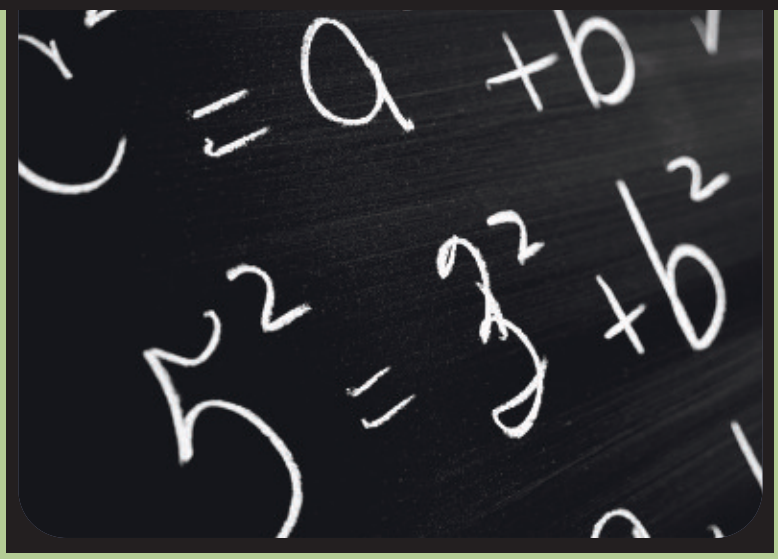
Preparing the Teachers Our Students Need:

Teacher Preparation and Professional Development



The Briefing Paper Series on Mathematical Literacy

Improving the mathematics skills of our citizenry has been a major concern for educators, policy makers, and the general public since long before Sputnik ushered in "new math." With the most recent decade of education reform and the advent of "new-new math," advances in mathematics research and education have led to both fruitful exchanges of ideas and challenging debates. Never before has it been so clear that mathematical literacy is vital for our nation's economic growth, security, and civic progress. And never has the call to bring *all* children to high levels of mathematical literacy been sounded so forcefully. Yet, though our culture, our country, and our schools by and large expect all adults to be able to read, we do *not* expect all adults to be proficient in mathematics. (How often does someone utter, "I was never good at math," only to be met with nods of understanding and compassion?) By and large, Americans accept the kinds of results that come from the widespread belief that not all children can learn mathematics beyond "arithmetic."

Believing that all children *can* learn mathematics, and, indeed, that they must, the Council of Chief State School Officers and Texas Instruments Incorporated, have joined together in a partnership to respond to the clarity of purpose and urgency of mission felt in the states today around mathematics education. This partnership will investigate the influences on mathematics education and develop recommendations for effective state actions to lead to improved student performance in mathematics. This paper is the introduction to a series of papers designed to analyze the imperatives and opportunities in several critical areas of mathematics education. The papers will explore the depth and type of mathematical knowledge that students will need to be successful in today's society; how that depth and type of mathematical knowledge is best taught and what this implies for schools and classrooms; and the conditions that need to be established to create this kind of teaching and learning in every classroom. Specific topics that will be addressed by this series include

- The Imperative of Mathematical Literacy
- Standards, Curriculum, Instruction, and Assessment
- Teacher Preparation and Professional Development
- Teacher Recruitment, Assignment, and Retention
- Opportunities for Support and Partnerships

In the first paper of this series, we made the case for why all students need to be literate in mathematics. This paper looks at what it will take to have a high quality teacher in every classroom by focusing on teacher preparation and professional development.

These briefing papers are developed specifically to be disseminated and used by those working to improve mathematics education. Permission is granted to reproduce and to quote items from the papers, as long as references to the authors and sponsoring organizations are provided. For this edition, the recommended citation would be: Lusi, Susan Follett, and Circe Stumbo, (2005), *Preparing the Mathematics Teachers Our Students Need: Teacher Preparation and Professional Development*, (Washington, DC: Council of Chief State School Officers and Texas Instruments).

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Preparing the Mathematics Teachers Our Students Need: Teacher Preparation and Professional Development

A High Quality Teacher in Every Classroom

The most direct route to improving mathematics and science achievement for all students is better mathematics and science teaching.[1]

While this statement seems intuitively obvious, it was not until the last decade that our nation began to analyze and quantify the impact that the quality of teaching has on student achievement. Says the Education Trust in summarizing research from Tennessee, Dallas, and Boston, "Schools—and especially teachers, it turns out—really DO make a difference."[2] In Tennessee, William L. Sanders found that students with the most effective teachers had average learning gains of 53 percentile points over one year, while low-achieving students who were taught by the least effective teachers had average learning gains of only 14 percentile points during the same time period.[3] Sanders found dramatic differences for middle- and high-achieving students as well. Data from Dallas and Boston show similar patterns of student achievement differences as a result of teacher quality.

In addition, these studies demonstrate that the effects of teacher quality are cumulative and long-lasting. The Tennessee data showed that the performance of fifth-grade students was still affected by the quality of their third-grade teachers, even though two years had passed. In Dallas, the average math scores of a group of third graders assigned to three highly effective teachers in a row rose from the 55th percentile in the third grade to the 76th percentile at the end of fifth grade. In contrast the average math scores of a slightly higher achieving group of third graders assigned three of the least effective teachers in subsequent years fell from the 57th percentile in third grade to the 27th percentile at the end of fifth grade.[4]

So what are the characteristics of effective teachers? There is broad agreement that effective teachers of mathematics need to know mathematics very well (have strong content knowledge) and also know how to teach mathematics to students in ways that help them learn the material (have strong pedagogical knowledge).[5] According to the National Commission on Mathematics and Science Teaching for the 21st Century,

> The most consistent and most powerful predictors of higher student achievement in mathematics and science are: (a) full certification of the teacher and (b) a college major in the field being taught. Conversely, the strongest predictors of lower student achievement are new teachers who are uncertified, or who hold less than a minor in their teaching field.[6]

Teachers with strong verbal and math skills, as measured by standardized tests, are also more likely to produce significant student achievement gains than are their lower scoring peers.[7]

The evidence is clear: If, as a nation, we want to dramatically improve student achievement, then, as a nation, we need to dramatically improve the quality of our mathematics teachers and make sure that there is a high quality teacher for every classroom of students. This charge has profound implications for teacher preparation and continuing professional development.

Preparing High Quality Teachers

Put simply, students can't learn what they're not taught, and teachers can't teach what they don't know. Students are being expected to learn much more ambitious mathematical content to much higher standards; but they often are not being taught the mathematics they need because their teachers are unprepared to teach it to them. "Less than half of grade eight teachers have taken the mathematics courses needed as background for teaching effectively at this level, [and] less than 10 percent of grades five through nine teachers are mathematics specialists."[8] More than 25% of high school mathematics teachers do not have even a minor in the field.[9]

Teacher preparation simply must include rigorous content preparation. The Learning First Alliance recommends that teachers of grades 5–9 be mathematics specialists capable of teaching students a challenging curriculum that includes introductory algebra and geometry. In addition to this strong math background, the Alliance says that all mathematics teachers should understand the content taught throughout grades K–12 and particularly the content of the grades that come before and after the courses they teach so that they may help students who are behind and can create a bridge between the content they are teaching and the content students will be taught the following year.[10]

Content knowledge, while necessary, however, is not sufficient for teacher effectiveness.[11] As Richard Schaar of Texas Instruments Incorporated noted many industry leaders under-

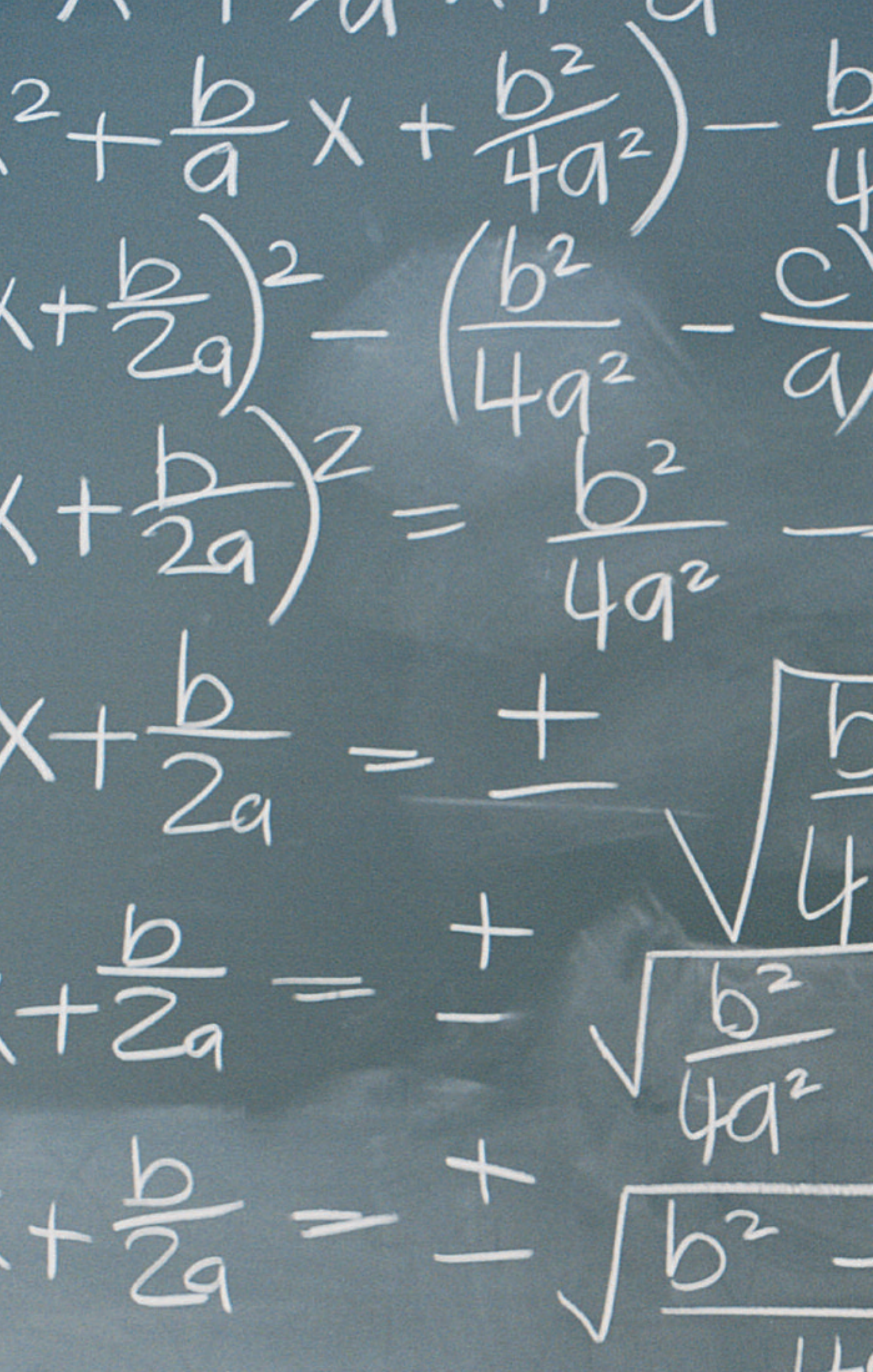
stand that our colleges and universities need to prepare both mathematicians *and teachers of mathematics* and that professionals in each of these fields have unique skill sets.[12] Teacher preparation programs must provide aspiring teachers with strategies and processes to teach math in ways that will engage their students with the content and help them all learn to high levels. Teachers need to know a variety of techniques and ways to structure lessons, as well as how to find the appropriate balance between learning skills, understanding concepts, and solving problems.[13] They need to understand how to use assessment data to improve and individualize instruction and how to teach students who have different learning styles and strengths.

The National Research Council's Committee on Science and Mathematics Teacher Preparation (CSMTP) studied and synthesized the research on teaching mathematics and released their report in 2001. CSMTP identified a lack of continuity and articulation within preparation programs and between preparation and professional development programs (and between higher education and schools more generally) as a challenge that makes preparing high quality teachers especially difficult. "Mathematics education, mathematics, and general pedagogy courses may be spread over several departments, and the mathematics coursework itself may be taken all or partially on a community college campus totally separated from the mathematics methods segment taught as part of the final degree program."[14] This coursework often bears little relationship to what mathematics teachers will actually be teaching. The CSMTP found that most college faculty have been unable "to provide the type of education that K–12 teachers need to succeed in their own classrooms" because they neither understand the standards/expectations that are now established for K–12 students (or the expectations for teachers that flow from these student expectations) nor do they understand good pedagogy or the classroom teaching environment of K–12 schools.[15] The CSTMP concluded that "fundamental restructuring of teacher preparation and professional development is needed to best serve the interest of students' learning and of their future success as individuals, workers, and citizens."[16]

To do this, the CSMTP recommends bringing higher education and schools into much closer working relationships in order to improve both teacher education and professional development. The panel recommended thinking of teacher preparation as a continuum, with school districts taking more responsibility for the initial preparation of teachers and university faculty playing a bigger role in ongoing professional development.[17] They pointed to Professional Development Schools (PDSs) as a promising move toward a more seamless system of teacher preparation and continuing development. A PDS is "an intentional partnership between a college or university and the K–12 sector for teacher education and the improvement of teaching and learning in the schools."[18] These schools can become "living laboratories" in which teachers, students and higher education faculty work together to observe, experiment, evaluate and revise teaching practices as they work together to improve student learning.[19] PDSs can also give preparing teachers more school-based experience—another vital step to improving teacher preparation.[20]

Maturing High Quality Teachers through Professional Development

Ironically, despite all of the problems described in teacher preparation above, we have in many ways relied too heavily on initial preparation to provide teachers with all of the skills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and knowledge they need. Teachers, unlike most professionals, are treated as experts on day one. Brand new teachers are given their own classroom(s) full of students and the same level of responsibility for teaching them as are 20-year veterans.

We are learning that this is a mistake. No preparation program, no matter how good, can transform a novice teacher into a high quality veteran. Teachers need a systematic and supported induction into the profession, as well as on-going professional development throughout their careers. High quality induction programs can continue to ramp up teachers' skills and knowledge as they are engaging with students and student work—and also make it more likely that they will stay in the profession. Teachers then need to continue learning throughout their careers in order to stay current in both content and pedagogy. Teacher learning cannot be seen as the responsibility of only teacher preparation programs:

> The CSMTP has concluded that teacher preparation must be seen in the future as much more continual and seamless than it is today. The college education that leads to initial certification to teach (also known as preservice education) should be viewed as only the first part of a complex, career-long learning process that involves continual intellectual growth both inside and outside the classroom.[21]

In fact, researchers such as Richard Elmore of Harvard University argue that current efforts to use accountability to improve student achievement will never be successful unless they are accompanied by substantial investments in professional development—and this professional development must be of high quality.[22] Elmore articulates the consensus view of the

Professional Development: The Consensus View

- Focuses on a well-articulated mission or purpose anchored in student learning of core disciplines and skills
- Derives from analysis of student learning of specific content in a specific setting
- Focuses on specific issues of curriculum and pedagogy
  - ➢ Derived from research and exemplary practice
  - ➢ Connected with specific issues of instruction and student learning of academic disciplines and skills in the context of actual classrooms
- Embodies a clearly articulated theory or model of adult learning
- Develops, reinforces and sustains group work
  - ➢ Collaborative practice within schools
  - ➢ Networks across schools
- Involves active participation of school leaders and staff
- Sustains focus over time – continuous improvement
- Models of effective practice
  - ➢ Delivered in schools and classrooms
  - ➢ Practice is consistent with message
- Uses assessment and evaluation
  - ➢ Active monitoring of student learning
  - ➢ Feedback on teacher learning and practice

Taken from Elmore, Bridging the Gap Between Standards and Achievement, p. 7, Exhibit 1.

characteristics of high quality professional development.

Unfortunately, many practitioners do not receive professional development with these characteristics today. The CSMTP found that while "high quality professional development programs that include intellectual growth as well as the upgrading of teachers' knowledge and skills must be expected and essential features in the careers of all teachers,"[23] teachers are often not supported in keeping their content and pedagogical knowledge current.

The Learning First Alliance also notes that professional development does not currently address the inadequacies of teacher preparation.[24] The level of support that working U.S. teachers receive differs markedly from that of some other industrialized countries. For example, according to the Learning First Alliance:

> Japanese teachers, unlike U.S. teachers, undergo long-term structured apprenticeships in their profession. They know much more mathematics than most U.S. teachers do, which enables them to work more flexibly based on students' needs. They also are provided with a great deal more assistance regarding how to teach specific lessons, and with comments on where students typically have trouble, with suggestions for what to do when the expected misconceptions arise. This help is provided for teachers at all levels.[25]

Japan also appears to value out-of-classroom time for teachers more than we do in the U.S. While Americans tend to think that teachers are not working if they are not in front of a class of students, the majority of Japanese teachers participate in lesson study groups that meet for two to five hours per week. Japanese teachers have time for planning, as well as for collaborative lesson planning.[26] Without time for on-going learning and support both in and out of the classroom, professional development is unlikely to change practice, and we are unlikely to get the student achievement gains we need in mathematics and elsewhere.[27]

Conclusion

The evidence is clear—if we expect all children to achieve to much higher levels in mathematics, we must better prepare and develop our teachers of mathematics. States have an important role to play in improving preparation and teacher quality overall. States establish entry standards for the teaching profession including course requirements, requirements for student teaching, and passing scores for required examinations. They also approve teacher preparation programs and, in some cases, support teacher professional development through funds, programs, and certifications. These authorities give states considerable leverage in initiatives to improve teacher quality and should be activated toward the goal of preparing high quality mathematics teachers for every school.

Endnotes

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Acknowledgements

In an effort to explore new ways of improving mathematics education in middle and high schools, the Council of Chief State School Officers and Texas Instruments formed a Technology Research and Development Advisory Committee ("R&D Committee") in the spring of 2004. This R&D Committee, consisting of state deputy superintendents or commissioners, district superintendents, and CCSSO staff, met in April 2004 to examine ways in which business and education can work together to build models that will enhance mathematical literacy. The idea for a series of short briefing papers on the core components of mathematics education was born out of that first R&D Committee meeting.

While the analysis and suggestions in this briefing paper are informed by the best collective thinking of that group of teachers, administrators, policy makers, product developers, and researchers, the primary authors of this paper are Circe Stumbo and Susan Follett Lusi. Jamie Poolos is the paper's editor. The authors wish to thank the many reviewers of the original drafts of this paper, including Lisa Brady-Gill and Richard Schaar of Texas Instruments Incorporated Michael DiMaggio and Rolf Blank of the Council of Chief State School Officers, and Patricia I. Wright.

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