

EXECUTIVE SUMMARY

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TIMSS 1999
International
Science Report





Executive Summary

In 1999, the Third International Mathematics and Science Study (TIMSS) was replicated at the eighth grade. Involving 41 countries and testing at five grade levels, TIMSS was originally conducted in 1995 to provide a base from which policy makers, curriculum specialists, and researchers could better understand the performance of their educational systems. Conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA), TIMSS was the first step in a long-term strategy, with further assessments in mathematics and science planned for 1999, 2003, and beyond.

TIMSS 1999, also known as TIMSS-Repeat or TIMSS-R, was designed to provide trends in eighth-grade mathematics and science achievement in an international context. Thirty-eight countries participated in TIMSS 1999. Of these, 26 countries also participated in TIMSS 1995 at the eighth grade and have trend data included in this report. Also, 1999 represents four years since the first TIMSS, and the population of students originally assessed as fourth-graders had advanced to the eighth grade. Thus, for 17 of the 26 countries that participated in TIMSS 1995 at the fourth grade, TIMSS 1999 also provides information about whether the relative performance of these students has changed in the intervening years.

Six content areas were covered in the TIMSS 1999 science test: earth science; life science; physics; chemistry; environmental and resource issues; and scientific inquiry and the nature of science. About one-fourth of the questions were in the free-response format, requiring students to generate and write their answers. (See Chapter 2 for example items illustrating the range of science concepts and processes covered in the TIMSS 1999 tests.) The achievement data are accompanied by extensive questionnaire data about the home, classroom, school, and national contexts within which science learning takes place.

Because a valid and efficient sample in each country is crucial to the quality and integrity of the study, TIMSS developed procedures and standards regarding coverage of the target population, participation, and the age and years of schooling of students. For 1999, all countries met the guidelines, and any variations that occurred are annotated. Indeed, TIMSS 1999 was conducted with rigorous attention to attaining high quality in all aspects of the project.

Students' Science Achievement

- ▶ Chinese Taipei and Singapore had the highest average performance, closely followed by Hungary, Japan, and the Republic of Korea. Other countries that performed very well included the Netherlands, Australia, the Czech Republic, and England. Lower-performing countries included the Philippines, Morocco, and South Africa (see Exhibits 1.1 and 1.2).
- ▶ Countries that showed an increase in average science achievement between 1995 and 1999 were Latvia (LSS)¹, Lithuania, Canada and Hungary. Several countries showed a small decrease in average achievement from 1995 to 1999, but only in the case of Bulgaria was it statistically significant.
- ▶ Boys had significantly higher average science achievement than girls in 16 of the 38 countries in 1999. This was attributable mainly to significantly higher performance by boys in physics, earth science, chemistry, and environmental and resource issues. The gender gap in science achievement is especially apparent among high-performing students, with 29 percent of boys on average across countries in the top achievement quarter, compared with 21 percent of girls. The average gender difference showed a decrease from 1995 to 1999, principally due to the gap narrowing in Hong Kong SAR, Slovenia, and Israel.

¹ Because coverage of the target population falls below 65%, Latvia is annotated LSS for Latvian-Speaking Schools only.

Students' Home Environment and Attitudes Towards Science


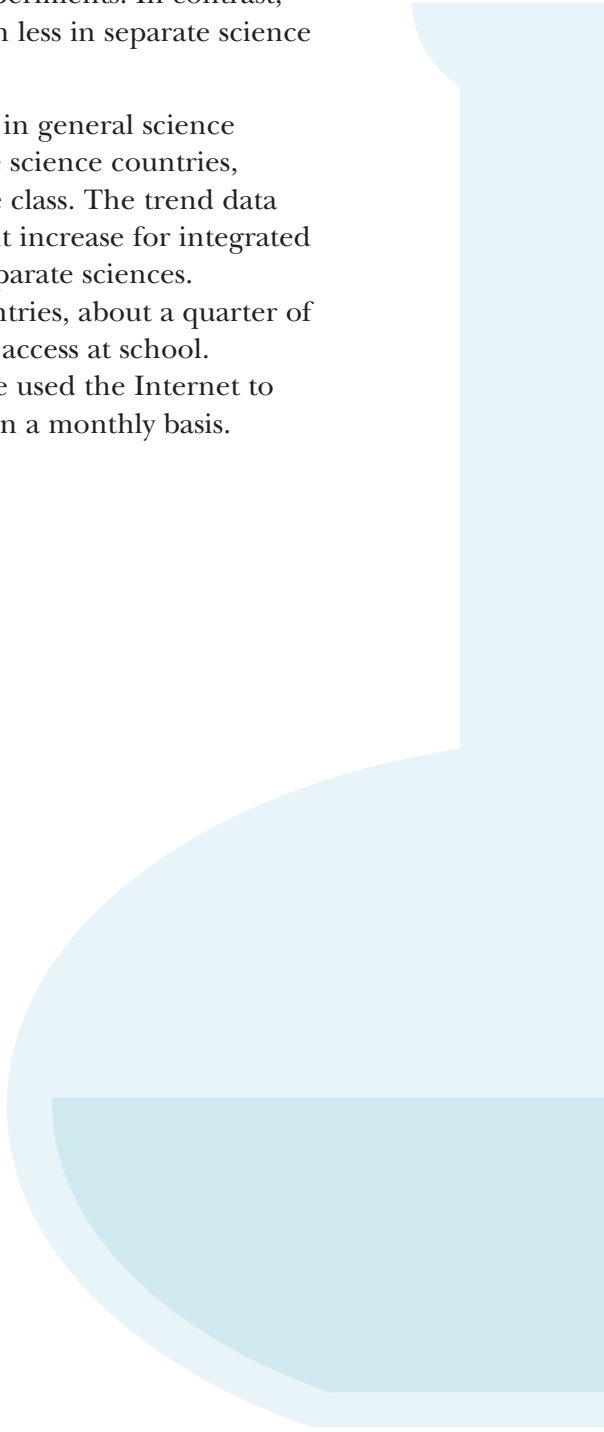
- ▶ Although the level of home educational resources varied considerably across countries, students from homes with a high level of educational resources (more than 100 books; all three study aids: computer, study desk, and dictionary; and at least one parent finished university) had higher science achievement than students from homes with fewer resources, on average internationally.
- ▶ Eighth-grade students internationally had high expectations for further education. On average across countries, more than half the students reported that they expected to finish university. In almost every country there was a positive association between educational expectations and science achievement.
- ▶ Eighth-grade boys generally had a more positive self-concept in science than girls. This difference was most pronounced in countries where the sciences are taught as separate subjects. Although girls in such countries, on average, had a more favorable science self-concept in biology, this was outweighed by a more favorable self-concept for boys in physics, and to a lesser extent in earth science and chemistry.
- ▶ Although student attitudes towards science were generally positive in countries where eighth-grade science is taught as a single subject, they were less positive in separate-science countries. Attitudes were most positive towards biology and earth science, and least positive towards physics and chemistry. Eighth-grade boys generally had more positive attitudes towards science than girls, particularly in physics, chemistry, and earth science. Girls had more favorable attitudes towards biology.

The Science Curriculum

- ▶ In 35 of the 38 countries, specifications for students' curricular goals in science were developed as national curricula. The exceptions were Australia, Canada, and the United States. In 21 countries, science was taught as a single general subject. In the other countries, separate courses were offered in the different science subjects.
- ▶ Testing and assessment were widely used methods to support curriculum implementation. Belgium (Flemish) and Chinese Taipei were the only countries that reported having no public examinations in science to certify students or select them for university or academic tracks. Approximately two-thirds of the countries conduct system-wide assessments at two or three grades, primarily to inform policy makers about achievement of the intended curriculum.
- ▶ On average across countries, instructional time designated in official curricula for science instruction increases from 11 percent at grade 4 to 16 percent at grade 8. This contrasts with a decrease in the proportion of instructional time designated for mathematics in most countries.
- ▶ Knowing basic facts and understanding science concepts received major emphasis in the official eighth-grade curricula of most participating countries, with at least moderate emphasis placed on application of science concepts. Few countries gave major emphasis to using laboratory equipment or performing science experiments.

Instructional Contexts and Practices

- ▶ Internationally, 58 percent of eighth-grade students were taught science by females and 42 percent by males, and similar percentages were found in a number of countries.
- ▶ Teacher's undergraduate and graduate studies provide some indication of their preparation to teach science. In most countries at least 80 percent of eighth-grade students were taught science by teachers with a major in the appropriate science subject.
- ▶ Eighth-grade science teachers reported only a moderate level of confidence in their preparation to teach science. On average, almost 40 percent of students were taught by teachers who reported a low level of confidence in their preparation. Teachers' confidence in their preparation was greatest for biology, and least for earth science, environmental and resource issues, and scientific methods and inquiry skills.
- ▶ The percentage of instructional time at the eighth grade that was devoted to science ranged from 6 to 19 percent in general science countries. For separate-science countries, the average percentage was six or seven percent for each subject, with students generally taking more than one subject. For the most part, the percentages reported by teachers corresponded with the percentages targeted in the intended curriculum.
- ▶ In 1999, teachers in general science countries reported that more than half the students were in science classes that met between about two and three and a half hours per week. In separate-science countries, students mostly were in classes that met for fewer than two hours per week.
- ▶ Videotapes of classes in the United States and Japan in TIMSS 1995 revealed that outside interruptions can affect the flow of the lesson and detract from instructional time. Internationally in 1999, about one-fifth of the students in general science countries reported that their science classes were interrupted pretty often or almost always, and 28 percent reported that their classes were never interrupted. Almost 40 percent of students in separate science classes reported that their classes were never interrupted.

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- ▶ Science teachers reported spending almost one-quarter of their class time, on average, on lecture-style presentations to the class. They reported devoting substantial percentages of their class time to student experiments (15 percent) and teacher-guided student practice (14 percent).
 - ▶ Almost 40 percent of eighth-grade students in general science countries were in classes where teachers and students reported a high degree of emphasis on conducting science experiments. In contrast, emphasis on experiments was reportedly much less in separate science classes, particularly earth science and biology.
 - ▶ Less than 10 percent of eighth-grade students in general science countries, and half this percentage in separate science countries, reported frequent use of computers in science class. The trend data from 1995 to 1999 show a small but significant increase for integrated science and small decreases for each of the separate sciences. Although there was great variation across countries, about a quarter of the students internationally reported Internet access at school. Despite this access, only 12 percent on average used the Internet to obtain information for science projects on even a monthly basis.
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School Factors

- ▶ Students in schools that reported being well resourced generally had higher average science achievement than those in schools where across-the-board shortages affected instructional capacity in science some or a lot. According to their principals, nearly half the students were in schools where instruction was negatively affected by shortages or inadequacies in instructional materials, budget for supplies, school buildings, instructional space, audio-visual resources, and library materials relevant to science instruction. More than half the students were in schools where the capacity to provide science instruction was affected by shortages or inadequacies in science laboratory equipment and materials, computers and computer software, library materials, and audio-visual resources.
- ▶ Clearly schools around the world expect help from parents. Internationally, 85 percent of students attended schools expecting parents to ensure that their children complete their homework, 79 percent attended schools expecting parents to volunteer for school projects or field trips, and about half attended schools expecting parents to help raise funds and to serve on committees.
- ▶ Internationally, one-fifth of the students attended schools where principals reported that attendance was not a problem. However, 60 percent were in schools where principals reported moderate attendance problems, and 19 percent were in schools with some serious attendance problems.
- ▶ Generally, the overwhelming majority of eighth-grade students attended schools judged by principals to have few serious problems threatening an orderly or safe school environment.

