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Principals' Views of Mathematics Teacher Learning

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Ongoing reforms in mathematics education in the U.S. have called for significant changes in instruction. Teachers from kindergarten through high school have been asked to include additional topics in their mathematics lessons (NCTM 1989, 2000, 2006). Furthermore, teachers have been encouraged to use instructional methods that foster meaningful student learning of mathematics concepts and procedures (Kilpatrick, Swafford & Findell, 2001). These demands, however, have been found to be quite challenging for teachers, and in many cases, require learning on the part of the teacher (Cohen, 2004; Fennema & Nelson, 1997).

To address this need for mathematics teacher learning, a variety of professional development programs have been developed. Still, research illustrates it is simply not enough to attend professional development and learn new ways of supporting student learning in one's classroom. The school in which one teaches must embrace such learning, and support the extended efforts needed to implement these issues with material and interpersonal resources (Gamoran et al., 2003; Little, 1993). In particular, school leaders are believed to play a central role in promoting mathematics teacher learning. Yet in contrast to the extensive literature on mathematics teachers' knowledge and practice, relatively little is known about the extent to which principals and other school leaders understand the nature of mathematics teaching today and the current demands for mathematics teacher learning.

In this article, we explore this issue by investigating the views held by a group of urban school principals concerning mathematics teacher learning. We focus our investigation on how the principals interpret particular challenges faced by mathematics teachers and the kinds of support they recommend providing teachers in the area of mathematics instruction. The results of this study advance our theoretical understanding of the relationship between the practices of school leadership and teacher learning. In addition, the study offers practical implications concerning how we might support principals in their efforts to promote mathematics teacher learning at their schools.

School Leadership and Subject Matter Reforms

Over the last decade, there has been increased interest in the role of school leaders in the implementation of educational reforms (Nelson, 1998; Spillane, 2000; 2002). One focus of such research has been on the ways in which administrators enable or constrain reforms that target specific subject matter. Research in this area emphasizes that many district and local leaders entered the field of administration at a time when leadership practices were considered fairly generic across academic subjects. Thus, observing a lesson, whether it was in mathematics, science, or social studies, called for largely the same expertise on the part of the administrator. In contrast, current educational theories highlight the subject-specific nature of student learning, and subsequently the need for administrators to be able to recognize features of instruction that are specific to particular domains.

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Related research examines the ways in which school leaders' interpretations of reform influence their leadership practices. In particular, researchers find that beliefs and knowledge about subject matter influence leaders' approach to reform implementation (Nelson & Sassi, 2000; Stein & D'Amico, 2000). For example, Burch and Spillane (2003) examined the views of elementary school administrators and curriculum coordinators concerning mathematics and literacy. They found that, overall, the leaders perceived mathematics to be a well-defined and highly-structured discipline in which mastery develops through formal training. In line with this perspective, the leaders believed that outside expertise was required in order to help teachers at their schools improve mathematics instruction. In contrast, the same leaders viewed literacy not as an isolated school subject, but rather as a diffuse domain related to multiple disciplines. Along these lines, they emphasized school-based activities and the sharing of pedagogical techniques as the basis for improving literacy instruction. Furthermore, as is the case for teachers, coming to understand the goals of reform is not always a simple matter for administrators. Specifically, Spillane (2000) illustrates that while district leaders may be aware of current mathematics education reform policies, they tend to focus on surface-level features of reform, such as the use of manipulatives and group work, rather than on more substantive aspects such as providing opportunities for student mathematical thinking.

PRINCIPALS' PROFESSIONAL VISION

In this research, we examine leadership practice by focusing on one component of leadership expertise that we call *principals' professional vision*. Professional vision is a construct introduced by Goodwin (1994) to describe the ways in which members of a professional discipline attend to the phenomena that is the focus of their work. For example, an archeologist recognizes variations in sands and stone, and a meteorologist can detect patterns in clouds and weather.

In prior work (Sherin, 2001, 2007) we characterized teachers' professional vision as the way in which teachers pay attention to classroom interactions. Furthermore, we identified two central components of teachers' professional vision: (a) how teachers identify significant aspects of classroom interactions, and (b) how teachers interpret what they notice as significant. Thus, teachers' professional vision is concerned both with what teachers notice and how they make sense of these events. Here we extend our investigation of professional vision to principals and in particular, to *principals' professional vision of mathematics teacher learning* (PVMTL). In other words, we are interested in what principals identify as significant issues related to mathematics teacher learning as well as how they make sense of these issues.

This focus on how principals notice and interpret mathematics teacher learning is not entirely new. For instance, Stein and Nelson (2003) discuss the notion of *leadership content knowledge* in the context of mathematics. In doing so, they emphasize the importance of school leaders having an understanding of how teachers learn to teach mathematics as well as an understanding of how to promote such learning among teachers. In other research, Nelson and Sassi (2000) investigate the expertise needed to supervise mathematics teachers. Drawing on the idea of practical judgment (Fenstermacher & Richardson, 1993), Nelson and Sassi argue that administrators need to know what to pay attention to and how to make sense of what they see happening in mathematics classrooms today. Here, we build on such work, but look specifically at how leaders identify and interpret situations that require mathematics teacher learning.

To be clear, by focusing on the professional vision of *principals* in particular, we recognize that we are taking a somewhat limited view of school leadership. Current models of leadership practice emphasize that authority is no longer considered to reside in a single person such as the principal. Instead, leadership in schools is typically distributed among formal and informal leaders (Spillane, 2006). Nevertheless, we believe that our attention to principals in this study is a valuable step towards understanding more broadly how school leaders identify and interpret the need for mathematics teacher learning.

SUPPORTING MATHEMATICS TEACHER LEARNING

Exploring principals' views of mathematics teacher learning requires familiarity with current research on the topic. Therefore, we now provide a brief overview of some key issues related to mathematics teacher learning. First, teaching mathematics effectively today calls for teachers to have an in-depth and well-connected understanding of the mathematics they teach (Ball & Cohen, 1999). Yet in many cases, teachers' knowledge of mathematics is lacking in this regard. For example, as learners themselves, teachers may have experienced multiplication as a set of facts to be memorized

and algorithms to be practiced. In contrast, in working with students today, teachers are expected to explore the meaning of multiplication, and to be able to illustrate multiplicative relationships with visual models and manipulatives. This focus on conceptual understanding in particular has been found to challenge many teachers' own understandings of mathematics (Ma, 1999). Moreover, even when provided with reform-based curricula or other new instructional strategies, teachers' limited knowledge of mathematics may constrain their successful use of the materials (Sherin, 2002).

Second, teachers are expected to pay close attention to the ideas that students raise about mathematics during instruction (e.g., Lampert, 2001). Rather than focus solely on whether a students' answer is correct or not, teachers are encouraged to unpack students' methods and to probe students' reasoning. Such diagnosis of student thinking requires knowledge not only of mathematics per se, but also of the ways that students' understand and learn mathematics (Ball, Thames, & Phelps, 2009). Furthermore, for many teachers, focusing on students' thinking requires a shift in perspective—toward the realization that students can in fact have interesting mathematics ideas, ideas that can potentially move a lesson forward (Franke, Carpenter, Levi, & Fenemma, 1991).

In light of these issues, a number of professional development programs have been created to support mathematics teachers in their own learning. To be productive, such programs must start from the premise that learning to align one's practices with the goals of reform takes time and involves in-depth reflection on the nature of mathematics and mathematics teaching. In particular, research has shown that effective professional development programs often include several common features (Ball & Cohen, 1999; Cohen, 2004; Wilson & Berne, 1999). First, they actively engage teachers in in-depth explorations of mathematics and encourage teachers to share their methods and solutions with peers. Second, they offer teachers the opportunity to analyze student mathematical thinking through analysis of classroom videotape or completed student work. Third, they promote teacher inquiry into and reflection on their own classroom practices.

In sum, the need for teacher learning in the area of mathematics has been clearly documented, as have attempts to support such learning through professional development. Yet the extent to which principals understand these issues is less well known.

Methods

RESEARCH DESIGN

This research takes place in the context of a larger study on the problem-solving practices of urban school leaders. Thirty-five principals from a large urban school district in the Midwestern U.S. volunteered to participate. Two-thirds of the principals were female and one-third were male. Furthermore, approximately one-third of the principals classified themselves as belonging to each of the following ethnic groups: African-American, Hispanic, and White. This breakdown aligns well with the school district as a whole, in which approximately two-thirds of principals identify themselves as belonging to a minority group. The principals averaged 54 years of age, and had, on average, 12 years of experience as classroom teachers and 11 years of experience as principals at their current schools.

Almost all of the principals worked at elementary schools that housed students from grades K – 8, while a few of the principals worked at middle schools. Two-thirds of the schools represented in the study served predominately African-American or Hispanic student populations. In addition, in all but a few schools, 67% or more of the students received free or reduced lunch.

Data for this study come from interviews conducted individually with each principal at his or her school site. In the interview, each principal was asked to respond to six scenarios—two focusing on mathematics teaching, two focusing on literacy instruction, and two exploring more general issues of school leadership. All six scenarios were designed to represent open-ended problems concerning school leadership and involved asking the principal how he or she would respond given a particular situation. The interviews lasted on average one hour. All interviews were audiotaped and transcribed.

For the purposes of this study, we focused exclusively on the two mathematics scenarios. The first of these, which we call Scenario A, described a situation in which the principal is reviewing lesson plans and finds that an otherwise proficient teacher is using a "drill and kill" style of mathematics instruction. In contrast, the philosophy of the school advocates a standards-based approach to support student learning. The question posed in the interview asks how the principal would "bring this teacher on board."

In the second scenario, Scenario B, the principal is told that a number of teachers at his or her school admit to not being comfortable teaching mathematics. In addition, students' test scores illustrate a weakness in the area of mathematics. The principal is then asked, "How will you address this situation?"

DATA ANALYSIS

Analysis of the data proceeded through three main phases. The goal of the first phase was to identify key dimensions along which the principals' PVMTL was exhibited in the interviews. That is, we wanted to establish categories related to what the principals' recognized as salient in the scenarios as well how they interpreted these salient features. To do this, we used a method of open coding (Emerson, Fretz, & Shaw, 1995) in which a subset of 10 interviews were reviewed by two researchers and evidence for potential coding categories was noted. This process was repeated until a stable set of coding categories was identified. As a result, six main coding categories were established: (a) the extent to which the principals focused on the subject matter of mathematics, (b) whether principals related the scenarios to situations experienced at their own schools, (c) steps that principals outlined in describing how they would respond to the teacher(s), (d) whether they offered reasons for the teachers' actions and (e) whether rationales were provided when recommending specific professional development opportunities.

The second phase of analysis involved systematically coding all 35 interviews along each of the specified dimensions. One researcher coded the entire data set, while a second researcher coded both scenarios from 12 principals. Inter-rater reliability ranged from 83% to 100% across all dimensions. Disagreements were resolved through discussion. We note that one participant did not address Scenario A or B in the interview, despite being presented with both scenarios. Two additional participants did not address Scenario A, and one more did not address Scenario B. These responses were removed from the data set and were not coded.

In the third and final phase of analysis, we examined the coded data in order to identify any patterns across all of the principals' PVMTL. In doing so, we identified some patterns that held across both scenarios presented to the principals, as well as patterns that were more specific to one scenario or the other.

Results

Our analysis of the interviews revealed several interesting features of the principals' PVMTL. In particular, three issues related to teacher learning were noticed by the majority of principals: (a) the realistic nature of the situations portrayed, (b) the role of the principal in affecting change in teachers' practices, and (c) the potential of professional development to support teacher learning. Despite these similarities in what was noticed, the principals' interpretations of these issues differed to varying degrees. Furthermore, we also noted one feature of the scenarios that most principals did not attend to in their responses—the fact that the scenarios presented were specific to mathematics. In what follows, we discuss these findings in greater detail. For the reader's reference, the results of coding of each principal's responses can be found in Appendix A.

RECOGNIZING A FAMILIAR SITUATION

Principals' responses indicated that, for the most part, they identified the two scenarios as familiar circumstances that they could realistically envision taking place. Comments such as "this is a situation that lots of schools are faced with" were not uncommon. In addition, the principals often referred to similar issues at their own schools; 73% of the principals mentioned the relevance of the scenarios to what was happening at their schools. Some principals explicitly noted the familiarity of the situation, making comments such as "that is a true scenario here" or "I encountered something similar to that." Other principals described the approaches they were currently using to address comparable situations. For example, one principal explained that "My 4th grade teachers just got back from the state [NCTM] conference," while another commented that "Locally here, we're involved with the Teachers' Academy for Math and Science. Our teachers go to classes there."

Additional evidence that the principals recognized the familiarity of these situations comes from the fact that the majority of principals (77%) were quite comfortable offering explanations for why the situations might have occurred. Principals suggested that the teachers might have been uncomfortable using their assigned curriculum materials, might have needed to improve their proficiency or confidence in math, or (for Scenario A) might have believed that their current teaching methods were effective. In sum, situations in which a teacher needed to improve his or her teaching in a particular area appeared fairly standard to this group of principals.

We note that 25% of the principals did express some skepticism about Scenario A.[1] In these cases, they tended to buy into the concern that a teacher might be using less-than-ideal teaching methods. Their concerns related more to the "technical" aspects of the question. For example, a few principals said that teaching issues were more likely to arise during classroom observations than through reading lesson plans. Other principals commented that they did not believe in imposing an all-school philosophy about how to teach. "It's difficult for me to put myself into this position that there's one philosophy, there's only one way of doing it."

RECOGNIZING A NEED FOR ACTION ON THE PART OF THE PRINCIPAL

In addition to recognizing the scenarios as representing familiar situations, the principals also recognized that they called for action on the part of the principal. Thus, rather than letting things progress in their current course, the principals' responses indicated that they believed they had an active role to play in improving the teachers' instruction in mathematics. Their comments also suggested that, rather than place the responsibility for change entirely on the part of the teachers, other school personnel, or professional development providers, they as principals expected to be directly involved. For example in response to Scenario A one principal explained, "What I would do, well first of all, the teacher and I would have a conversation." And another commented, "First and foremost I must observe her…I have to see for myself." Similarly, after hearing Scenario B, a principal stated "So now my job is to, how do I make teachers comfortable teaching something that they feel a little… insecure with." Rarely did a principal imply that change was primarily up to the teachers stating simply, "Well, they have to go to professional development."

Not only was the need to take action common across the principals' responses, there was also a great deal of commonality in the specific steps that the principals stated they would take. In fact, for both Scenarios A and B, the principals seemed to call on fairly well established routines to respond.

Scenario A Routines

In responding to Scenario A concerning the teacher who uses "drill and kill," principals routinely described three types of actions; principals explained that they would (a) *get additional information* about the situation, (b) explicitly *tell* the teacher what to do differently, and (c) *provide resources* that might help the teacher improve. In all, 60% of the principals referred to all three of these actions in their response; 81% referred to at least two.

Principals seemed to recognize that merely viewing a lesson plan does not provide adequate information about what is happening in the classroom. Overall, 88% of the principals said that they would want to *get additional information* about the situation in Scenario A. Many principals wanted to perform a sort of "triangulation" of the data by conducting classroom observations, looking at student test data, or talking with adults in the school who might be more familiar with the situation. Principals also expressed an interest in getting additional information because they wanted to know more about why the teacher was relying on "drill and kill" methods. It was common for principals to express an interest in "talk[ing] with the teacher to find out her reasoning why." As one principal explained:

> I guess the first thing I'd want to know is does the teacher have the necessary materials to use? Does the teacher know how and feel comfortable using [the materials]? Or is it just a philosophical thing?

Here the principal is concerned both with the materials available to the teacher, and the teacher's perception of whether or not she knows how to use the materials. The principals also described steps that extended beyond gathering information and were intended to instigate change. In all, 75% of the principals said that they would explicitly *tell* the teacher that she needed to adopt new teaching methods. For example, one principal emphasized that she would "explain that this is not acceptable at our school." In contrast, a few principals recognized a need for change, but did not feel that it would be effective to directly tell the teacher what to do:

> It would be something where you wanted the teacher to actually realize she had to change, not with someone dictating to her. …You want them to be, you know to help, a self discovery that maybe there's a different way.

To be clear, a number of principals were explicit that they would tell teachers their expectations in a way they

[1] None of the principals expressed concern that Scenario B was unrealistic.

believed was supportive. For example, one principal said that he "would not come down on the teacher as 'You are wrong,' but [as] 'This is what my expectations are.'" This focus on telling suggests to us that the principals may not be aware of the kind of learning typically required in order to shift one's instruction in line with the goals of reform. Mathematics education reform requires more than a simple change in instructional methods; it requires in-depth knowledge to support the use of such materials as intended. It seems possible that the focus on telling was intended only as a motivational factor, and not as the catalyst for change. However, this distinction was not made by the principals in their comments.

A third action that principals described was to *provide resources* that might help the teacher(s) improve. In using the term "resources" here, we draw on Gamoran and Anderson's (2003) notion that "material, human, and social resources [can] each contribute to schools'…capacity to support teacher change," (p.28). Principals proposed the use of such resources in 78% of their responses to Scenario A. Frequently mentioned forms of support include the opportunity to observe other teachers' classrooms, coaching and mentoring partnerships with teachers and administrators at the school, school-based staff development programs, the selection of new curricula or additional materials, externally facilitated professional development training, and formal coursework in mathematics education.

Scenario B Routines

These three categories of actions can also be discerned in principals' responses to Scenario B but to different degrees (Table 1). (Recall that Scenario B concerned a group of teachers who report that they were not comfortable teaching mathematics.) *Providing resources* was the most common response to Scenario B; all but one principal (97%) included at least one resource as part of his or her plan of action. Principals suggested a broad range of resources to help the teacher in Scenario A, from internally provided, informal support (e.g., peer observation), to more structured, externally facilitated professional development programs. In contrast, the resources suggested to help teachers in Scenario B were much more likely to be brought in from outside the school. For example, principals frequently mentioned formal professional development programs run by curriculum publishers or university instructors. It is possible the principals felt that, because an entire group of teachers needed support in Scenario B, there might not be sufficient resources to turn to within the school. In contrast, in Scenario A, where only a single teacher is described as having difficulty, there would likely have been other teachers within the school who were skilled at using reform-based strategies to support student learning.

Somewhat fewer principals (42%) expressed a desire to *get additional information* as part of their response to Scenario B as compared to Scenario A. We believe that this difference may reflect the fact that more sources of data were included as part of Scenario B (teachers' comfort and student test scores, versus only teachers' lesson plans in Scenario A). Thus, principals may have viewed the gathering of information as a key action, but believed that this task had already been completed in Scenario B.

The most noteworthy difference in principals' responses to the two scenarios is that, in Scenario B, they were much less likely to explicitly *tell* teachers their expectations for a change in teaching practices (24% for Scenario B versus 75% for Scenario A). We hypothesize two potential reasons for this difference. First, the teachers in Scenario B were clearly aware of the need to make a change in their teaching practices, whereas the teacher in Scenario A may or may not have seen a deficit. As one principal stated, "I try to separate those that are unwilling from those that are unable, because there is a major difference in those two

Table 1

STATED PRINCIPAL ACTIONS IN RESPONSE TO THE SCENARIOS			
	Description	**In Response to Scenario A**	**In Response to Scenario B**
Get Additional Information	Gather further data about problem	28/32 (88%)	14/33 (42%)
Tell	Explicitly state expectations to teacher(s)	24/32 (75%)	8/33 (24%)
Provide Resources	Suggest material and/or human supports for teacher(s)	25/32 (78%)	32/33 (97%)

types of people within a school setting." Thus, there may be little need for principals to tell the teachers in Scenario B that they expect a change, when they have already come to the principal asking for help. In addition, it is possible that principals expect *telling* to be more useful when dealing with a single aspect of one teacher's practice than when trying to effect broader change in a group of teachers' approaches.

RECOGNIZING THE ROLE OF PROFESSIONAL DEVELOPMENT IN TEACHER LEARNING

As stated above, one action principals frequently mentioned they would take is to provide opportunities for teachers to participate in professional development. Specifically, the majority of principals recognized that when considering issues of teacher learning, professional development is relevant. In fact, of the three actions described in the previous section, *providing resources* was the most commonly discussed across the two scenarios (in 88% of the total number of responses).

In the previous section, we discussed the range of resources suggested in response to Scenarios A and B. Specifically, principals described support from within as well as outside of their schools, they discussed formal workshops and informal gatherings, and they described resources that drew on both material and human expertise. In doing so, it was quite common for principals to suggest multiple resources that they would offer to teachers; 82% of the time in which resources were discussed, multiple resources were proposed. Yet, principals typically presented these resources simply as a list of possibilities without connecting specific ideas to the learning needed for teachers. For example, in response to Scenario A , one principal said he would ask the teacher:

> How can I help you? …What kind of services? Do you need additional training? Do you need some peer mentoring? Do you need me to come in and do some modeling for you?

In another case a principal stated:

> We can have some of our other teachers do presentations to some of them. If we have funds we can bring a specialist in to talk to them. Whatever textbook series we're using, they have a specialist who will come in. …Sometimes there's somebody at another school, neighboring school, who's really strong at math.

Note that in both of these examples, a number of supports were mentioned, but little detail was given concerning what the resources would involve, for example how much time teachers would participate and whether a program would occur only once or take place in an ongoing manner. Lack of attention to such details was quite common across the responses. In addition, principals typically provided little information concerning the specific content that would be covered in a class or workshop. While principals frequently suggested sending teachers to a workshop, for instance, they did so without elaborating what the content or goals of that workshop might be.

In addition to a lack of detail, principals tended to present multiple resources merely as a collection of possibilities, rather than as a deliberate sequence of actions. This is the case in both examples above. In contrast, in only 11% of responses did principals describe a progression of action, such as "I'd try to have her do some peer observations [first] and then [I'd] send in someone to help coach her along until she feels comfortable." Finally, we want to point out that in discussing different possible resources, the principals did not always provide an explanation as to why a particular resource might be useful given the context of the scenarios. In all, principals offered a rationale for a particular professional development opportunity in only 31% of the total responses (Table 2), and in most of these cases, the rationales reflect little of the complexity of teacher learning required. For example, in response to scenario B, the following principal suggested that he bring in a specialist from the textbook series. He explained,

Table 2

FEATURES OF "PROVIDE RESOURCES" ROUTINE		
	In Response to Scenario A	**In Response to Scenario B**
Multiple resources suggested	21/32 (66%)	26/33 (79%)
Sequence of resources suggested	5/32 (16%)	2/33 (6%)
Rationale for resource suggested	11/32 (34%)	9/33 (27%)

Table 3

SALIENCE OF MATHEMATICS IN PRINCIPALS' RESPONSES		
	In Response to Scenario A	**In Response to Scenario B**
Response does not mention mathematics	21/32 (66%)	15/33 (45%)
Response related superficially to mathematics	7/32 (22%)	12/33 (36%)
Substance of mathematics integral to response	4/32 (13%)	6/33 (18%)

"[The text] might have 400 pages but the kids never get through page 300 so that last 100 pages of math [the teachers] never learn." This principle seemed to recommend a review of mathematics units that most teachers at his school do not teach, rather than, as reformers would advocate, an in-depth investigation of the mathematics the teachers do teach.

ABSENCE OF A RECOGNITION OF MATHEMATICS

While what principals noticed in these scenarios is an important part of their PVMTL, it is also worth noting which aspects of the situations were not salient. In particular, many of the principals did not refer to mathematics at all (see Table 3). In other words, they were not attuned to recognizing these scenarios as subject-specific. One principal even explicitly emphasized the general nature of her response by saying, "There are two things that I believe will be effective in helping teachers succeed no matter what the subject matter is."

It is also worth noting that, even at those times when principals referred to something math-specific, they did not always focus on substantive issues in the teaching of mathematics today. For example, consider the following response to Scenario A:

> I might even ask one of the other teachers…to let her come in and observe how she sets up her cooperative learning groups that are working with the manipulatives and let her see that it's really a very controllable kind of thing to do. …I mean, I have this teacher in mind, as you ask me this question, who is a marvelous teacher but she is from the old school and she does think that kids should be in their desks and they shouldn't be moving around and they certainly shouldn't be playing with manipulatives.

In this response, the principal focused on the need for the teacher to learn how to use manipulatives in the classroom. The use of manipulatives in and of itself, however, does not constitute standards-based instruction. Teachers may simply add manipulatives in support of their traditional instructional approaches rather than use them to promote sense-making on the part of students (e.g. Cohen, 1990). Here then, it seems as if the principal viewed the solution as one of learning new forms of classroom management, rather than of developing new understandings of mathematics or of how manipulatives support student learning. This sort of response was common, even among those principals who displayed an understanding that the domain of mathematics presents its own unique challenges to teachers.

There were a few principals, however, who recognized that in order to improve mathematics instruction, teachers needed to learn not just new ways to manage their classrooms, but new ways of thinking about the subject itself. One principal stated that "Part of the problem, I think, is the fact that many elementary teachers have an elementary certificate…and they're not specialists. The new math that's in place today demands that teachers are literate in math." The implication here is that to be "literate in mathematics" today requires knowledge of mathematics that extends beyond what many elementary school teaches are prepared for. Other principals commented specifically on the new forms of conceptual understanding that students must achieve:

> Most of our kids are weak in making estimation and judgments and doing graphs and percentages; problem solving….They can add, they can subtract, they can count; they do really well on those common things like that, computations. But when it comes to reading a graph, doing estimation, they have a problem with that.

Along the same lines, another principal explained:

> So it's not just all about computation. And basically that's, I'm sure, what you're talking about when you say 'drill and kill.' It's computation, computation, or doing the same thing over and over and over again until you

> get the way I have taught it to you. Because schools really have changed quite a bit and now what you look for are students who are able to utilize the information, methodologies, techniques in more than one area. So, you're looking at being able to cross reference information, and build on your experiences.

These principals emphasized the kinds of mathematics knowledge among students that teachers will need to be able to support. In this way, the principals' PVMTL not only incorporated an understanding of the subject-specific nature of mathematics teaching, it incorporated familiarity with substantive issues related to ongoing reforms in mathematics.

Discussion and Conclusion

In this article, we examined how a group of urban principals view issues related to mathematics teacher learning. In particular we investigated principals' responses to two scenarios that called for improvements in mathematics teachers' instruction. Our study is framed in terms of principals' *professional vision of mathematics teacher learning*. Thus, we were interested in characterizing what the principals noted as key issues surrounding the need for mathematics teacher learning as well as how they made sense of these issues.

First, in terms of what the principals noticed as salient in the two scenarios, there was a great deal of commonality. Specifically, the majority of principals in our sample considered the issue of teacher learning to be quite familiar, and they reported experiencing similar situations at their own schools. At the same time however, the principals did not seem to recognize the complexity of what teachers needed to learn and of the process that would be required to support such learning. In particular, the principals did not usually view the subject area of mathematics as relevant in considering how to address the two scenarios. Most principals did not mention issues related to the particular teaching of mathematics in their responses, or if they did, mathematics was not treated in a substantive context. In only 15% of the responses did the principals discuss specific demands of mathematics teaching and learning and the relationship between such demands and the given scenarios.

This lack of attention to mathematics on the part of the principals is of concern, particularly in light of current research which finds that teacher learning is a decidedly subject specific matter (e.g., Ball & Cohen, 1999). If principals continue to view teacher learning as a generic issue, they may not promote instructional improvements of the sort envisioned by current educational reforms. Furthermore, without an understanding of the complexity of the mathematics learning that is needed, principals are unlikely to recognize and support the difficult process that most teachers engage in as they work to shift their practices in the direction of reform. To be clear, we are not suggesting that principals must be experts in all subject areas—able to diagnose specific teaching difficulties in light of domain-specific issues. Rather, our claim is that principals need to be aware of the fact that supporting teacher learning calls for attention to subject-specific concerns and is a complex and demanding process for teachers.

Second, in considering how the principals made sense of what they understood to be key features of the scenarios, our results highlight that the principals generally relied on established routines to respond. For example, almost two-thirds of the principals explained that, in response to Scenario A, they expected to *get additional information*, *tell* the teacher to change her instruction, and *provide resources* to support the teacher's learning.

Prior research cites the importance of routines in expert performance (e.g., Berliner, 1994). Establishing routines is thought to help experts manage the cognitive load of complex tasks and efficiently direct a range of activities. Similarly, we recognize the potential benefits for principals of drawing on familiar actions to respond to problematic events that arise. At the same time, however, we note that there are limitations to the use of routines. Precisely because they are familiar, people may not question their effectiveness (Spillane, 2006). In this study, for example, all but one principal expected to engage teachers in professional development. Yet most principals failed to mention a critical step in this process—considering why or how certain programs might support teacher(s) given the particulars of each scenario. For instance, what might be the advantages, for the teacher in Scenario A, of observing another teacher at the school versus attending a workshop on the assigned curriculum versus co-teaching a series of lessons with a district mathematics specialist? At issue here are both the affordances of particular professional development programs as well as the needs of the specific teachers involved.

Recall that many principals (77%) hypothesized reasons underlying the problems presented in each scenario. It seems possible that encouraging principals to connect these reasons to the goals of various professional development programs could be a productive way to help principals think more carefully about those programs they make available to teachers. In doing so, however, principals must also examine the extent to which the reasons they propose reflect the substantive challenges that teachers face in implementing the goals of mathematics reform.

Furthermore, 64% of the principals stated that they wanted to *get additional information* by talking with teachers, observing instruction, investigating student work, and more. Despite these claims, few principals explained how they would then use this information in order mediate the given scenario. Several researchers explain that collecting data about current school activities is an important component of school leadership (e.g., Nelson & Sassi, 2005; Spillane, 2006) In line with this idea, the principals in our sample seemed to recognize the value of gathering information about situations they faced. Yet until they learn to apply this information to the situation at hand, the principals are not taking full advantage of this routine. Moreover, in the case of the scenarios we investigate here, the information principals proposed to collect may be precisely the information they need—about the teacher(s) and about the specific difficulty faced—in order to make an informed decision about the kinds of professional development opportunities to pursue.

The lens of professional vision offers a unique approach for studying principals' views of teacher learning. In particular, this construct highlights the need to understand how leaders interpret situations involving teacher learning and what they identify as significant in such situations. Moving forward it will be important to extend this study to other contexts. In particular, rather than relying on principals' self reports, it will be valuable to investigate principals' actions in practice, in the context of their own school sites. Such data would allow us to examine the robustness of the results we report here, and the application of principals' professional vision to situations at their own schools.

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APPENDIX:
Detailed Coding of Principal Responses

	SCENARIO A										SCENARIO B									
					Stated Routines for Addressing Scenario			Features of "Provide Resources" Routine							Stated Routines for Addressing Scenario			Features of "Provide Resources" Routine		
Principal	Questions Validity of Scenario	Offers Reasons for Scenario	Relates to Own School	Role of Mathematics	Provide Resources	Tell	Provide Resources	Multiple Resources	Rationale Provided	Sequence of Resources	Questions Validity of Scenario	Offers Reasons for Scenario	Relates to Own School	Role of Mathematics	Provide Resources	Tell	Provide Resources	Multiple Resources	Rationale Provided	Sequence of Resources
1				Absent	X	X	X	X				X	X	Substantive	X		X	X		
2												X	X	Substantive	X	X	X	X		
3				Absent	X	X	X	X				X	X	Absent			X			
4												X	X	Superficial	X	X	X	X	X	
5		X		Superficial	X	X	X					X		Absent	X		X	X		
6		X		Superficial	X	X	X		X					Absent			X	X		
7	X	X		Substantive		X						X	X	Superficial			X	X		
8		X	X	Substantive	X	X	X	X		X		X		Absent		X	X	X		
9		X		Absent	X	X								Absent			X	X		
10		X	X	Absent	X	X	X	X				X	X	Superficial		X	X	X		
11		X	X	Superficial	X	X	X	X				X		Absent	X		X	X		
12		X	X	Absent	X							X		Absent	X		X	X	X	
13				Absent			X	X		X		X		Absent			X	X	X	X
14	X	X	X	Absent	X	X							X	Absent			X	X		
15			X	Absent		X	X	X					X	Absent			X			
16	X	X		Substantive	X	X	X	X	X			X	X	Substantive		X	X			
17		X	X	Superficial	X	X	X	X	X			X	X	Superficial	X		X	X		
18		X		Absent	X		X	X	X	X		X		Absent			X	X	X	X
19		X	X	Absent	X	X	X	X	X				X	Absent	X					
20		X	X	Superficial	X	X	X	X	X	X				Superficial			X	X		
21		X		Absent	X	X	X	X				X	X	Superficial	X		X	X	X	
22	X	X		Absent	X		X						X	Superficial			X	X		
23		X	X	Absent	X	X	X	X	X	X		X		Superficial	X		X	X	X	
24				Absent	X	X	X	X				X		Superficial			X	X		
25		X		Absent	X							X	X	Substantive	X		X	X	X	
26	X	X		Absent	X		X	X				X		Absent	X	X	X			
27	X			Absent	X							X		Absent			X	X		
28		X	X	Absent	X	X	X	X				X	X	Superficial	X		X	X		
29		X	X	Superficial	X		X	X	X				X	Superficial			X			
30		X	X	Substantive	X		X	X	X			X	X	Substantive	X	X	X	X		
31	X	X	X	Superficial	X	X	X	X	X											
32		X		Absent	X	X	X		X			X	X	Substantive			X	X	X	
33				Absent		X						X		Absent		X	X	X		
34	X	X	X	Absent	X		X	X				X	X	Superficial			X		X	

Note: Empty cells indicate that the principals did not include this information in their responses. Shaded cells indicate that principals did not respond to the given prompt in the interview.