

Highlights of Results from TIMSS

THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Now Available

International comparative results in mathematics and science achievement for seventh- and eighth-grade students around the world can be found in two companion reports:



Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study

Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study



These two reports describe student achievement in mathematics and science, respectively, for seventh and eighth graders in 41 countries. Results are presented for major content areas within each subject, and include breakdowns by gender. Country-by-country results are displayed for example items to illustrate the range of topics covered. Results are included for selected background and attitudinal factors for eighth-grade students. Information also is provided about teacher characteristics and instructional practices.

key findings

▶ Singapore was the top-performing country in mathematics and science at both the eighth and seventh grades. Korea, Japan, and the Czech Republic also performed very well in both subjects. Hong Kong and the Flemish-speaking part of Belgium also were among the top countries in mathematics. (See pages 2 and 3 for a full listing of the results.)

▶ For most countries, even though gender differences were minimal in mathematics, they were pervasive in science. Boys outperformed girls, particularly in physics, chemistry, and earth science.

▶ Home factors were strongly related to mathematics and science achievement in every TIMSS country (i.e., educational resources, books in the home, and parents' education).

▶ A positive relationship was observed between liking mathematics and the science subject areas and achievement in them, especially for mathematics. Most, but not all, eighth-graders reported liking mathematics and science to some degree.

Highlights of the findings and further information about TIMSS are presented in the following pages.

November 1996

TIMSS

Table 1

Achievement in Mathematics

Eighth Grade*		Seventh Grade*	
Country	Average Achievement	Country	Average Achievement
Singapore	643	Singapore	601
Korea	607	Korea	577
Japan	605	Japan	571
Hong Kong	588	Hong Kong	564
Belgium (Fl)	565	Belgium (Fl)	558
Czech Republic	564	Czech Republic	523
Slovak Republic	547	Netherlands	516
Switzerland	545	Bulgaria	514
Netherlands	541	Austria	509
Slovenia	541	Slovak Republic	508
Bulgaria	540	Belgium (Fr)	507
Austria	539	Switzerland	506
France	538	Hungary	502
Hungary	537	Russian Federation	501
Russian Federation	535	Ireland	500
Australia	530	Slovenia	498
Ireland	527	Australia	498
Canada	527	Thailand	495
Belgium (Fr)	526	Canada	494
Thailand	522	France	492
Israel	522	Germany	484
Sweden	519	Sweden	477
Germany	509	England	476
New Zealand	508	United States	476
England	506	New Zealand	472
Norway	503	Denmark	465
Denmark	502	Scotland	463
United States	500	Latvia (LSS)	462
Scotland	498	Norway	461
Latvia (LSS)	493	Iceland	459
Spain	487	Romania	454
Iceland	487	Spain	448
Greece	484	Cyprus	446
Romania	482	Greece	440
Lithuania	477	Lithuania	428
Cyprus	474	Portugal	423
Portugal	454	Iran, Islamic Rep.	401
Iran, Islamic Rep.	428	Colombia	369
Kuwait	392	South Africa	348
Colombia	385		
South Africa	354		

Table 2

Achievement in Science

Eighth Grade*		Seventh Grade*	
Country	Average Achievement	Country	Average Achievement
Singapore	607	Singapore	545
Czech Republic	574	Korea	535
Japan	571	Czech Republic	533
Korea	565	Japan	531
Bulgaria	565	Bulgaria	531
Netherlands	560	Slovenia	530
Slovenia	560	Belgium (Fl)	529
Austria	558	Austria	519
Hungary	554	Hungary	518
England	552	Netherlands	517
Belgium (Fl)	550	England	512
Australia	545	Slovak Republic	510
Slovak Republic	544	United States	508
Russian Federation	538	Australia	504
Ireland	538	Germany	499
Sweden	535	Canada	499
United States	534	Hong Kong	495
Germany	531	Ireland	495
Canada	531	Thailand	493
Norway	527	Sweden	488
New Zealand	525	Russian Federation	484
Thailand	525	Switzerland	484
Israel	524	Norway	483
Hong Kong	522	New Zealand	481
Switzerland	522	Spain	477
Scotland	517	Scotland	468
Spain	517	Iceland	462
France	498	Romania	452
Greece	497	France	451
Iceland	494	Greece	449
Romania	486	Belgium (Fr)	442
Latvia (LSS)	485	Denmark	439
Portugal	480	Iran, Islamic Rep.	436
Denmark	478	Latvia (LSS)	435
Lithuania	476	Portugal	428
Belgium (Fr)	471	Cyprus	420
Iran, Islamic Rep.	470	Lithuania	403
Cyprus	463	Colombia	387
Kuwait	430	South Africa	317
Colombia	411		
South Africa	326		

*Eighth and seventh grades in most countries. Latvia is annotated LSS for Latvian Speaking Schools only. Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures. The report presents standard errors for all survey estimates.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.



TIMSS Results About Teaching and Learning

- ▶ Most countries reported that four years of post-secondary education, practice in teaching, and some form of examination were required for teacher certification.
- ▶ In many countries, students generally were in mathematics and science classes of fewer than 30 students. Korea was a notable exception, with most students in classes of 40 or more.
- ▶ Mathematics teachers in many countries reported a high frequency of calculator use in their classes, often for checking answers, routine computation, and solving complex problems. Again, Korea was the exception, where it was reported that calculators were seldom used.
- ▶ Teacher demonstrations of experiments were common in science classes regardless of whether eighth graders were taught science as a single subject or as separate science subjects, as is done in much of Europe.
- ▶ Notwithstanding a considerable range in student reports, eighth graders in about half the countries reported doing an average of 2 or 3 hours of homework each day. Most typically, students reported studying mathematics for roughly an hour each day, and science for somewhat less than that.
- ▶ Eighth graders in most countries reported spending as much out-of-school time each day in non-academic activities as they did in academic activities. Most typically, students reported watching 1 or 2 hours of television each day as well as spending several hours playing or talking with friends, and nearly 2 hours playing sports. (Of course, for teenagers, these activities often occur simultaneously, such as watching television and talking with friends on the phone.)

fyi About TIMSS

Since its inception in 1959, the International Association for the Evaluation of Educational Achievement (IEA) has conducted a series of international comparative studies designed to provide information to policy makers, educators, researchers, and practitioners about educational achievement and learning contexts.

TIMSS is the largest and most ambitious of these studies ever undertaken. The successful collaboration of research centers around the world in implementing TIMSS is a tribute to the dedication and professionalism of all involved. All told, TIMSS achievement testing in mathematics and science included:

- 45 countries
- 5 grade levels (3rd, 4th, 7th, 8th, and final year of secondary school)
- more than half a million students
- testing in more than 30 different languages
- more than 15,000 participating schools
- nearly 1,000 open-ended questions, generating millions of student responses
- performance assessment
- questionnaires from students, teachers, and school principals containing about 1,500 questions
- many thousands of individuals to give the tests and process the data

TIMSS was conducted with attention to quality at every step of the way. Rigorous procedures were designed specifically to translate the tests, and numerous regional training sessions were held in data collection and scoring procedures. Quality control observers monitored testing sessions. The samples of students selected for testing were scrutinized according to rigorous standards designed to prevent bias and ensure comparability.

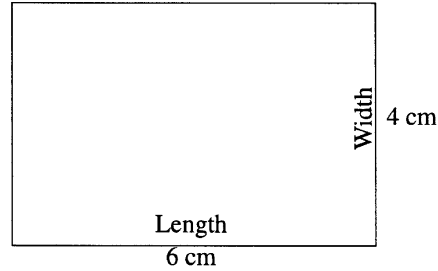
The international direction of TIMSS is funded by the National Center for Education Statistics of the U.S. Department of Education, the U.S. National Science Foundation, and the Canadian Government. Each country provides its own funding for the national implementation of TIMSS.

EXAMPLE ITEM 1 FRACTIONS & NUMBER SENSE

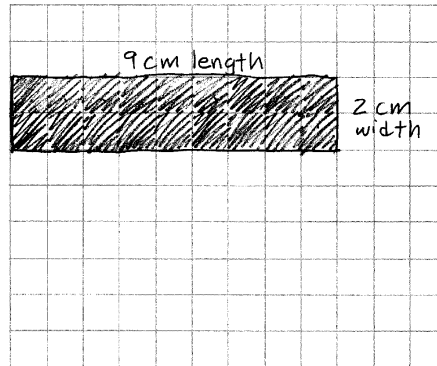
A car has a fuel tank that holds 35 L of fuel. The car consumes 7.5 L of fuel for each 100 km driven. A trip of 250 km was started with a full tank of fuel. How much fuel remained in the tank at the end of the trip?

- (A) 16.25 L
- B. 17.65 L
- C. 18.75 L
- D. 23.75 L

EXAMPLE ITEM 2 MEASUREMENT



In the space below, draw a new rectangle whose length is one and one-half times the length of the rectangle above, and whose width is half the width of the rectangle above. Show the length and width of the new rectangle in centimeters on the figure.



International Average Percent Correct

Item	Grade
1	39
2	31
3	58
4	65

EXAMPLE ITEM 3 ALGEBRA

If m represents a positive number, which of these is equivalent to $m + m + m + m$?

- A. $m + 4$
- (B) $4m$
- C. m^4
- D. $4(m + 1)$

EXAMPLE ITEM 4 PROPORTIONALITY

Three-fifths of the students in a class are girls. If 5 girls and 5 boys are added to the class, which statement is true of the class?

- (A) There are more girls than boys.
- B. There are the same number of girls as there are boys.
- C. There are more boys than girls.
- D. You cannot tell whether there are more girls or boys from the information given.

Table 3 Percent Correct on Selected Mathematics Items – Eighth Grade*

Country	Example 1	Example 2	Example 3	Example 4
<i>Australia</i>	42	31	65	74
<i>Austria</i>	33	51	73	73
Belgium (Fl)	49	48	69	82
Belgium (Fr)	36	43	64	76
<i>Bulgaria</i>	63	27	72	57
Canada	36	27	61	66
<i>Colombia</i>	29	5	34	30
Cyprus	30	35	59	63
Czech Republic	43	36	75	70
<i>Denmark</i>	31	24	36	68
England	40	28	42	69
France	34	43	65	75
<i>Germany</i>	37	34	57	67
<i>Greece</i>	29	23	57	59
Hong Kong	48	46	79	78
Hungary	46	43	72	67
Iceland	25	18	59	66
Iran, Islamic Rep.	30	24	34	51
Ireland	42	35	53	78
<i>Israel</i>	41	48	70	75
Japan	–	–	75	82
Korea	50	54	65	82
<i>Kuwait</i>	22	10	29	25
Latvia (LSS)	38	31	58	57
Lithuania	38	24	56	51
<i>Netherlands</i>	50	40	51	77
New Zealand	40	27	55	70
Norway	37	32	52	73
Portugal	37	22	42	50
<i>Romania</i>	39	28	64	52
Russian Federation	41	39	75	47
Scotland	38	27	53	71
Singapore	70	–	82	85
Slovak Republic	38	35	77	62
<i>Slovenia</i>	31	37	75	66
<i>South Africa</i>	23	4	33	31
Spain	25	28	59	62
Sweden	43	30	51	74
Switzerland	44	47	54	76
<i>Thailand</i>	44	20	49	56
United States	34	16	46	62

*Eighth grade in most countries.

Latvia is annotated LSS for Latvian Speaking Schools only. Countries shown in italics did not satisfy one or more guidelines for sample participation rates, age/grade specifications, or classroom sampling procedures. The report presents standard errors for all survey estimates.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.



Even though eighth graders in the top-performing countries had very high achievement, in most countries students had difficulty with multi-step problem solving and applications. (See *Example Items 1 and 2*). For example, students were asked to draw a new rectangle whose length was one and one-half times the length of a given rectangle and whose width was half the width of that rectangle. In only two countries (Korea and Austria) did at least half the students correctly draw the new rectangle.



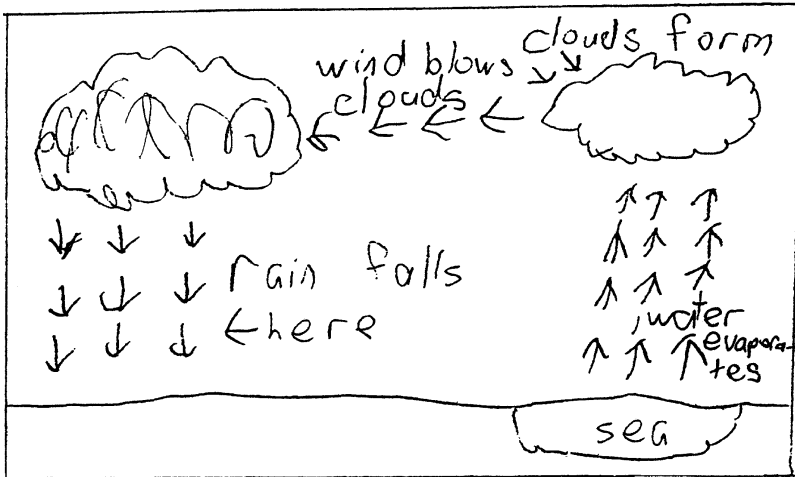
In algebra (*Example Item 3*), just over half the students across all countries, on average, correctly identified $4m$ as being equivalent to $m+m+m+m$. There was, however, a very large range of performance from country to country. Three-fourths or more of the students answered the question correctly in the Czech Republic, Hong Kong, Japan, the Russian Federation, Singapore, the Slovak Republic, and Slovenia.



Students also found the proportionality items difficult. One of the least difficult problems in this area (*Example Item 4*) asked about adding five girls and five boys to a class that was three-fifths girls. On average, fewer than two-thirds of the students across countries correctly answered that there would still be more girls than boys in the class.

EXAMPLE ITEM 5 EARTH SCIENCE

Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.



**International
Average
Percent Correct**

Item Grade

5 32

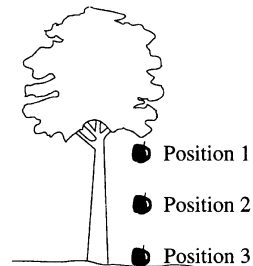
6 55

7 50

EXAMPLE ITEM 6 PHYSICS

The drawing shows an apple falling to the ground. In which of the three positions does gravity act on the apple?

- A. 2 only
- B. 1 and 2 only
- C. 1 and 3 only
- D. 1, 2, and 3



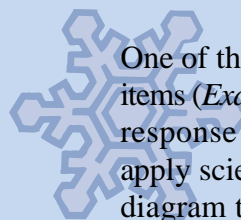
EXAMPLE ITEM 7 CHEMISTRY

Carbon dioxide is the active material in some fire extinguishers. How does carbon dioxide extinguish a fire?

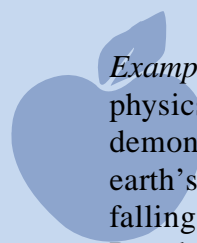
A fire needs oxygen to burn so a fire extinguisher sprays out the carbon dioxide to replace the presence of oxygen. Without oxygen, a fire can't burn.

Table 4 Percent Correct on Selected Science Items – Eighth Grade*

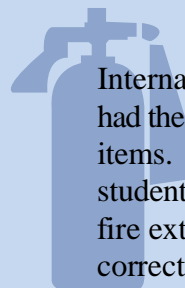
Country	Example 5	Example 6	Example 7
<i>Australia</i>	33	57	61
<i>Austria</i>	43	61	74
Belgium (Fl)	60	62	58
Belgium (Fr)	32	52	33
<i>Bulgaria</i>	19	41	46
Canada	39	63	61
<i>Colombia</i>	15	48	23
Cyprus	24	36	41
Czech Republic	27	81	57
<i>Denmark</i>	39	51	33
England	53	51	71
France	32	51	50
<i>Germany</i>	35	55	69
<i>Greece</i>	17	30	37
Hong Kong	25	74	37
Hungary	22	72	62
Iceland	33	40	57
Iran, Islamic Rep.	11	51	63
Ireland	51	55	66
<i>Israel</i>	17	61	63
Japan	43	58	45
Korea	23	72	54
<i>Kuwait</i>	25	50	49
Latvia (LSS)	19	41	42
Lithuania	9	61	29
<i>Netherlands</i>	57	58	56
New Zealand	29	54	65
Norway	55	49	63
Portugal	24	53	35
<i>Romania</i>	21	50	33
Russian Federation	59	42	54
Scotland	40	48	59
Singapore	57	59	70
Slovak Republic	25	72	46
<i>Slovenia</i>	24	57	52
<i>South Africa</i>	6	36	15
Spain	34	55	43
Sweden	49	59	70
Switzerland	38	53	57
<i>Thailand</i>	16	57	34
United States	40	64	62



One of the more difficult earth science items (*Example Item 5*) was an extended-response item requiring students to apply scientific principles and draw a diagram to explain the earth’s water cycle. Internationally, about one-third or fewer of the students provided a completely correct response that included all three steps in the water cycle – evaporation, transportation, and precipitation. Performance on this item varied widely across countries, however, with percentages correct ranging from less than 10% in Lithuania and South Africa to 60% in Flemish-speaking Belgium.



Example Item 6 was a multiple-choice physics item requiring students to demonstrate knowledge of how the earth’s gravitational force acts on a falling apple. Except in the Czech Republic and the Slovak Republic, where about three-fourths or more of students responded correctly, students’ responses to this item indicated a common misconception that gravity does not act on a stationary object when it is on the ground.



Internationally, eighth-grade students had the most difficulty with the chemistry items. *Example Item 7*, which required students to explain how carbon dioxide fire extinguishers work, was answered correctly by about half or fewer of the students in many countries. In only four countries did 70% or more of the students correctly explain the displacement of oxygen required for combustion (Austria, England, Singapore, and Sweden).

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