Photo by ANNETTE HOLMSTROM

Bjorn Burke works with paper strips and a white board in Karen Vaver's class at University Place Primary School.

DISTRICT FINDS THE RIGHT EQUATION TO IMPROVE MATH INSTRUCTION

By Annette Holmstrom

Just months after implementing new instructional strategies for teaching math to her 2nd-grade students, Karen Vaver noted a significant difference in student achievement. "Our textbook has one lesson on adding with 8 or 9. Kids usually have trouble here, and typically only a handful of students get it. This year, it's a total flip-flop — only a handful of students don't have it yet."

After implementing new strategies to help students learn fractions concepts, 4th-grade teacher Lori Moore remarked, "I've never seen this high of a rate of success. And the looks on their faces when they get it? Wow. Many of these students have never earned 100% on a math test."

Teachers learned the instructional strategies to which they credit such turnarounds when they participated in a comprehensive, evidence-based professional development initiative that came to life in response to one school district's need to "fix" the math problem. The math problem is common to most U.S. school districts, and education leaders are well aware that U.S. math achievement lags far behind many other countries in the world (Mullis, Martin, & Foy, 2008).

University Place (Wash.) School District Superintendent Patti Banks found the conspicuous income gap for math scores even more disturbing. In her school district, only 23% of low-income 10th-grade students passed the state math test in 2008. All students will be required to pass this test beginning with the graduating class of 2014 in order to earn a diploma.

Pervasive evidence linking low-income students to low math scores can be found throughout U.S. school systems, despite the curriculum wars roiling the world of math instruction in attempts to address the problem.

Superintendent Banks challenged her administrative team to make increasing math achievement for low-income students a top priority and approved the redirection of sig-

nificant district resources to the task. Banks urged her colleagues to "transfer the external sense of urgency created by the accountability movement to an internal, culture-driven sense of urgency born out of a sense of calling, missionary zeal, and professionalism" in order to guarantee that each student received a world-class mathematics education.

In the University Place School District Department of Teaching and Learning, three interrelated spheres of influence met to put a plan into action:

- *Professional development*, represented by me. I believed that implementation of evidence-based best practices for effective instruction, as well as high-quality job-embedded professional learning structures, inevitably led to student achievement gains.
- *Math*, represented by Jeff Loupas, director of mathematics, assessment, and technology. Loupas disagreed, insisting it was all about the math.
- *Administration*, represented by Andrew Eyres, executive director of teaching and learning. Eyres pointed out that, without administrative support, it mattered little who was right: The plan was doomed to fail.

It turns out all three of us were right.

As a result of our initial efforts and with the support of a U.S. Department of Education math-science partnership grant, the University Place School District now leads the Math: Getting It Project, a multilayered, ongoing mathematics initiative involving three local school districts and a local university. Components of the initiative include summer math institutes, teacher leader learning, targeted curriculum and assessment work, and professional learning communities focused on math instruction as well as administrator training and support.

PROFESSIONAL DEVELOPMENT

All components of the program were designed to align with NSDC's Standards for Staff Development and reflect Richard Elmore's consensus view of what effective professional learning must look like (Elmore, 2002). See the box above right.

Professional development included intensive summer institutes for grades K-12 teachers taught by in-district teacher leaders, designed to help teachers implement evidence-based, math-specific instructional strategies and increase math content knowledge and pedagogy. But summer institutes weren't the beginning and end of our learning.

Teacher leaders and professional learning communities

Research shows that the impact of professional learning activities on classroom practice is inversely related to how far away those activities are from the classroom itself (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). In order to link summer institute learning to classroom practice, teacher leaders facilitated building-based, grade-level professional learning communities that met regularly to work collaboratively on implementation of new instructional strategies, analyze changing student achievement data, design powerful formative assessment strategies to guide instruction, and plan support for struggling students. During the school year, teacher leaders participated in learning to help them develop necessary skills to build highly functioning professional learning communities, as defined in the Math: Getting It Project learning community rubric. That rubric is summarized in the box on p. 60.

The professional learning community rubric kept teachers and administrators focused on the three crucial questions that should drive the work of those within a professional learning community, according to Richard DuFour (2004):

- What do we want each student to learn?
- How will we know when each student has learned it?
- How will we respond when a student experiences difficulty in learning?

Curriculum and assessment work

Once teacher leaders and their teams began to meet, teachers quickly spoke about their need for support on two

CRITERIA FOR EFFECTIVE PROFESSIONAL DEVELOPMENT

Effective professional development:

- Focuses on a well-articulated mission or purpose anchored in student learning.
- Derives from analysis of student learning of specific content in a specific setting.
- Focuses on specific issues of curriculum and pedagogy.
- Derives from research and exemplary practice.
- Connects with specific issues of instruction and student learning in the context of actual classrooms.
- Embodies a clearly articulated theory or model of adult learning.
- Develops, reinforces, and sustains group work.
- Involves active participation of school leaders and staff.
- Provides sustained focus over time and continuous improvement.
- Provides models of effective practice.
- Utilizes assessment and evaluation.
- Provides timely feedback on teacher learning and practice.

Source: Elmore, 2002.

fronts. First, leaders and their teams asked for help integrating new instructional strategies with existing curriculum. They also asked for assistance designing classroom formative assessments to inform math instruction and enrich their discussions.

So grade-level leaders then convened to align and revise curriculum maps as well as design formative assessments, which were then shared with teachers districtwide through the learning community structure and on the web site.

These work sessions, while guided by Department of Teaching and Learning staff, stayed grounded in classroom practice. If it didn't work in the classroom, teachers reported it. Continuous improvement and refinement of curriculum and assessments continues as part of the professional learning community and work team cycle.

MATHEMATICS

Yet what about that math? What was the missing ingredient, according to Loupas, our math expert? Within mathematics education, a body of research clearly points to certain instructional strategies specific to teaching math content that prove far more effective than traditional strategies, especially for struggling math students. Math-specific strategies complement what we know about effective instructional strategies generally, yet have content-specific elements found only in math instruction.

The bedrock instructional principle underlying math strategies involves the explicit teaching of referential, hands-on manipulative models as part of regular math instruction. For example:

- When learning fractions operations concepts, students use fraction circles, paper strips, folding paper, and two-sided color chips. More than 30 years of convincing evidence from the University of Minnesota's Rational Number Project (Cramer, Post, & delMas, 2002) clearly points to the effectiveness of these content-specific strategies.
- When students first develop number sense and learn to perform whole-number operations, they use ten-frames, hundreds charts, paper strips, place value mats, and base ten blocks to develop a deep understanding of place value. Place value models help students successfully learn addition, subtraction, multiplication, and fraction concepts, and reinforce foundational math concepts necessary for understanding algebraic concepts later on.

While many elementary math teachers use math manipulatives such as these for instruction, the math models in the Math: Getting It Project are different. First, teachers use only those models most strongly connected to significant increases in student math achievement. These models also differ from traditional approaches because students incorporate powerful referential models to their mathematics academic background knowledge as they learn them.

For example, these models implicitly provide students with foundational math understanding of how and why the algorithm for multiplying fractions works, while simple memorization of the algorithm, a common student fallback strategy, does not. The old adage "Mine is not to reason why; just invert and multiply" will not lead students to deeper understanding of the crucial hows and whys of math, while referential math models inevitably do.

Most importantly, students will be able to reference these models later to remember, relearn, practice, and expand their math skills as they increase mathematical competency. Loupas explains, "These models will never need to be abandoned, as many traditional math learning strategies are. Without these models, many students can't make the leap from additive thinking to fractions concepts. They don't understand ideas such as why on-half plus one-third doesn't equal one-fifth. Our most at-risk students can't afford to learn strategies that will confuse them later on. Kids who need our help the most need to see that math makes sense. It makes sense when students learn with referential math models."

ADMINISTRATOR INVOLVEMENT

Administrators also play an important role in the district's math reform efforts. "Without the support of the superintend-

5 ESSENTIAL CHARACTERISTICS OF A PROFESSIONAL LEARNING COMMUNITY

Shared mission: The professional learning community demonstrates a high degree of commitment to continuously improve student math achievement, agreement on best practices for math instruction, eagerness to implement best practices, and commitment to collaboratively improve math instruction through the learning community structure.

Learning-focused collaboration: The professional learning community collaboratively shares ideas and strategies, plans learning and teaching activities, and works together to solve problems.

Collective inquiry: The professional learning community confidently uses a wide range of methods to investigate learning and teaching, using findings to inform and develop its practice. The community collects, analyzes, and uses data to support this process.

Action research: The professional learning community seeks to improve instructional practices for teaching mathematics and works collaboratively with others to improve instruction. Effects on student learning are the primary basis for assessing improvement strategies, and members constantly turn their learning and insights into action, rigorously assessing their efforts, demanding evidence in the form of student learning.

Results orientation: The professional learning community evaluates efforts based on tangible results, and stays hungry for evidence of student learning. Members continuously use this evidence to inform and improve their practice.

Source: Math: Getting It Project web site, www.upsd.wednet.edu/1613101012143043530/site/default.asp.

ent and building principals, we would find it very difficult to reinforce and support these changes," says Eyres. "With this support, teachers are making significant changes in their practice, even teachers who have been teaching math the same way most of their careers."

Administrators are better supporters of math teachers because they engaged in professional learning time studying math as well. Eyres says, "In administrator professional learning communities, University Place School District leaders spent significant time learning mathematics and math-specific pedagogical concepts because many administrators have some uneasiness with math, as some teachers do as well. When administrators knew what to expect in classrooms, they also knew how to help teachers develop necessary new skills that work to teach kids math."

University Place School District
University Place, Wash.

Number of schools: **8**
Enrollment: **5,632**
Staff: **307**
Racial/ethnic mix:

White:	**62.6%**
Black:	**16.4%**
Hispanic:	**6.6%**
Asian/Pacific Islander:	**13.3%**
Native American:	**1.1%**
Other:	**0%**

Limited English proficient: **2.1%**
Languages spoken: **18**
Free/reduced lunch: **34.2%**
Special education: **12.1%**
Contact: **Jeff Loupas**, director of mathematics and assessment
E-mail: **jloupas@upsd.wednet.edu**

Eyres and other district administrators continuously conducted classroom walk-throughs to gather data and track implementation for grant purposes, and used the opportunity to encourage administrative dialogue and study around support for effective instruction. Principals promoted learning by participating in lesson studies with professional learning communities, facilitating preplanning and debriefing sessions around focused topics for improving instruction.

LOW-INCOME STUDENTS

And what about low-income students, headed for a looming graduation requirement they may not be able to meet? For University Place School District math learners, things are changing quickly. Historically, the math achievement gap between low-income and other students widens in middle school; low-income students regress even further as math content demands increase. In 2009-10, however, state testing data shows that 7th graders closed this gap by 10% as they moved from 6th to 7th grade, an unprecedented turnaround that Superintendent Banks characterized as "significant, meaningful progress."

Newly implemented strategies have had a particularly dramatic impact on University Place students in the middle school Learning Assistance Program, where, in 2009, 63% of students received free and reduced lunches, as opposed to 37% in the general population. Learning Assistance Program students, who entered the program based on low math achievement scores, began quickly testing out of the remediation program. In 2009, almost one-quarter of the program's math students exited the intervention program first semester because of improved math achievement.

Laura Sloan, intermediate-level math specialist, credits the turnaround to new instructional models and better teaching. "Our low-income kids don't come in with the same background experiences our more privileged kids do," she says. "Money for low-income children may be welfare checks and check-cashing stores, for instance, not budgets and bank accounts, so poorer students come in already behind in real-world understanding of mathematics. These instructional models level the playing field between rich and poor by providing referential math knowledge that is very real to kids in the here and now. These models also provide powerful support for future math learning."

In Sloan's view, what has been the impact of her district's professional development in math so far? "It is very obvious to me the teachers who have gone through the professional development and those who have not," she says. "Trained teachers have changed the way they teach kids. They aren't satisfied with just the 'how' and don't go straight to teaching the algorithm without making sure students understanding the 'why' behind a math procedure. It is making a significant positive difference for our students."

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