

# Executive Summary



TIMSS 2007 is the fourth 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 2007 involving more than 60 participants. This report contains the science results for 37 countries and 7 benchmarking participants at the fourth grade and for 50 countries and 7 benchmarking participants at the eighth grade. Trend data are provided at the fourth and eighth grades for those countries that also participated in 1995, 1999, and 2003 (please see the Introduction for more information about TIMSS 2007).

## Science Achievement

- ▶ At the fourth grade, Singapore was the top performing country, with higher average science achievement than all of the other countries. Singapore was followed by Chinese Taipei and Hong Kong SAR, that were outperformed only by Singapore. Next came Japan, the Russian Federation, Latvia, England, the United States, Hungary, Italy, and Kazakhstan that also performed very well. Several benchmarking participants also had high average science achievement, including the U.S. state of Massachusetts, that was outperformed by Singapore but had higher average achievement than all other countries, and the state of Minnesota, that was outperformed only by Singapore and Massachusetts. The Canadian provinces of Alberta, British Columbia, and Ontario also performed very well.

- ▶ At the eighth grade, Singapore and Chinese Taipei had the highest average achievement in science. These were followed by Japan and Korea, that had higher average achievement than all countries except Singapore and Chinese Taipei. England, Hungary, the Czech Republic, Slovenia, Hong Kong SAR, and the Russian Federation also performed well. Among the benchmarking participants, average science achievement in Massachusetts was similar to that of the four top Asian countries (Singapore, Chinese Taipei, Japan, and Korea) and higher than all other participants. Minnesota had achievement similar to England, Hungary, the Czech Republic, Slovenia, Hong Kong SAR, and the Russian Federation.
- ▶ Asian countries had the highest percentages of students reaching the Advanced International Benchmark for science, representing fluency on items involving the most complex topics and reasoning skills. At the fourth grade, Singapore and Chinese Taipei had 36 and 19 percent of their students, respectively, achieving at or above the Advanced International Benchmark. At the eighth grade, Singapore and Chinese Taipei had 32 and 25 percent of their students, respectively, achieving at or above the Advanced International Benchmark. The median percentage of students reaching this Benchmark was 7 percent at the fourth grade and 3 percent at the eighth grade.
- ▶ Looking at trends across all of the participating countries, not taking into account whether countries have participated in two, three, or four cycles (eighth grade) of TIMSS, more countries showed improvement in average achievement between their first cycle of participation and TIMSS 2007 than declines at both fourth and eighth grades, although the pattern was less pronounced at eighth grade. At the fourth grade, 11 countries had higher average achievement in 2007 than in their first TIMSS assessment, 5 had lower average achievement, and 7 showed no significant change. At the eighth grade, 11 countries had higher average achievement in 2007 than in their initial assessment, 8 lower average achievement, and 16 showed no significant change.
- ▶ At both fourth and eighth grades, average science achievement for girls was higher than for boys on average across the TIMSS 2007 countries

(by 3 points at fourth grade and 6 points at eighth grade). At the fourth grade, the difference in average achievement was negligible in more than half the countries, whereas girls had higher science achievement than boys in 6 countries and boys had higher achievement than girls in 8 countries. At the eighth grade, girls had higher average science achievement than boys in 14 countries and boys had higher achievement than girls in 11 countries.

### **Factors Associated with Higher Achievement in Science**

- ▶ At both fourth and eighth grades, on average across countries, a large majority of students reported always or almost always speaking the language of the test at home, and these students had higher average science achievement than those who reported speaking it less frequently. Also, students from homes with more books had higher average science achievement than those from homes with fewer books.
- ▶ At the eighth grade, higher levels of parents' education were associated with higher average science achievement in almost all countries.
- ▶ On average across countries at the fourth and eighth grades, students from homes with a computer had higher science achievement than those from homes without a computer, and those from homes with an Internet-connected computer had higher achievement than students from homes without such a facility. Average achievement was highest among those reporting using a computer at home and at school and at home only, perhaps reflecting an economic advantage for those with a computer at home, and lowest among those reporting that they do not use a computer at all or use one only at places other than the home and the school. At both grades, computer use increased in a number of countries between 2003 and 2007.
- ▶ Fourth grade students generally had positive attitudes toward science, and those with more positive attitudes had higher average science achievement than students with less positive attitudes. This also was true at eighth grade for students in countries teaching science as a single, integrated subject. In countries teaching science as separate

subjects, eighth grade students' attitudes to biology were as positive as student attitudes to integrated science in single science countries, but somewhat less positive to earth science and particularly to chemistry and physics.

- ▶ There also was a positive association between level of self-confidence in learning science and science achievement at fourth grade, and at eighth grade among students in both single science and separate science countries. Further, eighth grade science achievement was higher for students in single science countries who reported placing a higher value on science. However, across the various sciences in separate science countries, the relationship was less clear cut.
- ▶ At both grades, on average, there was a positive association between attending schools with fewer students from economically disadvantaged homes and science achievement. Also, achievement was highest among students attending schools with more than 90 percent of students having the language of the test as their native language.
- ▶ Average science achievement was highest among students attending schools with few attendance problems and lowest among students attending schools where there were serious problems with students arriving late, absenteeism, and missing class. Such problems appear to be more serious at the eighth grade.
- ▶ Principals were asked the degree to which shortages or inadequacies in resources affected their schools' general capacity to provide instruction. At both grades, average science achievement was highest among students in schools where principals reported that resource shortages were not a problem. Also, there was an association between higher average achievement and more positive teachers' reports about the adequacy of their working conditions.
- ▶ At both fourth and eighth grades, science achievement was highest, on average, where principals and teachers had a positive view of the school climate. At the eighth grade, teachers had a somewhat less positive outlook on climate than principals. There was a positive association between average science achievement and students' perception of being safe in school at both fourth and eighth grades.

## Science Curriculum and Instruction

- ▶ One of the major differences among the science curricula of the TIMSS 2007 countries is that some countries teach science as a single, general subject through the eighth grade, while others teach the sciences as separate subjects, usually beginning in the fifth, sixth, or seventh grades. By the eighth grade, most of the continental European countries, as well as Algeria, Indonesia, Lebanon, Mongolia, Morocco, and the Syrian Arab Republic, were separately teaching some or all of biology, chemistry, physics, and earth science, although not necessarily at the same time. In some cases, chemistry and physics or biology and earth science were combined. Also, in some countries, earth science topics were taught as part of geography.
- ▶ At the fourth grade, there was some variation, but countries' prescribed curricula averaged 23 hours of total instruction per week, with less than one tenth of the time (9%) being for science instruction. Generally, there was very close agreement between the curriculum and teachers' reports about its implementation. On average internationally, fourth grade teachers reported a total of 24 hours of weekly instruction, with 8 percent being devoted to science. At the eighth grade for countries teaching general/integrated science, the average total instruction time per week was 27 hours with 12 percent being devoted to science instruction. Teachers' reports of 28 hours per week in total and 11 percent devoted to science instruction corresponded with the instructional time guidelines across the countries' curricula. Among separate science countries at the eighth grade, the total instructional time, on average, was similar to general science countries (28 hours vs. 27), but the percentage of instructional time devoted to science instruction was higher—24 percent (6% for each of four science subjects) compared to 12 percent. In general, teacher reports corresponded with curricular guidelines across the four science subjects.
- ▶ At the fourth grade, on average across countries, teachers reported devoting 40 percent of the science instructional time to life science, 25 percent to physical science, 24 percent to earth science, and 10 percent to other areas. At the eighth grade, on average internationally, teachers

reported devoting 28 percent of the science instructional time to biology, 24 percent to chemistry, 27 percent to physics, 16 percent to earth science, and 6 percent to other areas.

- ▶ For most countries, much of the science content assessed by TIMSS is included in their intended curricula. On average across countries at the fourth grade, the majority of the assessment topics (23 out of 35) were intended for all or almost all students. On average across countries at the eighth grade, most of the science assessment topics (34 out of 46) were intended for all or almost all students.
- ▶ According to their teachers, 61 percent of fourth grade students and 66 percent of eighth grade students, on average across countries, had been taught the science topics assessed.
- ▶ At both the fourth and eighth grades, the majority of students were taught science by teachers in their 30s and 40s. Although about one fourth of the students internationally were taught by teachers 50 or older, relatively few students were taught by younger teachers. On average, internationally, 70 percent of the fourth grade students and 81 percent of the eighth grade students had teachers with a university degree. However, there was some variation at the fourth grade.
- ▶ Most countries have a national or regional science curriculum, and most countries reported that teachers received specific preparation in how to teach the science curriculum as part of pre-service education. At the eighth grade, on average internationally, most students had teachers who had studied science (81%), but fewer students (39%) had teachers whose major area of study was science education. However, the teachers of the fourth grade students in a number of countries reported little specific training or specialized education in science.
- ▶ At the fourth grade, on average internationally, 54 percent of the students were taught by teachers who reported feeling very well prepared to teach the science topics in the TIMSS assessment. Greater percentages of students had teachers feeling well prepared to teach life science (59%) and earth science (56%) than physical science (46%). At the eighth grade, 70 percent of the students had teachers who reported being very well prepared to teach the TIMSS science topics overall, with some variation

across the sciences: chemistry (77%), physics (70%), biology (67%), and earth science (62%).

- ▶ The textbook remains the primary basis of science instruction at both the fourth and eighth grades. On average internationally, 52 percent of the students at fourth grade and 53 percent at eighth grade had teachers who reported using a textbook as the primary basis of their lessons. For another 34 percent of the fourth grade students and 40 percent of the eighth grade students, teachers reported using textbooks as a supplementary resource.
- ▶ According to teachers, internationally on average, most time in eighth grade science classes was spent on having students listen to lecture-style presentations (25%) and working on problems with teacher guidance (17%). Considerable time also was spent having students work on solving problems independently (13%), and listening to the teacher re-teach and clarify content or procedures (13%). Together, these four activities accounted for 68 percent of the class time at the eighth grade.
- ▶ At the fourth grade, science homework was not very prevalent and there was little relationship between teachers' emphasis on homework and student achievement. At the eighth grade, teachers reported placing more emphasis on science homework than at fourth grade, although there was considerable variation across countries. Several countries were assigning less homework in 2007 than in 2003.
- ▶ At the eighth grade, teachers used classroom tests to some extent for nearly all of the students. According to teachers' reports, 76 percent of eighth grade students were given science tests at least monthly, on average internationally. About one third were given a science test or examination every two weeks (or more frequently). On average, 23 percent of the students were taught by teachers who reported testing them with only or mostly constructed-response items, another 62 percent by teachers who reported using about half constructed-response and half multiple-choice items, and only 14 percent by teachers who reported using only or mostly multiple-choice items.

