

# Middle Matters

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## What We've Learned from the TIMSS

### Middle School Math Reform

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**P**robably few in the United States have not heard something about the Third International Mathematics and Science Study (TIMSS). The relatively mediocre performance of U.S. eighth-grade students in the TIMSS has become popular fodder for the media and discussions of education reform. In fact, we characterized U.S. math and science as "a mile wide and an inch deep," claiming it is unfocused, repetitive, and unchallenging. Many believe fixing the shallow curriculum will be a panacea for all real and imagined shortcomings. While curriculum reform does deserve attention, how a curriculum is taught just as critically affects the nature and quality of students' learning (Schmidt, McKnight, Raizen, 1997; Schmidt, et al, 1999, 1996).

#### Disappointing Results from TIMSS

The TIMSS results for mathematics form a disappointing picture of decline for U.S. students as they progress through school. U.S. fourth graders performed relatively better in mathematics than our eighth graders and our eighth graders performed relatively better than our twelfth graders. While U.S. fourth-grade students performed above the international mean (NCES 1997), eighth graders' performance was about the same as the international mean, with 20 of the 41 participating countries scoring higher than the U.S. (NCES,

1996). By twelfth grade, U.S. students performed well below the international mean, were out performed by the students in 14 countries, and, out of the 21 participating countries, outperformed only the students in Cyprus and South Africa (NCES, 1998).

Comparisons among countries at the end of secondary school are difficult, the overall pattern of decline is clear. Because U.S. students did not begin in a relatively poor position but fell behind later, analyzing what occurs in the middle grades is essential in understanding how and when students lose ground.

#### A More Coordinated Curriculum

The U.S. intends teachers to teach--and students to learn--more mathematics topics every year in first through eighth grade than do the vast majority of other TIMSS countries. In the grades 5-8, the U.S. expects between 27 and 32 topic to be taught each year. This far exceeds the international median for each of these grades (21-23 topic per year) and contrasts sharply with the 20-21 topics intended by the highest achieving TIMSS countries. When specific topics are introduced to students also differs. In the top achieving countries, students are introduced to an average of seven topics during the first three grades and about 15 during grades four to six. U.S. stu-

dents are introduced to nearly three times as many topics in the first three grades (20) and a few less during grades four to six (12). In seventh and eighth grade, top-achieving countries introduce almost twice as many topics as does the U.S. (10 vs. 6). Thus the overall pattern for the U.S. appears to be to introduce students to many mathematics topics in the early grades, to continue to teach these every year, to move on to other topics before students achieve mastery, and to introduce few new topics to students in the last two years of middle school.

U.S. mathematics textbooks, which are "first-in-the-world" in terms of page size and number of pages, similarly cover a large number of topics, but with little depth. U.S. fourth- and eighth-grade textbooks include many more topics than was typical across all TIMSS countries. Internationally, eighth grade textbooks devoted on average more than 75 percent of their space to five topics while U.S. textbooks devote on average only 45 percent to five main topics. Fourth grade textbooks follow a similar pattern.

In a similar analysis, eighth-grade teachers mirrored this diffuse emphasis, devoting about 45% of their teaching time to their five most emphasized topics. Internationally, the five most emphasized topics took about 40 to 80 percent of teaching time. Overall, fourth- and eighth-grade teachers in the top-achieving countries tended to teach fewer topics than U.S. teachers and were consequently able to devote close to 20 percent more of their time to five topics than their U.S. counterparts.

As fundamentally important as modifying the focus, coherence, and quality of the curriculum may be, it is not a magic bullet that can correct all that ails U.S. mathematics education. It can, however, form a solid foundation, without which further reform and improvement is difficult, if not impossible. Perhaps the greatest benefit of the TIMSS is learning that what stu-

dents study--the specific topics emphasized and sequenced throughout a comprehensive curriculum--impacts students' learning.

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# Reforming Middle School Math Curriculum for "World Class" Learning

The following observations and recommendations, based on the curricula of the top-achieving TIMSS countries, are a starting point for developing a more focused, coherent, and quality math curriculum in the U.S.

**How math is taught is as important as what is taught.** Examining what the top-achieving countries cover in math may prove misleading as the secret of the recipe lies not in the ingredients but in how they are prepared. U.S. students are exposed, to some extent, to virtually every topic that students in higher-achieving countries study. The major difference appears to be in how topics are selected, sequenced, developed, and emphasized across the entire span of grades.

**Reduce review and repetition.** The "mile wide, inch deep" characterization seems especially apt for the U.S. middle school math curriculum, which is replete with repetitious and non-challenging material. The spiral curriculum model, in which topics are revisited each year in increasing depth, appears to become a circular holding pattern in the middle grades. The same topics are studied each year but with little increased depth until students get to high school where courses cover individual math disciplines. Repeating elementary and introductory material is not common in most other TIMSS countries, suggesting that students don't need as much review as the U.S. curriculum provides.

**Choose a small number of topics.** Perhaps the best way to improve overall mathematics literacy is to lay a firm foundation for all students through the in-depth study of a few carefully chosen topics before students hit the high school cafeteria of courses.

**Teach no topic before it is time.** Clearly it is possible to teach many mathematics topics in early grades, but not all are necessary. In order to focus and emphasize a smaller set of topics, some must be relegated for study in another grade.

**Bring standards into focus.** The current laundry list of standards--which varies from state to state--does not provide teachers with focused and coherent guidance for their classroom activities.

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