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TIMSS: What Have We Learned about Math and Science Teaching? ERIC Digest.

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The Third International Mathematics and Science Study (TIMSS), conducted during the 1994-95 school year, has been used extensively to compare the mathematics and science achievement of students and the instructional practices of schools worldwide. TIMSS followed in the wake of other reports and documents (National Commission on Excellence in Education, 1983; National Council of Teachers of Mathematics, 1989; 1995; American Association for the Advancement of science, 1989, 1993; Executive Office of the President, 1990) that have focused attention on the importance, conditions, and goals of science and mathematics education. In addition to providing data on the progress of U.S. students towards national goals, TIMSS has enabled comparisons of some U.S. educational practices to those of other countries. Tests were designed to reflect the mathematics and science curricular goals of several TIMSS countries, and students in both public and private schools were tested three levels: 9 years of age, 13 years of age, and those in their final year of secondary school.

CRITICAL QUESTIONS

In the U.S., the TIMSS data have been used to address five main questions: (1) How does student knowledge of mathematics and science in the U.S. compare to that of students in other nations? (2) How do science and mathematics curricula and expectations for student learning in the U.S. compare to those of other nations? (3) How does classroom instruction in the U.S. compare with that of other nations? (4) Do U. S. teachers receive as much support in their efforts to teach as do their counterparts in other nations? and (5) Are U. S. students as focused on their studies as their international counterparts? (USDOE, 1997, p. 4).

DATA COLLECTION METHODS

In order to gain a broad picture of educational systems, several different types of data were collected:

* Assessments lasting 90 minutes were administered, with all students receiving both multiple-choice and free-response items. A smaller number of participants also completed hands-on assessments.

* Questionnaires given to students, teachers, and school administrators focused on beliefs about mathematics and science, teaching practices, and school polices.

* Curriculum guides and textbooks from participating countries were examined to determine subject-matter content, sequencing, and expected learning outcomes.

* In the U.S., Germany, and Japan, selected classrooms of 13-year-olds were videotaped so that instructional practices could be studied and compared.

* Researchers spent three months in the U.S., Germany, and Japan observing and interviewing educators, students, and parents to prepare ethnographic case studies. Findings were used to evaluate the educational and social environments of schooling in the three countries.

KEY RESULTS

Achievement. U. S. 4th-graders scored above the international average in both mathematics and science, while 8th-graders scored below average in mathematics. Mathematics achievement among U.S. students seemed weakest in the areas of geometry, measurement, and proportionality.
Curriculum. The majority of participating countries have a national curriculum, with only nine, including the U.S., leaving curriculum decisions to educators at the local or state levels. The 8th-grade mathematics curriculum in the U.S. seems comparable to the average 7th-grade curriculum for other participating countries, putting U.S. students a full year behind their global counterparts at age thirteen. Even though they are falling behind in mathematics, it is interesting to note that, on average, students in the U.S. spend more hours in mathematics and science classes than do students in Germany and Japan. Curricular comparisons with Germany and Japan show that less high-level mathematical thought is required of U.S. students.

Teaching. Through talking with teachers it was discovered that the primary goal of U. S. mathematics teachers is to teach students how to obtain answers, while teachers in other countries are more concerned with helping students understand mathematical concepts. Also, most Japanese teachers who were observed practiced elements of the reform movement, while U. S. teachers reported familiarity with reform principles without necessarily implementing them (USDOE, 1997).

Teachers' Lives. U.S. teachers generally have more college education than their international counterparts. German and Japanese teachers undergo long-term structured apprenticeship programs, however, and teachers in Japan reported more opportunities to discuss teaching-related issues than did U. S. teachers.

Students' Lives. Tracking seems to be implemented differently in the U.S., Germany, and Japan. Students of differing abilities are typically divided into separate classrooms in the U.S. and Germany, but in Japan there is no ability grouping until after testing at grade ten. Also, differences in the content of mathematics courses were noted among different ability groups in the U.S., while in Germany and Japan the same concepts were addressed in all groups, with differences being limited to the depth or rigor of approach.

More homework is given and more class time is spent discussing it in the U.S., but time spent on homework out of school was about the same for all three countries. Many of the same distractions are seen in all nations; heavy television viewing was noted for both U.S. and Japanese students.

For more details about TIMSS and its findings, visit the Website at timss.bc.edu/timss1995.html.

TIMSS-R

In 1999, the Third International Mathematics and Science Study-Repeat (TIMSS-R) focused on the mathematics and science achievement of 8th-graders. With 38 nations participating, the U.S. was able to compare the achievement of its 8th-graders in the original TIMSS to the achievement of its 8th-graders four years later, as well as to their international counterparts. TIMSS-R also included a videotape study of 8th-grade mathematics and science teaching in seven nations. Preliminary findings include the following:

* Between 1995 and 1999, there was no change in 8th-grade mathematics or science achievement in the U, S.

* In mathematics, U.S. 8th-graders outperformed peers in 17 nations, and performed lower than peers in 14.

* In science, U.S. 8th-graders outperformed their peers in 18 nations, and performed lower than peers in 14.

* Among the 17 nations whose 4th-graders participated in the original TIMSS and whose 8th-graders participated in TIMSS-R, the relative mathematics and science performance of U.S. students was lower for 8th-graders in 1999 than it was for

4th-graders in 1995.

* According to their teachers, U.S. 8th-graders were less likely than their international counterparts to be taught mathematics by teachers with a major or concentration in mathematics, but as likely as international peers to have teachers who majored in mathematics education.

* Among U.S. 8th-graders in 1999, 86% reported working from worksheets or textbooks on their own almost always or pretty often during mathematics lessons, compared to the international average of 59 %.

* A higher percentage of U.S. 8th-graders reported that they could almost always or pretty often begin their mathematics or science homework during class (74%and 57%, respectively) than their international peers (42% and 41%, respectively).

Finally, compared to international students in 1999, a higher percentage of U.S. 8th-graders reported having to explain the reasoning behind an idea in most science lessons, conducting experiments or investigations in science lessons, using computers in mathematics and science lessons, and attending schools with Internet access. For more information, visit the TIMSS-R Website at nces.ed.gov/timss/timss-r/index.asp.

CONCLUSIONS

There is no easy answer to the question of how to help U.S. students move to the top of the international comparisons, but the results from TIMSS and TIMSS-R have important implications. The TIMSS National Research Center suggests: (a) Providing better preservice and inservice opportunities to enhance teacher knowledge of mathematics and science; (b) Improving the consistency and focus curricula; (c) Increasing opportunities for teachers to interact within and across subject areas; (4) Aligning national standards, curriculum frameworks, instructional methods, and assessment practices; (5) Eliminating tracking; and (6) Encouraging policy changes that will support improved curriculum and instruction.

It is interesting to note that despite having greater access to computers, the Internet, and experiential lessons, a higher percentage of U.S. students than international students reported working on their own from worksheets and textbooks in 1999. Clearly, the access to more resources within classrooms has not dramatically altered routine classroom experiences.

RESOURCES

For more information on TIMSS and TIMSS-R, please visit the following Websites:

- U.S. National Research Center for TIMSS ustimss.msu.edu

- TIMSS pages at the National Center for Educational Statistics nces.ed.gov/timss

- -The International Study Center at Boston College timss.bc.edu

- TIMSS resources at the Eisenhower National Clearinghouse www.enc.org/topics/timss/

- -Mathematics and Science Education Around the World: What Can We Learn From The Survey of Mathematics and Science Opportunities (SMSO) and the Third International Mathematics and Science Study (TIMSS)? www.nap.edu/books/0309056314/html/1.html

- Executive summary: A Splintered Vision: An Investigation of U.S. Science and Mathematics Education ivc.uidaho.edu/timss/splintrd.html

- A TIMSS Primer (Fordham Report) www.edexcellence.net/library/timss.html

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