Elementary and Middle School Teachers' Perceptions of their Principals' Instructional Leadership in Mathematics: Preliminary Results[1]

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Introduction

For over a decade, federal, state, and local policy initiatives have focused on how to improve the content and quality of mathematics instruction. Improved student achievement is the primary goal of these reforms. The federal mandates of the *No Child Left Behind Act* and state-mandated, high-stakes, standardized testing are far-reaching examples of such initiatives. Improved student achievement is widely thought to be linked to adoption of standards-based curricula that, in turn, are aligned to standardized tests. However, the implementation of new curricula and policy initiatives often require teachers and administrators to develop new understandings of the nature of teaching and learning. At this time of change, with the exception of recent work by Elmore (2005) and some others, the degree to which teachers' and principals' views of the nature of mathematics instruction are consistent with each other is largely unexplored and yet such common understandings may be essential to long-term instructional reform.

Research has shown that administrators' understanding of high quality mathematics instruction and their ideas about how they can support it are significantly influenced by their ideas about the nature of mathematics, teaching, and learning (Nelson, 1998; Spillane & Halverson, 1998; Spillane & Thompson, 1997). It has been proposed that administrators' leadership content knowledge (LCK) – their knowledge of the subject matter of instruction, and beliefs about how it is learned and how it is effectively taught –

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is critical to their effectiveness as school and district leaders for the improvement of instruction in the school and ultimately, student achievement (Stein & D'Amico, 2000; Stein & Nelson, 2003).

We are currently engaged in a large-scale, mixed methods study of elementary and middle school principals' Leadership Content Knowledge for mathematics. The study investigates the LCK for mathematics of approximately 500 elementary and middle school principals in 14 sites affiliated with 8 Mathematics and Science Partnership (MSP) projects. The MSPs participating in this study are all located east of the Mississippi River in the mid-Atlantic states, the Great Lakes region, the upper mid-west, and the south east. There is one non-MSP site in New England[3] (Nelson, et.al., 2005).

The study is designed, overall, to describe the nature of LCK in a large sample of principals and to examine changes in LCK as a function of participation in a year-long professional development seminar, *Lenses on Learning* (Grant, et. al, 2003 a, b, c, 2005). Three central research questions guide the research effort:

1. How can we characterize the nature and level of LCK for mathematics in a large sample of elementary and middle school principals?
2. What can we learn about LCK from efforts to improve it through professional development?
3. How does LCK affect principals' practice as instructional leader, in particular in terms of their classroom observations, judgments about the quality of instruction, and interactions with teachers regarding their mathematics instruction?

A major source of information for this study comes from pre/post program analysis of participants' responses to a survey instrument that probes principals' beliefs about how students learn mathematics and how it should be taught, and the nature of their mathematics content knowledge. One part of this survey includes Likert-type belief scale items that address principals' views of mathematics and mathematics learning and teaching. The work reported here is sub-study designed to supplement this self-report data by providing some independent information about the effect of the *Lenses on Learning* seminars on principals' practice. To this end, we administered a survey to over 800 teachers working in the schools of principals participating in our study, it contained, among other things, the identical set of Likert survey items.

The teacher survey collected data on these teachers' views of a number of activities that constitute aspects of their principals' instructional leadership in mathematics – how often principals visited math classes, what principals talked with teachers about after classroom visits, the kinds of instructional strategies principals expected teachers to use, and what the overall culture of the school was like with particular attention to mathematics instruction. As we elaborate below, we administered the survey to teachers at the beginning of their principals' participation in the project (in the fall of 2005); a follow-up survey will be administered in the spring of 2006, at the end of the principals'

[3] We attempted to recruit several western and southwestern sites but these sites were unable to participate for a variety of reasons.

participation. This paper presents preliminary results from the first administration of the teacher survey, which provides baseline data on teachers' views of the instructional leadership in mathematics provided by their principals. We also present four case studies in which we examine the beliefs of principals and teachers in the same school about how students learn mathematics and how it should be taught and explore the nature of the alignment between teachers' and principals' views. We offer some speculations about the significance of these particular sets of beliefs and the degree of alignment that we see in the case study schools.

Background and Rationale

Though much of the recent effort in both research and professional development in mathematics education (and other academic subjects) has been directed at changes on the classroom level, it has been well understood for a number of years that the ability to effect large-scale reforms will require a systemic approach (O'Day & Smith, 1993; Togneri & Anderson, 2003). For a number of years studies of the implementation of educational policies have included school policy and practice as well as examining district, state, and national policy (cf. Elmore & Burney, 1997; Fuhrman, 1999). One line of work that views administrative practice in schools as the enactment of policy focuses on the principal and the principal's interactions with teachers as policy-relevant (cf. Coburn, 2002; Hightower, et al., 2002; Nelson & Sassi, 2005; Spillane, 1998).

Our own work proceeds from this perspective. We take the position advocated by Michael Lipsky 25 years ago, that school principals are "street-level bureaucrats" who, in enacting policy, define it. Lipsky (1980) showed that public service workers make important decisions about the provision of services, and exercise wide discretion in their work:

> Policemen decide who to arrest and whose behavior to overlook. Judges decide who shall receive a suspended sentence and who shall receive maximum punishment. Teachers decide who will be suspended and who will remain in school, and they make subtle determinations of who is teachable. (p. 13)

We align ourselves with Lipsky's notion that the daily decisions and actions of "street-level" administrators, in our case teachers and administrators in schools, constitute the implementation of policy, and from this perspective are interested in what principals and teachers know and believe about the learning and teaching of mathematics and how this knowledge and belief affects the actions that they take in schools.

In our prior work, which has involved fine-grained qualitative analyses of small numbers of principals' practice, we have focused on understanding how principals construe their charge to serve as instructional leaders in mathematics in their schools, and have closely examined the ways their understanding and beliefs about the nature of mathematics, and about mathematics teaching and learning, affect their interactions with teachers (Nelson

& Sassi, 2000; 2005). This work has included careful observation of principals interacting with teachers in their schools, for example, during classroom observations and post-observation "supervision" meetings.

As we have moved from small, qualitative studies to a larger, quantitative one, we no longer have the same opportunity to directly observe the relationships between principals and their teaching staffs. The size of the current study makes this impractical, yet we still felt it was important to get a sense of the nature of the of the work principals were doing with their teachers as they provided instructional leadership in mathematics. We were further interested in finding out the degree to which teachers perceive their principals the same way the principals do, and the degree to which there is a consistent perspective about the principal among the teachers in a school. It is easy to imagine that, in schools where principal and teachers share a perspective on mathematics learning and teaching, the kind of work that the staff can do together to further the development of excellent teaching will be of a different sort than in schools where principals and teachers fail to see eye to eye. The survey data we report on here is a first step toward being able to answer these questions and, we hope that it contributes to a systemic look at the school-level implementation of instructional policy in mathematics education.

Research Methods

Sample. To obtain a sample that is sufficiently large and varied to provide valid data about teachers' perceptions of their principals' instructional leadership in mathematics, we randomly drew the names of one-half of the intervention principals' schools from our main study, as well as one-half of the schools of the principals in the control group. For this paper we consider the data from only Cohort 2 of the main study (12 sites) because Cohort 1 surveys (2 sites) were administered on paper rather than electronically and had not been scanned in time for this data analysis.

A total of 195 schools, representing all 12 sites in Cohort 2, participated in the teacher study. We obtained the names and contact information for all of the teachers in those schools who taught mathematics (excluding athletic coaches and other specialist teachers) —approximately 2500 teachers in all. We made several attempts to contact all of these teachers, inviting them to participate in the study and offering a small incentive for doing so. A total of 841 teachers from 137 different schools completed the survey; in 13% of the schools (n=18) greater than 50% of teachers responded. Our analysis showed that the 137 principals were not significantly different from the almost 400 principals in the Cohort 2 principal sample. Analysis also indicated that the 18 schools whose teacher response rate was greater than 50% were representative of the overall Cohort 2 sample.

Data Collection Instruments. Teachers completed a survey that asked them about their perception of their principal's instructional leadership and practices in doing classroom observation and teacher supervision in mathematics. The survey was administered on-line to Cohort 2 teachers, except in one site where paper copies were used. (These surveys were scanned in time for inclusion in this paper so the data for this paper includes

all of Cohort 2.) The survey took about a half-hour to complete. The survey collected data about teachers' professional backgrounds and how they felt about teaching mathematics. It also included several sections that inquired about:

- the principal's approach to mathematics teaching and learning in the school;
- the principal's overall communication style and the kinds of issues the principal comments on after observing a mathematics class;
- the overall culture of mathematics teaching in the school
- the teachers' own beliefs about how children learn mathematics and how it should be taught.

The fourth section listed above was identical to a section on the LCK survey administered to principals, and provided an opportunity to analyze the degree of alignment between teachers and their principals on some basic issues of mathematics, mathematics learning, and pedagogy. While most of the survey was multiple choice and machine scoreable, there were several opportunities for teachers to respond to questions in an open-ended way as well.

Data Analysis. To facilitate analysis, we constructed seven composite variables, which are:

1. Principal's Comments about Math Teaching and Learning: Direct Instruction
2. Principal's Comments about Math Teaching and Learning: Build Student Understanding
3. Principal's Communication with Teacher: Evaluator
4. Principal's Communication with Teacher: Collaborator
5. Professional Community
6. My Principal and I Talk
7. Math Views

To create the first six composite variables, we asked several mathematics education colleagues who had not previously worked with the survey to group the questions into several categories that made sense to them. The convergence in assignment of items to categories among these experts was substantial. Using the items that they all agreed fell into particular categories, we conducted reliability checks on these sets of items to see if they were providing us similar data. The items in each composite variable were highly correlated, with reliability coefficients varying between .83 and .95.

The first composite variable, Principals' Comments about Math Teaching and Learning: Direct Instruction, contains items which address the extent to which the principal appears to emphasize the importance of direct instruction, mastering computation before problem-solving, having a quiet and orderly class, and adhering to the lesson plan. This variable is composed of five items and the reliability coefficient is .83.

The second variable, Principals' Comments about Math Teaching and Learning: Build Student Understanding, contains items that ask if the principal takes a position aligned

with the philosophy espoused in the NCTM *Standards*; for example, emphasizing the importance of developing students' conceptual understanding, encouraging students to make their own math discoveries, working with students' confusion to build strong mathematical understanding, and encouraging students to discuss ideas with each other. This variable is composed of eight items and the reliability coefficient is .95.

The third variable, Principals' Communication with Teacher: Evaluator, contains items that describe the principal as an evaluator of the teachers' instruction. These items include: the principal tends to critique aspects of teaching, the principal tells me his/her evaluation of my teaching, and the principal coaches me in areas that need improvement. This variable is composed of four items and the reliability coefficient is .85.

The fourth variable, Principals' Communication with Teacher: Collaborator, contains items which describe the principal as a collaborator in the teacher's learning. These items include: the principal tends to express curiosity about ideas that come up in my class, the principal asks questions that make me think further about students' math thinking; the principal listens to my ideas about how my students are learning math, and the principal expresses curiosity about ideas that come up in class. This variable is composed of six items and the reliability coefficient is .93

The fifth variable, Professional Community, contains items that characterize the kind of "learning community" that exists in the school; for example, questions about whether the principal encourages teachers to: share lesson plans and teacher-made worksheets, discuss issues brought up in class, discuss math across different grade levels, and observe in one another's classrooms, as well as questions about whether the principal provides time for teachers to meet and share ideas, focuses on instructional issues in faculty meetings, and actively arranges professional development opportunities for the teaching staff. This variable is composed of eight items and the reliability coefficient is .90.

The sixth variable, My Principal and I Talk, contains three items asking the teachers to respond yes or no to whether they talk with their principal about mathematics instruction, about what they do when they teach math, and about mathematics teaching. We interpret this variable to be a measure of the principal's degree of engagement with the teacher about mathematics instruction. This variable is composed of three items and the reliability coefficient is .89.

The seventh variable, Math Views, is a composite variable composed of nine items that also appear on the LCK principal survey. This variable allows us to easily compare teachers' and principals' responses with regard to their beliefs about the teaching and learning of mathematics (as assessed by the survey questions). This variable was constructed using a factor analysis of all the belief scale items. This was the strongest factor that fell out. These items generally reflect a conventional or direct instruction perspective on math teaching and learning. The reliability coefficient is .80.

Findings

Background of teachers

In this section we will report on the background characteristics of all the Cohort 2 teachers who responded to the survey (n=841). They are all elementary and middle school teachers who teach mathematics. They come from 12 sites affiliated with 6 Mathematics and Science Partnership (MSP) projects. The MSPs participating in this study are all located east of the Mississippi River in the mid-Atlantic states, the Great Lakes region, the upper mid-west, and the south east. There is one non-MSP site in New England. The sites represent urban, rural, and suburban districts.

Level of education and teaching history. This is a well-educated group of teachers. Almost 37% have a Bachelors degree, and about 61% have a Masters degree (MA, MS or MEd). Just 2% of the sample hold degrees above a Master's (Certificate of Advanced Study or Doctorate). Almost 14% of the teachers in the Cohort 2 sample held an undergraduate or graduate degree in mathematics or a mathematics-related field. The majority of teachers in this sample (slightly over 90%) hold a standard teaching certificate, nearly 9% have a probationary certificate, and approximately 1% hold provisional, emergency, or temporary certificates.

By and large this sample is comprised of experienced teachers, most of whom have taught at their current schools for a substantial period of time. Table 1 shows the total number of years the teachers in this sample have taught, the number of years they have been at their current school, and the number of years they have taught at their current grade level. This group of teachers has very stable teaching histories. The largest part of the sample, 76%, have taught between 4 and 20 years. 60% have been at their current school 4 – 20 years, and 57% have taught at their current grade for 4 – 20 years. Eighty-one percent of the teachers in the sample teach elementary school (grades K-5), and the rest teach middle school (grades 6-8).

Years	Total Years Taught		Years Current School		Years at Current Grade	
	n=684	%	n=830	%	n=775	%
3 or fewer	107	16%	263	32%	316	41%
4 to 10	295	43%	337	41%	305	39%
11-20	228	33%	169	20%	139	18%
21 or more	51	8%	59	7%	13	2%

Table 1
Teaching Experience of Cohort 2 Teachers

Teachers' orientation toward mathematics and mathematics instruction. In order to better understand the perspective toward mathematics and mathematics instruction that teachers were coming from when they responded to the survey, we asked teachers how they felt about teaching mathematics and about their comfort level with math. We

speculated that teachers' own feelings about and comfort with the math they were teaching might influence their responses on the survey about their principals' instructional leadership. When asked about their feelings about teaching mathematics, overwhelmingly teachers responded that they liked teaching mathematics (85%) and only slightly less than 2% reported that they disliked it; for 13% of the sample their feelings were neutral or slightly positive.

These percentages are similar to the percent of teachers who reported that they were comfortable with math: almost 87% of the sample responded that they would rate themselves as feeling comfortable with math overall, and just over 94% of the sample rated themselves as feeling comfortable with elementary school math. (Only 48% of teachers rated themselves as comfortable with middle-school math; nearly 28% indicated they were uncomfortable with middle-school math.) Not surprisingly, more elementary teachers reported being comfortable with elementary school math (95%) than with middle school math (42%), while middle school teachers reported essentially equal levels of comfort (96% of them were comfortable with elementary school math and 90% reported feeling comfortable with middle school math). Overall, the teachers in this sample seem to have a positive view of mathematics and are comfortable with the level of mathematics that they are currently teaching. Given that this survey was explicitly about math, it may be that teachers who like math and are comfortable with it were more likely to respond.

Teachers and their principals

Teachers reported that their principals were quite active in visiting mathematics classes. Table 2, below, shows the number of times teachers reported that their principals were likely to visit their math class in a given school year. Although almost half of the teachers reported that their principal visits their mathematics class once or twice during the school year, 45% of teachers reported that their principal visits their math class three or more times a year, and nearly 20% reported that principals visit their class 5 or more times a year. The data in Table 3 shows that 43% of teachers report that principals' visits are less than 15 minutes in length. This suggests that many principals pop in and out of classes rather than staying for extended periods of time. We wonder whether principals who are visiting classes in this way are there long enough to assess the substantive work of the class. It is also possible that most of the teachers who responded to this survey are sophisticated mathematics instructors and principals tend to think that since their instruction is good, they do not need to spend a lot of time with these particular teachers. Furthermore, we cannot tell from these data whether the principals who visit less frequently stay longer, or the principals who visit often stay for shorter periods of time. Some principals may be doing only one long, substantive visit and then use shorter visits to confirm or disconfirm impressions they got on the longer visit.

We did not find a correlation between the number of years a teacher has taught and the number of times the principal visits his or her math classroom. In many districts principals are required to observe teachers who are new to the district at least once during

Frequency of principals' visits (per year)	% of teachers
Not at all	7% (n=60)
Once or Twice	48% (n-397)
Three or Four	26% (n=213)
Five or More	19% (n=163)

Table 2
Teachers' reports of frequency of principals' visits to mathematics classes

Approx. length of principal's classroom visits	% of teachers
Less than 15	43% (n=357)
15 to 30	26% (n-218)
30 to 45	22% (n=185)
45 or more	9% (n=76)

Table 3
Teachers' reports of duration of principals' visits to mathematics classes

the school year and often more frequently. We do not see this showing up in these data, though these principals probably observe the new teachers teaching a few different subjects.

Data from the survey indicate that almost all of the teachers looked to colleagues for support and guidance in teaching mathematics, but only 39% looked to their principal (see Table 4). The survey included a small space for teachers to write about additional sources of support that they used and they commonly listed websites and professional development workshops. Since the vast majority of the teachers who responded to the survey are in districts participating with an MSP project (94% of respondents), professional resources outside of their school may be more prevalent and accessible than for the average population of teachers.

	Yes	No	N/A
Principal	39% (n=286)	58% (n=421)	3% (n=21)
Assistant Principal	18% (n=122)	41% (n=283)	41% (n=283)
Colleagues	99% (n=808)	1% (n=7)	0% (n=0)
Professional Resources outside your school	83% (n=620)	14% (n=104)	3% (n=25)
Math Specialist or Coach	57% (n=416)	18% (n=133)	25% (n=186)

Table 4
Sources of support for teachers in mathematics

Although we do not have data that compares principals' involvement in mathematics instruction with their involvement with literacy instruction, the overall findings from this

teacher survey seem to support Spillane's (2005) finding that primary school principals were much less likely to be involved with leadership roles in mathematics than for language arts (and even less likely to be involved with leadership routines in science). It may be that if we asked the sample of teachers to whom they look for support in language arts, more of them would report that they look to their principal. In our data, teachers performed leadership roles in mathematics more than their principals.

The teachers also reported on the mathematics materials that the principal expected them to use. Almost 83% of the surveyed teachers reported that their mathematics text is mandated by their school system. However, only 70% of teachers reported that their principal expected them to use a published math program on a daily basis. While there seems to be a discrepancy between the existence of a mandated text and its expected use, on the survey teachers could also indicate that their principal expected them to use a published math program as needed, which 24% of them did. Added together, 94% of the teachers surveyed were expected by their principal to use a published math program daily or as needed. This finding highlights the importance of the choice of curriculum and the quality of implementation of that curriculum to math instruction in elementary and middle schools, because that math program will be the primary means of instruction.

Table 5 summarizes teachers' reports of how often their principals expect them to use supplementary "skill and practice" materials, supplementary hands-on/problem-solving materials, and materials teachers have collected or created. Expected use of supplementary materials on an 'as needed' basis was very high, regardless of whether these were for skill and practice or for hands-on/problem solving.

	Never	Monthly	Weekly	Daily	As Needed
Published Math Program	2% (n=14)	.1% (n=1)	5% (n=43)	69% (n=573)	24% (n=200)
Supplementary Skill and Practice Materials	1% (n=9)	.4% (n=3)	8% (n=62)	27% (n=219)	64% (n=527)
Supplementary hands-on/problem-solving materials	1% (n=8)	.5% (n=4)	12% (n=102)	34% (n=277)	52% (n=431)
Materials collected or created	1% (n=9)	1% (n=8)	8% (n=61)	16% (n=126)	75% (n=610)

Table 5
Type of mathematics instructional materials principals expect teachers to use

In asking teachers about how often their principals expect them to use supplementary materials we wanted to see whether schools differed in their emphasis on the use of skill/practice materials and hands-on/problem-solving materials and if this was related to the curriculum that the school used. For example, in a school using an NSF-sponsored curriculum like *Investigations*, was it more or less likely for the teachers to be expected to supplement with skill and practice materials? The data that specifies which curriculum a

school currently uses comes from our survey of principals. This analysis will be forthcoming.

Alignment of teachers' and principals' beliefs about the learning and teaching of mathematics. The teacher survey contained two sections that were identical to the sections on the LCK principal survey, making it possible to compare the responses of the teachers to the responses of their principals. The first of these sections asked participants to rank their comfort level with math overall, as well as their comfort level with elementary school math and middle-school math, specifically. The second section contained 18 statements that asked teachers and principals about their own beliefs about the teaching and learning mathematics[4].

Table 6 presents a side-by-side comparison of teachers' and principals' responses to the question of their comfort level with mathematics. The teachers' overall comfort with math was much higher than the principals': only 45% of principals said they were comfortable with mathematics, overall, while 87% of teachers said that they were. It is perhaps not surprising that teachers express more comfort with math than do principals, since they teach math regularly. However, since more than half the principal sample reported they are not comfortable with math overall, we wonder how this might affect their ability to perform classroom observations and be an instructional leader in the subject.

	Teachers			Principals		
	Uncomfortable	Neutral	Comfortable	Uncomfortable	Neutral	Comfortable
Overall	4% (n=28)	9% (n=65)	87% (n=618)	32% (n=43)	23% (n=30)	45% (n=60)
Elementary math	1% (n=9)	4% (n=31)	94% (n=674)	6% (n=9)	10% (n=14)	83% (n=111)
Middle-grades math	28% (n=196)	24% (n=170)	48% (n=343)	40% (n=53)	18% (n=24)	42% (n=56)

Table 6
Teachers' and Principals' degree of comfort with mathematics

In the belief-scale section of the surveys we noticed several interesting trends in the principals' and teachers' responses. Participants were asked to respond to the statements in the survey on a 7-point scale, where 7 indicated a view of mathematics teaching and learning aligned with the NCTM *Standards*, and 1 indicated a more conventional view of teaching and learning. Most of the principals and teachers in our sample agreed with instructional methods that support the NCTM *Standards* such as group work, discussions, and the use of manipulatives. There was more variability and disagreement in their responses about items that considered how mathematical concepts are learned and taught. While this at first seems contradictory, earlier research by Cohen and Hill (2001) find similar trends with a different sample of teachers and Nelson, et.al. (2004) found this

[4] This section of our instrument was adapted from an instrument created for the Teacher Education and Learning to Teach study conducted by the National Center for Research on Teacher Education, Michigan State University, 1985.

trend among a small sample of principals. Nelson and Sassi (2000) and Spillane (2000) provide two different, but complementary, explanations for this phenomenon from the literature on administrators. One explanation is based on the history of administrator training for classroom observation, the other based on administrators' views of the nature of mathematics instruction itself. Cohen and Hill provide tentative explanations for the teacher population.

In a study of administrators' supervisory practices, Nelson and Sassi reported that, deriving from process-product research on teaching that emphasized teacher behaviors, many principals have been trained to attend to the behavioral features of classrooms such as wait time and objectively observable indicators of student engagement. Principals typically do not attend to the mathematical thinking that is going on. When they observe standards-based mathematics classes they tend to continue to focus on behavioral features of the class but substitute a new set of behaviors for the old. Now they look for the presence of manipulatives, small group discussion, students explaining their problem-solving strategies, etc. These features tend to be easily observable, generic features that are independent of the mathematical thinking going on in the class. Such principals have not shifted their observation practices to look for how teachers' *use* of these pedagogical tools gives their students the opportunity to do the hard work of making sense of the mathematical ideas at play in their classroom. It is only as principals' views of how children learn mathematics move toward a constructivist position that they begin to consider how teachers' pedagogical moves might influence the development of students' ideas.

In his study of district leaders (including principals) who had recently participated in mathematics education reforms, Spillane (2000) found that district leaders tended to focus on the *form* of the reform rather than the *function* of the reform (the function being the development of conceptual understanding of mathematics in addition to procedural knowledge). When focusing on the instructional *forms* of classrooms, principals tended to see the use of manipulatives, group work, and student discussion, and they missed deeper aspects of what mathematical thinking the students are doing. Spillane goes on to say that, "…these forms of instruction were understood chiefly in terms of modal pedagogical functions, that is, as instructional strategies that preserve the conventional view of mathematics as teaching procedural knowledge" (p. 154). District leaders easily shifted their focus from one kind of surface feature to another, but their deeper understanding of what mathematics means had not changed.

In their study of California teachers who had been through a decade of reform efforts in mathematics, Cohen and Hill (2001) found that teachers had adopted many of the reform ideas, but most also held onto corresponding (and from the reformers' perspective contradictory) conventional ideas about mathematics teaching and learning. They offer several possible explanations, the first is similar to Spillane's analysis above, that the closer the reform statements came to requiring significant rethinking of what it means to know mathematics and how mathematics is learned, the less likely teachers are to agree with them. Cohen and Hill argue that teachers can easily add things like manipulatives, discussions, writing about math, and group work to their math lessons because these are

instructional strategies they are already familiar with. However, changing their core beliefs about what it means to teach and learn math is much more challenging. Cohen and Hill's second explanation for these apparently contradictory data is that teachers are sent so many disparate and conflicting messages from policymakers, district leaders, and school leaders that they may have learned to piece together inconsistent messages to form a composite by which they can teach. The third explanation they offer is that teachers learn from their practice that neither the reform nor the conventional platform meets the needs of all of their students and so they take the instructional strategies and ideas that work best for them and their students without worrying about what philosophy of learning these strategies and ideas come from. All of these explanations paint a complex picture of what is happening as principals and teachers at the school level go about enacting and defining policy.

The data from our study suggests that principals and teachers in our sample seem to have accepted surface-level changes of classroom pedagogy, but are still grappling with some of the deeper level changes in how to think about the subject of mathematics. Our preliminary analysis of the belief scale items found the same trend as in the research cited above (Cohen and Hill, 2001; Nelson et.al., 2004; Nelson and Sassi, 2000, and Spillane 2000). Of the eighteen statements on this scale, there were four that the principals in our study agreed with more strongly than any of the others: that students should discuss ideas, work together on tasks, use models and visual aids, and show their work when solving problems. Between 80 and 93 percent of teacher and principal respondents agreed with these statements. These data suggest that these teachers and principals look for and agree upon certain features of classrooms that teachers can easily enact and principals can easily see, and that these are considered to be good instructional practices. We speculate that these principals are looking at the behavioral aspects, or forms, of classrooms much as they always have. They are simply looking for different instructional forms and that teachers may not have changed their understanding of what it means to teach math and to know math, but have embraced these instructional techniques. On these ideas, the teachers and principals are in alignment.

There was another set of four items where there was a high degree of variance in both the principals' and the teachers' responses. These items all related to deeper features of mathematics classrooms—statements that challenge conventional ideas the most and offer a different perspective on what it means to learn and teach math. These items relate to how teachers and schools navigate individual students' mathematical thinking. They include items about how teachers should structure student learning—for example, the role of confusion in learning, how to best serve students who are having difficulty, the importance of remembering the correct rules or formulas to solve problems and when might students be ready to consider new ideas. How teachers and principals respond to such items relate to their beliefs about how students learn mathematics. Do they view students as building their conceptual understandings each day, filling in more pieces, making more linkages? Or do they view students as layering one piece of knowledge on top of another, and without a strong foundation, nothing more can be built? These items suggest areas where these teachers and principals may be reconceptualizing what it means to teach and learn math, and the fact that their thinking is under

development (and therefore also in flux) that contributes to the higher degree of variance in their responses to these items.
Interestingly, the teachers' responses indicated a higher degree of agreement with these more conventional statements than did the principals' responses. Ten to thirty percent more teachers agreed with these conventional items than principals. This suggests that teachers are more likely than principals to hold on to these conventional beliefs and to merge them with reform practices. Perhaps this is due to the second and third explanations that Cohen and Hill (2001) offer—that teachers piece together the inconsistent messages that they get about mathematics instruction to appease a wide variety of constituents (district leaders, school leaders, parents), or that teachers may have learned from experience that having a wide repertoire of instructional strategies is the best way for them to meet the needs of all their students. These findings again point to how important the daily decisions of teachers and principals are to how mathematics policy gets implemented and enacted.

Summary. By examining data from both our survey of principals' LCK and our survey of associated teachers we are able to characterize these principals and teachers as groups. The majority of the teachers are experienced and by and large are comfortable with the mathematics that they teach, though their beliefs about how children learn mathematics and how it should be taught are slightly more conventional than are the principals' beliefs. The principals are less likely to be comfortable with mathematics. Many of the principals observe math classes briefly (though they may observe these same teachers in other subjects more often) but a surprising proportion visits the teachers' math classes 4 or 5 times a year. Each of our analyses of this group data raises provocative questions for further investigation.

While the group data is interesting and useful, we were especially interested to look at the places where we could examine data from principals and teachers who work in the same schools. As we noted earlier, much systemic study of mathematics education reform has focused on district, state, and national levels. However, it is in the daily work of principals and teachers in schools that "the rubber meets the road," so to speak. This is where what principals and teachers believe about mathematics education, and the kinds of leadership and instruction they, together, are able to provide, determines the way policies promulgated in other parts of the system actually play out in the lives of children.

In the following section of this paper we examine four of the 18 schools for which we have LCK data for the principals and teacher survey data for at least 50% of the teachers in the school. These case studies offer a glimpse of the dynamic environment within schools, in which important issues of mathematics instruction are being worked out (or not) on a daily basis.

Profiles of four schools

The schools profiled here were chosen to represent different configurations of principals' LCK, teachers' and principals' beliefs about mathematics learning and teaching, and the

level of the principal's engagement with teachers in matters related to mathematics instruction. In each profile we sketch out the degree of alignment between principal and teachers on a number of dimensions and raise conjectures about how each school is positioned to move forward with its mathematics program.

Galahad [5]

Principal's LCK - high math, progressive beliefs about learning and teaching, high alignment of beliefs between principal and teachers, high engagement

At the Galahad Elementary School (grades K-5), the combination of data from the LCK principal survey and the teacher survey present the profile of a well-aligned school in which the teachers and principal are engaged together in implementing a new math curriculum which aligns with their shared beliefs about how students learn math and the most effective pedagogical approaches for teaching math. The principal's strong math background and knowledge of mathematics for teaching, as well as beliefs aligned with those of the teachers' and those underlying the curriculum materials they use, put him in a good position to lead this school in improving mathematics instruction and student achievement.

The principal at Galahad has 16 years of administrative experience in both suburban and rural schools, as well as 14 years of teaching experience. For seven of those 14 teaching years, the principal taught math and language arts at the middle school level. He took a significant amount of mathematics coursework in high school (more than four courses), and went on to study calculus and linear algebra in college in addition to taking two math courses for educators. This level of mathematics coursework is unusual in our sample of principals. Not surprisingly, the principal reported that he feels extremely comfortable with mathematics overall, and with elementary and middle-school mathematics in particular. The principal's score on the mathematics for teaching portion of the LCK survey[6] was among the top fifteen percent of scores in our principal sample, reflecting the strong math background this principal reported.

In addition to his high mathematics score on the survey, this principal's responses in the beliefs section indicated that his beliefs were similar to the philosophy and approaches articulated in the NCTM *Standards*. This principal's responses were in the highest one-third of all the principals who were surveyed, with a score on the Math Views composite variable of 5.2 (on a scale of 1 to 7). The viewpoints of principal and teaching staff at the Galahad School were well aligned: the average Math Views score for teachers was 4.8 (above the mean of 4.1 for all teachers surveyed).

In 2005-06 (the year our teacher survey was given), Galahad was in its first year of implementing *Everyday Mathematics*, an NSF-funded program designed according to the

[5] All schools are identified by pseudonym.

[6] This section of the LCK survey was adapted from Ball et al (2002), who have created a corpus of items measuring teachers' mathematics knowledge for teaching as part of a *Study for Instructional Improvement (SII)*. All of the items have been field tested with teachers and analyzed for validity and reliability (Ball, Hill, & Bass, 2002; Hill, Schilling, & Ball, 2003).

principles underlying the *Standards* (Goldsmith, Mark, & Kantrov, 2000). Prior to this, the school used basal textbooks. Given the high degree of alignment in beliefs between the teachers, principal, and the curriculum materials now in use, we would expect that adoption of this new curriculum would likely be uncontroversial within the school. Comments from the teachers indicate that *Everyday Math* has, indeed, been enthusiastically accepted. For example, consider the following teachers' observations:

- "I enjoy the excitement of our new math program seen by my students and parents. The in-services have helped to make starting a new program very easy."

- "Hands-on math activities in math motivate both the teacher and the students. All of *Everyday Math* is hands-on."

In additional to an alignment of beliefs between principal and teachers, the teachers in this school report a high level of principal engagement with mathematics instruction. For example, in addition to turning to colleagues for support, 85% of the teachers at Galahad reported that they look to the principal for support, guidance, and suggestions in teaching math. This is one of the highest percentages for any school in the whole Cohort 2 sample of 137 schools. This principal also visits math classes frequently. All teachers responding to the survey at Galahad reported that the principal would visit their math class at least once during the school year and 64% thought the principal was likely to visit three or four times during the year. Most of the teachers, 85%, reported that the principal would stay for 30-60 minutes to observe a math lesson. Again, this shows much more principal engagement in mathematics instructional leadership than in the majority of schools in this sample.

Table 7 shows Galahad teachers' responses to survey questions about the principal's approach to mathematics teaching and learning and communication style (particularly after classroom observations), and the overall culture or community of mathematics instruction in the school. (In Table 6, the mean ratings of the teachers at the Galahad School are compared to the overall sample means.)

The teachers at Galahad school report that the principal makes slightly fewer than average comments about teaching that follow a direct instruction model for our overall sample, but makes more comments than average that show a belief that students build their own understanding in mathematics (among the top third of the sample). This aligns with his responses on the epistemology section of the survey, which also lean towards a progressive view of mathematics teaching and learning.

The supportiveness of the professional community in this school again is above average for our sample. Teachers noted that their principal talks to them about their mathematics teaching more than average for our sample (their ratings were in the top third of the entire sample of responding teachers) Their responses to this question aligns with the observation that a vast majority of the teachers (85%) reported that they look to their principal for support and guidance in mathematics instruction.

	Overall Sample mean (n=841)	Galahad mean (n=14)
Comments about Math Teaching and Learning: Direct Instruction	3.2	3.0
Principal's Comments about Math Teaching and Learning: Build Student Understanding	4.2	5.4
Principal's Communication with Teacher: Evaluator	4.2	5.8
Principal's Communication with Teacher: Collaborator	3.8	5.0
Professional Community	4.7	5.1
My Principal and I Talk (scale 1 to 3)	1.6	1.9

Table 7[7]

Mean ratings of the Galahad Elementary School teachers' perceptions of their principal's instructional leadership variables in comparison with entire sample means

Tall Oaks

Principal's LCK- average math, conventional beliefs about mathematics teaching and learning, some alignment of principal's and teacher's beliefs, high engagement

Tall Oaks Elementary (grades K-5) is a school in which both principal and teachers have relatively conventional beliefs about how mathematics should be taught. The principal is quite active and engaged with the math program and, unusually, many of the teachers look to her for guidance and support in mathematics. While she principal did not report what curriculum the school is using, we speculate that it is a basal program, and that the

[7] In table 7 all of the variables are on a scale of 1 to 7 except for the My Principal and I Talk composite which is on a scale of 1 to 3. The higher the value, the more likely the principal's comments reflect that position. For example, if the teachers reported that the principal always made comments about mathematics teaching and learning that were aligned with a direct instruction approach, the mean would be a 7 for the variable 'Comments about Math Teaching and Learning: Direct instruction'. If the teachers reported that the principal always made comments about mathematics teaching and learning aligned with a instructional approach to build student understanding, the mean would be a 7 for the variable 'Comments about Math Teaching and Learning: Build Students Understanding'. This also holds for Tables 8, 9, and 10 where we report on these data.

adoption of a standards-based curriculum might be problematic for this school, despite the high level of principal involvement in the mathematics program, because both teachers' and principal's beliefs are more aligned with traditional math programs (though not completely aligned with each other). It is likely that substantial professional development would be needed in order for all the staff of this school to begin to develop some comfort with the approaches of such curricula, a sense of what mathematics classrooms could look like, and some of the mathematical and pedagogical practices that are called for by these new materials.

The principal at the Tall Oaks Elementary School is relatively new to her job, with just 4 years of administrative experience as a principal and assistant principal in rural areas, although she became a principal after 17 years in the classroom, (she taught grades 5, 6, 7, and 9, and taught all subjects in grades 5 and 6 for 14 years). The principal's own mathematics background includes high school and college algebra, as well as statistics and math for elementary teachers. Unlike the principal at Galahad, the Tall Oaks principal reported being uncomfortable with math overall and with middle school math as well. (She did report feeling comfortable with elementary school math.) She reported attending recent mathematics professional development activities through the local MSP. Despite indicating an overall discomfort with mathematics, this principal's mathematics score on the principal survey was slightly above average (score of 20; average score for the entire sample was 18 out of 31). While this principal reported an overall discomfort with mathematics, most of the Tall Oaks teachers responding to our survey did not: 80% expressed overall comfort with mathematics and 100% say they are comfortable with elementary math. (In contrast, however, only 27% feel comfortable with middle school math. Since Tall Oaks is an elementary school, few teachers would be experienced with or expected to teach middle-grades math. Seventy-three percent of teachers report that they like teaching math, 20% are neutral, and only one teacher (7%) reports disliking teaching math.

In contrast to the principal at Galahad, the Tall Oaks principal's score on the epistemology portion of our survey indicated beliefs leaning towards directed instruction or guided discovery as preferred instructional strategies for mathematics. In this regard, survey results suggest that Tall Oaks principals and the teachers share similar beliefs about the learning and teaching of mathematics. The principal had a Math Views score of 4.1 (in the bottom third of the sample of principals), and the mean score for Tall Oaks teachers on this variable was 3.2, in the lower third of all teachers surveyed. Thus, while teachers and principal are fairly well aligned in their views, these views are more traditional than the (also aligned) views of the staff at Galahad. Because we do not have information about the mathematics materials in use at Tall Oaks, we cannot speculate how beliefs about mathematics and mathematics learning and teaching might interact with their mathematics instructional materials.

As at Galahad, the teachers at the Tall Oaks Elementary School reported that their principal had a high level of engagement in discussing the teaching and learning of math and in creating a collegial professional environment. For example, 73% of these teachers look to the principal for support—well above the average of 40% for the whole sample of

teachers. Teachers also look to their assistant principal for support, 69% reported. (As is common in this sample, all teachers report looking to colleagues for support.) Also uncommon in this school is that 60% of the teachers report that the principal visits 5 or more times in a school year. In the entire Cohort 2 sample only 19% of teachers say the principal visits their classrooms that frequently. When the Tall Oaks principal visits, 73% of teachers report that s/he stays for 15-45 minutes.

Table 8 summarizes Tall Oaks teachers' responses to survey questions about the principal's approach to mathematics teaching and learning, communication style (particularly after classroom observations), and the overall culture or community of mathematics instruction in the school. The mean ratings of the teachers at the Tall Oaks school are compared to the overall sample means.

	Overall Sample mean (n=841)	Tall Oaks mean (n=16)
Principal's Comments about Math Teaching and Learning: Direct Instruction	3.2	4.8
Principal's Comments about Math Teaching and Learning: Build Student Understanding	4.2	5.4
Principal's Communication with Teacher: Evaluator	4.2	5.5
Principal's Communication with Teacher: Collaborator	3.8	5.2
Professional Community	4.7	6.0
My Principal and I Talk (scale 1 to 3)	1.6	1.8

Table 8
Mean ratings of the Tall Oaks School teachers' perceptions of their principal's instructional leadership variables in comparison with entire sample means

The teachers report that the principal makes more comments than average as compared to our total sample about the teaching and learning of math overall (top third of all teachers surveyed) and that the principal places significantly more emphasis on comments relating to the direct instruction of mathematics than teachers in the study typically report (top twenty percent of all teachers surveyed). This finding is in line with the findings of the principal survey that the principal's beliefs lean towards a conventional view of mathematics teaching and learning.

The Tall Oaks teacher data suggests that their principal communicates with teachers about their mathematics instruction more frequently than average (top third), and that her conversations with teachers about mathematics class have an emphasis on both evaluation and collaboration. The teachers' ratings on the professional community variable is also in the top third of our survey responses. This finding is consistent with the teachers' report that 73% of them look to the principal for support and guidance in mathematics instruction.

Wheatley

Principal's LCK - average math, mixed beliefs about how students learn mathematics and how it should be taught, low alignment with teacher beliefs, low engagement

At Wheatley Elementary School (grades K-5), the principal reports being uncomfortable with mathematics and her mathematics for teaching scores indicate that her mathematical knowledge is modest. Her beliefs about how math should be taught are relatively progressive, but, according to teachers' survey reports, she does not implement these beliefs when doing classroom observations. Furthermore, on our survey, the teachers report she is less engaged with mathematics instruction than are the principals at either the Galahad or Tall Oaks schools.

The teachers, on the other hand, are less progressive in their beliefs than the principal. While the school uses *Everyday Mathematics*, the teachers find it frustrating. Given that the teachers' responses on the belief scale items were neutral and that the principal (whose beliefs are more aligned with *Everyday Mathematics*) isn't perceived by the teachers as providing strong leadership in mathematics instruction, it is not surprising that some teachers might find the program frustrating. It is likely that mathematics instruction in this school would benefit from both a more engaged principal who can connect her ideas to her practice and professional development for the teachers to help them better understand how to teach with this curriculum.

The principal at the Wheatley Elementary School has 16 years of administrative experience at the elementary and middle school levels in suburban areas and nearly 26 years of teaching experience. For five of her years as a teacher, she taught all subjects in grades 4, 5, or 6; the other 20 years were as a middle school English and Social Studies teacher. The principal took three years of mathematics coursework in high school including algebra and geometry, and in college took statistics and two math courses for teachers. She rates herself as extremely uncomfortable with mathematics overall, but neither comfortable nor uncomfortable (neutral) with regard to elementary and middle grades mathematics. (This leads us to wonder what kind of mathematics she is thinking about when she rates her own discomfort with it: perhaps she is thinking of high school or college-level mathematics.) On the mathematics for teaching portion of the principal survey, this principal had an average score, in the middle of our sample of principals.

Her scores on the epistemology portion of the principal survey were interesting and somewhat inconsistent. They were among the highest on the belief scale items (an average of 6.3 out of a possible 7), in the top five percent of principals sampled, but very low (lower fifth of the sample) on a set of open response questions that required interpretation of a classroom scenario. This discrepancy may indicate that the principal has adopted much of the rhetoric associated with the standards-based reform movement, but, in fact, does not notice (or interpret as desirable) those features in a classroom. The open-response section of the LCK principal survey asks principals to read a fourth grade classroom scenario and comment on whether or not the teaching depicted there is good teaching. In her response, this principal focused on the teacher's role in keeping the students on track and following the lesson plan, and did not appreciate the teacher's flexibility in following student's ideas that is associated with principals who scored toward the progressive end of our beliefs continuum. Rather, this principal was critical of the teacher for making the decisions she did. However, this principal also showed concern for student thinking, for students questioning their assumptions, and for students considering all possibilities. This closer look at this principal's open response writing permits us to better explore the meaning of some of the findings about this principal in other parts of the survey. For example, in Table 11 teachers report that the principal places more emphasis on being an evaluator of their instruction than on being a collaborating with them to think about their lessons. This more evaluative stance towards teachers aligns with what we read in the principal's reaction to the teaching depicted in the classroom scenario.

There was a considerable discrepancy between the principal's and teachers' views of mathematics (as measured by their Math View scores): her score of 6 is a good deal higher than the teachers' mean score of 4.2, (The principal's score was in upper top 10% of our sample of principals, while the Wheatley teachers' mean score was only slightly above the mean of 4.1 for entire sample of teachers). The teachers' more traditional views of mathematics teaching were elaborated by a teachers' comment about what it is like to teach mathematics. One teacher wrote, "[Teaching math] can be fun, but can be very frustrating with the program we use". If, as our data suggest, Wheatley teachers are accustomed to teaching in a fairly conventional way, and if they don't perceive their principal as a significant resource (which we discuss further below), then one might question how well they are implementing *Everyday Mathematics*.

Teachers' responses to the survey suggest that the Wheatley principal is less engaged with mathematics instruction than are the principals at the Galahad or Tall Oaks. Wheatley's teachers reported principal engagement at a level at or slightly above the average level of principal engagement for the whole sample. (Sixty-three percent of teachers at the Wheatley report that the principal visits their math class once or twice in a year. Fifty-five percent of teachers report that the principal usually stays just 5-30 minutes.) But despite an average level of reported engagement, Wheatley teachers don't seem to consider their principal as a resource for their issues of mathematics instruction: only 18% of respondents reported that they looked to the principal for support, guidance, and suggestions in teaching math. (We wonder if this is because teachers recognize that

the principal holds different views of what is "supposed" to be happening in math class, and don't find that her views are helpful for their day-to-day issues.)

Table 9 reports Wheatley teachers' responses to the survey questions about the principal's approach to mathematics teaching and learning, communication style (particularly after classroom observations), and the overall culture or community of mathematics instruction in the school. The mean ratings of the teachers at the Wheatley school are compared to the overall sample means.

Even though relatively few teachers look to their principal for support and guidance in mathematics, they did note that she comments frequently about math teaching and learning (the average teacher rating for Wheatley teachers is nearly one level higher than the average for the overall sample). As noted above, the teachers see their principal more as an evaluator than a collaborator. In addition, the professional community rating was below average at the Wheatley, in contrast to the above average ratings for the Tall Oaks and Galahad principals.

	Overall Sample mean (n=841)	Wheatley mean (n=11)
Comments about Math Teaching and Learning: Direct Instruction	3.2	4.1
Principal's Comments about Math Teaching and Learning: Build Student Understanding	4.2	4.6
Principal's Communication with Teacher: Evaluator	4.2	5.0
Principal's Communication with Teacher: Collaborator	3.8	3.8
Professional Community	4.7	4.5
My Principal and I Talk (scale 1 to 3)	1.6	1.5

Table 9
Mean ratings of the Wheatley teachers' perceptions of their principal's instructional leadership variables in comparison with entire sample means

Park Road

Principal's LCK - high math, neutral beliefs about the learning and teaching of mathematics, high alignment of beliefs between principal and teachers, low engagement

The principal of Park Road Elementary School (grades K-6) provides a contrast to the other three cases profiled above: like the principal of Galahad, his mathematics score was high; like the Wheatley principal, he is relatively disengaged from considering issues of mathematics instruction in the school; and unlike any of the prior three cases, neither he nor his teachers reported strong feelings how mathematics should be taught. Based on these findings, this school might benefit from significant investment in building a greater sense of community around mathematics instruction, building the principal's instructional leadership, and professional development for the principal and teachers to build knowledge of effective teaching practices.

Park Road's principal has been a principal for 5 years in an urban setting. In his earlier teaching career he had taught all subjects in 6th grade for seven years. The principal reports having taken three years of high school math, including algebra and geometry, as well as college algebra and logic and two education courses about math for teaching. Like the Wheatley principal, he reports that he feels uncomfortable about mathematics, overall, but extremely comfortable with elementary and middle school math. His math score on the principal survey was in the top third of principals.

The principal's mean score on the epistemology portion of the principal survey (4.4), indicates a neutral position on a conventional-to-progressive continuum but slightly below average for our sample On the same items the Park Road teachers' mean score was 4.0. Teachers' and principal's scores on the same items were thus fairly well aligned and both below average for their respective overall samples.

The school uses both a reform-based curriculum (*MathThematics*) and a conventional, basal textbook (Scott-Foresman math materials). Since the teachers' and principal's beliefs are relatively neutral with respect to mathematics instruction, it would be interesting to know how they use these two materials in concert with each other. The teachers at Park Road Elementary express some frustration with mathematics at their school. One teacher writes, "Too much pressure to have students perform well on achievement tests. I teach to the state third grade achievement test." Another comments, "Lack of number sense and mastery of basic facts is a building-wide problem which greatly effects [sic] the mastery of math skills." These comments suggest an overall emphasis on the importance of basic skills.

Like the teachers at the Wheatley school, the teachers at Park Road Elementary School report one of the lowest levels of principal engagement in mathematics instruction in the sample; only 17% of them reported they look to their principal for support. 58% of the teachers reported that the principal visited their math class once or not at all during the school year. Of the teachers that the principal does visit, 78% report visits of 30 minutes or less. Although the principal scored well on the math portion of our principal survey,

he is visiting math classes and talking with teachers less often than the principals in the other schools profiled.

As one can see from Table 10, responses from the teachers at Park Road about the nature of communication and community at their school are quite different from those at the other schools. The principal is not only relatively disengaged in terms of visiting mathematics lessons, he also discusses mathematics instruction much less than in the other schools in our sample (ratings for this variable are in the bottom fifteen percent of the overall sample). Teachers' ratings of the professional community variable are somewhat higher, but still in the bottom third of the overall sample. (This somewhat elevated professional community score may reflect the fact that, while teachers don't turn to the principal for guidance, they do look to their building colleagues for support, guidance, and suggestions in teaching mathematics, so there is a degree of community around mathematics instruction in the school even though it is not led or facilitated by the principal.) One teacher expressed desire for more school-wide discussion of mathematics, noting, "I would love for our school to have more opportunities for mathematical in-services and cross-grade level meetings."

	Overall Sample mean (n=841)	Park Road mean (n=12)
Comments about Math Teaching and Learning: Direct Instruction	3.2	1.8
Principal's Comments about Math Teaching and Learning: Build Student Understanding	4.2	1.1
Principal's Communication with Teacher: Evaluator	4.2	1.3
Principal's Communication with Teacher: Collaborator	3.8	1.8
Professional Community	4.7	3.2
My Principal and I Talk (scale 1 to 3)	1.6	1.3

Table 10
Mean ratings of the Park Road teachers' perceptions of their principal's instructional leadership variables in comparison with entire sample means

Summary. The four school profiles presented here show very different configurations of knowledge and belief about mathematics and mathematics teaching and learning on the

part of principals and teachers. These different configurations suggest quite different possibilities for the future of mathematics instruction in these schools. In two cases, Galahad and Park Road, there is good alignment between principal and teachers regarding beliefs about the nature of mathematics learning and teaching, suggesting that principal and teachers may reinforce each others' efforts. In the case of Galahad, principal and teaching staff seem to be working together to implement a reform mathematics curriculum; in the case of Park Road they may stay in their mixed position, using both traditional and reform materials, unless pushed by some outside force.

In the case of Wheatley, the principal appears to take a somewhat more progressive position than the teachers (at least in terms of espoused beliefs). Thus, while they are using curriculum materials that are designed to promote mathematical understanding as well as skill, the lack of alignment between the principal's perspectives on math teaching and learning and those of her teaching staff may suggest that the school would profit from more professional development for the teachers that centers on promoting students' mathematical understanding and support for the principal to actually enact her beliefs in her practice.

In the Tall Oaks case, teachers' views about mathematics instruction were quite traditional; the principal's were somewhat more progressive so that alignment between teachers and principal was modest. Without knowledge of the curriculum in use in the school, we cannot speculate about the likely impact on the mathematics program of this marginal alignment.

The degree to which, and ways in which, the principal was engaged with the mathematics program also varied widely among these case study schools. In Galahad and Tall Oaks the principals were highly engaged, while in Wheatley and Park Road principals' engagement with the mathematics program was very low. Interestingly, engagement does not seem to be associated with either alignment of beliefs or with the principals' comfort with mathematics.

Concluding Remarks

In this paper we have presented findings about the knowledge and beliefs about how mathematics is learned and should be taught held by a number of elementary and middle school principals and the teachers in their schools. We embarked on this inquiry as part of a larger study of the principals' LCK and its effects on their practice of instructional leadership for mathematics. We were interested in finding out how the teachers in these schools viewed their principals in this respect, and eventually we will be assessing whether teachers perceive changes in principals' leadership behavior as the result of their taking a *Lenses on Learning* course.

However, as we analyzed this baseline data we began to see that we were in the position to develop a preliminary sketch of the dynamic relationship between the principal and teachers in a school in a fairly detailed way. The profiles of the Galahad, Tall Oaks,

Wheatley and Park Road schools illustrate how different dimensions of principal and teacher knowledge and belief combine to make quite specific environments for mathematics instruction in each school. While we are working with survey data, and therefore are quite distanced from these schools themselves, we are persuaded that analyses of the relationships between principal and teachers in a school with respect to mathematics instruction can add substantially to the picture of systemic change that is emerging from studies at district, state, and national levels.

We are left with a number of provocative questions to guide future work. Because of our overall focus on LCK, we would be interested to know more about how principals' mathematics knowledge and comfort with mathematics affects how much, and in what ways, principals engage with teachers' mathematics instruction. Our surveys contain one type of data for these analyses and we expect to be able to do this analysis soon.

This study was not designed to link the ideas and practices of teachers and principals in schools with salient aspects of the school's policy environment—at local, state, and national levels. However, we see in our case studies glimpses of this larger environment, as in teachers' thoughts about the curriculum materials they are using or the impact of high-stakes testing programs. It would be most interesting and important to develop ways to study schools that make more visible the ways in which the policy environment is enacted on a daily basis. In the third stage of this research, we will be conducting a small number of field-based case studies in which we hope to collect observational and interview data from teachers and principals that can supplement the survey data we currently have. We plan to be alert to the policy environment as we do this work.

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