions. In this situation, Connie described the connection she saw to the readings and then moved on swiftly. In both of these instances, participants tended to focus on aspects of the videotapes that Connie believed were not central. Although this inclination was not limited to discussions of videotaped cases, it did seem much more apparent during them. Participants' examinations of students' thinking through the eyes of a teacher in the narrated cases resulted in different observations than their examinations of unnarrated or edited videotape. The openings prompted by videotaped cases illustrate differences between facilitating a discussion of a narrated case and a video segment. We were struck by the skill required of the facilitator to field this array of unanticipated responses.

Navigating Openings in the Curriculum to Support Teachers' Professional Learning

Thus far we have offered glimpses of four types of openings in the curriculum that we observed three different DMI facilitators confront and navigate. Our aim in this section is to consider what our analysis of openings in the curriculum helps us understand about the work of supporting teachers' professional learning. We begin by revisiting the tensions underlying each opening. Then, by discussing patterns we observed in how the facilitators' approached navigating the openings, we identify and describe three critical components of the work involved in facilitating the DMI curriculum. This analysis lays the groundwork for us to speculate on the nature of the support that facilitators are likely to find productive.

The Tensions Underlying the Openings

Our investigation of openings revealed that a set of tensions underlay the discourse patterns and that these tensions often figured into the facilitators' decision making. We do not view these tensions as "problems" that were avoidable or readily fixable. Instead, they are similar to the dilemmas of teaching identified by Lampert (1985). She argues that because the work of teaching involves attending to multiple, often competing agendas, teachers constantly confront dilemmas of practice. She suggests that the work of teaching involves managing these dilemmas, rather than seeking to eliminate them. Like most curriculum outlines, the DMI guide provides structure and direction, but assumes that the facilitator will play an important role in guiding teachers through that structure. The tensions DMI facilitators faced involved competing goals, expectations, and approaches that facilitators need to navigate. Examining these tensions can provide insights into the work of facilitating teacher learning.

The first opening involved participants' assumptions that facilitators advocated a particular approach to teaching mathematics. Participants routinely questioned or challenged facilitators about details of this "favored approach." Although each facilitator responded to these questions and challenges differently, all three wrestled with similar issues—tensions between what participants wanted from professional

development and the assumptions underlying the DMI curriculum. Participants tended to ask for pedagogical direction and advice while the curriculum's stance discouraged facilitators from providing answers, thus forcing teachers to explore for themselves. The DMI stance assumes that through these explorations teachers will develop a solid base on which to make pedagogical decisions.

In the second opening, we identified a tendency for participants to insert prescriptive advice about how to teach. Facilitators found these instances awkward for two reasons. They wanted to maintain a stance of inquiry in the seminar, so they tried to promote a discourse in which participants asked questions rather than gave answers. But facilitators also wanted participants to find the atmosphere of the seminar safe and supportive. Thus the tension that the facilitators faced in this instance was between their aims of creating a safe and affirming environment and their hopes of maintaining an inquiry-oriented stance in their seminars.

In the third opening, we described the multiple and varied opportunities that arose in each session around explorations of mathematical ideas. In openings of this type, facilitators had to decide what they thought was important for participants to explore or learn, how they might invite participants to do so, how much to push the explorations, and whether the timing seemed right. In some cases these decisions were complicated by the facilitator's own mathematical learning. In other words, facilitators not only confronted doubts about pushing the mathematical learning for others but also struggled to understand the ideas themselves.

The fourth opening we described illustrates the particular kind of challenge that arises while facilitating discussions of videotaped episodes. During these discussions, participants tended to make observations and raise questions along a wide range of issues, many of which drew their attention away from the facilitator's intended focus. Consequently, these discussions were more difficult to keep on course than the discussions based on written cases. A decision to follow the participants' lead, as Connie felt inclined to do, would likely take the discussion well away from the facilitator's planned lesson. While facilitating discussions of videotape segments, Connie faced a tension between her desire to follow the leads of participants' observations and her goal to maintain her intended focus. As we observed, all three facilitators faced this tension during many discussions; however, it seemed more apparent during the videotape discussions.

As we look across the four openings and the tensions that underlie them, we see conflicts between and within the goals and commitments of the facilitators, the expectations of the participants, and the agenda of the DMI curriculum. In other words, openings are created by interactions among facilitators, participants, and the DMI curriculum. To navigate these openings, facilitators had to make determinations about these competing goals. As we discuss in the following section, this navigational activity was critical to the work of supporting participants' learning.

Navigating Openings in the Curriculum

Our observations revealed that facilitators' responses to openings varied tremendously. On some occasions their responses seemed spontaneous, even automatic. At other times facilitators seemed entirely cognizant of the competing goals at play and of the trade-offs that a particular decision was likely to entail. Regardless of the extent to which the facilitators' decisions were explicit or tacit, we found that all three facilitators engaged in a set of three activities central to the navigating process: (a) reading the participants and the discourse, (b) considering responses and possible consequences, and (c) taking responsive action. This cycle of activities, which includes analysis and consideration of goals and taking action, is similar to a model proposed by Remillard (1996) of the teacher's role in shaping the enacted curriculum. Similar to Remillard's findings, we found that this process was not linear, but fluid and interactive and often appeared spontaneous. In the following paragraphs, we draw on our earlier examples of openings to illustrate these activities.

Reading participants and the discourse

Throughout the openings we saw examples of facilitators reading participants and the discourse to take stock of the general group as well

as individual participants' understandings, interests, intentions, and comfort levels. For example, when teachers in Connie's seminar raised questions about the role of praise in supporting children's thinking, Connie entertained several related questions before responding in order to read where the group was on this issue. Connie used the level of concern in participants' voices and the persistence of their questions to determine how important this question was to them. Similarly, when a participant in Jennifer's seminar interjected an imperative related to teaching decimals, Jennifer noted the authority with which he spoke and the awkward silence that fell over the group. Marilyn also read participants in her seminar as they explored the array model of 2-digit multiplication. She listened to them discuss the model, assessing the insights they were gaining.

Considering responses and possible consequences

As facilitators read participants and the discourse, they considered possible responses they might take with respect to their goals for the seminar. Sometimes this process was tacit and happened rapidly. The goals they weighed options against were multiple and sometimes conflicted with one another. For example, in considering whether to question Marvin's pedagogical claim, Jennifer weighed several goals. She believed that neither the content of his advice nor the way in which he stated it supported her goal of promoting an inquiry-oriented stance toward learning. On the other hand, she was concerned that challenging Marvin would fly in the face of another goal—creating a safe and congenial environment for learning. Similarly, when considering how to respond to participants' pedagogical challenges and questions, each facilitator weighed the goal of supporting and acknowledging participants' developing insights about teaching against the goal of encouraging inquiry into mathematical ideas.

In several instances the process of weighing responses against competing goals involved balancing mathematical goals against the curriculum agenda. This was the case for Connie when she considered whether to pursue claims that participants made about place value or stick with the suggested plans offered in the curriculum. She believed that mathematical questions were a productive way to encourage teachers to examine their assumptions. But, she also valued the insights of the curriculum developers and felt reluctant to move the conversation too far off track. Understanding that unpacking the structure of the number system was an underlying goal of the complete module, she suspected that the issues raised in the moment would reemerge. So, she decided not to pursue it at that time.

Taking responsive action

Through the process of considering responses and goals, the facilitators decided how to respond to the opening. Sometimes their actions favored one goal over another. When Jennifer decided not to respond to Marvin's pedagogical interjection in order to keep the discourse smooth, she was following what she believed would foster a safe learning environment. At other times facilitator actions reflected an attempt to navigate two or more conflicting goals. Connie's response to teachers who continually asked for pedagogical advice exemplifies this approach. In deciding to explain her perspective on pedagogical development, and by agreeing to act as a sounding board in these conversations, Connie acknowledged participants' yearning for pedagogical advice while maintaining her commitment to prioritizing mathematical explorations.

Awareness of the Navigational Process

We found that the more options and possible consequences facilitators were able to consider in light of competing goals, the more likely they were to take deliberate action. We saw this difference, for example, in the choices Marilyn made regarding how hard to press participants to examine mathematical ideas. Initially Marilyn tended to avoid these opportunities. She expected that the curriculum itself would support participants' mathematics learning. Her primary concern was to create a safe learning environment for the participants. Over time, as her understanding of competing goals increased, she recognized that the seminar contained limited opportunities for deep mathematical learning. She began to weigh her concerns for a comfortable learning environment against the goal of extending mathematical learning op-

portunities. Her choice to encourage participants to explore the mathematics reflected both her growing understanding of the goal to foster mathematical learning and her sense that a comfortable learning environment may involve risk taking.

We believe that as facilitators gain experience working with the DMI curriculum, they are increasingly likely to recognize places where openings in the curriculum occur. Marilyn, for example, represents a case of a facilitator whose tendency to recognize and deliberately navigate openings increased with her use of the curriculum. Initially she viewed her role as primarily organizational. As the sessions proceeded, she began to take a more deliberate stance in facilitating participants' learning. Through gaining awareness of openings and competing goals associated with them, facilitators may become more likely to take explicit action in response to openings in the curriculum. The relationship between navigating openings and growth in facilitators' awareness of this process is reminiscent of Remillard's (1996) observation regarding teacher learning and curriculum use:

> The most fruitful sites for learning occurred when the teachers had to read the text, their students, or situations in their teaching with an eye toward designing or constructing curriculum. This process of reading and decision making caused the teachers to reexamine their beliefs and understandings that, in turn, influenced the curriculum they enacted. (pp. 256)

Conclusion

The openings in the curriculum we have described emerged from interactions between the DMI curriculum and the facilitators' and participants' understandings and beliefs. Although these first-time facilitators frequently experienced these openings as awkward points in the discourse, they also demonstrated that openings can actually be rich with opportunity. Because openings tend to be initiated by the concerns and observations of participants, including the facilitator, they invite opportunities to structure conversations and explorations designed to extend or challenge participants' knowledge and beliefs. We found that, when the facilitator was aware of the tensions at play and how choices among goals influenced the discourse, the openings had the potential to be places of important learning for both participants and facilitators. In other words, well-navigated openings allowed facilitators to take deliberate action to foster the kind of learning intended by DMI developers. In a sense, openings may be signals that the curriculum is working. From this perspective, even the awkward moments in the discourse held great potential for supporting teachers' learning.

Our close analysis of these openings has helped us understand the work of facilitating the DMI curriculum. Yet, we do not claim that the openings discussed here are the only openings likely to emerge in DMI seminars. As we mentioned earlier, we selected these four openings because of their prominence in our data and because facilitators' struggles with them made their navigational work particularly visible. Our analysis revealed other openings as well. For example, all three facilitators confronted instances in which a participant made statements that were mathematically incorrect. In these instances facilitators struggled with whether and how to encourage participants to revise their mathematical thinking while they managed the group's comfort level with taking risks.

We believe that there may be a set of openings common to DMI seminars that might be investigated. Such an investigation would inform the preparation of DMI facilitators. Moreover, because openings emerge from participants' interactions with opportunities initiated in the curriculum, an analysis of common openings would provide a site for examining participating teachers' learning through DMI seminars.

For now, we turn our attention toward a different question: What does the analytic frame of navigating openings help us understand about using curriculum to support teachers' professional learning about mathematics learning and teaching? In particular, we consider the kind of support facilitators might find productive as they learn to navigate openings in ways that foster learning intended by the curriculum.[3] It is important to note that, regardless of their years of experience in professional development work, the three facilitators in the present study were first-time users of the DMI curriculum. We assume that their navigational work

with openings will change with subsequent uses of the curriculum. In fact, examining these changes over time can offer insight into facilitators' learning. At the same time our findings from these facilitators' initial encounters with the curriculum have implications for supporting facilitator learning.

It seems sensible to suggest that facilitators need to learn more mathematics themselves, as well as skills and dispositions that support inquiry into mathematical ideas. In short, the knowledge and facilitating skills and agendas that facilitators bring to their work make a difference in how they navigate openings. However, our work suggests that more subject-matter knowledge and skill at fostering inquiry alone may not necessarily improve the potential of the DMI curriculum. We argue that productive opportunities for facilitators must also help them learn to (a) recognize openings, (b) identify and unpack the tensions that underlie them, and (c) understand processes of navigating them. We examine each of these suggestions in closing and speculate about how this learning could support facilitators' use of the DMI curriculum.

We identified openings initially by focusing on places in the curriculum that seemed difficult or uncomfortable for facilitators or participants. Through our analysis we came to view openings as places in the curriculum where critical learning goals could be pursued. We believe that facilitators would benefit from learning to recognize openings in the curriculum and frame them as points where participant learning can be supported deliberately. Such a view of openings would cast a different light on the facilitator's role. Although facilitators may continue to find openings difficult to navigate, they would recognize them as the natural consequences of how participants engage with the curriculum. In short, openings could be understood as an indication that the curriculum is working and as places where the most critical and deliberative work of the facilitator can occur.

To support participants' learning within openings, facilitators would need to learn to unpack them. We argued earlier that each opening involved tensions among competing goals. Further, we saw important differences in each facilitator's awareness and understanding of these tensions. We believe that facilitators need to learn to uncover and understand the tensions underlying openings. At the same time they need to have opportunities to examine their own goals and learn about the goals of the curriculum. This learning would involve coming to understand the range of tensions at work in any one opening. It would also involve helping facilitators expand their repertoires of responses within an opening. We observed, for example, the change in options available to Marilyn as she began to see a wider array of alternative goals at play. As a result, she deliberately chose to push participants to explore mathematical ideas more deeply. We can speculate that, through learning to recognize and unpack competing goals underlying openings, Marilyn would be increasingly likely to take deliberate action to foster the learning agendas of the curriculum.

As facilitators learn to unpack openings, they also need to consider possible consequences of actions they might take. This learning, we speculate, would promote a clearer sense of the connections between facilitators' decisions and participants' learning. This understanding is perhaps the most critical of the navigational process. A facilitator's choosing, for example, to act as a sounding board in conversations that move quickly away from mathematical learning and into pedagogical approaches has different consequences for participant learning than asking participants to refocus their conversation on the mathematics in the case. We are not suggesting that one approach is preferable. Instead, we argue that each approach has consequences for the interaction taking place as well as for what and how participants learn, especially over time. We believe that, as facilitators learn to examine various responses in light of possible consequences, they will grow increasingly aware of the range of navigational choices available to them, and the connection between those choices and what participants may be learning over time. This awareness will likely result in facilitators taking increasingly deliberate stances to foster learning that the curriculum was designed to initiate.

Earlier we claimed that in some instances facilitators began to recognize openings in the curriculum and considered various ways to navi-

gate them. However, we argue that relying on experience alone to foster facilitators' abilities to identify openings and use them deliberately to promote participant learning leaves much of what is needed to chance. Just as facilitators need to take deliberate action to support participants' learning, those supporting facilitators must intentionally structure opportunities for each facilitator to learn to recognize, unpack, and navigate openings in the curriculum.

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Notes

[1] An earlier version of this paper titled "Supporting Teachers' Professional Learning Through Navigating Openings in the Curriculum" was presented at the annual meeting of the American Educational Research association, San Diego, April 1998.

[2] The names of facilitators are pseudonyms.

[3] The developers of the DMI curriculum have continued to examine this question. Besides a journal written by a fictitious facilitator in the materials to support facilitators' thinking, they offer a teacher educator institute and an electronic discussion forum for facilitators using the curriculum. These forms of support provide additional sites for future research.

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