


# Essential Qualities of Math Teaching Remain Unknown

By [Sean Cavanagh](#)

It is one of most widely accepted axioms in math education: Good teachers matter.

But what are the qualities of an effective mathematics teacher? The answer, as [a recent federal report](#)  suggests, remains frustratingly elusive.

Research does not show conclusively which professional credentials demonstrate whether math teachers are effective in the classroom, the report found. It does not show what college math content and coursework are most essential for teachers. Nor does it show what kinds of preservice, professional-development, or alternative education programs best prepare them to teach.

As a result, while the report of the National Mathematics Advisory Panel, released last month, offers numerous conclusions about math curriculum, cognition, and instruction, many of its recommendations about improving teaching are more tentative and amount to a call for more research.

“It is, in some ways, where the action has to come next,” said Deborah Loewenberg Ball, the member of the panel who chaired its working group on teacher issues.

“We should put a lot of careful effort over the next decade into this issue so that we can be in a much different place 10 years from now.”

The uncertainty about math teaching skills emerges at a time when policymakers at all levels see a need to boost students’ math and science achievement as a key to sustaining the nation’s future economic health and producing a skilled workforce.

One reason the panel found a paucity of evidence on effective math instruction is that it set a high standard for the type of research it would accept, as Ms. Ball acknowledged.

Yet its members found a deeper pool of research in other areas of math, such as how students learn in the subject, and how students’ confidence in their ability influences their persistence and engagement in math study.

## Credentials and Content

The panel was also more confident in calling for “a more focused, coherent” curriculum in pre-kindergarten through 8th grade math—the primary age group studied—with a more logical progression from less difficult topics to more sophisticated subject matter. (“[Panel Calls for Systematic, Basic Approach to Math](#),” March 19, 2008.)

But when it came to drawing conclusions about the necessary skills and preparation of educators responsible for delivering that content, the report’s authors said much less is known.

On the one hand, effective math teachers have an impact on student achievement, the panel found. It cited a study showing that differences in the quality of teaching accounted for 12 percent to 14 percent of variation in students’ math achievement in elementary grades.

But the 90-page report also says it is hard to determine what credentials and training have the strongest effect on preparing math teachers to teach, and teach well. Research has not provided “consistent or convincing” evidence, for instance, that students of certified math teachers benefit more than those whose teachers do not have that licensure, it found.

Similarly, a weak connection exists between teachers’ college math coursetaking and the achievement of their students at the elementary level, though there was a stronger link between that educational background and high school achievement, the panel found.

When it comes to the specific math-content knowledge teachers need, the available research is also sketchy, the panel concluded. But the report does offer some direction on that topic.

It emphasizes, for instance, the importance of educators’ having a solid grasp of “mathematics for teaching”—or an in-depth knowledge of the specific math needed for their classes and how to make it understandable to students.

Ms. Ball, the dean of the school of education at the University of Michigan in Ann Arbor, conceived that concept, also referred to as “mathematical knowledge for teaching,” along with a team of researchers. That work has been widely cited in education policy circles.

### **Classroom Know-How**

Ms. Ball believes the emphasis on giving aspiring teachers more classroom-specific math skills must occur on several fronts.

Schools of education—ideally, entire networks of them—must devise courses and tests, in partnership with mathematics faculty, that provide “instructionally relevant” content knowledge for teacher-candidates, rather than just focusing on more generic math content, she said.

States, which license teachers, should produce certification tests that better measure math teachers’ knowledge of instructionally relevant content, Ms. Ball added.

Ideally, states would partner with each other to craft tests using similar standards to cover a wider swath of the teaching population, she said.

Cathy L. Seeley, a former president of the 100,000-member National Council of Teachers of Mathematics, said she also favors emphasizing those classroom skills.

There is a growing recognition of the need to give aspiring math teachers, particularly those who will teach in the early grades, college coursework that is tailored more specifically to working with students, rather than simply piling on more advanced math, said Ms. Seeley, who was not on the math panel.

But shaping education school courses, professional development, and licensure tests around that concept takes time, she said.

“It’s a different kind of mathematics and an emerging area,” said Ms. Seeley, now a senior fellow at the University of Texas at Austin. “It’s not about how much math you have—it’s about the particular math you know.”

The working group of the math panel that studied teacher issues, like the panel as a whole, placed the greatest value on “scientifically rigorous” research, such as

randomized controlled trials. The working group acknowledged, though, that conducting such rigorous studies in the area of teacher preparation and content knowledge is difficult.

Many researchers and scholars have bemoaned the lack of firm evidence, not just in mathematics but across subjects, about what preparation and credentials are most likely to produce high-quality teaching. ("[Study Casts Doubt on Value of 'Highly Qualified' Status](#)," April 4, 2007.)

The dearth of strong research on the attributes of effective teachers applies to science, another high-need subject in many schools, said Heidi Schweingruber, the acting director of the board on science education at the congressionally chartered National Research Council.

Ms. Schweingruber co-directed a 2006 federal study on teaching and learning in K-8 science, which she says revealed a lack of high-quality research on effective teacher preparation and professional development in that subject.

### **Specialist Knowledge**

Establishing a link between teacher preparation and student achievement in many ways represents "the holy grail" in teacher education research, Ms. Schweingruber said. But there are many factors affecting teacher preparation and student performance that can undermine such research, she said.

"Our sense was there was even less known in science than there was in math," she said. The best available knowledge about how to prepare and mentor science teachers, she said, is more commonly rooted in "professional wisdom" than definitive research.

The Institute of Education Sciences, the research arm of the U.S. Department of Education, is supporting a number of research projects on the characteristics and qualifications of effective teachers, and on effective practices in professional development, a spokesman said.

In addition, the IES recently issued a request for applications to set up a Center on Teacher Effectiveness to study the issue in greater depth, though it has not been determined which teacher subject-area would be its focus, the agency said.

On the topic of strategies to recruit and retain math teachers—who are in great demand in districts—the panel said evidence was generally favorable, though not conclusive, that financial incentives help.

Evidence was also mixed on the benefits of elementary school math specialists, who teach only that subject, as opposed to having to cover all subjects, as is common at that level of education. While specialists are used in China, Singapore, and Sweden, the panel's report said, they are not widely employed in most high-performing nations.

Even so, the panel's report urges that research be conducted on elementary-level math specialists, because the potential benefits are so great. Using specialists could be a "practical alternative" to attempting to raise the math skills of all elementary teachers, "a problem of huge scale," the report notes.

Cost is sometimes cited as a barrier to hiring specialists, but another hurdle is the belief that young students benefit from "the nurturing of a single teacher," rather than being taught by a group of them, said Ms. Seeley, who added that she does not buy that argument.

The possible upside of using specialists "is huge," she said. Today, most elementary teachers, as subject-matter generalists, are likely to have taken only one or two college math courses at most, she pointed out.

"I don't care if you have math specialists or not—but I think you should guarantee you have someone teaching math who knows it and likes it," Ms. Seeley said. An elementary math specialist, she added, is more likely to be "someone who knows math and likes it."