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QUALITATIVELY DIFFERENT

Mathematics Education for Teachers

By Abner Oakes, Senior Program Associate for The Center

The National Mathematics Panel report confirms the growing body of evidence that the mathematics that teachers need to know and be able to use in the act of teaching is qualitatively different than what one typically learns in a "pure" math class.

—Denise Mewborn, Ph.D., professor of mathematics education and chair of the Department of Mathematics and Science Education at the University of Georgia at Athens

In 2008, Foundations for Success: The Final Report of the National Mathematics Advisory Panel *was released. This month's newsletter represents the fourth publication by The Center for Comprehensive School Reform and Improvement on mathematics education and the second publication that focuses on the panel's report.*

A key section of the report focuses on "Teachers and Teacher Education." The mathematics panel found that differences in teacher attributes contributed to differences in the mathematics achievement of their students:

- Twelve to 14 percent of the variability in mathematics achievement gains for elementary students can be attributed to teacher effectiveness in teaching mathematics.
- Academic achievement was impacted by the extent to which students were taught either by a series of effective or ineffective teachers (National Mathematics Advisory Panel, 2008).

The mathematics panel made seven recommendations on this topic of teachers and teacher education.[1] However, one recommendation that is central to improved mathematics teaching and student learning is the recommendation

1 To learn more about these recommendations, visit www.centerforcsri.org and select "Resources by Topic," and then select "Mathematics."

concerning teachers' knowledge and use of mathematical content:

> The mathematics preparation of elementary and middle school teachers must be strengthened as one means for improving teachers' effectiveness in the classroom. This includes [preservice] teacher education, early career support, and professional development programs. A critical component of this recommendation is that teachers be given ample opportunities to learn mathematics for teaching. That is, teachers must know in detail and from a more advanced perspective the mathematical content they are responsible for teaching and the connections of that content to other important mathematics, both prior to and beyond the level they are assigned to teach. (National Mathematics Advisory Panel, 2008, p. xxi)

For this newsletter, The Center solicited responses to this recommendation from a variety of people, including those who teach prospective elementary school teachers to those who plan and conduct professional development activities for these teachers in school districts. All of them agreed with the statement from the panel's report, and all of them reported working on it in ways particular to their own settings. As one assistant superintendent put it, "The delivery system for mathematics in the United States is broken and must be fixed. Teaching matters, especially in the area of mathematics. We must help our teachers become proficient in mathematics and move from hands on to minds on" (G. Talley, personal communication, September 2008).

When it comes to preservice work with prospective elementary school teachers, the University of Georgia at Athens (UGA) requires far more mathematical training than all other teacher training programs. All UGA undergraduates studying to be elementary school teachers take five semester-long mathematics courses; three of those courses are mathematics content courses taught by members of the University's mathematics department, and the other two are mathematics methods courses taught by faculty in UGA's Department of Mathematics and Science Education. In a recent report by the National Council on Teacher Quality (2008), UGA's preservice mathematics work was the only program out of 77 reviewed to be rated "exemplary."

UGA's teacher education program has worked hard to bridge "the traditional dichotomy between 'content' and 'methods' classes and… what is taught in these courses," according to Denise Mewborn, Ph.D., professor of mathematics education and chair of the Department of Mathematics and Science Education at UGA (D. Mewborn, personal communication, September 2008).

Mewborn went on to say the following:

> [This] recommendation of the national math panel confirms the growing body of evidence that the mathematics that teachers need to know and be able to use in the act of teaching is qualitatively different than what one typically learns in a 'pure' math class. Teachers need to learn to solve a problem several different ways, compare and contrast the various solution strategies, explain the connections among the strategies, explain why each strategy works, and consider things such as which strategies they would highlight in a classroom situation, for what purpose, and in what order. (D. Mewborn, personal communication, September 2008)

"I strongly agree with the statement from the national math panel," said Sybilla Beckmann, Ph.D., professor of mathematics at UGA. She went on to say the following:

> One thing I would clarify is that prospective teachers need a more comprehensive, bigger-picture view of the math they will teach. In

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> particular, this means that teachers should know a variety of ways to solve problems, including standard ways and nonstandard ways. They should also be able to detect methods that seem plausible on the surface but are in fact not correct, and they should be able to explain why these methods are incorrect. (S. Beckmann, personal communication, September 2008)

Knowing a variety of ways to solve problems and possessing the flexibility to move from one method to another, as appropriate for a particular problem, are critical skills for an effective mathematics teacher (as well as for a successful mathematics student). Deep conceptual knowledge can help teachers move seamlessly from their preservice study to actual teaching in the school building. Many districts across the country are beginning to do what they can to help teachers build and ultimately use that knowledge, as Denise Mewborn commented, "in the act of teaching."

For instance, Michelle Dubois, mathematics curriculum specialist at Kentwood (Michigan) Public Schools, which serves about 9,600 students, believes that when "teachers have a narrow, minimal understanding of the mathematics they are required to teach, they are limited in the ways they can teach that mathematics to their students. That is, if a teacher can only see a concept or problem in one way, and that way is different from the student's current perspective, the two have no way of communicating with each other.

"A teacher with a deep understanding of math," Dubois continued, "has the ability to see concepts with multiple representations. They can recognize a student's perspective of a concept or problem, relate to it, build on it, and coach the student into new understanding. The teacher has the flexibility that comes from background knowledge and depth of understanding" (M. Dubois, personal communication, September 2008).

These comments echo what Garet and colleagues discovered in their 2001 research: the "importance of professional development that focuses on mathematics and science content. Much of the literature on professional development focuses on the process and delivery system; our results give renewed emphasis to the profound importance of subject-matter focus in designing high-quality professional development" (Garet, Porter, Desimone, Birman, & Yoon, 2001, p. 936).

So what are school districts doing to ensure, as the recommendation from the mathematics panel states, that teachers "know in detail and from a more advanced perspective the mathematical content they are responsible for teaching"? For some this work begins with two steps: one, ensure that all of the district's important players are on the same page, and, two, create a system to gather information on the strengths and weaknesses of teacher knowledge that can help drive professional development.

At DeKalb County Schools, the third-largest school district in Georgia, the district "established a K–12 mathematics think tank… comprised of central office staff, teachers, and local school administrators to discuss successes, challenges, and strategies for improvement of mathematics instruction," according to Gloria Talley, deputy superintendent for curriculum and instruction. Talley went on to say that "subsequent meetings have been held with mathematics teachers K–12 to gather their input regarding key strategies for teacher training and math success" (G. Talley, personal communication, September 2008).

The DeKalb school system has put into practice what McLaughlin and Talbert (1993) discussed: "Strong professional community provides context for sustained learning and developing the profession…. The path to change in the classroom core lies within and through teachers' professional communities: learning communities which generate knowledge, craft new norms of practice, and sustain participants in their efforts to reflect, experiment, examine, and change" (p. 18).

One of the country's largest school districts has taken a similarly strategic and inclusive approach to this work, particularly with that district's Title I resource teachers and their district partners, such as mathematics coaches who are assigned to schools. A district-level Title I administrator wrote about that work, now in its third year:

> In year one we presented an overview of standards-based mathematics education, focusing on building a common understanding of the standards-based change process, using the National Council of Teachers of Mathematics' (NCTM) Principles and Standards for School Mathematics and having participants engage in action research that would support standards-based instruction. In year two, we extended the professional development…to include strategies for diverse learners. Again, participants were expected to do action research…. This school year, in light of the NCTM's Curriculum Focal Points and the National Mathematics Panel's release of their findings and recommendations, we intend to have participants delve deeper into understanding the critical skills needed for students to be competent and ready for higher levels of mathematics. The professional development will focus on applications for two critical foundations of mathematics: fluency with whole numbers and fluency with fractions. (Anonymous, personal communication, September 2008)

More and more, school districts are looking for ways to build capacity within individual schools, with district- and school-level coaches and activities that very specifically target classrooms. The Pawtucket (Rhode Island) School Department, with 16 schools and about 10,000 students, has an initiative called Energizing Mathematics Teaching (EMT). Leslie Clark, the mathematics coordinator for the district, and her mathematics coaches work with pairs of teachers from each of the district's 10 elementary schools.

"These teachers engage in a full day of professional development, once per month," commented Clark. "These teachers in turn deliver an abbreviated version of the training that they have received to the [other] teachers and support staff in their buildings. We call these lead teachers our EMTs" (L. Clark, personal communication, September 2008).

From 2005–06, the second school year of Pawtucket's EMT initiative, to 2007–08, end-of-year test scores for all Pawtucket elementary school students in the area of mathematics have improved, from an Index Proficiency Score of 76.6 to 78.5. Also, EMTs showed improved knowledge and confidence in the area of mathematics. During the 2005–06 school year, 15 of them were given a short survey in September and again in June, and were asked to rate their improvement in areas such as ability to promote multiple strategies, to attend to student thinking, and to balance procedural and conceptual learning. In these areas, from the fall to the spring, mean scores improved from 27 percent to 33 percent. One EMT wrote, "I never realized how little I knew…even after being a math major in college."

But for Lynda Hickey, director of instruction at Winchester (Virginia) Public Schools, "providing teachers with effective professional development is just the tip of the iceberg. Teachers must also be given common planning time to work collaboratively to discuss student achievement results, intervention strategies, and the best methods of modifying instruction." In Hickey's 3,800-student district, "teachers at the elementary and middle school are given large blocks of time each day in which to work as a professional

"Time is an issue here. If teachers have to find out what to teach by themselves in their very limited time outside the classroom and decide how to teach it, then where is the time for them to study carefully what they are to teach?"

learning community. Vertical and grade-level team articulation—elementary with elementary, middle with middle, and elementary with middle school teachers—is critical to building the teachers' expertise of content material as well as to the achievement of students" (L. Hickey, personal communication, September 2008).

Hickey's observation echoes what Liping Ma wrote 10 years ago: "Time is an issue here. If teachers have to find out what to teach by themselves in their very limited time outside the classroom and decide how to teach it, then where is the time for them to study carefully what they are to teach?...It is clear that they do not have enough time and appropriate support to think through thoroughly what they are to teach" (Ma, 1999, p. 149).

The 45 main findings and recommendations from the National Mathematics Panel are serving as a clarion call for K–12 mathematics teaching and learning, and the preparation and continued professional development of those that teach mathematics, no matter the grade level, remain a central issue. The mathematics panel made clear that the country's lead in the area of mathematics will be relinquished this century "without substantial and sustained changes to its educational system." (National Mathematics Advisory Panel, 2008, p. xi.) Fortunately, the panel's report is providing a blueprint that, with proper support, can make a difference in how we prepare our students for an advanced education and productive careers.

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The Center
FOR COMPREHENSIVE SCHOOL REFORM AND IMPROVEMENT

1100 17th Street NW, Suite 500
Washington, DC 20036

P: 877-277-2744 > **W**: www.centerforcsri.org
P: 202-223-6690 > **F**: 202-223-8939