

Executive Summary

TIMSS 2003 is the third in a continuing cycle of international mathematics and science assessments conducted every four years. TIMSS assesses achievement in countries around the world and collects a rich array of information about the educational contexts for learning mathematics and science, with TIMSS 2003 involving more than 50 participants. This report contains the mathematics results for 46 countries and four benchmarking participants at the eighth grade and for 25 countries and three benchmarking participants at the fourth grade. Trend data are provided at the eighth and fourth grades for those countries that also participated in 1995 and 1999 (please see the Introduction for more information about TIMSS 2003.)

Students' Mathematics Achievement in 2003

- At both the eighth and fourth grades, Singapore was the top-performing country having significantly higher average achievement in mathematics than the rest of the participating countries.
- At the eighth grade, with the exception of Singapore, the Republic of Korea, Hong Kong SAR, and Chinese Taipei had significantly higher average achievement than all of the other participating countries.
- At the fourth grade, Hong Kong, SAR had significantly higher performance than all countries except Singapore, and, in turn, Japan and Chinese Taipei outperformed the rest of the countries except Singapore and Hong Kong, SAR.

Trends in Mathematics Achievement

- At the eighth grade, several countries showed significantly higher average achievement in 2003 compared to the previous assessments in 1995 and 1999. Korea, Hong Kong SAR, Latvia (LSS),¹ Lithuania, and the United States, as well as the benchmarking Canadian province of Ontario, showed a pattern of improvement from assessment to assessment with significant change over the 8-year period from 1995 to 2003. Of the countries participating only in the 1999 and 2003 assessments, Israel and the Philippines showed significant improvement.
- At the eighth grade, countries showing a decrease in average achievement in 2003 compared to previous assessments (1995, 1999, or both) included Japan, Belgium (Flemish), the Russian Federation, the Slovak Republic, Sweden, Bulgaria, Norway, Cyprus, Macedonia, Iran, and Tunisia as well as the benchmarking Canadian province of Quebec.
- At the fourth grade, many countries showed significant gains in average achievement between 1995 and 2003, including Hong Kong SAR, Latvia (LSS), England, Cyprus, New Zealand, and Slovenia as well as the benchmarking province of Ontario. The only significant declines were found in the Netherlands, Norway, and Quebec province.

Gender Differences in Mathematics Achievement

- At the eighth grade, the gender difference in TIMSS 2003 was negligible in many countries. However, there were variations across countries with girls outperforming boys in the same number of countries that boys outperformed girls. The girls had significantly higher average achievement than boys in Serbia, Macedonia, Armenia, Moldova, Singapore, the Philippines, Cyprus, Jordan, and Bahrain.

¹ Trend data for Latvia are annotated LSS because they include Latvian-speaking schools only.

In contrast, boys had higher achievement in the United States, Italy, Hungary, Lebanon, Belgium (Flemish), Morocco, Chile, Ghana, and Tunisia as well as in two benchmarking participants – the US state of Indiana and Quebec province.

- The trend results at the eighth grade show a few more countries with improvement for girls than for boys. Girls had improved performance and boys did not in four countries, whereas there was no country in which boys improved and girls did not. Both girls and boys improved in five countries and Ontario province. Reflecting declines in achievement across assessments, both genders had lower achievement in TIMSS 2003 in seven countries and Quebec province as did the girls in Belgium (Flemish).
- At the fourth grade, the TIMSS 2003 results by gender paralleled those at the eighth grade. Girls had significantly higher average achievement in Singapore, Moldova, the Philippines, and Armenia. Boys had higher average achievement in the Netherlands, the United States, Italy, Cyprus, Scotland, and in the two Canadian provinces.
- The fourth-grade trend results for the genders mirror the overall results, showing more countries with improvements than declines and consistency between girls and boys. Both boys and girls improved in six countries and Ontario province, while both declined only in Norway and Quebec province.

Performance at the International Benchmarks in TIMSS 2003

TIMSS identified four benchmark levels to describe what students know and can do in mathematics and demonstrate the range of performance internationally – advanced, high, intermediate, and low. There were large differences across countries in the percentages of students reaching the various benchmarks.

At the eighth grade, students reaching the **advanced benchmark** used algebraic, geometric, and measurement concepts in complex

problem situations. At the other end of the performance continuum, those reaching the **low benchmark** demonstrated some basic mathematical knowledge.

- The highest performing countries – Singapore, Chinese Taipei, Korea and Hong Kong SAR – had about one-third of their students or more (from 31 to 44%) reaching the advanced benchmark followed by Japan with 24 percent. In contrast, all other countries had 11 percent or less of their students reaching the advanced benchmark, including 19 of the lowest-performing countries with 1 percent or less.
- The nine highest-performing countries and the two Canadian provinces had 95 percent or more of their students reaching the low benchmark whereas the eight lowest-performing countries had less than half their students reaching the low benchmark.

At the fourth grade, students reaching the **advanced benchmark** used understanding of fractions and decimals, measurement concepts, and data interpretation in a wide variety of relatively complex situations. Those reaching the **low benchmark** demonstrated some mathematical knowledge.

- With fewer and more homogenous countries at the fourth grade, Singapore had 38 percent of its students reaching the advanced benchmark followed by 21 to 22 percent of the students in Hong Kong SAR and Japan. Five of the lowest-performing countries had 1 percent or less of their students reaching the advanced benchmark.
- Eight countries as well as the US state of Indiana had 95 percent or more their students reaching the low benchmark and all except four countries had at least three-fourths of their students reaching this level. In the four lowest-performing countries (the Philippines, Iran, Tunisia, and Morocco), less than half the students reached the low benchmark.

Students' Home Context for Learning Mathematics

- At the eighth grade, students were asked about the level of their parents' schooling and their own expectations. Higher levels of parents' education were associated with higher student achievement in almost all countries. Also, students expecting to finish university had substantially greater average mathematics achievement than those without university expectations.
- At both the eighth and fourth grades, in general, students from homes where the language of the test was always or almost always spoken had higher average achievement than those who spoke it less frequently.
- At both the eighth and fourth grades, across countries on average, there was a clear-cut relationship between number of books in the home and mathematics achievement.
- Mathematics achievement was positively related to computer usage, particularly at eighth grade, with average achievement highest among students reporting using computers at home and at school. Next highest was achievement among students using computers at home but not school, followed by students using computers at school but not home, and then those using computers at other places or not using them at all. At both grades, the percentages of students reporting that they did not use a computer at all varied dramatically across countries – from one percent or less to as many as two-thirds at the eighth grade and three-fourths at the fourth grade.

The Mathematics Curriculum

- Most countries had mathematics curricula defined at the national level (except Australia and the United States) and often supported by ministry directives, instructional guides, school inspections, and recommended textbooks.

- At the eighth grade, all participants emphasized understanding mathematical concepts and principles followed by mastering basic skills. At the fourth grade, mastering basic skills was emphasized most, followed by understanding concepts and principles.
- In relation to the TIMSS assessment at the eighth grade, on average, participants reported that nearly all the number topics (96%) were included in their curricula, 78 percent of the measurement topics, 67 percent of the geometry topics, 63 percent of the algebra topics, and 39 percent of the data topics.
- At the fourth grade, on average, 81 percent of the measurement topics assessed were included in the participants' curricula, 68 percent of the number topics, 62 percent of the data topics, 54 percent of the patterns and relationships topics, and 38 percent of the geometry topics.
- At the eighth grade, across countries on average, teachers reported that 95 percent of the students had been taught the number topics, 78 percent the measurement topics, 69 percent the geometry topics, 66 percent the algebra topics, and 46 percent the data topics.
- At the fourth grade, across countries on average, teachers reported that 86 percent of the students had been taught the measurement topics, 80 percent the data topics, 79 percent the patterns and relationships topics, 77 percent the number topics, and 55 percent the geometry topics.

Teachers of Mathematics

- Mathematics teachers reported considerable teaching experience. At both the eighth and fourth grades, on average, students were taught by teachers with 16 years of experience.
- On average, 76 percent of the eighth-grade students and 65 percent of the fourth-grade students were taught by teachers with at least a university degree.

- Seventy percent of the eighth-grade students, on average, had mathematics teachers with a mathematics major and more than half (54%) with a major in mathematics education or both. At the fourth grade, teachers typically studied primary or elementary education (80% of the students with such teachers, on average).
- At both grades, schools reported that their professional development programs emphasized improving content knowledge and teaching skills. More than 80 percent of students were taught mathematics by teachers having at least some professional development training in these areas.
- Across the five mathematics content areas assessed, teachers reported being ready to teach nearly all the major topics tested by TIMSS. Almost all of the eighth-grade students were taught by such teachers – 90 percent or more for 15 out of 18 topics (all but three data topics). Similarly, 90 percent or more of the fourth-grade students were taught by teachers reporting readiness for teaching 14 of the 16 topics (exceptions were two geometry topics).

Classroom Instruction

- At the eighth grade, on average, teachers reported that 27 percent of the instructional time was devoted to algebra, 26 percent to geometry, 21 percent to number, 10 percent to each of measurement and data, and 6 percent to other. At fourth grade, the profile was different, with number receiving 38 percent of the instructional time. Patterns and relationships, measurement, and geometry each were given 13 to 16 percent, data 9 percent, and other 6 percent.
- At the eighth grade, on average, teachers reported asking 62 percent of students to practice numerical operations and 43 percent to work on fractions and decimals in at least half their lessons. At the fourth grade, teachers reported an overwhelming emphasis on having stu-

dents practice numerical operations (82% of students in half or more of the lessons).

- At the eighth grade, on average, for 45 percent of students, teachers reported devoting some time in at least half their lessons to asking students to decide what procedures to use for solving complex problems.
- At both eighth and fourth grades, the textbook was often the foundation of mathematics instruction. On average, about two-thirds of students at both grades had teachers who reported using a textbook as the primary basis for their lessons, and another third as a supplementary resource.
- On average, the three most common instructional activities were teacher lecture, teacher-guided student practice, and students working on problems on their own (totaling 59% of the time at eighth grade and 61% at fourth grade).
- Policies about calculator usage varied dramatically from country to country. At the eighth grade, in 10 countries nearly all the students (98% or more) were permitted to use calculators. In contrast, less than half were permitted to use calculators in seven countries. At fourth grade, on average, more than half the students were not permitted to use calculators. Only five countries reported permitting widespread calculator usage (at least 90% of students).
- The percentages of eighth-grade students asked to use calculators in half their lessons averaged from 27 percent for checking answers to 14 percent for exploring number concepts. Relatively few fourth-grade students were asked to engage in any calculator activities in as many as half their lessons.
- At the eighth grade, on average, 56 percent of students were taught by teachers who used only or mostly constructed-response tests.

These students had higher average achievement than did students whose teachers used only multiple-choice tests or a combination.

School Contexts for Learning and Instruction

- At the eighth grade, average mathematics achievement was 57 points higher for students in schools with few students from economically disadvantaged homes than for students attending schools with more than half their students from disadvantaged homes. At fourth grade, the difference was 47 points.
- At both eighth and fourth grades, there was a strong positive relationship between the principals' perception of school climate (based on seven questions about behaviors of teachers, parents, and students) and average mathematics achievement. Asked the same seven questions, teachers had a somewhat more gloomy view of school climate than principals, but the relationship with achievement still was positive.
- Teachers were asked about the safety of their schools' neighborhoods, how safe they felt in their schools, and the sufficiency of security policies and practices. On average, 72 percent of eighth-grade students and 75 percent of fourth-grade students attended schools characterized as safe by their teachers. At both grades, there was a positive relationship between school safety and mathematics achievement.