

BUILDING TEACHER CAPACITY

ORIENTING PATTERNS OF PRACTICE TO FOCUS ON STUDENT LEARNING

A MATH TEAM'S REFLECTION

Early last summer several members of a secondary math team met to discuss their program. Two years ago, and after a one-year pilot, their district had adopted standards-based mathematics curriculum materials in both their middle and high schools. In their review, the teachers listed what was going well and where they wanted to see improvement.

Among the things going well with the math program in the middle school they named: teacher organization and self reflection, student cooperation with each other, evidence of student mathematical thinking, staff collegiality (“We’re always talking math”), student improvement in reading and writing skills, fewer student/parent complaints, and growth as teachers. The teachers saw room for improvement in these areas: training for special education teachers and paraprofessionals, creating meaningful parent information—especially help with homework and math’s big ideas, establishing more holistic grading criteria, providing challenge for all students, and finding a way to move the “less enthused” along. As an added benefit they said, “Connections to other disciplines are cool.”

For the high school the teachers generated somewhat different lists. They saw positive things going on such as: the advantage of block scheduling for standards-based math classes, real-world content of the curriculum, access to calculators, seeing kids more persistent in problem solving, evidence of critical thinking, finding the lessons more enjoyable to teach, the access to deep mathematics given to all kids through technology, and multiple avenues to solve problems. Their review also identified challenges for the high school program: articulation and emphasis over the three-year program, synchronization with the science department’s prerequisites for certain courses; collaboration with school counselors on post secondary requirements, administrative support in situations where students needed more work, and collaboration with each other on pacing and other instructional issues.

Finally, these teachers wanted administrators to “ask tough questions of teachers” about how to change classroom instruction, use resources well, and meet the challenge to shift paradigms about teaching and learning. Though already in their third year, this math team saw their implementation as an on-going process.

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“Leadership as an offspring of culture is the meaning-making aspect of culture centered around practice—people doing things together.”

DRATH AND PALUS, 1994,
MAKING COMMON SENSE,
LEADERSHIP AND MEANING
MAKING IN COMMUNITY, P. 13.

The progress and challenges the teachers in the opening story identified as they reviewed the results of their implementation gave evidence of effective mathematical instruction. Their list reminds district leaders that, more than anything else, implementing standards-based mathematics requires long-term commitment to continuous improvement—in part due to the paradigm shift it represents, in part to the depth of knowledge the curricula demand, and in part to a growing collegial relationship teachers must develop among themselves. Because teacher competence is so critical to student success, as well as to the public's acceptance of standards-based mathematics, their professional development takes on particular significance (Cohen and Hill, 1998, p.1). Given that teacher beliefs about learning as well as their mathematical preparation are most challenged by the underlying philosophy and expanded content embodied in the new curriculum materials, teachers require extended engagement with ideas and practices represented in standards-based mathematics. These converging forces create another paradox: *Recognizing that student achievement is closely linked with the professional capacity of teachers, how do school leaders reconcile the long-held norms of teacher-culture with the new demands currently being placed on public schools?* (Stigler and Hiebert, 1998, p. 6).

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"The effectiveness of mathematics teaching and learning is a function of teachers' knowledge and use of mathematical content, of teachers' attention to and work with students, and of students' engagement in and use of mathematical tasks. Effectiveness depends on enactment, on the mutual interdependent interaction of the three elements... as instruction unfolds."

KILPATRICK, J., SWAFFORD, J.,
FINDELL, B. (EDS.), 2001,
ADDING IT UP, p. 9

Besides attention to the initial decision-making phase a mathematics adoption requires, study participants acknowledged that implementation was similarly demanding. Given the importance of teacher capacity to student achievement, leaders explained that fostering new patterns of practice were critical and most likely to occur if professional development mirrored recent research about the nature of learning itself. Unlike fluctuations in seasonal weather patterns, standards-based mathematics represents a major climate shift that challenges the cultural norms woven into classroom practices. Capacity building meant expanding teachers' comfort with and knowledge of mathematics as well as updating their classroom skills. As implementations progressed in participating districts, professional growth relied more and more on relationships teachers developed with each other and their engagement in collegial conversations.

CULTURAL SHIFT

As in any culture, teaching activities are governed by scripts that not only determine behavior, but that are so widely shared they go unseen. Scripts are learned over time and create mental models about how things work, resulting in a set of beliefs that maintain the culture's stability. (Stigler, J. and Hiebert, J, 1998, p. 5-6). The narratives study participants shared demonstrated how some of teaching's cultural scripts played out in the face of instructional change.

REVISIT INSTRUCTIONAL ROLES

Not surprisingly, attitudes towards standards-based mathematics paralleled attitudes toward Minnesota Graduation Standards and provided insight into beliefs about teaching. Some of the beliefs expressed in the data include:

- **TEACHER AS EXPERT** General openness to the new requirements tended to diminish as the grade levels increased, which one principal explained this way: “Teachers in the higher grades tend to bring a secondary philosophy, centered on subject matter, and the teachers in the lower grades have a more student-centered, methods approach.” She thought secondary math teachers relied more on their mastery of the subject and tended to minimize methods related to brain-based theories of learning.¹ One administrator explained, “With the new curriculum materials, the teacher’s role changes from stand-and-deliver-I-am-the-expert, to a coaching model.” He said that in the past kids were expected to sit passively and mimic what the teacher did. When teachers are confronted with expectations to substitute lectures with facilitated student activities, they feel they are giving up control of the educational process.

- **AUTONOMY OF THE CLASSROOM** On another front, control was once core to the cultural construct of teaching. Difficulty in letting go of this deeply held belief is especially evident in mathematics education.² The uncertain climate that flows from today’s “results-oriented education” bumps against cultural norms based on teacher autonomy, suggesting that teachers do not know how to determine when students are learning. Additional demands in school structuring, along with curriculum guidelines coming from the state, further increase the reluctance of some of her teachers to work with the new curriculum. A principal said: “Frankly, I think they are afraid. Right now it seems overwhelming to teachers to be implementing a new curriculum with all the rest that is going on.” In that district, besides implementing standards-based mathematics, they were working with Graduation Standards and the teachers were moving into another building. On top of that, with cuts in spending, the district was in the process of moving the middle school from an eight-period day to seven. The subsequent juggling left some teachers fearful that they could not absorb the multiple, simultaneous demands. Another district described similar stress as the district moved to block scheduling while implementing its standards-based math curriculum. As schools restructure in response to student needs within tight fiscal restraints, and as broad district and state goals evolved, many teachers found their idiosyncratic classroom practices threatened.³

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“Changing any important aspect of our teaching is a difficult and complicated process that is intricately tied to our knowledge, our experiences, and our beliefs about mathematics, teaching, and learning. Change involves negotiating a series of steps, any of which can slow down or stop the process. But change can also be interesting and invigorating, and the ultimate goal of providing the best possible experience for students makes it all worth the effort.”

EDWARDS, (2000), *CHALLENGES OF IMPLEMENTING INNOVATION, MATHEMATICS TEACHER ONLINE*, P. 5.

EXAMINE MATHEMATICAL BELIEFS AND TEACHER FEARS

The interviews point out that not only do teachers need to adapt to new teaching patterns, they need to adjust their notion of what mathematics is. Some teachers come to the classroom with minimal levels of mathematics study, and others have a narrow view about what mathematics means. Both deficits leave them reluctant to undertake new curriculum materials⁴. One elementary teacher was clear: “When I went to school math was a plain awful, simply an ugly experience. At the chalk board we were all afraid to make mistakes and be embarrassed in front of our friends. We couldn’t see the connections. All we knew was that we just had to do it.” With memories like this, it is not surprising that many elementary teachers take only the minimal math requirements in college. Confronted with curriculum materials that require deeper mathematical knowledge, some teachers understandably resist.

• **TEACHER KNOWLEDGE /STUDENT CAPACITY** One principal’s observation illustrated the tension between teacher knowledge and student capacity: “The fifth grade content in our integrated program requires teachers to have a better grasp of mathematical concepts. At the same time, teachers are finding that their students are in fact capable of handling the more demanding content.” In a different district, some secondary teachers refused to take advantage of professional opportunities that were available to them. The curriculum director suggested: “I think these teachers were afraid that some of the younger teachers would see what the veterans don’t know.” He said some high school teachers had been in the classroom over 20 years never had statistics, and, frankly, probably wanted to retire without having to take it.

• **MATH SCRIPTS** Among the ideas that troubled elementary teachers accustomed to ‘one right answer’ is the notion that there are many ways to solve problems. Because standards-based mathematics is grounded in current learning theory, “Rather than teaching one algorithm, kids are asked to use their prior knowledge to generate new knowledge. They can think mathematically, if they are allowed to,” said a curriculum specialist. She explained that the challenge new curriculum materials bring is to move teachers from a “bunch of tricks and strategies,” to teaching mathematical concepts. For many teachers, mathematics education boils down to mastering a set of procedures, yet the new curriculum materials expect students to understand large mathematical concepts and to be able to think mathematically⁵. On the secondary level, NCTM standards content includes disciplines once dismissed by math teachers, especially statistics and probability. Again, standards challenge cultural scripts because standards suggest that teaching is less about a personal repertoire and more about larger instructional goals.

“We took the NCTM standards and made them make sense. We digested the ideas and put them into our own words and asked ourselves how they relate to our practice.”

PRINCIPAL

• **TOO MUCH TIME** The most common objection raised had to do with the amount of time teachers would have to spend on lesson preparations. In standards-based curricula, dependence on work sheets and other drill routines is replaced with extended problems, collaborative learning, and written and verbal explanations of student understanding. Some teachers expressed a reluctance to give more than an hour of instructional time to mathematics, which reflects a culture that prioritizes language literacy over numeracy. To her own surprise, a third grade teacher who worried about giving so much time to math reported: “I think my children’s writing has become much better.” She said the curriculum asks students to use the grammar and complete sentence work they learn in language. “It carries over to social studies too. Years ago I would never have said, ‘Just like in math’ when I was speaking about sentence structure or answers in another subject,” she added.

• **STATEWIDE TEST RESULTS** The current emphasis on standardized tests creates additional anxiety for teachers even when the tests themselves are measuring higher-level skills. In most cases, if elementary teachers were reluctant to adopt the standards-based curriculum materials, they were teaching third or fifth grade. “Third grade is also having some troubles. We wonder if it is a weaker link or if it is because third grade teachers are feeling pressure from the MCAs (Minnesota Comprehensive Assessments),” said one administrator. “Because drill and practice are not as evident in these programs, they worry that students will not master the basic skills,” added a staff developer. She noted that calculator use compounds this perception for some teachers. Because scores are published and compared, many teachers cannot help evaluate themselves based on student scores rather than on student understanding of the material. Several teachers who had been using the curriculum for some time suggest that student facility with basic facts may falter, not because the new curriculum materials are weak, but because teachers miss the power that the games have to make learning basic facts fun. “It’s important to use the games and encourage parents to play them with their children at home.”

• **DIFFICULTY OF ASSESSMENT** In addition to statewide tests, teachers expressed uncertainty about evaluating student work in the new system. They find it difficult to grade students in a program that emphasizes student thinking and their grasp of mathematical concepts. “In the past we had a very shallow way of evaluating student mastery. Now we look at how they arrive at their answers and ask them to take apart their strategies, so we have a more more complete picture of what they really understand,” explained one teacher. One piloting teacher said assessment takes her a long time and that she has tried a few different ways to do it. She added, “Now I have a check list that I made into a grid. I put it on a clip board and then use post-it notes to

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“Again, it is not a program, but a well-trained professional, one who can use research-based information and strategies, that is going to make mathematical learning happen. It’s the teacher, the teacher, the teacher.”

PRINCIPAL

write my observations.” Later, she transfers her observations to the student’s page in her record book.

• **NEED FOR SUPPORT** Other fears expressed by teachers had to do with administrative support for everything from the training teachers need to learn the new curriculum, to purchasing the materials and manipulatives required, to allowing teachers time together so they can compare strategies or examine student work. One district described the level of anxiety in these terms: “Overall the climate appeared to leave no room for mistakes. In the early days of piloting, the teachers wanted a lot of assurances, to know they would have district support in terms of training and materials.”

The obstacles and barriers teachers raise in the face of change find their roots in a culture that casts teaching as an individualistic practice with high levels of autonomy and only loose connections to district or even state goals and expectations. (Elmore, 2000, p. 15-17). Asked what the biggest challenge was, one principal said, “I would think that because the mindset change is so demanding for those of us who have been teaching a long time, the paradigm shift is our biggest hurdle.” He said that on the one hand, he didn’t want to send a message that what teachers had been doing for years was not valuable, but still he needed to ask them to look at what they were doing as it compares to current research on learning. He said, “We are devoting a good deal of staff development to curriculum and instruction change in general.”

NEW KNOWLEDGE AND EXPERIENCE

Change, especially profound change in long-held thinking, cannot be mandated. The new curriculum materials ask teachers to rethink their views on teaching and to expand their definitions of mathematics. Convinced thinking patterns would change if given new knowledge and experiences, study participants suggest employing a range of learning opportunities:

• **PROVIDE EARLY IN-DEPTH TRAINING** Teaching activities are part of a larger cultural system. In order to appreciate standards-based curriculum materials, teachers needed to grapple with the big ideas affecting education as a whole and the influence those ideas have on classroom practice—having a big picture view provided teachers with a framework within which to place their new learning. Some districts reported that their earlier work with Graduation Standards helped prepare the way for standards-based mathematics. Typically, these districts began orienting their staff to the standards several years before they became law.

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PRINCIPLES FOR EFFECTIVE PROFESSIONAL DEVELOPMENT:

- Sessions must have students and their learning at the core—and that means all students.
- Beyond mathematical content, mathematics educators need specialized knowledge/skill that distinguishes them from other mathematicians.
- The same principles that guide student learning guide professional development; people can only teach in ways that they have learned.
- Opportunities must align with and support system-based changes that promote student learning.

Adapted from LOUCKS HORSLEY, 1994, DESIGNING PROFESSIONAL DEVELOPMENT FOR TEACHERS OF SCIENCE AND MATHEMATICS.

• **VALUABLE GROUNDWORK** Before launching into training specifically geared to the mathematics curriculum material under adoption, one district laid groundwork they believed would help teachers think about their beliefs and put the new curricula into context. District leaders asked their building principals and math committee members to plan staff meetings around two books. Chapters from *Best Practice, New Standards for Teaching and Learning in America's Schools* (1998) and *Beyond Arithmetic: Changing Mathematics in the Elementary Classroom* (1995) were discussed in buildings across the district⁶. Commenting on *Beyond Arithmetic*, one teacher said, "It 's an excellent book because it ties the theory to the lesson and helps you see how it all works together."

• **PHILOSOPHICAL UNDERSTANDING** Standards-based mathematics curriculum materials are difficult to teach. A math specialist recalled presenting in one district where teachers didn't have much initial training: "They were already two years into the program and their lack of training showed. Teachers just were not into it...If you don't understand the philosophy, you simply don't make the effort." A teacher from a different district echoed this thought saying, "Frankly, if you don't get the training, it's hard to understand why you are doing one thing or another." Subsequent conversations suggested that inadequate training jeopardizes the curriculum's potential to help improve student learning and that the temptation then is to blame the curriculum, not the lack of training. As leaders said many times, these curriculum materials require intensive, ongoing training. Besides richer content and more sophisticated mathematics, they require a change in how teachers approach their students and engage them in the lessons.

• **SOURCES FOR PROFESSIONAL DEVELOPMENT** While some districts conducted their own training by bringing in Minnesota teachers experienced with the curriculum materials, other districts took advantage of training provided by publishers. One administrator commented that "though it was expensive, they provided training tailored to the program we chose, and gave teachers the philosophy that got them all on board." Still another district combined their publisher's full-day learning session with the district's own in-service days during workshop week. Regardless of how development was delivered, the sessions described were intensive, interactive and reflective. Teachers had time to "try out" lessons, raise concerns, and explore resources.

• **INCLUSION** Teachers said that besides regular classroom teachers, special education teachers needed to be able to use the strategies, and districts needed to adapt the individual learning plans (IEPs) to reflect standards-based values. One teacher said "the percent of right answers do not really tell us anything about the level of achievement or understanding a student has mastered." A first grade teacher's story explained why:

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PRINCIPLES OF BEST PRACTICE LEARNING:

- STUDENT-CENTERED - begin with young people's real interests
- EXPERIENTIAL - students are immersed in the context that surrounds the subject of study
- HOUSTIC - children learn best when they encounter whole ideas
- AUTHENTIC - real, rich, authentic ideas are the heart of the curriculum
- EXPRESSIVE - children employ the whole range of communication media
- REFLECTIVE - provide opportunities to debrief and abstract from experience
- SOCIAL - learning is always socially constructed and often interactive
- COLLABORATIVE - cooperative learning taps the social power of learning
- DEMOCRATIC - the classroom is a model community
- COGNITIVE - understanding as a product of higher-order thinking
- DEVELOPMENTAL - children grow through definable though flexible stages
- CONSTRUCTIVIST - children reinvent and recreate every cognitive system
- CHALLENGING - children are challenged with choice and responsibility for their learning

ADAPTED FROM BEST PRACTICES, NEW STANDARDS FOR TEACHING AND LEARNING IN AMERICA'S SCHOOLS, 1998, p. 7.

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"What we have learned from research now brings us back to the issue of values. We now know that we can design curriculum and pedagogy to help students meet the ambitious goals outlined by the NCTM Standards. The question is whether we value these goals enough to invest in opportunities for teachers to learn to teach in the ways they [the standards] require."

HIEBERT, 1999, *RELATIONSHIP BETWEEN RESEARCH AND THE NCTM STANDARDS*, P. 12.

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VIDEOS

Mathematics: What Are You Teaching My Child?
Marilyn Burns. New York: Scholastic, 1994.

Failing the Grade, (ABC Prime Live) TIMSS Report, February 11, 1998.

Keynote Presentation by George "Pinky" Nelson, SciMath^{MN} 5th Annual Assembly, February 22, 1999.

Navigating in a Changing World, St. Paul, MN: SciMath^{MN}, 1997.

She observed her students taking a standardized test. A conscientious student who demonstrates above grade-level understanding in mathematics became so nervous about a test that he scored very low, while a classmate with a severe learning disability, who did not have a clue, randomly answered questions and scored surprisingly high. Getting the right answer does not necessarily mean understanding the mathematics.

• **IMPACT OF TRAINING** One administrator recalled that some of his middle school teachers did not take advantage of the early training and had a tough time the first year. He said, "In spite of their reluctant use of the curriculum, student scores went up, which finally convinced them to get some training so they could take better advantage of the strategies in the program. They attended MASP² sessions where top-notch teachers simulated the way a lesson should be taught."⁷ Back in their own classrooms now, these same teachers "are finding fewer discipline problems, and that even kids who struggle are experiencing some measure of success, so are less of a problem," he added. The administrator also noted that these middle school math teachers now support heterogeneous classrooms because they "see the exchange between kids of many abilities helpful for all. No teacher wants to teach a class of 'low kids' anymore."

Professional training exposed teachers to standards-based philosophy as it relates to the program and methods in the new curriculum. Though preparing lessons in the new curriculum generally requires more work, with a big picture view of standards-based mathematics teachers can prepare their lessons with greater understanding.

MAKE THE CURRICULUM VISIBLE

The adage that "seeing is believing" proved true when teachers who were interviewed ranked opportunities to see other, more experienced educators in action as very important.

• **MODELS AND DEMONSTRATIONS** In one district, teachers visited other classrooms which made a big impact. One reluctant teacher changed her mind after such a visit saying, "I couldn't believe what the children in second grade were doing. The children were so much further ahead in what they were doing compared to my own students." Another said, "I believe observing and watching others teach was important and I think seeing the children's work helped me see the depth of the program." Yet another reported gaining confidence when her district brought in teachers during their training. "It was the frosting on the cake! She talked about how to get ready, how she assesses the student work, and that we don't have to spend exactly the time on a topic

that the book suggests. That made me feel a lot better.” Several teachers felt it was important to “see the dynamics of the lessons and the materials in action,” while other appreciated insights from fellow teachers who were frank and honest. For example, “They said assessment was the most difficult part and so we were ready for that,” said one teacher.

- **VIDEOS** Curriculum leaders used videos in training sessions and staff meetings. When site visits and visiting experts were not a possibility, videos provided some of the same benefits as demonstrations. Having models and demonstrations helped teachers replace old images of classroom practice with new ones, convinced them there was substance in the new approach, and at the same time gave them the confidence that they could accomplish what they saw other teachers doing.

PROVIDE ONGOING LEARNING OPPORTUNITIES

Professional growth is a continuous process. Participants agreed that the standards-based curriculum materials needed more than “one shot” training experiences. One district described their plan to break the training into manageable pieces this way. “We got permission from the teachers’ association and from staff to take the day-long in-service scheduled for January, and divide it up.” The staff development coordinator and the curriculum director drew on their understanding of best practices and applied it to their professional development: “We wanted to keep the learning on-going, and keep it reflective.” Rather than wait until half the year was over, they tended to issues related to implementation in two-hour sessions about every other month. Another district had a major training the summer before implementation began and then had a fall in-service and a two-day professional development time in January.

- **PROFESSIONAL MEMBERSHIPS** Another way to provide on-going professional growth is through membership in Minnesota’s Mathematics Best Practice Network and Minnesota Council of Teachers of Mathematics (MCTM). One teacher in a small district credited both groups for bringing her where she is today: “Even though I was skeptical at first, because I am not a math major or specialist, the network has been a great experience....Math teachers were willing to explain their understanding and listen to my perspective. Sometimes we would sit down in a K-12 mixed group and work on high-level math problems together. I could understand it because the method was so good.” As someone who was “turned off” to math by eighth grade, this teacher was convinced the standards-based curriculum materials will be relevant to children and keep them engaged with mathematics through high school. Another teacher reported coming back

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“Effective programs of teacher preparation and professional development help teachers understand the mathematics they teach, how their students learn that mathematics, and how to facilitate that learning. In these programs, teachers are not given prescriptions for practice or ready-made solutions to teaching problems. Instead, they adapt what they are learning to deal with problems that arise in their own teaching.”

KILPATRICK, J., SWAFFORD, J.,
FINDELL, B. (EDS.), 2001,
ADDING IT UP, P. 10.

from MCTM with “with a whole new way to look at mathematics.”

• **ONGOING PROFESSIONAL DEVELOPMENT** Ongoing experience with the mathematics and methods used in standards-based curriculum materials allows teachers to examine new issues as they surface in the classroom. From the narratives, it appears that early concerns about the amount of time preparing lessons and materials gave way to later concerns about assessing student work. As teachers became more comfortable with these elements, their interest turned toward how math concepts were developed from one grade level to another. In one school, fifth grade teachers invited colleagues from the middle school into their classrooms to teach some lessons so students could see the connection to the math they would have next year.

Constructivism, the philosophy that underpins standards-based mathematics curricula, believes that instead of receiving knowledge from others, learners construct their thinking out of their experience (Sparks, 1994). But, they do not do this alone. Teachers play a critical role in helping children learn by guiding the learning, using questioning strategies, helping students make meaning of their work, and by generalizing big ideas. The professional development activities districts described were designed to prepare teachers to use constructivist methods. In one degree or another, districts modeled those very methods in their training sessions. Through activities and follow-up conversations, teachers, principals and administrators engaged the new materials with their students’ needs in mind. They questioned and refined their thinking in the larger context of research on learning, began to see alternatives and to change their thinking over time.

COLLEGIAL CONVERSATION

As teachers piloted their standards-based curriculum materials they shared new insights with colleagues in both formal and informal settings. Evidence from student attitudes and teacher enthusiasm gradually opened minds and changed perspectives. The resulting exchanges began to alter patterns of professional relationships as leadership from within teaching ranks evolved. Participants used several strategies to reshape the profession.

EXPAND THE PILOT’S SCOPE

Teachers who piloted standards-based curriculum materials in participating districts were encouraged to find multiple avenues to increase the interest and participation of their non-piloting colleagues.

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“In order to talk with our colleagues we needed to make our self-assessment and reflections explicit, deliberate, and systematic. This process not only enhanced our abilities to converse, it also meant that we documented alternate solutions to similar problems. It has pushed us to try others’ suggestions and to revise plans that we’d thought we knew worked, in turn encouraging us to push our thinking about mathematics teaching.”

• **STAFF MEETINGS** At least one district decided to take the laundry list of management information and announcements out of staff meetings and put it in email as a way to free up time to talk about standards-based mathematics. “We took the NCTM standards and made them make sense. We digested the ideas and put them into our own words and asked ourselves how they relate to our practice,” said one principal. In some districts, piloting teachers demonstrated lessons or parts of the curriculum during staff meetings. Reserving staff meetings to focus on the needs of students created space for teachers to talk among themselves about what mattered most. One district gave piloting teachers training to help them lead discussions and paced the information they would then share in their buildings. “In this way, mastering the material has not been so overwhelming,” a principal explained.

• **TABLE TALK** Teachers who were piloting also took opportunities in casual conversation to talk about their math classes. One teacher said, “Because I am enthusiastic and have a good working relationship with my peers, I have influence. I tell my colleagues that ‘once you try a lesson and have success, you build your confidence and understanding.’” In one school piloting teachers used lunch room “table talk” to tell their peers about what was happening in their classrooms: “I make it a practice to come down to lunch and say what fun we just had in math class. Then I tell the teachers there what we did during the lesson and how the kids responded,” said one teacher. As her principal noted, the tone of conversation in his building had changed. Instead of the grumbling about “this kid” or “that form,” teachers were talking about their practice. With attention refocused on the reason they were teachers, their sense of commitment and satisfaction increased.

• **FACE-TO-FACE TIME** According to one principal, “The staff turned to piloting teachers and invited them into their classrooms.” In addition, teachers reported asking administrators to build in time during grade-level meetings for discussions about the math curriculum. “You’d be surprised how much we learn from each other. We compare what worked and what didn’t and help each other become more successful,” said one teacher. A middle school teacher who had been teaching standards-based mathematics for several years explained that now that they are very familiar with the curriculum, they are using team time to compare student work: “We are trying to learn from kids’ work what it is we need to do to move them along. We get insights into what’s going on in their heads when we talk about their work. It’s pretty awesome.”

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“Unless we have a core of teacher leaders who ‘get this’, believe it, understand the thinking, we cannot do grad standards well, whether it is mathematics, reading or science. Solid implementation will require the support of teacher leaders who are close to the classroom and who can manage and move refinements along.”

PRINCIPAL

TEACHER REFLECTIONS
ON PROFESSIONAL
DEVELOPMENT:

“My training for the new math program has really changed my feelings about math. The program brings math to life for kids. It makes them feel part of their learning.”

“Because we moved slowly, I feel my thinking and teaching of math has had time to change with reflection. I feel I spend more time on math and get deeper into it—well past rote memorization of numbers.”

“I believe my classroom is more alive with math this year. I realize I have just touched the beginning of the new curriculum and KNOW I will continue learning better ways to teach and develop the mathematical ability of my students.”

“I love it. The kids do too. Even though this is my last year teaching, it’s been great to be involved in this program! I wouldn’t, couldn’t, go back to teaching the old way.”

“The implementation process has been very thoughtful. We have given the staff a chance to reflect and come to consensus. I really appreciate that the principals were involved. My teaching has changed in all areas of the curriculum.”

DEVELOP TEACHER LEADERS

Instead of unquestioning compliance, professionalism for teachers is grounded in shared knowledge and shared responsibility for decisions made (Darling-Hammond, 1997, p. 94)⁸. In two of the participating districts, leadership made conscious efforts to develop teacher leadership in the buildings. In larger districts, administrators suggested the demands for ongoing staff development and professional time could be handled best at the building level: “Ultimately, it is the teacher leader that makes change happen in the building. They become the credible leadership on site because they are in a position to show and model curriculum for their colleagues,” said one administrator.

• **FORMAL APPROACH** One of the districts created a teacher-leader network that would interface with district leadership as part of administration efforts to implement graduation standards. The administrator said, “We needed to highlight teachers in buildings who see the benefits to kids, who understand continuous improvement, and who, from their own reflection, will help their peers ask, ‘What does this mean for our craft?’” In that district, overall 118 teachers committed to two years on their respective building leadership teams and help develop building improvement plans, work on curriculum committees and bring decisions to the rest of the staff⁹. Membership on the leadership team rotates among staff. Eventually it should help the district “reach a critical mass of educators more deeply committed to the larger vision,” the administrator explained. He said they look for people who “will take the risk to help find solutions.”

• **INFORMAL APPROACH** In another district, membership on the math curriculum committee evolved into a major commitment that partnered teachers with their building principals. As part of their development, committee members were steeped in a peer-coaching model, exposed to extensive research on learning theory, encouraged to challenge and ask questions, and, were given full responsibility to decide which curriculum to adopt. During the piloting year, besides working with the curriculum in their own classrooms, these teachers also shared information with colleagues and organized parent meetings. As their implementations got under way, they also helped extend professional development during staff meetings and became resource people in the buildings for their colleagues.

To achieve the goal of higher student achievement, participating district administrators enlisted teachers and shared their leadership. As Elmore (2000) describes it, distributive leadership “is primarily about enhancing the skills and knowledge of people in the organization” (p. 15). Pilot teachers in the study were given new

knowledge beyond techniques, were encouraged to try things out, raise questions, and had access to ongoing learning (Darling-Hammond, 1997, p. 27). Through their collegial conversations, teachers began to change the patterns of their practice from the inside. The overall response of fellow teachers created a willingness to work with the new curriculum materials. One district administrator noted the high level of professionalism saying, "In spite of their work load, teachers come to the trainings. No one wants to opt out, but they want assurances it is worth their time." In this district, teachers are reminded often that "they are living the question and to find the answers they all have to work with the material." Other administrators pointed to small groups who were having trouble. One said, "The fifth grade teachers have made the shift and put in a good effort even though they had reservations." She said her middle school teachers, who were very traditional, would experience frustration, but she doubted they would "dig in their heels." In sharing leadership with the teachers, administrators encouraged professional growth. They believed that "teachers will honor the research, will recognize their own best practice and will see themselves improve as teachers."

PATTERNS OF PRACTICE

Three large cultural forces are converging on public education and causing a major shift in professional development as well as classroom practice: 1) results driven education (standards-based) that focuses on what students actually understand and what they are able to do with that understanding; 2) systems thinking that takes into account interdependent relationships within school systems, and 3) constructivism's research-based theory about how learners construct their own knowledge (Sparks, 1999, p. 26-27).

District leaders in the study recognized that teachers, like anyone else, adapt to their circumstances and develop new attitudes by facing difficult situations and learning to live with the realities of change. As the climate of standards-accountability bears down on districts and teachers, the need to rethink instructional patterns increases. Suggesting that today professional development and curriculum review can be viewed as one and the same thing, district leaders focused on two facets of professional development. First, since personal and professional capacity to adapt requires that people shore up their ability to reflect, increase tolerance for frustration, and see their own blind spots and patterns of resistance (Heifetz, 1994, p. 5), district leaders arranged an *array of opportunities to help teachers refocus their practice more on student learning* than on teaching activities. Second, because teaching is a cultural activity affecting the whole system with its reinforcing elements, changing classroom practice meant *enlisting teacher leaders who*

CHANGES TEACHERS OBSERVED IN THEIR STUDENTS:

"I have noticed that their writing skills have greatly improved and not just in math."

"I see students more willing to take risks using trial and error. They seem more confident in their problem solving."

"This process is just beginning, but seems to be taking hold. Students seem able to come up with creative solutions to mathematical problems. This shows me they are not learning rote methods but starting to develop a deeper understanding of mathematics."

"I have seen math anxiety reduced and a greater understanding of concepts increased. There has been significant sharing of ideas, materials and strategies. It has helped to make my class more cohesive and appreciate each other's ideas."

"The biggest change I have seen in my first graders is their ability to move between addition and subtraction with little confusion."

engaged their peers in conversations that gradually rewrote the cultural scripts they had learned over time. In their “table talk” teachers were encouraged to question those scripts in the light of new demands on children and schools. District leaders who kept teachers’ attention focused on the overriding issue of student learning found it a valuable key to help teachers overcome old patterns and create new ones.

Districts that moved too quickly, without fully training their teachers, reported uneven and poor instruction as well as frustration on the part of teachers. Leaders who do not invest in deep initial training, and then ongoing professional development, ran the risk of having invested in the new curriculum without being able to reap rewards in terms of student achievement. Going back to retrain teachers is more difficult and expensive than it is to do it well from the beginning. Thorough professional development, centered around challenging standards-based curriculum with its emphasis on problem solving, leads to improved test scores in subjects such as reading and writing, in addition to mathematics (ENC, p. 44).

The urgency to improve student achievement in mathematics is matched by the imperative to invest in professional development. The critical step to changing teacher attitudes about teaching and mathematics is to redirect their energy to the underlying professional responsibility they have to children in their classrooms. Without ignoring the significance of the challenge new standards pose for them, teachers need to understand that the risk of failure is large, but especially for children.

DISCUSSION QUESTIONS

1. What are the mental images, “scripts”, of how a person should teach in your community? Consider a) goals for instruction, b) the nature of mathematics and c) the characteristics of a typical lesson.
2. What do teachers in your district believe about how children learn mathematics? What are the teachers saying and what are they doing that provide clues to their beliefs?
3. What strategies might you use in your district to help teachers rethink their views on teaching and expand their definitions of mathematics? How will professional development in your district need to change?

END NOTES: BUILDING TEACHER CAPACITY

1. In a 1998 survey of teachers, Minnesota Council of Teachers of Mathematics (MCTM) learned that elementary teachers appear to be more supportive of reform efforts and to have more a positive outlook on Minnesota's Graduation Standards than their secondary counterparts. In the Twin Cities metro area, the need for and support of reform was higher than elsewhere (p. 4).
2. The disparity between expressed beliefs and classroom practice indicate that old cultural scripts continue to prevail. For example, mathematics teachers in the United States say that students' mathematical success depends on their grasp of mathematical concepts, but observations of typical lessons suggest that teachers really believe school mathematics can be reduced to a set of rules. In addition, teachers break mathematical information into manageable pieces for students, suggesting that teachers are unwilling to allow students to do their own learning. By contrast, in Japan, teachers believe confusion is part of the natural learning process; they think students learn best through a variety of activities, including struggling with a problem first and then discussing it later (National Research Council, 1999).
3. Cultural scripts about autonomy create norms within the teaching profession that suggest teaching is an idiosyncratic, mysterious technique that teachers develop individually over time. In that mode goals can only be ambiguous, and definitions of teacher success highly individualistic. Elmore (2000) argues that effective schools and student success require, instead, a coherent set of instructional goals that provide teachers and districts with direction that give meaning to learning and impetus to collegiality. The role required of district leaders is to promote a view of teaching as a body of knowledge and set of skills that can be learned over time (p.16-17).
4. Nationally, one-fifth of high school math teachers have neither a major nor a minor in mathematics, and the typical elementary teacher takes three or fewer math courses in college. In view of new standards in mathematics that require more challenging instruction, this deficit is critical. Susan Loucks-Horsley criticizes current professional development saying "it is typically weak, limited, and fragmented, incapable of supporting [teachers] as they carry the weight of adequately preparing future citizens. Programs fall short of helping teachers develop the depth of understanding they must have of mathematics content, as well as how best to help their students learn it" (ENC, p.2).
5. Teachers at a professional development session were asked to rate the importance of certain ideas on a scale of 1 to 10, where 10 signified high agreement. Some of their responses: Math problems have only one right answer (8); all students can learn important and challenging math (3); Effective teachers explain HOW to work problems (8); students should NOT use calculators until they master the basics (8); reading and writing belong in language arts, not in math (8)... These responses indicate how far professional development has yet to go in shifting teachers' thinking about mathematics.
6. Best Practice: New Standards for Teaching and Learning in America's Schools, 2nd edition (1998), by Steven Zemelman, Harvey Daniels, and Arthur Hyde. Published in Portsmouth, NH.

Arthur Hyde and Beyond Arithmetic: Changing Mathematics in the Elementary Classroom (1995), by Jan Mokros, Susan Jo Russell and Karen Economopoulos. Published in Palo Alto, CA: Dale Seymour.
7. MASP² stands for Minneapolis and St. Paul Merging for Standards-based Practice. Directed by Dr. Thomas Post from the University of Minnesota, MASP² is an NSF project to help acquaint districts with NSF-funded mathematics curriculum materials.
8. An occupation becomes a profession when it assumes responsibility for developing a shared knowledge base for all its members, and for transmitting that knowledge through professional education, licensing and ongoing peer review. Professions put the interests of clients first and apply the best of current knowledge to

those interests. Professionalism is a continuous process looking for practical means of accountability and that socializes its members to an ethic of concern for all clients (Darling-Hammond, 1997, p. 298-299).

9. Successful schools, like other successful organizations, reduce specialization, work in teams that have access to learning and authority. They rely on principles of human performance and motivation by providing opportunities to make a difference and do something well. (Darling-Hammond, 1997, p. 150-152).