Statement to the National Math Panel
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Good morning, and thank you for giving me the opportunity to speak to you today.

I am employed as professor of mathematics at Louisiana State University. For more than a decade, I have been involved in the design and delivery of courses and programs for undergraduates who intend to become middle- and high-school mathematics teachers. I have received NSF grants in the Course, Curriculum and Laboratory Improvement program (CCLI), the Science, Technology, Engineering and Mathematics Teacher Preparation program (STEMTP) and Noyce Scholars program to support these activities. I have also worked with a variety of federal and state projects to provide professional development for practicing mathematics teachers. During this time, I have done my best to keep abreast of the research literature in mathematics education, or at least that part of it that is relevant to middle and high-school teaching. My involvement with teachers has drawn me deeper and deeper into the school world, and I now spend a significant amount of time with K-12 students, teachers, administrators, data specialists and evaluators. Some of the most extreme educational conditions—both good and bad—can be found in Louisiana schools. I have witnessed the whole range.

The purpose of this statement is first to convey to you the difficulties faced by myself and my colleagues involved in mathematics-teacher education that arise from the lack of a scientific knowledge base for work in the field of education, and second to elaborate on the nature of this problem, which is critical if we are to improve the situation we face. We all provide for our students what we believe is best, but many of us are dissatisfied with the evidence we have to go on in structuring teacher-training, and we have very little idea of how what we provide plays out in the classrooms in which our students eventually teach. This is a problem I face every day in a very concrete, practical way: What are the most important things that a university-based mathematics educator can do to support future teachers? What is the evidence that these things are effective? What is the reason why they work? Given the importance of the job of educating teachers, one would expect to be able to find some solidly established principles on which to build, but this seems not to be the case. There is, however, no shortage of advice. Suggestions, models and guidelines are plentiful—so plentiful and varied, in fact, that I suspect I could probably find justification for almost any reasonable program I might try. To be sure, there are some powerful ideas (*e.g.*, knowledge of mathematics for teaching), promising models (*e.g.*, UTeach at the University of Texas) and useful syntheses (*e.g.*, the CBMS recommendations on teacher education). But these are exceptions. They stand out against the din of pronouncements that seem to derive their strength more from personal passion than from fact. Or at least this is the impression that I am left with after all the years I have devoted to mathematics education.

I would like to offer some general observations concerning things that could be of real help. First, we need to understand the relationship between the facts of our educational situation and the values we bring when thinking about those facts. To make a comparison, in medicine there is a perceptible layering of knowledge; clinical practices are based partly on traditions and values, partly on personal experience, and also clearly on uncontested facts of medical science. In the field of education, in contrast, we seem to lack a structured body of knowledge about schooling that informs educational practice in the way basic medical science informs medical practice. Much thinking in education blends facts and values in a way that would seem peculiar to a medical researcher or a physician. I have heard some of my colleagues in education say that their goal is to develop "prescriptive theories," a concept I find hard to comprehend. The mixing of facts and values is often subtle, but the tendency occurs in every ideological camp. I am fully aware of the philosophical traditions on the impossibility of cutting reality cleanly into two domains, one of fact and one of value. It is not my purpose to debate this idea. Nor do I think it would make any sense to exclude considerations of value from our thinking about education. I only want to suggest that as a practical matter, we might be much more diligent about identifying the fundamental facts that we all agree are beyond our ability to change on the one hand, and articulating our (possibly different) values more dispassionately on the other. Selecting an elementary mathematics curriculum, for example, is an area where both facts and values come into play, but in practice the distinction is often blurred. This harms communication and decision-making. We need more concerted and thoughtful efforts to make clear distinctions between facts and values and to state values with careful and precise detail.

My second observation is that educational research seems to lack the kind of organized, high-level intellectual structures that set the stage for cumulative progress. Many authors seem to be more interested in proposing a novel way of looking at the world of education than improving the detail in a widely accepted picture. The Babel in educational research cannot be remedied simply by imposing quality-control benchmarks or officially favoring some methodologies. I suspect that much larger, much longer and much better-funded research projects might help, especially if more social, cognitive and statistical scientists could be recruited to join the effort. Stepping back to take in the broader picture, our hopes for educational science are part of the dream of a systematic "social science that matters." Examples such as the Project on Human Development in Chicago Neighborhoods suggest that serious support for serious work on serious problems can, over time, lead to knowledge that does matter. But it's not my intention to suggest science policy. I simply want to point out that the fragmentation of educational research renders it a poor guide for people like me who want to make wise practical decisions about training teachers. When I hear someone say, "the research shows that…," I know it means, "I found some publications that support my conviction that…." When I make a decision about what to put in the curriculum for teachers, I want to feel that I've made a decision based on solid knowledge. I don't want to feel like I'm joining a cult.

The third thing I want to speak about as a hopeful consumer of educational research is our poor understanding of the kind and quality of the mathematics instruction that is provided in the USA. What is actually transpiring in U.S. classrooms day-to-day? I suspect this may be the most controversial of the things I am saying. What strikes me is not only the level of ignorance, but the fact that it is widely unrecognized. Many people will say that we know a lot, but I think this is illusory. It is easy to believe we know a lot because hundreds of millions of Americans have

each individually witnessed thousands of math classes (as students themselves), because official observations of classrooms for a variety of purposes are routine, and because there have been a number of very careful studies of instructional practices (most prominently of course the Third International Math and Science Study, TIMSS and its descendents). However, even if everyone has seen a lot of math instruction, it's unlikely that anyone's experience includes a representative sample. On the contrary, almost everyone sees an extremely biased sample. Moreover—as social scientists warn us—participant reports of social processes may be extremely difficult to translate into scientifically meaningful information.

As for the observations that are performed for professional reasons, there are no universal standards for how they ought to be done. Observations done in one district at one time may be completely different in structure and purpose from those done at another time or place, and they cannot be meaningfully compared or combined. Finally, while studies such as TIMSS have helped us develop some important "idealized typifications" of instructional practice, they have not given us a good picture of the variation that that's out there. To describe the range of practices in mathematics instruction in this country and how they are distributed geographically and by race and class would require much bigger studies than any yet conducted. How does the profile of instructional practices in Albuquerque (say) compare with the profile in Baton Rouge, or Hartford or Boise? How do the qualities of math instruction vary between different populations within the same district or school? What are the exceptional practices, good and bad?

To underscore the level of ignorance on these matters, let me say that I recently searched through several of the most widely referenced handbooks on mathematics education—over 3000 pages of research review and summary. The indices of these books refer to only 5 pages for "observation", and a page-by-page search reveals few references to substantial observational studies with more than a handful of subjects. Similarly, a search of the ERIC database reveals a couple of dozen small, scattered and highly specialized observational studies of mathematics teaching, mostly in the lower grades, but no major, synthetic works. Moreover, studies of instructional practices involving significant numbers of teachers are almost always based on surveys, not direct observation; this is true not only in mathematics but in all academic subjects.

Teachers learn to teach from a number of sources: their own schooling, their experiences in training and their colleagues on the job. With care, intelligence and perseverance, university-based educators may be able to provide improved preparation. But this is unlikely to happen unless we have a clear picture of the instructional reality that is out there at present and sure measures of the influence we exert. A scientific focus on the classroom, free from ideology, curious about fundamental processes and based on extensive systematic observation would open a two-way street, equipping teacher-educators with an improved understanding of the problems teachers have to solve, providing them with better access to the wisdom contained in existing practices, and identifying exceptional solutions to instructional problems. I hope that the Panel can encourage the development of such a science.

Thank you.
James J. Madden