

**Special Report
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Resources**Text-only | [Flash Special Report](#)****MATH: What's the Problem?**

Most agree that math smarts are essential to the country's future.

Yet, U.S. students' math scores rank below those of many other countries. Why do so many people struggle with math? Why is math so important, anyway?

Credits & Acknowledgements

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Arithmetic may be the last of the three Rs, but mathematics is a subject that touches every family. Improving math education has been a topic of national focus on-and-off for as long as there has been formal schooling. As international assessment tests found U.S. students being outperformed by those in many other countries, a 2007 report, "Rising Above the Gathering Storm," made improving math education key to improving the science and technology enterprise. Meanwhile, the National Mathematics Advisory Panel (NMAP) diagnosed the delivery system for math education as being "broken and in need of repair." A long list of recommendations highlighted the importance of research to guide effective teaching from the earliest grades, and algebra as a gateway subject to higher-order math learning. Among the voices in this discussion are two members of the NMAP: Joan Ferrini-Mundy, the National Science Foundation's (NSF) division director for the Division of Research on Learning in Formal and Informal Settings; and Deborah Loewenberg Ball, dean of the School of Education at the University of Michigan. They are joined by William Schmidt, university distinguished professor of education and statistics at Michigan State University.

VIDEO TRANSCRIPT

WILLIAM SCHMIDT: I think the problem is that just we simply have not done an adequate job of teaching our children and so we've done that for generations and so, therefore, adults say "I'm no good at math," and that's sort of okay. They think of it that way. It's sort of funny and they communicate that to their kids and people think it's only if you really have a math gene, but that's just so wrong. Other countries respect mathematics and they expect all kids to learn it to some basic level. They're all not going to be math people, but they all can learn it to a basic level.

STUDENT: 9, 10, 11, 12, 13, 14, 15, 16 -

DEBORAH LOEWENBERG BALL: That's very good. You're like -

DEBORAH LOEWENBERG BALL: I was a French major in college. In high school, I was fascinated with languages and humanities and social sciences and found my way toward elementary school teaching where, in fact, a course of math was one of the subjects I had to teach. Within a few years, I found that my ability to teach my own students math was less good than my ability to teach other subjects.

DEBORAH LOEWENBERG BALL: You're doing fine. You can't think of other ones?

STUDENT: What? Oh my gosh.

DEBORAH LOEWENBERG BALL: So, I began studying math at that point, once I was an elementary school teacher, and that essentially grew and launched an interest that I've had ever since, and the question about what is it about teaching young children mathematics that - what is the demands of the teacher?

DEBORAH LOEWENBERG BALL: I want to give you some directions for how to work on this. You're going to work in teams today and on your team -

DEBORAH LOEWENBERG BALL: Well, elementary math lab is first and foremost a program for schoolchildren in the area, and we deliberately designed this program to enroll students who are struggling in mathematics and we chose the age level of entering fifth graders who are about 10, because this is a key age at which children who begin to find math difficult or struggle with it really fall behind.

DEBORAH LOEWENBERG BALL: It's first and foremost a laboratory in learning and in teaching.

DEBORAH LOEWENBERG BALL: I want you to write down the way you'd record it with multiplication and I also want you to write down or sketch the rectangle.

DEBORAH LOEWENBERG BALL: Another feature is that we gather really good records of the work across the time of the laboratory class. It runs for two weeks, every day for two and a half hours and during that period, we videotape with more than one camera everything that's going on in the classroom. So, as a product of the laboratory, we have very high quality digital records that could be used for research purposes, for viewing by groups who aren't there live to create materials that could be used in teacher education elsewhere or in professional development.

JOAN FERRINI-MUNDY: One wonderful thing about the National Science Foundation is that we've been funding work in mathematics education aimed at improving mathematics teaching and learning for more than 50 years, going back all the way to the post-Sputnik new math curriculum and studies that were done in those years. So, we really do have a wonderful cadre of experts who have been studying mathematics teaching and learning. We've been studying international questions about mathematics education, and been developing and testing curricula and who have been working with teachers to improve the preparation and continuing growth of teachers.

JOAN FERRINI-MUNDY: I'd like to make a pitch for the importance of research about mathematics teaching and learning because everybody took math. It's possible to think that everybody – everybody does, in fact, have strong opinions about how math ought to be taught and how math ought to be best learned and so forth, and that needs to be supplemented and examined more fully, I think, through systematic research that can look at questions of teaching and learning, that can look at the ways in which certain materials might impact certain learners and so on. So, I'm very much supportive of the idea that interdisciplinary research that brings together mathematicians, scientists, mathematics educators, psychologists, cognitive scientists, statisticians, teachers, that's going to be part of the key to being able to solve some of our mathematics learning problems. Current reports and documentation would suggest that we are at risk relative to competitiveness and innovation, that we want to be sure we have a well prepared scientific and technological workforce and mathematics, of course, is at the center of that, but I would also add to this that it's important to have a mathematically literate populous and citizenry, people who can make sound decisions in their daily personal lives who can read and understand issues about health that depend upon statistics and mathematical ideas. So, again, both in terms of our technological and scientific competitiveness as well as our everyday life, I think math is important.

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International Comparisons****VIDEO TRANSCRIPT**

WILLIAM SCHMIDT: I guess the simple summary of this, in many ways, is that at 4th grade and third grade, we tend to do sort of okay around the average internationally. By the 8th grade, we're below the international average and by the 12th grade, we're essentially at the bottom of the international distribution. But I think what we've learned pretty clearly is one of the major differences among countries has to do with the nature of their curriculum. These countries that achieve well have high expectations, especially during the middle grades. They're more rigorous and demanding. In 8th grade in these top-achieving countries, the middle school curriculum is about algebra and geometry and in the U.S., for most kids, it's still arithmetic; fractions, decimals, and percents. The fact that I cited that at the middle grades in this country, we track children and it's only that small elite group that gets to take "the algebra class." So, I think we're hurting our situation by not giving all children this kind of basic education. I think it's time, after five, six years of arithmetic, it's time to move on. People in other countries often ask me, "Well, goodness, you keep reforming education but you never get any better. Why do you keep doing this?" And, I think the answer is because we've never really attacked the two central issues. We attack a lot of peripheral ones, and the two central are the curriculum, which I've spoken a little bit about, and the teachers. Now, I think the curriculum is the heart and the core of the matter. These kids, as they're growing up, they're not competing with the kid sitting next to them in school, even in the next school over, not even in New York or in the West Coast, but kids all over the world. So, from their point of view, this is serious because their future is really dependent on their adequate preparation in math and science.



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Can You Solve the Train Problem?**

Over several days, fifth-graders at the summer Elementary Mathematics Laboratory at the University of Michigan worked on a mathematics problem that called for creative thinking and persistent effort. The problem asked them to try to build a train that would meet a set of specific conditions in the arrangement of its cars and numbers of passengers that each could carry. Here's the problem:

The Train Problem

The EML Train Company makes five different-sized train cars: a 1-person car, a 2-person car, a 3-person car, a 4-person car, and a 5-person car. These cars can be connected to form trains that hold different numbers of people.

[graphic of white box] -- 1-passenger car
 [graphic of red box] -- 2-passenger car
 [graphic of green box] -- 3-passenger car
 [graphic of purple box] -- 4-passenger car
 [graphic of yellow box] -- 5-passenger car

A customer named Mr. Howe wants to order a special 5-car train that uses exactly one of each of the different-sized cars. He wants to be able to break apart his 5-car train to form smaller trains, one to hold exactly each number of people from 1 to 15. In addition, he wants to be able to form these smaller trains using cars that are next to each other in the larger train.

For example, if he purchased this train:

[graphic of white box, red box, green box, purple box, yellow box lined up horizontally]

He would be able to make a white-red-green train, or a red-green-purple-yellow train, but not a red-yellow train.

Can the EML Train Company fill Mr. Howe's order? Explain how you know.

In the end, the students had answered the question.

So how about you? Try the problem yourself and see in more detail the challenge that these fifth graders were facing.



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