Chapter 2

Performance at the TIMSS 2011 International Benchmarks

One-third of the Singaporean students reached the fourth grade Advanced International Benchmark, as did 29 percent of students in Korea (median percentage across countries: 5%). At the eighth grade, four East Asian countries had the largest percentages of students reaching this advanced level of performance (18–40%).

Six countries raised achievement across their entire fourth grade student distribution, from low to high performers, and showed improvement across all four international benchmarks over the past decade. At the eighth grade, only three countries showed improvement across all benchmarks, and three had declines.

The TIMSS achievement scale summarizes student performance on test items designed to measure breadth of knowledge in science content domains, as well as a range of cognitive processes within the knowing, applying, and reasoning domains. TIMSS reports achievement at four points along the scale as international benchmarks: Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400).

This chapter presents the science results at the TIMSS 2011 International Benchmarks. To interpret achievement at the benchmarks, the TIMSS & PIRLS International Study Center worked with the TIMSS 2011 Science and Mathematics Item Review Committee (SMIRC) to conduct a detailed scale anchoring analysis to describe science achievement at the benchmarks. The chapter presents those descriptions along with a number of example items and related student performance data to illustrate performance at each of the benchmarks.

TIMSS 2011 Science Framework

The items used in TIMSS 2011 were selected and developed based on the TIMSS 2011 Science Framework contained in the *TIMSS 2011 Assessment Frameworks*. The science assessments at the fourth and eighth grade each were organized around two dimensions: a content dimension specifying the subject matter or content domains to be assessed, and a cognitive dimension specifying the thinking processes that students are likely to use as they engage with the content. As illustrated below, the fourth grade has three content domains: life science, physical science, and earth science. Life science received 45 percent of the assessment emphasis, physical science, 35 percent, and earth science, 20 percent. At the eighth grade, there are four content domains: biology, chemistry, physics, and earth science. Biology received 35 percent of the assessment emphasis and physics received 25 percent, while chemistry and earth science each received 20 percent. The same three cognitive domains—knowing, applying, and reasoning—were used at both the fourth and eighth grades, although there was a little less emphasis on knowing at eighth grade and somewhat more emphasis on reasoning.

Fourth Grade Content Domains	Eighth Grade Content Domains
45% Life Science	35% Biology
35% Physical Science	20% Chemistry
20% Earth Science	25% Physics
	20% Earth Science

Fourth Grade Cognitive Domains	Eighth Grade Cognitive Domains
40% Knowing	35% Knowing
40% Applying	35% Applying
20% Reasoning	30% Reasoning

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● **Advanced** International Benchmark

625

Students apply knowledge and understanding of scientific processes and relationships and show some knowledge of the process of scientific inquiry. Students communicate their understanding of characteristics and life processes of organisms, reproduction and development, ecosystems and organisms' interactions with the environment, and factors relating to human health. They demonstrate understanding of properties of light and relationships among physical properties of materials, apply and communicate their understanding of electricity and energy in practical contexts, and demonstrate an understanding of magnetic and gravitational forces and motion. Students communicate their understanding of the solar system and of Earth's structure, physical characteristics, resources, processes, cycles, and history. They have a beginning ability to interpret results in the context of a simple experiment, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument.

○ **High** International Benchmark

550

Students apply their knowledge and understanding of the sciences to explain phenomena in everyday and abstract contexts. Students demonstrate some understanding of plant and animal structure, life processes, life cycles, and reproduction. They also demonstrate some understanding of ecosystems and organisms' interactions with their environment, including understanding of human responses to outside conditions and activities. Students demonstrate understanding of some properties of matter, electricity and energy, and magnetic and gravitational forces and motion. They show some knowledge of the solar system, and of Earth's physical characteristics, processes, and resources. Students demonstrate elementary knowledge and skills related to scientific inquiry. They compare, contrast, and make simple inferences, and provide brief descriptive responses combining knowledge of science concepts with information from both everyday and abstract contexts.

● **Intermediate** International Benchmark

475

Students have basic knowledge and understanding of practical situations in the sciences. Students recognize some basic information related to characteristics of living things, their reproduction and life cycles, and their interactions with the environment, and show some understanding of human biology and health. They also show some knowledge of properties of matter and light, electricity and energy, and forces and motion. Students know some basic facts about the solar system and show an initial understanding of Earth's physical characteristics and resources. They demonstrate ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.

○ **Low** International Benchmark

400

Students show some elementary knowledge of life, physical, and earth sciences. Students demonstrate knowledge of some simple facts related to human health, ecosystems, and the behavioral and physical characteristics of animals. They also demonstrate some basic knowledge of energy and the physical properties of matter. Students interpret simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Fourth Grade Results for the
TIMSS 2011 International Benchmarks in Science

Fourth Grade TIMSS 2011 International Benchmarks of Science Achievement

Exhibit 2.1 summarizes what fourth grade students scoring at the TIMSS International Benchmarks typically know and can do in science. Detailed descriptions of each benchmark level are presented together with example items in subsequent sections of the chapter.

There was substantial variation in performance between students achieving at the Advanced International Benchmark and the Low International Benchmark. At the fourth grade, students at the Advanced International Benchmark applied their knowledge and understanding of scientific processes and relationships across the four content domains, and showed some knowledge of the process of scientific inquiry. They had a beginning ability to interpret results in the context of a simple experiment, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument. Students at the High International Benchmark applied their knowledge and understanding of the sciences to explain phenomena in everyday and abstract contexts. They demonstrated elementary knowledge and skills related to scientific inquiry, and compared, contrasted, and made simple inferences. At the Intermediate International Benchmark, students had basic knowledge and understanding of practical situations in the sciences, and they demonstrated ability to interpret information in pictorial diagrams and applied factual knowledge to practical situations. Students at the Low International Benchmark had some elementary knowledge of life, physical, and earth sciences, and interpreted simple diagrams, completed simple tables, and provided short written responses to questions requiring factual information.

Fourth Grade Achievement at the
TIMSS 2011 International Benchmarks of Science Achievement

Exhibit 2.2 presents the percentage of students reaching each TIMSS 2011 International Benchmark for countries participating in the fourth grade assessment. The results are presented in descending order based on the percentage of students reaching the Advanced International Benchmark, first for fourth grade countries, followed by sixth grade countries and benchmarking participants on the second page. The percentage of students reaching the Advanced Benchmark is indicated in the bar graph with a black dot. Because students who reached the Advanced Benchmark also reached the other

benchmarks, the percentages illustrated in the graph and shown in the columns to the right are cumulative.

At the fourth grade, the countries with the largest percentages of students reaching the Advanced International Benchmark also were the countries with the highest average science achievement (see Chapter 1). The two countries with the highest achievement—Singapore and Korea—had the largest percentages of students reaching the Advanced International Benchmark. One-third of the Singaporean fourth grade students reached the Advanced Benchmark, as did 29 percent of the Korean students. Twenty percent of the students in Finland reached this level, followed by the Russian Federation (16%), Chinese Taipei (15%), the United States (15%), and Japan (14%).
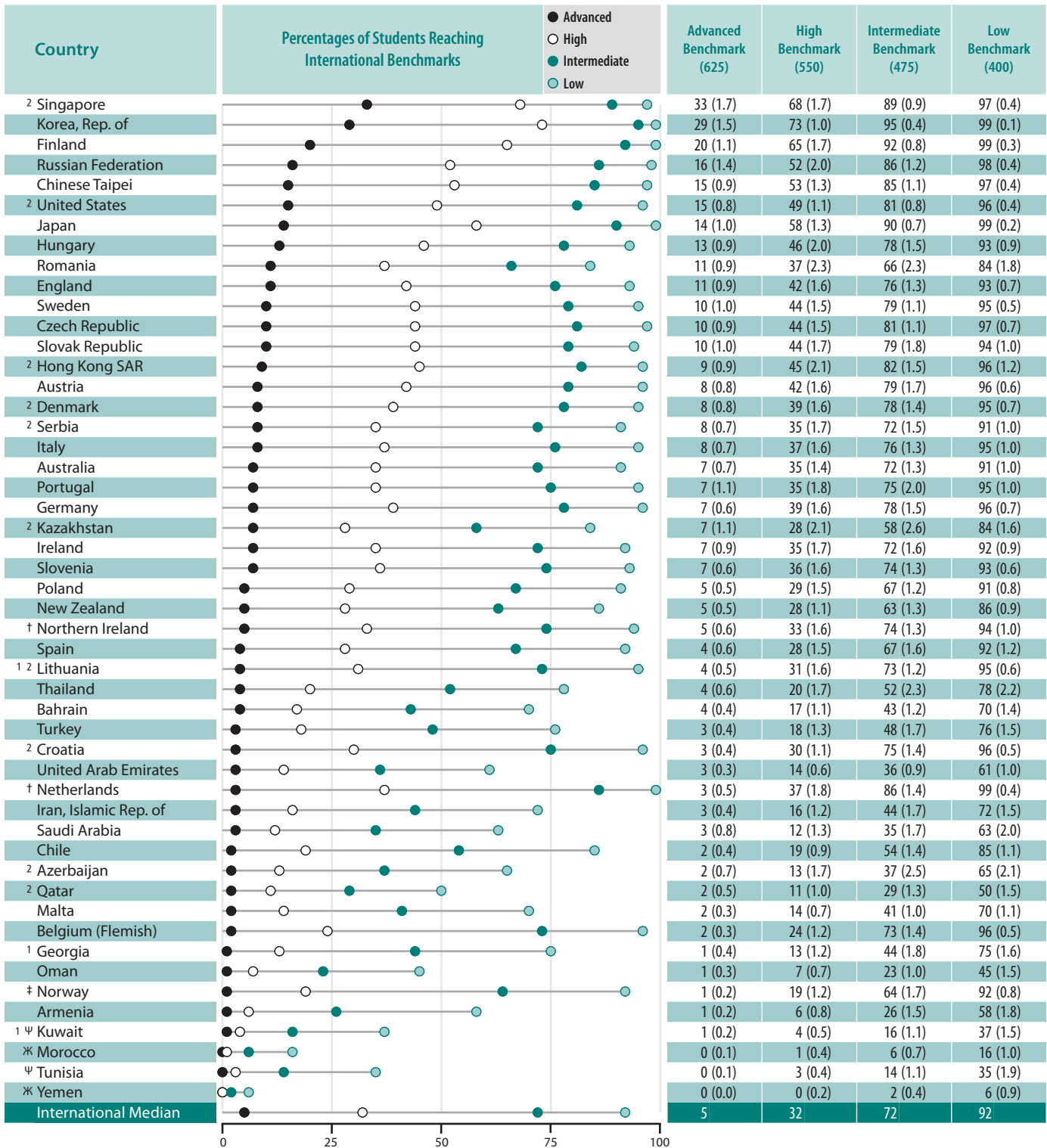
Exhibit 2.2 also provides useful information about the distribution of achievement in each country. For example, even though the Netherlands had many fewer students (3%) reaching the advanced level than did the top-performing countries, the percentages of fourth grade students from the Netherlands reaching the intermediate level (86%) and low level (99%) were comparable to the percentages reaching these levels among the highest-performing countries.

As a point of reference, Exhibit 2.2 provides the median for each of the benchmarks at the bottom of each of the four right hand columns. By definition, half of the countries will have a percentage in the column above the median and half will be below the median. The median percentages of students reaching the International Benchmarks were as follows: Advanced–5 percent, High–32 percent, Intermediate–72 percent, and Low–92 percent. The high median percentage of students reaching the low level indicates that many countries are able to educate almost all of their fourth grade students to a basic level of science achievement.

Fourth Grade Trends in Performance at the
TIMSS 2011 International Benchmarks of Science Achievement

Exhibit 2.3 shows the changes in percentages of fourth grade students reaching the four benchmarks for countries and benchmarking participants that also participated in TIMSS 1995, 2003, and/or 2007. An up arrow indicates that the percentage of students reaching a benchmark is higher in 2011 than in the past cycle, and a down arrow indicates that the percentage is lower in 2011. The patterns in this exhibit generally mirror the trends in average achievement discussed in Chapter 1, and can provide further information about countries' improvement or decline over time.
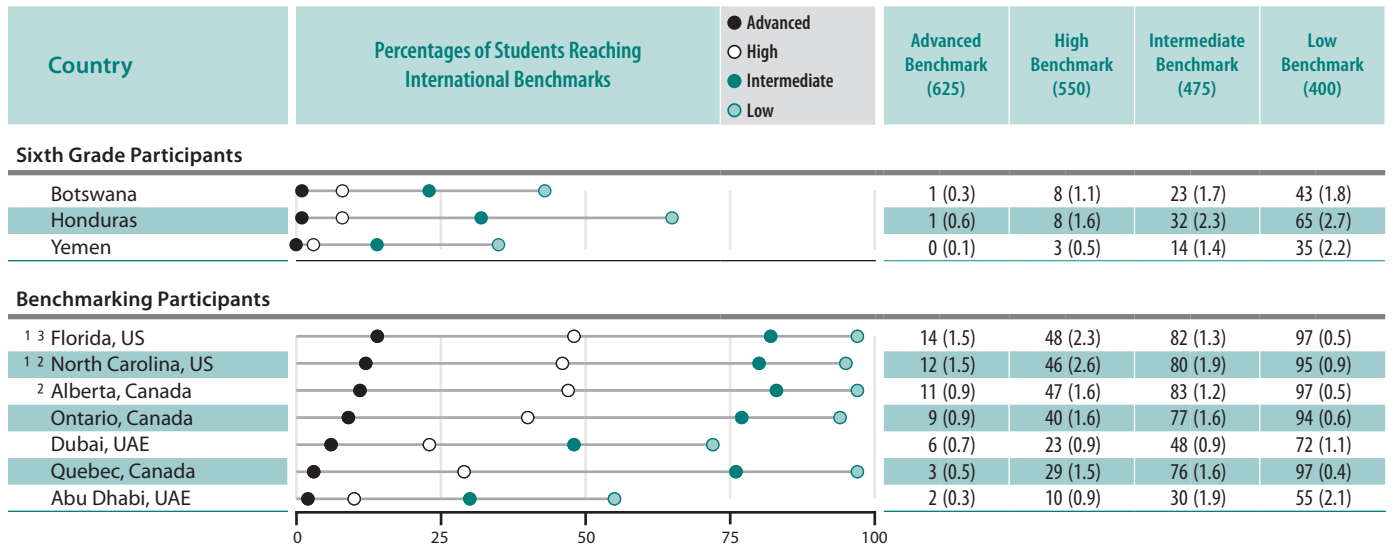
SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Country	Percentages of Students Reaching International Benchmarks	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Legend	● Advanced ○ High ● Intermediate ○ Low				
[2] Singapore		33 (1.7)	68 (1.7)	89 (0.9)	97 (0.4)
Korea, Rep. of		29 (1.5)	73 (1.0)	95 (0.4)	99 (0.1)
Finland		20 (1.1)	65 (1.7)	92 (0.8)	99 (0.3)
Russian Federation		16 (1.4)	52 (2.0)	86 (1.2)	98 (0.4)
Chinese Taipei		15 (0.9)	53 (1.3)	85 (1.1)	97 (0.4)
[2] United States		15 (0.8)	49 (1.1)	81 (0.8)	96 (0.4)
Japan		14 (1.0)	58 (1.3)	90 (0.7)	99 (0.2)
Hungary		13 (0.9)	46 (2.0)	78 (1.5)	93 (0.9)
Romania		11 (0.9)	37 (2.3)	66 (2.3)	84 (1.8)
England		11 (0.9)	42 (1.6)	76 (1.3)	93 (0.7)
Sweden		10 (1.0)	44 (1.5)	79 (1.1)	95 (0.5)
Czech Republic		10 (0.9)	44 (1.5)	81 (1.1)	97 (0.7)
Slovak Republic		10 (1.0)	44 (1.7)	79 (1.8)	94 (1.0)
[2] Hong Kong SAR		9 (0.9)	45 (2.1)	82 (1.5)	96 (1.2)
Austria		8 (0.8)	42 (1.6)	79 (1.7)	96 (0.6)
[2] Denmark		8 (0.8)	39 (1.6)	78 (1.4)	95 (0.7)
[2] Serbia		8 (0.7)	35 (1.7)	72 (1.5)	91 (1.0)
Italy		8 (0.7)	37 (1.6)	76 (1.3)	95 (1.0)
Australia		7 (0.7)	35 (1.4)	72 (1.3)	91 (1.0)
Portugal		7 (1.1)	35 (1.8)	75 (2.0)	95 (1.0)
Germany		7 (0.6)	39 (1.6)	78 (1.5)	96 (0.7)
[2] Kazakhstan		7 (1.1)	28 (2.1)	58 (2.6)	84 (1.6)
Ireland		7 (0.9)	35 (1.7)	72 (1.6)	92 (0.9)
Slovenia		7 (0.6)	36 (1.6)	74 (1.3)	93 (0.6)
Poland		5 (0.5)	29 (1.5)	67 (1.2)	91 (0.8)
New Zealand		5 (0.5)	28 (1.1)	63 (1.3)	86 (0.9)
† Northern Ireland		5 (0.6)	33 (1.6)	74 (1.3)	94 (1.0)
Spain		4 (0.6)	28 (1.5)	67 (1.6)	92 (1.2)
[1] [2] Lithuania		4 (0.5)	31 (1.6)	73 (1.2)	95 (0.6)
Thailand		4 (0.6)	20 (1.7)	52 (2.3)	78 (2.2)
Bahrain		4 (0.4)	17 (1.1)	43 (1.2)	70 (1.4)
Turkey		3 (0.4)	18 (1.3)	48 (1.7)	76 (1.5)
[2] Croatia		3 (0.4)	30 (1.1)	75 (1.4)	96 (0.5)
United Arab Emirates		3 (0.3)	14 (0.6)	36 (0.9)	61 (1.0)
† Netherlands		3 (0.5)	37 (1.8)	86 (1.4)	99 (0.4)
Iran, Islamic Rep. of		3 (0.4)	16 (1.2)	44 (1.7)	72 (1.5)
Saudi Arabia		3 (0.8)	12 (1.3)	35 (1.7)	63 (2.0)
Chile		2 (0.4)	19 (0.9)	54 (1.4)	85 (1.1)
[2] Azerbaijan		2 (0.7)	13 (1.7)	37 (2.5)	65 (2.1)
[2] Qatar		2 (0.5)	11 (1.0)	29 (1.3)	50 (1.5)
Malta		2 (0.3)	14 (0.7)	41 (1.0)	70 (1.1)
Belgium (Flemish)		2 (0.3)	24 (1.2)	73 (1.4)	96 (0.5)
[1] Georgia		1 (0.4)	13 (1.2)	44 (1.8)	75 (1.6)
Oman		1 (0.3)	7 (0.7)	23 (1.0)	45 (1.5)
‡ Norway		1 (0.2)	19 (1.2)	64 (1.7)	92 (0.8)
Armenia		1 (0.2)	6 (0.8)	26 (1.5)	58 (1.8)
[1] Ψ Kuwait		1 (0.2)	4 (0.5)	16 (1.1)	37 (1.5)
Җ Morocco		0 (0.1)	1 (0.4)	6 (0.7)	16 (1.0)
Ψ Tunisia		0 (0.1)	3 (0.4)	14 (1.1)	35 (1.9)
Җ Yemen		0 (0.0)	0 (0.2)	2 (0.4)	6 (0.9)
International Median		5	32	72	92

Chart scale: 0, 25, 50, 75, 100

Җ   Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.

Ψ   Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%.

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Country	Percentages of Students Reaching International Benchmarks	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
	● Advanced ○ High ● Intermediate ○ Low				

Sixth Grade Participants

Country		Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Botswana		1 (0.3)	8 (1.1)	23 (1.7)	43 (1.8)
Honduras		1 (0.6)	8 (1.6)	32 (2.3)	65 (2.7)
Yemen		0 (0.1)	3 (0.5)	14 (1.4)	35 (2.2)

Benchmarking Participants

Country		Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
[1] [3] Florida, US		14 (1.5)	48 (2.3)	82 (1.3)	97 (0.5)
[1] [2] North Carolina, US		12 (1.5)	46 (2.6)	80 (1.9)	95 (0.9)
[2] Alberta, Canada		11 (0.9)	47 (1.6)	83 (1.2)	97 (0.5)
Ontario, Canada		9 (0.9)	40 (1.6)	77 (1.6)	94 (0.6)
Dubai, UAE		6 (0.7)	23 (0.9)	48 (0.9)	72 (1.1)
Quebec, Canada		3 (0.5)	29 (1.5)	76 (1.6)	97 (0.4)
Abu Dhabi, UAE		2 (0.3)	10 (0.9)	30 (1.9)	55 (2.1)

0   25   50   75   100

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Country	Advanced International Benchmark (625)				High International Benchmark (550)			
	Percent of Students				Percent of Students			
	2011	2007	2003	1995	2011	2007	2003	1995
Singapore	33	36	25 ▲	14 ▲	68	68	61 ▲	42 ▲
Korea, Rep. of	29			22 ▲	73			67 ▲
Russian Federation	16	16	11 ▲		52	49	39 ▲	
Chinese Taipei	15	19 ▼	14		53	55	52	
United States	15	15	13	19 ▼	49	47	45 ▲	50
Japan	14	12	12	15	58	51 ▲	49 ▲	54 ▲
Hungary	13	13	10 ▲	7 ▲	46	47	42	32 ▲
England	11	14 ▼	15 ▼	15 ▼	42	48 ▼	47 ▼	42
Sweden	10	8			44	37 ▲		
Czech Republic	10	7 ▲		12	44	33 ▲		42
Slovak Republic	10	11			44	42		
Hong Kong SAR	9	14 ▼	7	5 ▲	45	55 ▼	47	30 ▲
Austria	8	9		13 ▼	42	39		45
Denmark	8	7			39	35 ▲		
Italy	8	13 ▼	9		37	44 ▼	35	
Australia	7	10 ▼	9	13 ▼	35	41 ▼	38	40 ▼
Portugal	7			2 ▲	35			13 ▲
Germany	7	10 ▼			39	41		
Ireland	7			8	35			36
Slovenia	7	6	3 ▲	2 ▲	36	36	22 ▲	14 ▲
New Zealand	5	8 ▼	9 ▼	11 ▼	28	32 ▼	38 ▼	35 ▼
Lithuania	4	3	3		31	30	30	
Netherlands	3	4	3	6 ▼	37	34	32 ▲	38
Iran, Islamic Rep. of	3	2 ▲	1 ▲	0 ▲	16	12 ▲	7 ▲	3 ▲
Belgium (Flemish)	2		2		24		28 ▼	
Georgia	1	1			13	5 ▲		
Norway	1	1	2	8 ▼	19	17	15 ▲	32 ▼
Armenia	1		2		6		10 ▼	
Ψ Tunisia	0	0	0		3	3	2	

Benchmarking Participants

Country	2011	2007	2003	1995	2011	2007	2003	1995
Alberta, Canada	11	12		21 ▼	47	48		57 ▼
Ontario, Canada	9	12	13 ▼	10	40	45 ▼	47 ▼	37
Dubai, UAE	6	4			23	21 ▲		
Quebec, Canada	3	5 ▼	3	9 ▼	29	32	25 ▲	40 ▼

▲ 2011 percent significantly higher

▼ 2011 percent significantly lower

Ψ Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%. Such annotations in exhibits with trend data began in 2011, so data from assessments prior to 2011 are not annotated for reservations.

An empty cell indicates a country did not participate in that year's assessment.

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Exhibit 2.3: Trends in Percentages of Students Reaching the International Benchmarks of Science Achievement (Continued)

TIMSS 2011 Science 4th Grade

Country	Intermediate International Benchmark (475) Percent of Students				Low International Benchmark (400) Percent of Students			
	2011	2007	2003	1995	2011	2007	2003	1995
Singapore	89	88	86	71 ▲	97	96	95	89 ▲
Korea, Rep. of	95			93 ▲	99			99
Russian Federation	86	82	74 ▲		98	96 ▲	93 ▲	
Chinese Taipei	85	86	87		97	97	98 ▼	
United States	81	78 ▲	78 ▲	78 ▲	96	94 ▲	94 ▲	92 ▲
Japan	90	86 ▲	84 ▲	87 ▲	99	97 ▲	96 ▲	97 ▲
Hungary	78	78	76	67 ▲	93	93	94	90
England	76	81 ▼	79	72	93	95 ▼	94	90 ▲
Sweden	79	76			95	95		
Czech Republic	81	72 ▲		77 ▲	97	93 ▲		95 ▲
Slovak Republic	79	75			94	92		
Hong Kong SAR	82	88 ▼	87 ▼	69 ▲	96	98	98 ▼	91 ▲
Austria	79	76		79	96	93 ▲		94
Denmark	78	72 ▲			95	93 ▲		
Italy	76	78	70 ▲		95	94	91 ▲	
Australia	72	76 ▼	74	72	91	93	92	89
Portugal	75			43 ▲	95			73 ▲
Germany	78	76			96	94 ▲		
Ireland	72			70	92			91
Slovenia	74	74	61 ▲	45 ▲	93	93	87 ▲	79 ▲
New Zealand	63	65	73 ▼	66	86	87	91 ▼	85
Lithuania	73	74	73		95	95	95	
Netherlands	86	79 ▲	83	82 ▲	99	97	99	98
Iran, Islamic Rep. of	44	36 ▲	28 ▲	15 ▲	72	65 ▲	58 ▲	42 ▲
Belgium (Flemish)	73		79 ▼		96		98 ▼	
Georgia	44	26 ▲			75	59 ▲		
Norway	64	54 ▲	49 ▲	65	92	84 ▲	79 ▲	88 ▲
Armenia	26		38 ▼		58		66 ▼	
Ψ Tunisia	14	14	10 ▲		35	32	27 ▲	

Benchmarking Participants

Country	2011	2007	2003	1995	2011	2007	2003	1995
Alberta, Canada	83	82		84	97	96		94
Ontario, Canada	77	79	81 ▼	71 ▲	94	95	96	90 ▲
Dubai, UAE	48	48			72	72		
Quebec, Canada	76	74	66 ▲	77	97	96	91 ▲	94 ▲

▲ 2011 percent significantly higher

▼ 2011 percent significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

In general, there were more improvements across the International Benchmarks in 2011 than there were declines. Six countries have improved since 1995 at all four benchmarks: Singapore, Korea (with a ceiling effect at the Low Benchmark), Hong Kong SAR, Portugal, Slovenia, and Iran. Since 1995, Japan had gains at all except the Advanced Benchmark, and Hungary had gains at all except the Low Benchmark. The United States, the Czech Republic, and the Canadian province of Ontario improved at the two lower benchmarks, although the United States also showed a decline in the percentage of students reaching the Advanced Benchmark since 1995.

No countries or benchmarking participants showed declines in the percentages of students at the intermediate or low levels since 1995. However, in addition to the United States, six other countries showed declines at the advanced level (England, Austria, Australia, New Zealand, the Netherlands, and Norway), and three of these also showed declines at the high level (Australia, New Zealand, and Norway).

Fourth Grade TIMSS 2011 Low International Benchmark

Exhibit 2.4 presents the detailed description of student achievement at the Low International Benchmark. At this benchmark, students had some elementary knowledge of life, physical, and earth sciences, and interpreted simple diagrams, completed simple tables, and provided short written responses to questions requiring factual information.

As specified in the TIMSS 2011 Science Framework, almost half of the fourth grade assessment (45%) was devoted to items in the life science domain. Several items answered correctly by students achieving at the lower scale levels assessed knowledge of characteristics and life processes of living things, one of the topics in the TIMSS Framework. Exhibit 2.5 presents Example Item 1, a question requiring students to apply elementary knowledge about the physical characteristics of animals and illustrating performance at the Low International Benchmark. With an international average of 83 percent correct across the fourth grade countries, this item was relatively easy for students in most countries.

Exhibit 2.6 presents Example Item 2, in which students must interpret a simple diagram and recognize that an iron nail completes an electric circuit. This elementary knowledge of physical science exemplifies the Low International Benchmark, where students demonstrated some basic knowledge of physical properties of matter. The international average was 71 percent correct, and this item was relatively easy for students in many countries.

Low International Benchmark

400

Summary

Students show some elementary knowledge of life, physical, and earth sciences. Students demonstrate knowledge of some simple facts related to human health, ecosystems, and the behavioral and physical characteristics of animals. They also demonstrate some basic knowledge of energy and the physical properties of matter. Students interpret simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.

In life science, students demonstrate knowledge of some simple facts related to human health. For example, they state one effect the Sun can have on unprotected skin and name one thing humans can do to maintain good physical health. They also demonstrate some knowledge of behavioral and physical characteristics of animals. Students recognize that fat layers help keep some animals warm, that wings are common to birds, bats, and butterflies, and that birds sit on their eggs to keep them warm. Students exhibit an elementary understanding of ecosystems. They recognize a predator in a list of animals and match animals to their ecosystems.

In physical science, students demonstrate some basic knowledge of energy and the physical properties of matter. For example, they recognize that an iron nail can complete an electrical circuit and allow a light bulb to glow, and they identify wind as the cause of movement in a sail boat. Students recognize that the vibrations that produce sound in a guitar start with the strings and, from a diagram, recognize which of a set of thermometer readings shows the hottest water.

In earth science, students identify one way people use air and they identify a planet other than Earth that orbits the Sun.

Students interpret simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.

Country	Percent Correct	
Korea, Rep. of	99 (0.3)	⬥
² United States	96 (0.5)	⬥
² Croatia	95 (0.9)	⬥
² Singapore	95 (0.7)	⬥
Finland	95 (0.9)	⬥
Sweden	95 (0.9)	⬥
Ireland	95 (0.9)	⬥
Austria	94 (0.9)	⬥
England	94 (1.4)	⬥
‡ Norway	93 (1.3)	⬥
Germany	93 (1.1)	⬥
New Zealand	93 (1.2)	⬥
Portugal	92 (1.3)	⬥
Russian Federation	92 (1.0)	⬥
Australia	92 (1.5)	⬥
Slovenia	91 (1.3)	⬥
† Netherlands	91 (1.5)	⬥
† Northern Ireland	91 (2.0)	⬥
² Denmark	91 (1.3)	⬥
² Serbia	91 (1.4)	⬥
Czech Republic	90 (1.6)	⬥
Poland	90 (1.4)	⬥
Slovak Republic	89 (1.5)	⬥
Italy	89 (1.6)	⬥
¹ ² Lithuania	89 (1.4)	⬥
Belgium (Flemish)	88 (1.4)	⬥
Spain	87 (1.3)	⬥
Japan	87 (1.5)	⬥
Thailand	86 (1.5)	
¹ Georgia	86 (2.1)	
Hungary	84 (1.6)	
Chile	84 (1.5)	
International Avg.	**83 (0.2)**	
Armenia	83 (1.7)	
Chinese Taipei	83 (1.5)	
Romania	83 (2.7)	
Malta	82 (1.6)	
² Hong Kong SAR	79 (2.1)	
² Kazakhstan	79 (1.8)	⬦
Turkey	79 (1.5)	⬦
Bahrain	75 (2.1)	⬦
² Azerbaijan	75 (2.1)	⬦
United Arab Emirates	74 (1.1)	⬦
Saudi Arabia	70 (1.9)	⬦
Iran, Islamic Rep. of	62 (2.1)	⬦
² Qatar	62 (2.1)	⬦
Tunisia	61 (2.7)	⬦
Oman	61 (1.6)	⬦
¹ Kuwait	54 (2.1)	⬦
Morocco	47 (2.3)	⬦
Yemen	31 (2.3)	⬦

Content Domain: Life Science

Cognitive Domain: Applying

Description: Recognizes that wings are common to birds, bats, and butterflies

What do birds, bats and butterflies have in common?

A. feathers

B. hair

C. internal skeleton

● wings

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Country	Percent Correct	
Sixth Grade Participants		
Honduras	77 (2.2)	⬦
Botswana	52 (2.0)	⬦
Yemen	52 (2.3)	⬦

Country	Percent Correct	
Benchmarking Participants		
¹ ³ Florida, US	97 (1.0)	⬥
² Alberta, Canada	96 (0.9)	⬥
¹ ² North Carolina, US	95 (1.2)	⬥
Ontario, Canada	93 (1.0)	⬥
Quebec, Canada	92 (1.5)	⬥
Dubai, UAE	79 (1.6)	⬦
Abu Dhabi, UAE	70 (2.3)	⬦

⬥   Percent significantly higher than international average

⬦   Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Country	Percent Correct	
Japan	94 (1.1)	⬠
Chinese Taipei	94 (1.1)	⬠
² Singapore	94 (1.0)	⬠
Austria	89 (1.3)	⬠
Germany	88 (1.4)	⬠
Slovak Republic	87 (1.7)	⬠
Finland	86 (1.8)	⬠
² United States	84 (1.2)	⬠
² Hong Kong SAR	84 (1.6)	⬠
England	84 (1.7)	⬠
Korea, Rep. of	83 (1.6)	⬠
Iran, Islamic Rep. of	82 (1.8)	⬠
Sweden	79 (2.0)	⬠
Portugal	79 (2.1)	⬠
Belgium (Flemish)	78 (1.8)	⬠
Czech Republic	77 (2.2)	⬠
Slovenia	76 (2.3)	⬠
Ireland	76 (2.0)	⬠
² Serbia	76 (2.2)	⬠
† Northern Ireland	75 (2.2)	
² Denmark	75 (2.1)	
Malta	75 (2.1)	
Romania	74 (2.2)	
Poland	74 (2.1)	
¹ ² Lithuania	74 (2.0)	
New Zealand	74 (1.7)	
Australia	74 (1.9)	
Hungary	73 (2.1)	
² Croatia	73 (1.9)	
Russian Federation	72 (2.2)	
International Avg.	**71 (0.3)**	
Spain	71 (2.2)	
Oman	68 (1.8)	
Thailand	68 (2.5)	
‡ Norway	67 (2.2)	
Turkey	63 (1.5)	⬡
² Kazakhstan	62 (2.7)	⬡
Italy	62 (2.7)	⬡
† Netherlands	62 (2.4)	⬡
² Qatar	61 (2.1)	⬡
United Arab Emirates	61 (1.4)	⬡
Armenia	60 (2.4)	⬡
Chile	59 (1.9)	⬡
² Azerbaijan	57 (3.3)	⬡
Bahrain	57 (2.0)	⬡
¹ Georgia	56 (2.2)	⬡
Saudi Arabia	53 (2.8)	⬡
Tunisia	46 (2.6)	⬡
Morocco	43 (2.3)	⬡
Yemen	36 (1.9)	⬡
¹ Kuwait	34 (2.0)	⬡

Content Domain: Physical Science

Cognitive Domain: Applying

Description: From a simple circuit diagram, recognizes that an iron nail can complete an electrical circuit

The following picture shows a lightbulb connected to a battery in an electrical circuit. Which of the following objects connected to Points 1 and 2 will allow the bulb to glow?

Point 1
Point 2
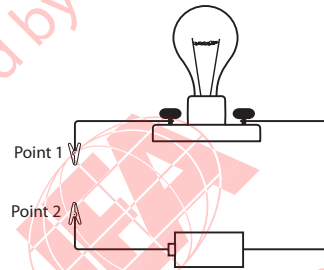
- ● iron nail
- Ⓑ plastic spoon
- Ⓒ rubber band
- Ⓓ wooden stick

Country	Percent Correct	
Sixth Grade Participants		
Botswana	68 (2.1)	
Yemen	59 (2.5)	⬡
Honduras	59 (2.3)	⬡

Country	Percent Correct	
Benchmarking Participants		
¹ ² North Carolina, US	91 (1.8)	⬠
¹ ³ Florida, US	80 (2.0)	⬠
² Alberta, Canada	78 (1.8)	⬠
Ontario, Canada	76 (1.8)	⬠
Quebec, Canada	71 (2.2)	
Dubai, UAE	69 (2.3)	
Abu Dhabi, UAE	58 (2.7)	⬡

⬠ Percent significantly higher than international average

⬡ Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Fourth Grade TIMSS 2011 Intermediate International Benchmark

Exhibit 2.7 provides the detailed description of student achievement at the Intermediate International Benchmark. At this level, students had basic knowledge and understanding of practical situations in the sciences, and they demonstrated ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations. The majority of students in most countries reached this benchmark.

As mentioned in discussing performance at the low level (Example Item 1), characteristics and life processes of living things was a topic in the TIMSS Science Framework. Example Item 3 in Exhibit 2.8 is a slightly more difficult life science item that requires students to pair three animals with their distinguishing biological characteristics. In TIMSS 2011, some of the constructed response items were worth 1 point and some 2 points, and the illustrative answers provided with the example items always show an answer that received full credit. The number of possible points for each constructed response item is indicated across the bottom of the exhibit. In this item, students who correctly identified the monkey, grasshopper, and octopus received the maximum score of 1 point. The international average percent correct was 58 percent, with a considerable range in performance across countries. In Korea, Singapore, and Hungary, the percent correct was 80 percent or more, compared to 16 percent or less in Morocco and Yemen.

Exhibit 2.9 presents Example Item 4, a constructed response item from the domain of earth science exemplifying the basic, practical knowledge that characterizes student performance at the Intermediate Benchmark. Students answering this item correctly stated one form of energy the Earth receives from the sun. On average, across fourth grade countries, 54 percent of students answered correctly.

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● Intermediate International Benchmark

475

Summary

Students have basic knowledge and understanding of practical situations in the sciences. Students recognize some basic information related to characteristics of living things, their reproduction and life cycles, and their interactions with the environment, and show some understanding of human biology and health. They also show some knowledge of properties of matter and light, electricity and energy, and forces and motion. Students know some basic facts about the solar system and show an initial understanding of Earth's physical characteristics and resources. They demonstrate ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.

In life science, students demonstrate some knowledge of the characteristics of living things. For example, students can identify a characteristic that all living things share. From pictures of animals, students pair each animal with its distinguishing biological characteristics (skeleton, milk production, number of legs). Students also recognize the stomach as an organ where digestion takes place. Students demonstrate knowledge of the interactions of living things with their environments as well as the impacts humans can have on their environment. They can complete a food chain and distinguish between human activities that have positive or negative effects on the environment. Students show some understanding of the reproduction and life cycles of organisms. They recognize that for mammals, a male and a female are needed to reproduce. Students also know that tadpoles hatch from frogs' eggs and the function of seeds. Students demonstrate knowledge of some basic facts related to human biology and health. They recognize that the body needs more oxygen during exercise. Students recognize common preventative health measures, including how people can protect their teeth from decay and the benefit of hand washing. They also recognize how influenza is transmitted.

In physical science, students show knowledge about some properties of matter and light. For example, from a list of common materials, students indicate which of them will burn; recognize the order of ice, liquid water, and steam from coldest to hottest; and recognize that salt water is a mixture. Students also recognize that an image of the sun in a lake results from sunlight reflecting off of water. Students show knowledge about some facts of electricity and energy and apply their knowledge to practical situations. Students identify electricity as the energy source for household objects. They recognize that a metal object can complete an electric circuit (e.g., in a flashlight) or could be the unknown, hidden component in a complete electric circuit. Students show and apply introductory knowledge of forces and motion. They state a reason why two objects of identical size and shape can travel different distances after a push and, from a diagram, they identify the direction of the force of Earth's gravity.

In earth science, students show an initial understanding of Earth's physical characteristics and resources. For example, they provide evidence for the existence of air by considering an inflated balloon, match a list of landscape features to their descriptions, and describe one thing people can do to avoid wasting water. In addition, students know some basic facts about the solar system. They can state one form of energy Earth receives from the Sun and state two planets other than Earth that orbit the Sun.

Students interpret information in pictorial diagrams, apply factual knowledge to everyday situations, and provide simple explanations for biological and physical phenomena.

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PERFORMANCE AT THE TIMSS 2011 INTERNATIONAL BENCHMARKS

CHAPTER 2   **95**

Country	Percent Full Credit	
Korea, Rep. of	88 (1.4)	⬤
² Singapore	83 (1.4)	⬤
Hungary	80 (1.8)	⬤
Italy	79 (1.9)	⬤
² Denmark	76 (1.8)	⬤
Slovak Republic	75 (1.9)	⬤
Portugal	74 (2.0)	⬤
Russian Federation	72 (2.5)	⬤
Japan	70 (1.8)	⬤
Australia	70 (2.0)	⬤
² United States	69 (1.3)	⬤
Chinese Taipei	69 (2.0)	⬤
² Hong Kong SAR	69 (2.1)	⬤
England	67 (2.4)	⬤
Belgium (Flemish)	66 (1.8)	⬤
Germany	66 (2.3)	⬤
† Northern Ireland	66 (2.5)	⬤
Sweden	65 (2.4)	⬤
² Croatia	65 (2.0)	⬤
Thailand	64 (3.3)	
Spain	64 (2.3)	⬤
Poland	64 (1.9)	⬤
Finland	64 (2.4)	⬤
‡ Norway	63 (2.2)	⬤
Czech Republic	63 (2.5)	
Austria	63 (2.3)	⬤
¹ ² Lithuania	63 (2.4)	⬤
† Netherlands	60 (2.5)	
Chile	60 (2.2)	
New Zealand	59 (1.9)	
Slovenia	58 (2.5)	
International Avg.	**58 (0.3)**	
Ireland	58 (2.0)	
² Kazakhstan	57 (2.8)	
Malta	54 (2.1)	
Romania	53 (2.9)	
Turkey	53 (1.6)	⬇
² Serbia	51 (2.6)	⬇
Iran, Islamic Rep. of	50 (1.8)	⬇
Bahrain	49 (2.5)	⬇
² Azerbaijan	47 (2.7)	⬇
United Arab Emirates	45 (1.2)	⬇
¹ Georgia	44 (2.5)	⬇
Armenia	38 (2.6)	⬇
² Qatar	38 (2.3)	⬇
Saudi Arabia	33 (2.6)	⬇
Oman	31 (1.5)	⬇
¹ Kuwait	29 (1.6)	⬇
Tunisia	26 (2.0)	⬇
Morocco	16 (1.6)	⬇
Yemen	14 (1.4)	⬇

Content Domain: Life Science

Cognitive Domain: Applying

Description: Pairs pictures of three animals with their distinguishing biological characteristics (skeleton, milk production, number of legs)

Monkey   Crocodile

Grasshopper   Octopus

Answer the following questions using the animals shown above. Write the name for the correct animal in the spaces below.

Which animal has an internal skeleton and produces milk for its young?

monkey

Which animal has an external skeleton and three pairs of legs?

grasshopper

Which animal has a soft body and no skeleton?

octopus

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Sixth Grade Participants		
Honduras	56 (3.1)	
Botswana	36 (2.3)	⬇
Yemen	29 (2.1)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
¹ ² North Carolina, US	74 (3.6)	⬤
¹ ³ Florida, US	72 (2.8)	⬤
Quebec, Canada	68 (2.3)	⬤
² Alberta, Canada	66 (2.4)	⬤
Ontario, Canada	63 (2.3)	⬤
Dubai, UAE	48 (1.9)	⬇
Abu Dhabi, UAE	41 (2.2)	⬇

⬤ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Country	Percent Full Credit	
² Singapore	82 (1.5)	⬆
Korea, Rep. of	79 (1.7)	⬆
Slovak Republic	75 (1.9)	⬆
² Hong Kong SAR	73 (1.9)	⬆
Russian Federation	73 (2.0)	⬆
† Northern Ireland	69 (2.4)	⬆
† Netherlands	69 (2.4)	⬆
Italy	68 (1.8)	⬆
Romania	68 (2.7)	⬆
Ireland	68 (2.4)	⬆
England	66 (2.6)	⬆
Austria	64 (2.5)	⬆
Australia	63 (2.3)	⬆
² United States	63 (1.4)	⬆
² Kazakhstan	62 (2.5)	⬆
Portugal	62 (2.5)	⬆
² Croatia	62 (2.4)	⬆
² Serbia	61 (2.1)	⬆
Chinese Taipei	61 (2.1)	⬆
² Denmark	61 (2.2)	⬆
Japan	59 (2.0)	⬆
Czech Republic	59 (2.5)	⬆
¹ Georgia	59 (2.6)	
Belgium (Flemish)	59 (1.9)	⬆
‡ Norway	57 (3.1)	
New Zealand	56 (2.0)	
Turkey	55 (1.3)	
Finland	55 (2.5)	
International Avg.	**54 (0.3)**	
Hungary	54 (2.0)	
Iran, Islamic Rep. of	54 (2.4)	
Slovenia	53 (3.2)	
Chile	53 (1.9)	
¹ ² Lithuania	53 (2.2)	
Thailand	52 (2.3)	
Spain	51 (2.3)	
Germany	48 (2.1)	⬇
Bahrain	47 (2.4)	⬇
Saudi Arabia	47 (2.3)	⬇
United Arab Emirates	46 (1.4)	⬇
Poland	45 (1.7)	⬇
Sweden	44 (2.3)	⬇
² Qatar	40 (1.8)	⬇
Malta	38 (2.3)	⬇
² Azerbaijan	37 (3.0)	⬇
Armenia	35 (2.1)	⬇
¹ Kuwait	29 (1.9)	⬇
Tunisia	29 (2.2)	⬇
Oman	24 (1.4)	⬇
Yemen	12 (1.3)	⬇
Morocco	9 (1.7)	⬇

Content Domain: Earth Science

Cognitive Domain: Knowing

Description: States one form of energy Earth receives from the sun

Write down one form of energy Earth receives from the sun.

Light

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Sixth Grade Participants		
Botswana	42 (2.4)	⬇
Yemen	40 (2.4)	⬇
Honduras	31 (3.1)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
¹ ³ Florida, US	67 (2.6)	⬆
² Alberta, Canada	64 (2.3)	⬆
¹ ² North Carolina, US	62 (3.0)	⬆
Ontario, Canada	60 (2.0)	⬆
Quebec, Canada	57 (2.2)	
Dubai, UAE	56 (1.7)	
Abu Dhabi, UAE	44 (2.5)	⬇

⬆   Percent significantly higher than international average

⬇   Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Fourth Grade TIMSS 2011 High International Benchmark

Exhibit 2.10 presents the description of achievement at the High International Benchmark. Students at this level have extended the breadth of their knowledge in the science content domains and applied their knowledge and understanding to explain phenomena in everyday and abstract contexts. They also demonstrated elementary knowledge and skills related to scientific inquiry, and compared, contrasted, and made simple inferences.

Exhibit 2.11 presents Example Item 5, which requires students to reason through a problem situation and justify their reasoning based on their knowledge of physical phenomena. This constructed response item exemplifies the type of brief descriptive response students scoring at the High Benchmark provided, using their knowledge of a science concept applied to an everyday context. On average internationally, 42 percent of students received full credit for this item, with a very wide range across countries (0–74%).

◯ **High** International Benchmark

550 | *Summary*

Students apply their knowledge and understanding of the sciences to explain phenomena in everyday and abstract contexts. Students demonstrate some understanding of plant and animal structure, life processes, life cycles, and reproduction. They also demonstrate some understanding of ecosystems and organisms' interactions with their environment, including understanding of human responses to outside conditions and activities. Students demonstrate understanding of some properties of matter, electricity and energy, and magnetic and gravitational forces and motion. They show some knowledge of the solar system, and of Earth's physical characteristics, processes, and resources. Students demonstrate elementary knowledge and skills related to scientific inquiry. They compare, contrast, and make simple inferences, and provide brief descriptive responses combining knowledge of science concepts with information from both everyday and abstract contexts.

In life science, students demonstrate an understanding of plant and animal structure and life processes. For example, they have some knowledge of the parts and functions of a flowering plant and can distinguish living from nonliving things and animals with backbones from those without backbones. Students demonstrate some understanding of reproduction and life cycles of organisms. They know that if the only remaining members of a species of mammal are female, they will not be able to reproduce, and can distinguish inherited from non-inherited features. Students demonstrate an understanding of ecosystems and can reason about organisms' interactions with their environment. They can identify a predator-prey relationship and human activities which have positive or negative effects on the environment. Students also understand that plants make food using energy from the Sun and recognize some plant and animal features that provide advantages in a given environment (the shape of leaves, animal coloration). Students demonstrate understanding of human responses to outside conditions and activities. They recognize the effect of light on pupil size and changes in the body during exercise.

In physical science, students demonstrate basic understanding of some properties of matter. For example, students can justify that objects with more volume do not necessarily weigh more. They explain that heat transferred through metal reaches a point that is closer to the heat source in a shorter time. They connect the color change and surface roughening of a metal object to the process of rusting, and also, in the context of an investigation, explain that solids (e.g., candy) dissolve faster in hot water than in cold water. Students also show a basic understanding of the properties of shadows. They recognize what causes a shadow to be formed and deduce the direction it is cast. Students show knowledge of electricity and energy and apply their knowledge to practical situations. Given a list of everyday objects, they identify which ones conduct electricity and which do not and they identify sources of energy and specify which can be used to produce electricity. Students apply some knowledge to and reason about gravitational and magnetic forces and motion. They recognize that gravity causes an object to fall to the ground, recognize that two metal bars that repel each other must be magnets, and identify the orientation of the poles of repelling magnets.

○ **High** International Benchmark

550 In earth science, students demonstrate a basic understanding of Earth's physical characteristics and resources. For example, they recognize that when water disappears from a surface, it goes into the air. They can, from a table showing location, temperature, and cloud cover, identify the place where it is most likely to snow. In addition, they can describe one advantage of farming near a river. Students have an understanding of some of Earth's processes, history, and cycles. They recognize that water flows from mountains to oceans via rivers, and that fossils are the best evidence that there were many kinds of animals on Earth that no longer exist today. They also recognize that an observation of low clouds can lead to a conclusion about their composition. Students show some knowledge of the solar system. They recognize that the solar system is made up of the Sun and its planets, identify the Earth, Moon, and Sun in a diagram showing their relative positions and orbits, and recognize that the moon's shape looks different at different times of the month.

Students demonstrate elementary knowledge and skills related to scientific inquiry. For example, from a table showing the results of an experiment, they can identify what was being studied in the experiment. Furthermore, they compare, contrast, and make simple inferences, and provide brief descriptive responses combining knowledge of science concepts with information from both everyday and abstract contexts.

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Country	Percent Full Credit	
Chinese Taipei	74 (2.2)	⬤
Austria	74 (1.9)	⬤
[2] Serbia	72 (2.3)	⬤
Russian Federation	71 (1.9)	⬤
Finland	71 (2.3)	⬤
Korea, Rep. of	68 (1.9)	⬤
Hungary	68 (1.9)	⬤
‡ Norway	62 (2.4)	⬤
Portugal	61 (2.4)	⬤
Poland	58 (1.8)	⬤
Sweden	56 (2.8)	⬤
Italy	56 (2.0)	⬤
Czech Republic	55 (2.9)	⬤
[1][2] Lithuania	54 (2.1)	⬤
Slovak Republic	53 (2.2)	⬤
[2] Singapore	52 (2.0)	⬤
Germany	51 (2.2)	⬤
[2] Hong Kong SAR	49 (2.2)	⬤
[2] Croatia	47 (1.8)	⬤
[2] United States	46 (1.5)	⬤
[2] Denmark	46 (2.4)	
Japan	45 (2.3)	
Belgium (Flemish)	45 (2.0)	
[2] Kazakhstan	45 (2.5)	
Slovenia	43 (2.1)	
Australia	43 (2.2)	
Spain	42 (2.1)	
International Avg.	42 (0.3)	
Chile	41 (2.1)	
† Netherlands	40 (2.7)	
† Northern Ireland	40 (2.1)	
Ireland	39 (3.4)	
England	39 (2.7)	
New Zealand	39 (2.2)	
Romania	38 (2.5)	
Turkey	36 (1.5)	▽
Saudi Arabia	35 (2.4)	▽
Thailand	30 (2.5)	▽
Iran, Islamic Rep. of	24 (1.6)	▽
[1] Kuwait	23 (1.7)	▽
Oman	21 (1.4)	▽
United Arab Emirates	19 (1.0)	▽
[2] Azerbaijan	19 (2.1)	▽
[1] Georgia	19 (2.0)	▽
Bahrain	19 (1.9)	▽
Malta	19 (1.8)	▽
Armenia	18 (1.8)	▽
Tunisia	15 (1.5)	▽
[2] Qatar	12 (1.8)	▽
Yemen	3 (0.6)	▽
Morocco	0 (0.2)	▽

Content Domain: Physical Science

Cognitive Domain: Reasoning

Description: Justifies that objects with more volume do not necessarily weigh more using a diagram of three objects of different materials ordered by volume

Jack's teacher places three objects on a table, as shown below. She puts them in order according to their volume.

styrofoam brick apple

Jack thinks that objects with more volume weigh more.

Do you agree with him?

(Check one box.)

☐ Yes

☒ No

Explain your answer.

It depends on what the object is made of. The brick is smaller than the styrofoam block but it is more dense so it probably weighs more.

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Sixth Grade Participants		
Honduras	22 (2.9)	▽
Yemen	19 (1.9)	▽
Botswana	6 (1.0)	▽

Country	Percent Full Credit	
Benchmarking Participants		
[2] Alberta, Canada	52 (2.3)	⬤
Ontario, Canada	51 (2.4)	⬤
Quebec, Canada	51 (2.5)	⬤
[1][2] North Carolina, US	49 (3.2)	⬤
[1][3] Florida, US	40 (2.4)	
Dubai, UAE	24 (1.2)	▽
Abu Dhabi, UAE	18 (2.0)	▽

⬤ Percent significantly higher than international average

▽ Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

TIMSS 2011 4th Grade
Science

Country	Percent Full Credit	
Portugal	78 (2.2)	⬤
Russian Federation	74 (2.5)	⬤
Korea, Rep. of	73 (1.6)	⬤
Slovak Republic	66 (2.4)	⬤
² United States	65 (1.6)	⬤
Finland	65 (2.2)	⬤
Sweden	64 (2.7)	⬤
England	63 (2.5)	⬤
‡ Norway	60 (3.3)	⬤
Spain	59 (2.4)	⬤
Chile	59 (1.9)	⬤
² Hong Kong SAR	58 (1.8)	⬤
United Arab Emirates	55 (1.2)	⬤
Australia	54 (2.5)	⬤
¹ ² Lithuania	54 (2.5)	⬤
Japan	53 (2.1)	⬤
Austria	53 (2.7)	
Czech Republic	52 (2.2)	
² Denmark	52 (2.3)	
Chinese Taipei	52 (2.2)	
¹ Kuwait	51 (2.4)	
Bahrain	51 (2.5)	
Hungary	51 (2.2)	
Malta	50 (1.9)	
Ireland	50 (2.6)	
² Kazakhstan	49 (2.9)	
† Netherlands	49 (2.6)	
Poland	49 (2.5)	
International Avg.	49 (0.3)	
Slovenia	48 (2.3)	
Thailand	48 (2.7)	
² Singapore	48 (1.8)	
² Qatar	47 (2.4)	
Romania	47 (3.0)	
Germany	44 (2.4)	
Italy	44 (2.3)	⬇
New Zealand	44 (2.0)	⬇
² Croatia	43 (2.1)	⬇
Iran, Islamic Rep. of	42 (2.2)	⬇
¹ Georgia	40 (2.4)	⬇
Saudi Arabia	39 (2.8)	⬇
Belgium (Flemish)	39 (2.5)	⬇
² Azerbaijan	39 (3.0)	⬇
² Serbia	39 (2.7)	⬇
Turkey	38 (1.8)	⬇
† Northern Ireland	35 (2.5)	⬇
Oman	30 (1.9)	⬇
Armenia	27 (2.4)	⬇
Tunisia	17 (2.1)	⬇
Morocco	16 (2.2)	⬇
Yemen	15 (1.7)	⬇

Content Domain: Earth Science

Cognitive Domain: Reasoning

Description: Identifies the Earth, Moon, and Sun from a diagram of their orbits

The figure below shows Earth, the Moon, and the Sun. Each body is labeled by a number. The arrows show the direction each body is moving.
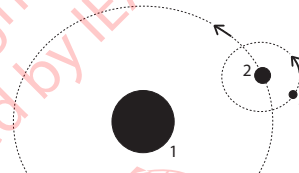
Fill in the correct number next to each body (1, 2 or 3).

Earth is body number: _____2_____

The Moon is body number: _____3_____

The Sun is body number: _____1_____

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Sixth Grade Participants		
Yemen	29 (2.2)	⬇
Botswana	26 (1.8)	⬇
Honduras	23 (2.6)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
¹ ³ Florida, US	68 (3.7)	⬤
¹ ² North Carolina, US	63 (3.4)	⬤
Quebec, Canada	59 (2.3)	⬤
Dubai, UAE	58 (2.3)	⬤
Abu Dhabi, UAE	54 (2.5)	⬤
² Alberta, Canada	48 (2.8)	
Ontario, Canada	46 (2.5)	

⬤　Percent significantly higher than international average

⬇　Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )　Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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According to the TIMSS 2011 Science Framework, fourth grade students are expected to demonstrate some understanding about Earth's place in the solar system. Exhibit 2.12 presents Example Item 6, which exemplifies the type of earth science knowledge exhibited by fourth grade students at the High Benchmark. Students are asked to identify the Earth, Moon, and Sun from a diagram of their orbits. Internationally, on average, 49 percent of the students answered this item correctly.

Fourth Grade TIMSS 2011 Advanced International Benchmark

Exhibit 2.13, on the following page, describes fourth grade performance at the Advanced International Benchmark. At this benchmark, students applied their knowledge and understanding of scientific processes and relationships across the four content domains, and showed some knowledge of the process of scientific inquiry. They had a beginning ability to interpret results in the context of a simple experiment, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument.

Example Item 7 in Exhibit 2.14 shows an example of the type of item in the life sciences that fourth grade students at the Advanced International Benchmark could answer correctly. This constructed response item required students to identify four major plant structures in a diagram and describe the function of most of the structures. On average across countries, only 21 percent of the students gained full credit on this item, which was relatively difficult for students in most countries. Eighty percent of students in Singapore gained full credit, but in no other country did more than 42 percent of students answer fully correctly.

In physical science at the Advanced Benchmark level, students demonstrated an understanding of magnetic forces and reasoned to form conclusions about them. Example Item 8 in Exhibit 2.15 is a constructed response item which required students to apply their knowledge of magnetic properties to a set of observations, reason and draw conclusions based on the observations, and provide support for their reasoning. On average internationally, this item also was relatively difficult, with 26 percent of students providing a response that received full credit.

● Advanced International Benchmark

625

Summary

Students apply knowledge and understanding of scientific processes and relationships and show some knowledge of the process of scientific inquiry. Students communicate their understanding of characteristics and life processes of organisms, reproduction and development, ecosystems and organisms' interactions with the environment, and factors relating to human health. They demonstrate understanding of properties of light and relationships among physical properties of materials, apply and communicate their understanding of electricity and energy in practical contexts, and demonstrate an understanding of magnetic and gravitational forces and motion. Students communicate their understanding of the solar system and of Earth's structure, physical characteristics, resources, processes, cycles, and history. They have a beginning ability to interpret results in the context of a simple experiment, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument.

In life science, students show knowledge of characteristics and life processes of a variety of organisms. For example, students identify the body covering that protects a reptile, recognize that muscles move bones, and they know the major parts of a flowering plant and can state their functions. Students show some understanding of reproduction and development of organisms. They recognize, from a list of animals, that the young form of humans looks most like the adult form, recognize examples of animals that take care of their young, and they describe how pollen is spread. Students communicate understanding of relationships in ecosystems and understand how organisms interact with their environment. They describe one physical change that takes place in a mammal as the weather gets cold, how migration increases the survival of birds, and a feature that helps a cactus survive in the desert. They also describe human activities that can lead to the extinction of animals. Students communicate understanding of factors related to human health. They state that calcium is needed for bone growth, explain why people should drink liquids frequently, and that sneezing transmits germs even when a person does not appear to be sick.

In physical science, students show understanding of the relationships among physical properties of materials and of the basic properties of light. For example, students can identify an unknown material as a gas based on its behavior in a closed container and they justify their answer. Given two groups of everyday objects, students recognize which property was used to classify them. In the context of an investigation, students explain what makes a solid dissolve faster in water and what makes a solution more dilute. They recognize that burning results in new substances and that light is made up of different colors. Students apply and communicate their understanding and reason about electricity and energy in practical contexts. They explain that a bulb will not light in an incomplete electrical circuit. They also recognize that heat needs to be supplied for melting and boiling, but not for freezing, and explain how a sweater can keep a bottle of water cold. Students demonstrate an understanding of magnetic and gravitational forces and motion and reason to form conclusions about them. They infer that magnets have different strengths from a diagram of magnets attracting pins from two different distances. Also, based on a series of diagrams providing pairwise information about the weights of cubes, they draw a conclusion about their relative weights. They reason, using diagrams, where children of the same and different weights should sit to balance a seesaw.

Exhibit 2.13: Description of the TIMSS 2011 Advanced International Benchmark (625) of Science Achievement (Continued)

TIMSS 2011
Science 4th Grade

● Advanced International Benchmark

625

In earth science, students communicate their understanding of Earth's structure, physical characteristics, resources, processes, cycles, and history. For example, they state two things that make up the Earth's crust and recognize that water covers most of Earth's surface. They describe one disadvantage of farming near a river and recognize that soil rich in decaying matter helps plants grow and that soils can change naturally over time. They also recognize how fish fossils are formed. Students demonstrate an understanding of the Earth in the context of the solar system. They recognize how long it takes for the Earth to orbit the Sun and rotate on its axis as well as describe how that rotation causes day and night. They also explain why the size and shape of a shadow appears different at different times of the day.

Students demonstrate some ability to recognize how a simple experiment should be set up. They have an elementary ability to interpret results, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument.

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PERFORMANCE AT THE TIMSS 2011 INTERNATIONAL BENCHMARKS

CHAPTER 2   105

Country	Percent Full Credit	
² Singapore	80 (1.6)	⬤
Korea, Rep. of	42 (2.2)	⬤
Thailand	40 (2.7)	⬤
Czech Republic	39 (2.8)	⬤
Bahrain	37 (2.7)	⬤
Italy	36 (2.4)	⬤
Romania	35 (2.6)	⬤
Hungary	34 (2.5)	⬤
² Croatia	33 (2.2)	⬤
Finland	32 (2.3)	⬤
Portugal	31 (3.0)	⬤
Iran, Islamic Rep. of	28 (2.1)	⬤
² Kazakhstan	27 (2.5)	⬤
Chinese Taipei	26 (1.8)	⬤
Austria	25 (2.2)	⬤
Slovak Republic	25 (2.2)	⬤
² United States	24 (1.0)	⬤
² Serbia	23 (2.0)	
United Arab Emirates	22 (1.3)	
¹ ² Lithuania	21 (1.8)	
England	21 (2.8)	
International Avg.	**21 (0.3)**	
Russian Federation	20 (1.8)	
Japan	20 (1.6)	
Oman	19 (1.7)	
Sweden	18 (1.9)	
¹ Kuwait	18 (1.6)	
Saudi Arabia	16 (2.3)	
² Hong Kong SAR	16 (1.5)	⬇
Spain	16 (1.8)	⬇
Slovenia	15 (1.6)	⬇
² Denmark	15 (1.6)	⬇
² Azerbaijan	15 (2.0)	⬇
² Qatar	13 (1.7)	⬇
Chile	13 (1.3)	⬇
Poland	13 (1.8)	⬇
Morocco	12 (1.2)	⬇
Turkey	11 (1.1)	⬇
Ireland	10 (1.9)	⬇
¹ Georgia	10 (1.9)	⬇
Germany	10 (1.2)	⬇
Australia	10 (1.3)	⬇
Armenia	10 (1.7)	⬇
† Northern Ireland	9 (1.4)	⬇
† Netherlands	8 (1.3)	⬇
Belgium (Flemish)	6 (1.0)	⬇
Malta	6 (1.0)	⬇
New Zealand	6 (1.0)	⬇
‡ Norway	4 (1.1)	⬇
Tunisia	2 (0.8)	⬇
Yemen	1 (0.5)	⬇

Content Domain: Life Science

Cognitive Domain: Knowing

Description: From a diagram of a flowering plant, identifies numbered parts and states a function of most of these parts

The diagram shows a flowering plant. Four of its parts are numbered.

In the table below, write the name of each part, and state its function.

Part Number	Name of Part	Function of Part
1	flower	produces seeds
2	stem	transports water and food
3	leaf	makes food for the plant
4	root	absorbs water, minerals, and nutrients into the plant

The answer shown illustrates the type of student response that was given 2 of 2 points.

Country	Percent Full Credit	
Sixth Grade Participants		
Honduras	16 (1.7)	⬇
Botswana	4 (0.9)	⬇
Yemen	3 (0.7)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
Dubai, UAE	31 (2.0)	⬤
¹ ³ Florida, US	24 (2.8)	
Ontario, Canada	22 (1.8)	
² Alberta, Canada	21 (2.4)	
Abu Dhabi, UAE	17 (2.1)	
¹ ² North Carolina, US	13 (2.3)	⬇
Quebec, Canada	8 (1.4)	⬇

⬤ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Country	Percent Full Credit	
[2] Singapore	66 (2.0)	⬤
Japan	50 (1.8)	⬤
Chinese Taipei	47 (2.3)	⬤
Finland	41 (2.6)	⬤
Sweden	37 (2.6)	⬤
[2] United States	37 (1.4)	⬤
England	35 (2.4)	⬤
Portugal	35 (2.1)	⬤
Belgium (Flemish)	35 (2.2)	⬤
Slovenia	32 (2.2)	⬤
‡ Norway	32 (3.4)	
[2] Hong Kong SAR	31 (2.3)	⬤
† Northern Ireland	30 (2.3)	
† Netherlands	30 (2.1)	
[2] Serbia	29 (1.9)	
Turkey	29 (1.7)	
[2] Denmark	28 (2.0)	
Czech Republic	28 (2.4)	
Germany	28 (1.7)	
Ireland	28 (2.4)	
Spain	27 (1.9)	
Australia	27 (1.8)	
Korea, Rep. of	27 (1.6)	
Russian Federation	27 (1.9)	
[2] Kazakhstan	27 (2.4)	
Poland	26 (1.9)	
International Avg.	26 (0.3)	
[1] Georgia	26 (2.3)	
Iran, Islamic Rep. of	26 (1.7)	
Bahrain	26 (1.6)	
New Zealand	25 (1.9)	
Malta	25 (1.9)	
[1] [2] Lithuania	24 (1.8)	
Romania	23 (2.4)	
Thailand	23 (1.7)	⬇
Italy	23 (1.9)	
Hungary	23 (1.8)	⬇
Saudi Arabia	22 (2.1)	⬇
Austria	21 (1.7)	⬇
Slovak Republic	20 (1.6)	⬇
Chile	20 (1.7)	⬇
Tunisia	19 (2.1)	⬇
United Arab Emirates	19 (1.0)	⬇
[2] Qatar	17 (1.9)	⬇
[2] Croatia	17 (1.6)	⬇
[1] Kuwait	15 (1.5)	⬇
Armenia	14 (1.6)	⬇
[2] Azerbaijan	12 (1.8)	⬇
Oman	6 (0.8)	⬇
Morocco	5 (0.7)	⬇
Yemen	1 (0.4)	⬇

Content Domain: Physical Science

Cognitive Domain: Reasoning

Description: Infers that magnets have different strengths from an observation of magnets attracting pins from two different distances

Betty has two magnets (A and B) and two metal pins that are the same.

She slides Magnet A along a table until a pin is attracted to the magnet. She slides Magnet B along a table until a pin is attracted to the magnet.

magnets   pins

She finds that Magnet A attracts the pin from 15cm and Magnet B attracts the pin from 10cm.

Steven says that both magnets are equally strong.

Do you agree?

(Check one box.)

☐ Yes

☒ No

Explain your answer.

magnet A is stronger because it attracted the pin from farther away than magnet B did.

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Sixth Grade Participants		
Honduras	19 (2.3)	⬇
Botswana	10 (1.5)	⬇
Yemen	9 (1.2)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
Ontario, Canada	39 (2.3)	⬤
[1] [3] Florida, US	38 (2.6)	⬤
[2] Alberta, Canada	34 (2.4)	⬤
[1] [2] North Carolina, US	34 (3.5)	⬤
Quebec, Canada	31 (2.2)	⬤
Dubai, UAE	22 (2.2)	
Abu Dhabi, UAE	17 (1.9)	⬇

⬤ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Country	Percent Correct	
Korea, Rep. of	63 (2.3)	⬤
Finland	61 (2.2)	⬤
Russian Federation	60 (2.0)	⬤
Japan	55 (2.1)	⬤
² United States	54 (1.6)	⬤
² Kazakhstan	53 (2.7)	⬤
² Azerbaijan	52 (2.9)	⬤
Slovak Republic	51 (2.2)	⬤
Hungary	51 (2.2)	⬤
² Croatia	48 (2.3)	⬤
Turkey	48 (1.7)	⬤
Chinese Taipei	48 (2.3)	⬤
Slovenia	47 (2.6)	⬤
Poland	45 (2.1)	⬤
¹ ² Lithuania	44 (2.2)	⬤
Australia	44 (2.0)	⬤
² Hong Kong SAR	44 (2.1)	⬤
Italy	43 (2.2)	⬤
Czech Republic	41 (2.4)	
Sweden	41 (2.4)	
Portugal	40 (3.7)	
² Singapore	40 (1.7)	
England	39 (2.5)	
International Avg.	39 (0.3)	
Romania	39 (2.7)	
† Northern Ireland	38 (2.5)	
Ireland	37 (3.5)	
Belgium (Flemish)	37 (2.1)	
New Zealand	36 (1.8)	
United Arab Emirates	36 (1.2)	
Austria	36 (2.3)	
² Denmark	35 (2.1)	
¹ Georgia	35 (2.6)	
² Serbia	34 (2.1)	⬇
Saudi Arabia	34 (2.4)	⬇
† Netherlands	33 (2.2)	⬇
Oman	32 (1.4)	⬇
Iran, Islamic Rep. of	31 (1.8)	⬇
Thailand	30 (2.4)	⬇
Spain	30 (2.0)	⬇
Bahrain	29 (1.9)	⬇
Armenia	29 (2.3)	⬇
Chile	28 (1.5)	⬇
‡ Norway	28 (2.4)	⬇
Malta	27 (2.0)	⬇
Germany	26 (1.8)	⬇
² Qatar	26 (2.7)	⬇
¹ Kuwait	22 (1.7)	⬇
Morocco	21 (1.7)	⬇
Yemen	19 (1.6)	⬇
Tunisia	19 (1.6)	⬇

Content Domain: Earth Science

Cognitive Domain: Knowing

Description: Recognizes a soil change due to natural causes

Which of these soil changes is due only to natural causes?

Ⓐ Loss of minerals due to farming.

Ⓑ Deserts forming due to tree cutting.

Ⓒ Flooding due to dam construction.

⬤ Minerals washing out due to heavy rain.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Country	Percent Correct	
Sixth Grade Participants		
Yemen	34 (2.2)	⬇
Botswana	27 (1.8)	⬇
Honduras	23 (2.5)	⬇

Country	Percent Correct	
Benchmarking Participants		
¹ ² North Carolina, US	51 (3.3)	⬤
¹ ³ Florida, US	48 (3.3)	⬤
Ontario, Canada	43 (2.1)	⬤
² Alberta, Canada	43 (2.8)	
Dubai, UAE	39 (2.4)	
Abu Dhabi, UAE	34 (2.1)	⬇
Quebec, Canada	29 (2.1)	⬇

⬤ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.2 for target population coverage notes 1, 2, and 3. See Appendix C.8 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Exhibit 2.16 presents Example Item 9, which exemplifies the knowledge of processes in earth science that is typical of students at the Advanced International Benchmark. On average, 39 percent of students internationally answered this item correctly, recognizing the soil change due to natural causes. As with most example items, there was wide variation across countries in the percentage of students correctly answering the item, in this case ranging from 19 percent to 63 percent.

Eighth Grade Results for the
TIMSS 2011 International Benchmarks in Science

Eighth Grade TIMSS 2011 International Benchmarks of Science Achievement

Exhibit 2.17 summarizes what eighth grade students scoring at the TIMSS International Benchmarks typically know and can do in science. Detailed descriptions of each benchmark level are presented along with example items in subsequent sections of the chapter. Similar to the fourth grade, at the eighth grade there was also a considerable difference in performance between students achieving at the Advanced International Benchmark and students at the Low International Benchmark.

Students performing at the Advanced International Benchmark communicated an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science. They also combined information from several sources to solve problems and draw conclusions, and provided written explanations to communicate scientific knowledge. Students at the High International Benchmark demonstrated understanding of concepts related to science cycles, systems, and principles. They also demonstrated some scientific inquiry skills, and combined and interpreted information from various types of diagrams, contour maps, graphs, and tables; selected relevant information, analyzed, and drew conclusions; and provided short explanations conveying scientific knowledge. At the Intermediate International Benchmark, students recognized and applied their understanding of basic scientific knowledge in various contexts. They interpreted information from tables, graphs, and pictorial diagrams, drew conclusions, and communicated their understanding through brief descriptive responses. Students at the Low International Benchmark recognized some basic facts from the life and physical sciences, as well as interpreted simple pictorial diagrams, completed simple tables, and applied their basic knowledge to practical situations.

● **Advanced** International Benchmark

625 *Students communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science.* Students demonstrate some conceptual knowledge about cells and the characteristics, classification, and life processes of organisms. They communicate an understanding of the complexity of ecosystems and adaptations of organisms, and apply an understanding of life cycles and heredity. Students also communicate an understanding of the structure of matter and physical and chemical properties and changes and apply knowledge of forces, pressure, motion, sound, and light. They reason about electrical circuits and properties of magnets. Students apply knowledge and communicate understanding of the solar system and Earth's processes, structures, and physical features. They understand basic features of scientific investigation. They also combine information from several sources to solve problems and draw conclusions, and they provide written explanations to communicate scientific knowledge.

○ **High** International Benchmark

550 *Students demonstrate understanding of concepts related to science cycles, systems, and principles.* They demonstrate understanding of aspects of human biology, and of the characteristics, classification, and life processes of organisms. Students communicate understanding of processes and relationships in ecosystems. They show an understanding of the classification and compositions of matter and chemical and physical properties and changes. They apply knowledge to situations related to light and sound and demonstrate basic knowledge of heat and temperature, forces and motion, and electrical circuits and magnets. Students demonstrate an understanding of the solar system and of Earth's processes, physical features, and resources. They demonstrate some scientific inquiry skills. They also combine and interpret information from various types of diagrams, contour maps, graphs, and tables; select relevant information, analyze, and draw conclusions; and provide short explanations conveying scientific knowledge.

● **Intermediate** International Benchmark

475 *Students recognize and apply their understanding of basic scientific knowledge in various contexts.* Students apply knowledge and communicate an understanding of human health, life cycles, adaptation, and heredity, and analyze information about ecosystems. They have some knowledge of chemistry in everyday life and elementary knowledge of properties of solutions and the concept of concentration. They are acquainted with some aspects of force, motion, and energy. They demonstrate an understanding of Earth's processes and physical features, including the water cycle and atmosphere. Students interpret information from tables, graphs, and pictorial diagrams and draw conclusions. They apply knowledge to practical situations and communicate their understanding through brief descriptive responses.

○ **Low** International Benchmark

400 *Students can recognize some basic facts from the life and physical sciences.* They have some knowledge of biology, and demonstrate some familiarity with physical phenomena. Students interpret simple pictorial diagrams, complete simple tables, and apply basic knowledge to practical situations.

Eighth Grade Achievement at the TIMSS 2011 International Benchmarks of Science Achievement

Exhibit 2.18 presents the percentage of students reaching each TIMSS 2011 International Benchmark. The results are presented in descending order based on the percentage of students reaching the Advanced International Benchmark, first for countries that tested eighth grade students, and then for ninth grade countries and benchmarking participants on the second page. The percentage of students reaching the Advanced Benchmark is indicated in the bar graph with a black dot. Because students who reached the Advanced Benchmark also reached the other benchmarks, the percentages illustrated in the graph and shown in the columns to the right are cumulative.

At the eighth grade, four East Asian countries had the largest percentages of students reaching the Advanced International Benchmark. Singapore had 40 percent of their students reach this benchmark, followed by Chinese Taipei (24%), Korea (20%), and Japan (18%). Next, the Russian Federation and England had 14 percent of their students reaching the Advanced Benchmark; Slovenia and Finland had 13 percent of their students reaching this level. Several of the US benchmarking states also had similarly high percentages of students at the Advanced Benchmark, including Massachusetts (24%), Minnesota (16%), Colorado (14%), Connecticut (14%), and Florida (13%).

Exhibit 2.18 also provides useful information about the distribution of achievement in each country. For example, Italy and Norway had only 4 and 3 percent of students, respectively, reaching the Advanced Benchmark, but nearly all students (90%) reaching the Low Benchmark.

As a point of reference, Exhibit 2.18 provides the median for each of the benchmarks at the bottom of each of the four right hand columns. By definition, half of the countries will have a percentage in the column above the median and half will be below the median. The median percentages of students reaching the International Benchmarks were as follows: Advanced–4 percent, High–21 percent, Intermediate–52 percent, and Low–79 percent. In comparison to the fourth grade, these percentages were lower at each level. On average across countries, nearly half of the eighth grade students did not reach the Intermediate Benchmark, and more than one-fifth did not reach the Low Benchmark, indicating that, compared to the fourth grade, more eighth grade students were being "left behind" their classmates.

Eighth Grade Trends in Performance at the
TIMSS 2011 International Benchmarks of Science Achievement

Exhibit 2.19 shows the changes in percentages of eighth grade students reaching the benchmarks for countries and benchmarking participants that also participated in TIMSS 1995, 1999, 2003, and/or 2007. An up arrow indicates that the percentage of students reaching a benchmark is higher in 2011 than the past cycle, and a down arrow indicates that the percentage is lower in 2011. The patterns in this exhibit generally mirror the trends in average achievement discussed in Chapter 1, and can provide further information about countries' improvement or decline over time.

Three countries—Korea, Slovenia, and Lithuania—improved since 1995 at all four benchmarks. The Russian Federation, Hong Kong, Iran, and the Canadian province of Ontario showed improvements at three benchmarks since 1995, and the United States showed improvement at the two lowest benchmarks. Since 1995, three countries declined at all four benchmarks: Hungary, Sweden, and Norway. Singapore declined since 1995 at the two lowest benchmarks, and Romania declined at the two highest benchmarks.
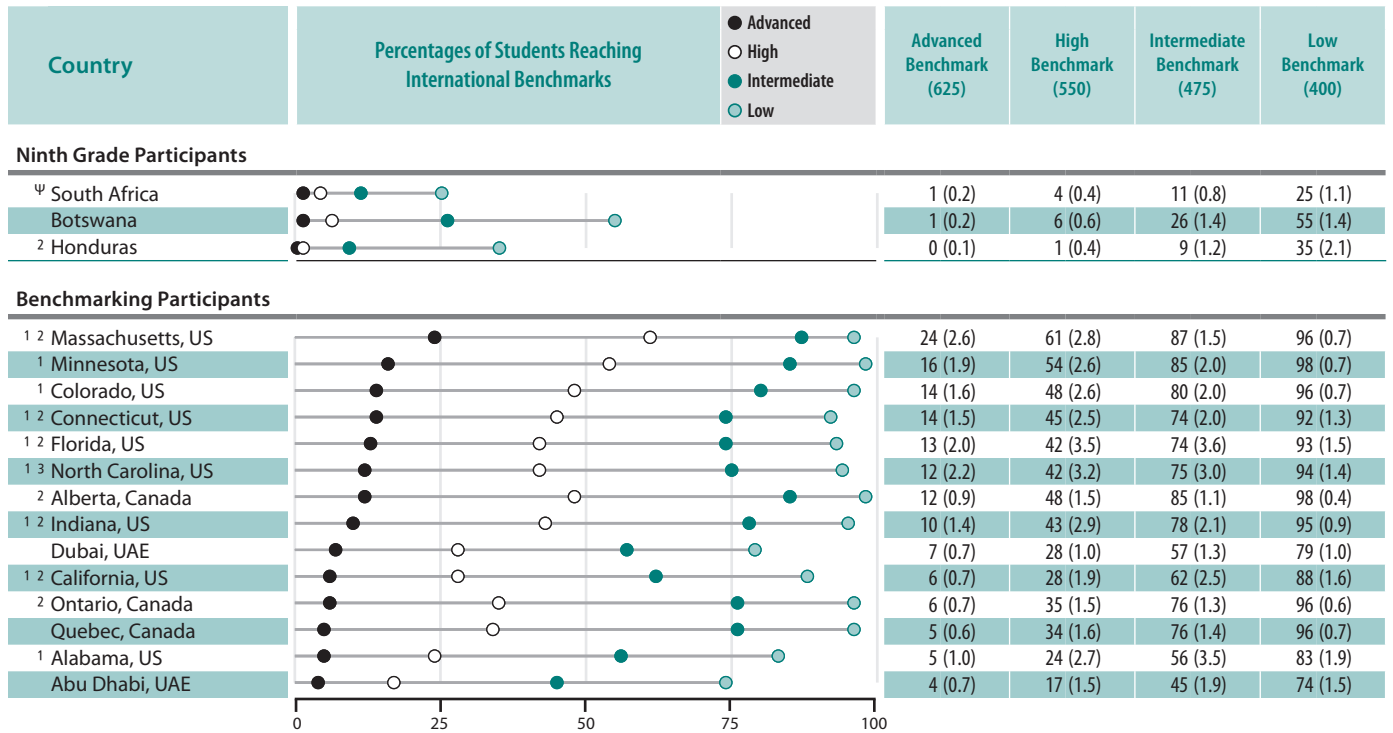
Country	Percentages of Students Reaching International Benchmarks	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
[2] Singapore		40 (1.7)	69 (2.0)	87 (1.6)	96 (0.7)
Chinese Taipei		24 (1.4)	60 (1.2)	85 (0.8)	96 (0.4)
Korea, Rep. of		20 (0.9)	57 (1.1)	86 (0.7)	97 (0.4)
Japan		18 (1.1)	57 (1.3)	86 (0.9)	97 (0.4)
[2] Russian Federation		14 (1.1)	48 (1.8)	81 (1.2)	96 (0.7)
‡ England		14 (1.5)	44 (2.6)	76 (2.3)	93 (1.2)
Slovenia		13 (0.8)	48 (1.4)	82 (1.2)	96 (0.5)
Finland		13 (1.2)	53 (1.7)	88 (1.0)	99 (0.3)
[3] Israel		11 (1.1)	39 (1.7)	69 (1.7)	88 (1.1)
Australia		11 (1.6)	35 (2.5)	70 (2.0)	92 (0.8)
[2] United States		10 (0.7)	40 (1.3)	73 (1.1)	93 (0.7)
Hong Kong SAR		9 (1.1)	47 (1.8)	80 (1.7)	95 (1.0)
New Zealand		9 (1.0)	34 (2.2)	67 (2.2)	90 (1.2)
Hungary		9 (0.8)	39 (1.5)	75 (1.4)	92 (0.8)
Turkey		8 (0.9)	26 (1.4)	54 (1.4)	79 (1.0)
Sweden		6 (0.5)	33 (1.3)	68 (1.4)	91 (0.7)
[1] Lithuania		6 (0.7)	33 (1.4)	71 (1.3)	92 (0.6)
Ukraine		6 (0.8)	29 (1.7)	64 (1.6)	88 (1.1)
Iran, Islamic Rep. of		5 (0.7)	21 (1.3)	50 (2.0)	79 (1.5)
United Arab Emirates		4 (0.4)	19 (0.8)	47 (1.1)	75 (0.9)
Italy		4 (0.5)	27 (1.4)	65 (1.4)	90 (1.1)
Kazakhstan		4 (0.6)	23 (1.9)	58 (2.5)	86 (1.2)
Bahrain		3 (0.3)	17 (0.7)	44 (1.0)	70 (0.7)
Qatar		3 (0.5)	14 (1.1)	34 (1.4)	58 (1.2)
Norway		3 (0.4)	22 (1.2)	62 (1.4)	90 (1.1)
Romania		3 (0.5)	16 (1.3)	47 (1.5)	78 (1.5)
Jordan		2 (0.3)	15 (1.0)	45 (1.5)	72 (1.5)
Macedonia, Rep. of		2 (0.4)	10 (1.0)	30 (1.7)	53 (2.0)
Oman		2 (0.2)	11 (0.5)	34 (1.0)	59 (1.3)
Armenia		1 (0.2)	12 (0.8)	37 (1.5)	66 (1.3)
Malaysia		1 (0.4)	11 (1.4)	34 (2.4)	62 (2.6)
Thailand		1 (0.5)	10 (1.3)	39 (2.1)	74 (1.7)
Chile		1 (0.2)	12 (0.9)	43 (1.4)	79 (1.5)
Palestinian Nat'l Auth.		1 (0.2)	10 (0.8)	33 (1.3)	59 (1.3)
Lebanon		1 (0.2)	7 (0.8)	25 (2.0)	54 (2.3)
Saudi Arabia		1 (0.2)	8 (0.8)	33 (2.0)	68 (1.8)
[1] Georgia		0 (0.1)	6 (0.6)	28 (1.5)	62 (1.5)
Syrian Arab Republic		0 (0.1)	6 (0.8)	29 (1.8)	63 (1.9)
Tunisia		0 (0.1)	5 (0.7)	30 (1.4)	72 (1.3)
Indonesia		0 (0.1)	3 (0.4)	19 (1.4)	54 (2.3)
Morocco		0 (0.0)	2 (0.2)	13 (0.7)	39 (1.0)
Ψ Ghana		0 (0.1)	1 (0.2)	6 (0.8)	22 (1.7)
International Median		4	21	52	79

Legend: ● Advanced ○ High ● Intermediate ○ Low

Scale: 0 25 50 75 100

Җ   Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.

Ψ   Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%.

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Country	Percentages of Students Reaching International Benchmarks	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)

● Advanced
○ High
● Intermediate
○ Low

Ninth Grade Participants

Country		Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Ψ South Africa		1 (0.2)	4 (0.4)	11 (0.8)	25 (1.1)
Botswana		1 (0.2)	6 (0.6)	26 (1.4)	55 (1.4)
² Honduras		0 (0.1)	1 (0.4)	9 (1.2)	35 (2.1)

Benchmarking Participants

Country		Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
¹ ² Massachusetts, US		24 (2.6)	61 (2.8)	87 (1.5)	96 (0.7)
¹ Minnesota, US		16 (1.9)	54 (2.6)	85 (2.0)	98 (0.7)
¹ Colorado, US		14 (1.6)	48 (2.6)	80 (2.0)	96 (0.7)
¹ ² Connecticut, US		14 (1.5)	45 (2.5)	74 (2.0)	92 (1.3)
¹ ² Florida, US		13 (2.0)	42 (3.5)	74 (3.6)	93 (1.5)
¹ ³ North Carolina, US		12 (2.2)	42 (3.2)	75 (3.0)	94 (1.4)
² Alberta, Canada		12 (0.9)	48 (1.5)	85 (1.1)	98 (0.4)
¹ ² Indiana, US		10 (1.4)	43 (2.9)	78 (2.1)	95 (0.9)
Dubai, UAE		7 (0.7)	28 (1.0)	57 (1.3)	79 (1.0)
¹ ² California, US		6 (0.7)	28 (1.9)	62 (2.5)	88 (1.6)
² Ontario, Canada		6 (0.7)	35 (1.5)	76 (1.3)	96 (0.6)
Quebec, Canada		5 (0.6)	34 (1.6)	76 (1.4)	96 (0.7)
¹ Alabama, US		5 (1.0)	24 (2.7)	56 (3.5)	83 (1.9)
Abu Dhabi, UAE		4 (0.7)	17 (1.5)	45 (1.9)	74 (1.5)

0   25   50   75   100

Exhibit 2.19: Trends in Percentages of Students Reaching the International Benchmarks of Science Achievement

Country	Advanced International Benchmark (625) Percent of Students					High International Benchmark (550) Percent of Students				
	2011	2007	2003	1999	1995	2011	2007	2003	1999	1995
Singapore	40	32 ▲	33 ▲	29 ▲	29 ▲	69	61 ▲	66	60 ▲	64
Chinese Taipei	24	25	26	27		60	60	63	61	
Korea, Rep. of	20	17 ▲	17 ▲	19	17 ▲	57	54	57	50 ▲	50 ▲
Japan	18	17	15 ▲	16	18	57	55	53 ▲	52 ▲	54
Russian Federation	14	11 ▲	6 ▲	15	11	48	41 ▲	32 ▲	41 ▲	38 ▲
England	14	17	15	17	15	44	48	48	45	43
Slovenia	13	11 ▲	6 ▲		8 ▲	48	45	33 ▲		32 ▲
Australia	11	8	9		10	35	33	40		36
United States	10	10	11	12	11	40	38	41	37	38
Hong Kong SAR	9	10	13 ▼	7	7	47	45	58 ▼	40 ▲	33 ▲
New Zealand	9		7	10	9	34		35	35	34
Hungary	9	13 ▼	14 ▼	19 ▼	12 ▼	39	46 ▼	46 ▼	53 ▼	44 ▼
Finland (7)	6			12 ▼		41			43	
Sweden	6	6	8		19 ▼	33	32	38 ▼		52 ▼
Lithuania	6	8	6	5	2 ▲	33	36	34	22 ▲	14 ▲
Ukraine	6	3 ▲				29	22 ▲			
Iran, Islamic Rep. of	5	2 ▲	1 ▲	1 ▲	1 ▲	21	14 ▲	9 ▲	11 ▲	11 ▲
Italy	4	4	4	6 ▼		27	24	23 ▲	26	
Bahrain	3	2 ▲	0 ▲			17	17	6 ▲		
Norway	3	2 ▲	2		6 ▼	22	20	21		32 ▼
Romania	3	2	4	5 ▼	5 ▼	16	16	20	21 ▼	22 ▼
Jordan	2	5 ▼	3 ▼	4 ▼		15	26 ▼	21 ▼	17	
Macedonia, Rep. of	2		2	3 ▼		10		13	17 ▼	
Oman	2	1 ▲				11	8 ▲			
Armenia	1		1			12		14		
Malaysia	1	3 ▼	4 ▼	5 ▼		11	18 ▼	28 ▼	24 ▼	
Thailand	1	3 ▼		2		10	17 ▼		18 ▼	
Chile	1		1 ▲	1		12		5 ▲	7 ▲	
Palestinian Nat'l Auth.	1	1	1			10	9	10		
Lebanon	1	1	0			7	8	4 ▲		
Georgia	0	0				6	5			
Syrian Arab Republic	0	1				6	9 ▼			
Tunisia	0	0	0	0		5	4	1 ▲	3	
Indonesia	0	0				3	4 ▼			
Ψ Ghana	0	0	0			1	1	0 ▲		

Benchmarking Participants

Country	2011	2007	2003	1999	1995	2011	2007	2003	1999	1995
Massachusetts, US	24	20		15 ▲		61	56		43 ▲	
Minnesota, US	16	11 ▲			17	54	45 ▲			50
Connecticut, US	14			14		45			43	
North Carolina, US	12			9		42			34	
Alberta, Canada	12			17 ▼	17 ▼	48			57	51
Indiana, US	10		8	14		43		40	44	
Dubai, UAE	7	6				28	27			
Ontario, Canada	6	7	7	7	5	35	37	41 ▼	34	26 ▲
Quebec, Canada	5	4	6	10 ▼	7	34	27 ▲	39	43 ▼	30

▲ 2011 percent significantly higher

▼ 2011 percent significantly lower

Ψ Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%. Such annotations in exhibits with trend data began in 2011, so data from assessments prior to 2011 are not annotated for reservations.

An empty cell indicates a country did not participate in that year's assessment.

Trend Notes: Trend results for Finland are based on 7th grade data from 1999 and 2011, and so Finland's 2011 results differ from Exhibit 2.18.

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Exhibit 2.19: Trends in Percentages of Students Reaching the International Benchmarks of Science Achievement (Continued)

TIMSS **2011** Science 8th Grade

Country	Intermediate International Benchmark (475) Percent of Students					Low International Benchmark (400) Percent of Students				
	2011	2007	2003	1999	1995	2011	2007	2003	1999	1995
Singapore	87	80 ▲	85	84	91 ▽	96	93 ▲	95	95	99 ▽
Chinese Taipei	85	83	88 ▽	86		96	95	98 ▽	96	
Korea, Rep. of	86	85	88	81 ▲	81 ▲	97	97	98	96 ▲	95 ▲
Japan	86	85	86	84	85	97	96	98	97	97
Russian Federation	81	76 ▲	70 ▲	73 ▲	71 ▲	96	95	93 ▲	92 ▲	92 ▲
England	76	79	81	76	75	93	94	96 ▽	94	93
Slovenia	82	81	75 ▲		69 ▲	96	97	96		93 ▲
Australia	70	70	76 ▽		69	92	92	95		89 ▲
United States	73	71	75	67 ▲	68 ▲	93	92	93	87 ▲	87 ▲
Hong Kong SAR	80	77	89 ▽	80	70 ▲	95	92	98 ▽	96	90 ▲
New Zealand	67		73	66	67	90		94 ▽	88	89
Hungary	75	80 ▽	82 ▽	83 ▽	80 ▽	92	96 ▽	97 ▽	96 ▽	95 ▽
Finland (7)	80			79		96			96	
Sweden	68	69	75 ▽		83 ▽	91	91	95 ▽		97 ▽
Lithuania	71	72	74	57 ▲	45 ▲	92	93	95 ▽	86 ▲	79 ▲
Ukraine	64	58 ▲				88	85			
Iran, Islamic Rep. of	50	41 ▲	38 ▲	38 ▲	43 ▲	79	76	77	72 ▲	81
Italy	65	62	59 ▲	59 ▲		90	88	87 ▲	86 ▲	
Bahrain	44	49 ▽	33 ▲			70	78 ▽	70		
Norway	62	58 ▲	63		72 ▽	90	87	91		94 ▽
Romania	47	46	49	50	51	78	77	78	78	77
Jordan	45	56 ▽	53 ▽	42		72	79 ▽	80 ▽	69	
Macedonia, Rep. of	30		42 ▽	46 ▽		53		72 ▽	73 ▽	
Oman	34	32				59	61			
Armenia	37		45 ▽			66		77 ▽		
Malaysia	34	50 ▽	71 ▽	59 ▽		62	80 ▽	95 ▽	87 ▽	
Thailand	39	48 ▽		54 ▽		74	80 ▽		87 ▽	
Chile	43		24 ▲	27 ▲		79		56 ▲	60 ▲	
Palestinian Nat'l Auth.	33	28 ▲	36			59	54 ▲	66 ▽		
Lebanon	25	28	20 ▲			54	55	48		
Georgia	28	27				62	61			
Syrian Arab Republic	29	39 ▽				63	76 ▽			
Tunisia	30	31	12 ▲	25 ▲		72	77 ▽	52 ▲	68	
Indonesia	19	27 ▽				54	65 ▽			
Ψ Ghana	6	6	3 ▲			22	19	13 ▲		

Benchmarking Participants

Country	2011	2007	2003	1999	1995	2011	2007	2003	1999	1995
Massachusetts, US	87	84		75 ▲		96	96		93 ▲	
Minnesota, US	85	82			79	98	96			94 ▲
Connecticut, US	74			74		92			92	
North Carolina, US	75			65 ▲		94			87 ▲	
Alberta, Canada	85			87	83	98			98	97
Indiana, US	78		79	76		95		96	93	
Dubai, UAE	57	58				79	82			
Ontario, Canada	76	77	81 ▽	72	61 ▲	96	96	97 ▽	95	88 ▲
Quebec, Canada	76	68 ▲	82 ▽	83 ▽	69	96	94	98 ▽	98 ▽	92

▲ 2011 percent significantly higher

▽ 2011 percent significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Eighth Grade TIMSS 2011 Low International Benchmark

Exhibit 2.20 presents the detailed description of student achievement at the Low International Benchmark. At this benchmark, students recognized some basic facts from the life and physical sciences, and interpreted simple pictorial diagrams, completed simple tables, and applied their basic knowledge to practical situations.

In biology at the eighth grade, the TIMSS 2011 Science Framework expects that students should be able to compare biological processes at the cellular level, including ideas about heredity. Exhibit 2.21 presents Example Item 1, which required students to recognize the basic biological fact that genetic material is inherited from both parents. On average across countries, this item was relatively easy and was answered correctly by 83 percent of the eighth grade students. In all countries and benchmarking jurisdictions, more than 60 percent of students answered the item correctly.

In chemistry at this benchmark level, students had some basic knowledge of chemical formulas. Exhibit 2.22 presents Example 2, in which students must recognize the chemical formula for carbon dioxide. On average across countries, this item also was relatively easy, with 85 percent of eighth grade students answering it correctly.

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Low International Benchmark

400

Summary

Students can recognize some basic facts from the life and physical sciences. They have some knowledge of biology, and demonstrate some familiarity with physical phenomena. Students interpret simple pictorial diagrams, complete simple tables, and apply basic knowledge to practical situations.

Students demonstrate some basic knowledge of biology. For example, they recognize that influenza is caused by a virus and that genetic material is inherited from both parents.

In chemistry and physics, students have some basic knowledge of chemical formulas and properties of substances as they change states. They recognize some aspects of conductivity and energy. For example, they recognize which material is a conductor of electricity and the type of energy in a compressed spring.

Students interpret simple pictorial diagrams, complete simple tables, and apply basic knowledge to practical situations.

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PERFORMANCE AT THE TIMSS 2011 INTERNATIONAL BENCHMARKS

CHAPTER 2 **119**

Country	Percent Correct	
Japan	95 (0.9)	⬥
Finland	94 (1.0)	⬥
Korea, Rep. of	93 (0.9)	⬥
² Singapore	92 (1.0)	⬥
Slovenia	91 (1.4)	⬥
Jordan	91 (1.1)	⬥
² United States	90 (0.8)	⬥
³ Israel	90 (1.4)	⬥
Chinese Taipei	89 (1.2)	⬥
‡ England	88 (1.7)	⬥
Hong Kong SAR	88 (1.5)	⬥
² Russian Federation	88 (1.5)	⬥
Italy	88 (1.6)	⬥
Hungary	87 (1.4)	⬥
Armenia	87 (1.4)	⬥
Tunisia	87 (1.2)	⬥
Ukraine	86 (2.2)	
United Arab Emirates	86 (1.0)	⬥
Australia	86 (1.5)	
Bahrain	85 (1.4)	
Saudi Arabia	85 (1.4)	
New Zealand	85 (1.6)	
¹ Lithuania	84 (1.7)	
Turkey	84 (1.3)	
Palestinian Nat'l Auth.	84 (1.3)	
International Avg.	**83 (0.2)**	
Sweden	83 (1.5)	
Romania	83 (1.5)	
Norway	82 (1.6)	
Qatar	82 (1.8)	
Syrian Arab Republic	81 (1.7)	
Oman	81 (1.2)	▽
Morocco	80 (1.6)	▽
Chile	80 (1.5)	▽
Kazakhstan	79 (1.7)	▽
Thailand	77 (1.8)	▽
¹ Georgia	76 (2.8)	▽
Lebanon	76 (2.2)	▽
Iran, Islamic Rep. of	75 (1.8)	▽
Indonesia	70 (2.3)	▽
Ghana	69 (1.5)	▽
Malaysia	69 (1.7)	▽
Macedonia, Rep. of	63 (2.4)	▽

Content Domain: Biology

Cognitive Domain: Applying

Description: Recognizes that genetic material is inherited from both parents

Twins are born. One is a boy and one is a girl.

Which statement is correct about their genetic makeup?

Ⓐ The boy and girl inherit genetic material from the father only.

Ⓑ The boy and girl inherit genetic material from the mother only.

● The boy and girl inherit genetic material from both parents.

Ⓓ The boy inherits genetic material from the father only and the girl inherits it from the mother only.

Country	Percent Correct	
Ninth Grade Participants		
South Africa	73 (1.2)	▽
² Honduras	66 (2.0)	▽
Botswana	63 (1.6)	▽

Country	Percent Correct	
Benchmarking Participants		
¹ ² Massachusetts, US	95 (1.3)	⬥
¹ Minnesota, US	94 (1.1)	⬥
¹ ² Indiana, US	92 (1.3)	⬥
¹ ³ North Carolina, US	91 (1.7)	⬥
¹ ² Connecticut, US	89 (1.8)	⬥
² Alberta, Canada	89 (1.3)	⬥
¹ Colorado, US	89 (2.0)	⬥
¹ Alabama, US	88 (2.2)	⬥
¹ ² Florida, US	87 (2.8)	
Quebec, Canada	87 (1.5)	⬥
² Ontario, Canada	87 (1.5)	⬥
¹ ² California, US	86 (1.8)	
Abu Dhabi, UAE	86 (1.4)	
Dubai, UAE	86 (1.8)	

⬥ Percent significantly higher than international average

▽ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Exhibit 2.22: Low International Benchmark – Example Item 2

Country	Percent Correct	
Japan	99 (0.3)	⬤
Chinese Taipei	98 (0.5)	⬤
Lebanon	97 (0.9)	⬤
Slovenia	96 (0.7)	⬤
Romania	94 (1.3)	⬤
Hungary	93 (1.0)	⬤
‡ England	92 (1.3)	⬤
[2] Russian Federation	92 (1.1)	⬤
Armenia	91 (1.1)	⬤
[2] Singapore	91 (1.1)	⬤
Korea, Rep. of	90 (1.4)	⬤
Italy	90 (1.2)	⬤
Hong Kong SAR	89 (1.6)	⬤
Indonesia	89 (1.5)	⬤
Ukraine	88 (1.5)	⬤
Kazakhstan	88 (1.6)	⬤
Macedonia, Rep. of	88 (1.4)	⬤
Qatar	87 (1.5)	
Syrian Arab Republic	87 (1.5)	
[3] Israel	86 (1.5)	
Oman	86 (1.6)	
Jordan	86 (1.4)	
[2] United States	86 (1.1)	
[1] Lithuania	85 (1.6)	
International Avg.	**85 (0.2)**	
Palestinian Nat'l Auth.	85 (1.2)	
Australia	84 (2.0)	
Norway	84 (1.8)	
New Zealand	84 (1.6)	
Turkey	83 (1.6)	
United Arab Emirates	83 (1.1)	
Morocco	82 (1.3)	▼
Sweden	81 (1.4)	▼
Finland	81 (1.9)	▼
Chile	80 (1.8)	▼
Ghana	79 (1.6)	▼
Bahrain	79 (1.5)	▼
Saudi Arabia	75 (1.8)	▼
Tunisia	73 (2.1)	▼
Thailand	73 (1.7)	▼
[1] Georgia	68 (1.9)	▼
Malaysia	67 (1.9)	▼
Iran, Islamic Rep. of	59 (2.3)	▼

Content Domain: Chemistry

Cognitive Domain: Knowing

Description: Recognizes the chemical formula of carbon dioxide

What is the chemical formula for carbon dioxide?

- Ⓐ CO
- ⬤ CO_2
- Ⓒ C
- Ⓓ O_2

Country	Percent Correct	
Ninth Grade Participants		
Botswana	73 (2.1)	▼
South Africa	72 (1.6)	▼
[2] Honduras	62 (3.0)	▼

Country	Percent Correct	
Benchmarking Participants		
[2] Alberta, Canada	93 (1.1)	⬤
[1] Minnesota, US	93 (1.7)	⬤
[1] Colorado, US	90 (2.1)	⬤
Dubai, UAE	90 (1.1)	⬤
[1] [2] Florida, US	89 (2.2)	⬤
[1] [2] Massachusetts, US	89 (2.4)	
[1] [3] North Carolina, US	88 (1.7)	
[1] [2] Connecticut, US	87 (2.2)	
[2] Ontario, Canada	85 (1.6)	
Abu Dhabi, UAE	84 (1.6)	
[1] [2] Indiana, US	84 (2.3)	
Quebec, Canada	84 (1.6)	
[1] Alabama, US	81 (1.9)	
[1] [2] California, US	79 (3.0)	

⬤ Percent significantly higher than international average

▼ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Eighth Grade TIMSS 2011 Intermediate International Benchmark

Exhibit 2.23 provides the detailed description of student achievement at the Intermediate International Benchmark. Students at this level recognized and applied their understanding of basic scientific knowledge in various contexts. They also interpreted information from tables, graphs, and pictorial diagrams, and drew conclusions, as well as communicated their understanding through brief descriptive responses.

Exhibit 2.24 presents Example Item 3, which illustrates a competence typical of the eighth grade Intermediate International Benchmark: interpret a graph and recognize what can be concluded from the data presented in the graph. The international average percent correct for this item was 57 percent, although in some of the highest-performing countries (Japan, Korea, and Finland) 80 percent or more of the students answered the item correctly.

In earth science at this benchmark level, students demonstrated an elementary understanding of Earth's processes. Exhibit 2.25 presents Example Item 4, an item in the earth science domain which requires students to apply their understanding of the processes of the water cycle. On average across countries, 63 percent of the eighth grade students correctly numbered each process in the order in which it takes place. However, the percentage of students answering correctly varied greatly across countries (14–92%), indicating that this particular earth science topic may be more widely taught in some countries than others.

● Intermediate International Benchmark

475 *Summary*

Students recognize and apply their understanding of basic scientific knowledge in various contexts. Students apply knowledge and communicate an understanding of human health, life cycles, adaptation, and heredity, and analyze information about ecosystems. They have some knowledge of chemistry in everyday life and elementary knowledge of properties of solutions and the concept of concentration. They are acquainted with some aspects of force, motion, and energy. They demonstrate an understanding of Earth's processes and physical features, including the water cycle and atmosphere. Students interpret information from tables, graphs, and pictorial diagrams and draw conclusions. They apply knowledge to practical situations and communicate their understanding through brief descriptive responses.

In biology, students demonstrate some understanding of human health. For example, students understand how vaccination helps prevent illness and which cells destroy bacteria. They also state why exercise is important for good health. Students apply their knowledge of life cycles, adaptation, and heredity. They recognize that a tree has growth rings. They also explain that an animal's coloration protects it from predators and that an acquired characteristic cannot be passed on to the next generation. Students interpret and explain information about ecosystems and the effect of population changes. They recognize an organism that is a producer. They analyze information about a lake ecosystem and explain how an introduced population can affect an existing population.

Students have some knowledge of chemistry in everyday life. For example, they recognize that a fire can be stopped by cutting off the supply of oxygen, they recognize, from a description of indicator color changes, that neutralization has occurred, and, in the context of an investigation, they recognize the condition under which nails would rust. Students also have elementary knowledge of properties of solutions and the concept of concentration. They identify which of two solutions is more dilute and justify their selection.

In physics, students are acquainted with some aspects of force, motion, and energy. For example, they recognize the position of a fulcrum that requires the least amount of force to move a heavy object. Given a diagram showing a ball being thrown upward, they state the force that causes the ball to fall. In addition, students draw conclusions from a line graph showing the results of an investigation comparing two heat sources.

In earth science, students demonstrate an elementary understanding of Earth's processes and physical features. They describe a cause of earthquakes, recognize where active volcanoes are found and which soil change is due to a natural cause rather than human activity. Students demonstrate an understanding of the water cycle and knowledge of atmospheric conditions. They order the processes involved in the water cycle and match each process with its description. They recognize that air temperature at high altitudes is very low and that carbon dioxide is increasing over time in Earth's atmosphere.

Students interpret information from tables, graphs, and pictorial diagrams and draw conclusions. They apply knowledge to practical situations and communicate their understanding through brief descriptive responses.

Country	Percent Correct	
Japan	82 (1.7)	⬤
Korea, Rep. of	80 (1.6)	⬤
Finland	80 (1.9)	⬤
Italy	79 (1.9)	⬤
2 Russian Federation	75 (1.9)	⬤
2 Singapore	75 (1.6)	⬤
Sweden	75 (1.7)	⬤
3 Israel	74 (1.7)	⬤
1 Lithuania	74 (2.0)	⬤
Norway	73 (2.5)	⬤
2 United States	73 (1.2)	⬤
Slovenia	71 (1.9)	⬤
‡ England	69 (2.6)	⬤
Australia	66 (2.3)	⬤
Chinese Taipei	64 (2.0)	⬤
New Zealand	62 (1.9)	⬤
Chile	62 (2.0)	⬤
Romania	61 (1.9)	
Hong Kong SAR	60 (2.3)	
Malaysia	60 (1.8)	
Turkey	60 (1.9)	
International Avg.	57 (0.3)	
Ukraine	56 (3.0)	
United Arab Emirates	54 (1.5)	⬇
Iran, Islamic Rep. of	51 (1.9)	⬇
1 Georgia	49 (2.6)	⬇
Tunisia	49 (2.1)	⬇
Hungary	48 (2.1)	⬇
Saudi Arabia	46 (2.3)	⬇
Bahrain	46 (2.1)	⬇
Lebanon	46 (2.5)	⬇
Indonesia	46 (2.2)	⬇
Thailand	45 (2.1)	⬇
Macedonia, Rep. of	45 (2.3)	⬇
Kazakhstan	44 (2.3)	⬇
Qatar	43 (2.2)	⬇
Jordan	43 (2.3)	⬇
Armenia	42 (2.2)	⬇
Morocco	42 (1.4)	⬇
Oman	42 (1.5)	⬇
Palestinian Nat'l Auth.	38 (1.9)	⬇
Syrian Arab Republic	32 (2.6)	⬇
Ghana	30 (1.5)	⬇

Content Domain: Biology

Cognitive Domain: Reasoning

Description: Interprets a graph showing changes in pulse rates before, during, and after exercise and recognizes what can be concluded from the graph

John measures his pulse rate before he exercises. It is 70 beats per minute. He exercises for one minute and measures his pulse rate again. He then measures it every minute for several minutes. He draws a graph to show his results.
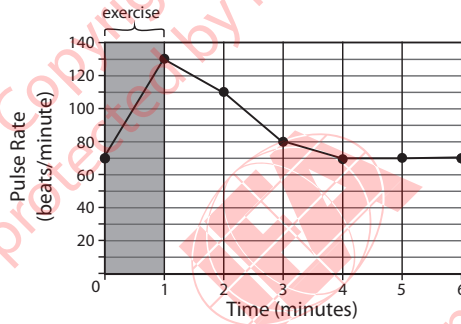
What can be concluded from his results?

Ⓐ His pulse rate increased by 50 beats per minute.

Ⓑ His pulse rate took less time to slow down than to increase.

Ⓒ His pulse rate after 4 minutes was 80 beats per minute.

⬤ His pulse rate returned to normal in less than 6 minutes.

Country	Percent Correct	
Ninth Grade Participants		
Botswana	48 (1.7)	⬇
2 Honduras	37 (2.1)	⬇
South Africa	31 (1.3)	⬇

Country	Percent Correct	
Benchmarking Participants		
1 Minnesota, US	79 (2.5)	⬤
1 2 Massachusetts, US	77 (2.8)	⬤
1 3 North Carolina, US	76 (3.2)	⬤
1 2 Indiana, US	76 (2.3)	⬤
Quebec, Canada	76 (2.0)	⬤
1 2 Connecticut, US	75 (2.7)	⬤
2 Alberta, Canada	73 (2.1)	⬤
2 Ontario, Canada	71 (2.2)	⬤
1 Colorado, US	70 (3.0)	⬤
1 2 Florida, US	67 (3.9)	⬤
1 2 California, US	64 (2.5)	⬤
1 Alabama, US	60 (3.0)	
Dubai, UAE	57 (2.0)	
Abu Dhabi, UAE	55 (2.2)	

⬤ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Country	Percent Full Credit	
Finland	92 (1.2)	⬆
Hong Kong SAR	85 (1.6)	⬆
2 Singapore	83 (1.5)	⬆
Chinese Taipei	82 (1.6)	⬆
Korea, Rep. of	81 (1.6)	⬆
2 Russian Federation	79 (1.7)	⬆
‡ England	79 (2.5)	⬆
3 Israel	79 (2.1)	⬆
Sweden	78 (1.9)	⬆
1 Lithuania	76 (1.6)	⬆
Slovenia	76 (2.2)	⬆
Hungary	74 (2.1)	⬆
New Zealand	72 (2.3)	⬆
Australia	71 (2.0)	⬆
Italy	71 (2.1)	⬆
2 United States	71 (1.4)	⬆
Japan	71 (2.2)	⬆
Ukraine	69 (2.7)	⬆
Norway	67 (2.2)	
Chile	66 (1.9)	
International Avg.	63 (0.3)	
Tunisia	62 (2.1)	
United Arab Emirates	62 (1.3)	
Thailand	61 (2.3)	
Oman	60 (1.7)	
Bahrain	59 (2.0)	⬇
Iran, Islamic Rep. of	58 (2.2)	⬇
Jordan	57 (2.1)	⬇
Romania	56 (2.2)	⬇
Saudi Arabia	56 (2.5)	⬇
Kazakhstan	55 (2.9)	⬇
1 Georgia	54 (2.8)	⬇
Turkey	54 (2.1)	⬇
Lebanon	50 (2.8)	⬇
Malaysia	49 (2.2)	⬇
Armenia	47 (2.7)	⬇
Syrian Arab Republic	46 (2.7)	⬇
Palestinian Nat'l Auth.	45 (1.9)	⬇
Indonesia	45 (2.5)	⬇
Qatar	45 (2.3)	⬇
Morocco	44 (1.6)	⬇
Macedonia, Rep. of	37 (2.7)	⬇
Ghana	14 (1.5)	⬇

Content Domain: Earth Science

Cognitive Domain: Applying

Description: Given a starting point, orders the processes involved in the water cycle

The following five statements describe processes involved in the water cycle. Water evaporation from the sea is identified as a first step in the water cycle.

Number the other statements 2 through 5 in the order in which these processes take place.

_2_ Water vapor rises in warm air.

_5_ Water travels along a river to the sea.

_1_ Water evaporates from the sea.

_3_ Water vapor is cooled and forms clouds.

_4_ Clouds move and water falls on land as rain.

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Ninth Grade Participants		
Botswana	41 (1.8)	⬇
2 Honduras	27 (2.0)	⬇
South Africa	18 (1.4)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
Quebec, Canada	80 (1.6)	⬆
1 Minnesota, US	79 (2.5)	⬆
2 Alberta, Canada	77 (2.1)	⬆
2 Ontario, Canada	76 (1.9)	⬆
1 2 Massachusetts, US	76 (2.5)	⬆
1 3 North Carolina, US	76 (2.3)	⬆
1 Colorado, US	75 (2.5)	⬆
1 2 Indiana, US	74 (2.4)	⬆
1 2 Florida, US	73 (3.4)	⬆
Dubai, UAE	68 (2.0)	⬆
1 2 Connecticut, US	67 (3.3)	
1 2 California, US	62 (3.6)	
Abu Dhabi, UAE	60 (2.3)	
1 Alabama, US	58 (3.0)	

⬆ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Eighth Grade TIMSS 2011 High International Benchmark

Exhibit 2.26 presents the detailed description of achievement at the High International Benchmark. Eighth grade students at this level demonstrated understanding of concepts related to science cycles, systems, and principles. They also demonstrated some scientific inquiry skills, and combined and interpreted information from various types of diagrams, contour maps, graphs, and tables; selected relevant information, analyzed, and drew conclusions; and provided short explanations conveying scientific knowledge.

Example Item 5, shown in Exhibit 2.27, illustrates an item in the chemistry domain that requires reasoning. Students were asked to identify a property of metals and describe how this property could be used to determine whether an unknown substance is a metal or nonmetal. This item demonstrates the increasing sophistication in knowledge and skill demonstrated by students at the High International Benchmark, which is reflected in an international average percent correct of 35 percent.

Exhibit 2.28 presents Example Item 6, an item from the physics domain that requires students to recognize that molecules of a liquid slow down as the liquid cools. This multiple choice item was relatively less difficult than Example Item 5, with 58 percent of eighth grade students, on average, answering the item correctly.

Example Item 7, shown in Exhibit 2.29, illustrates a competence typical of students reaching the eighth grade High International Benchmark—interpreting information appearing in various types of diagrams (in this case, a contour map). This item was moderately difficult; on average across countries, 38 percent of students answered it correctly. As with Example Item 4, there was particularly wide variation across countries in the percentage of students answering this item correctly (4–84%), indicating that this topic also may be more widely taught in some countries than others.

○ High International Benchmark

550

Summary

Students demonstrate understanding of concepts related to science cycles, systems, and principles. They demonstrate understanding of aspects of human biology, and of the characteristics, classification, and life processes of organisms. Students communicate understanding of processes and relationships in ecosystems. They show an understanding of the classification and compositions of matter and chemical and physical properties and changes. They apply knowledge to situations related to light and sound and demonstrate basic knowledge of heat and temperature, forces and motion, and electrical circuits and magnets. Students demonstrate an understanding of the solar system and of Earth's processes, physical features, and resources. They demonstrate some scientific inquiry skills. They also combine and interpret information from various types of diagrams, contour maps, graphs, and tables; select relevant information, analyze, and draw conclusions; and provide short explanations conveying scientific knowledge.

In biology, students demonstrate an understanding of aspects of human biology. For example, they recognize the food that is a good source of carbohydrates, recognize what happens to biceps and triceps when an elbow bends, and state one function of the uterus. They also demonstrate an understanding of characteristics, classification, and life processes of organisms. Students classify animals based on physical and behavioral characteristics. They indicate which gas is released into the air and which gas is removed during photosynthesis and animal respiration. Students communicate understanding of processes and relationships in ecosystems. They interpret food chains and recognize competition and predation relationships. They recognize factors that are likely to lead to a change in population size and can predict how populations change over time. They justify whether or not planting trees to decrease the amount of carbon dioxide in a city is a good decision.

In chemistry, students show an understanding of the classification and composition of matter. For example, students recognize elements and compounds from a list of symbols and formulas and recognize a diagrammatic representation of the structure of a water molecule. Given the chemical formula for an acid, they identify the number of atoms of each element in the molecule and the state of each of three substances at a given temperature from a table of melting and boiling points. Students show an understanding of chemical and physical properties and changes. They identify a property of metals and use it to determine whether an unknown substance is a metal or nonmetal, and they recognize chemical processes in everyday activities that involve energy absorption and release. Students use information presented in several tables to work through a multi-step investigation about the mass and density of gold jewelry.

In physics, students apply their knowledge of forces and motion to everyday and abstract situations. For example, they can identify the forces acting on students sitting on a wall. In addition, they recognize an object likely to be used as a lever. Students apply knowledge about the relationship between depth and pressure in water. Given a diagram showing densities of objects and liquids and the objects floating or sinking in the liquids, they identify each liquid. Students apply knowledge to situations related to light and sound. They recognize the pathway of light for an object to be seen, apply their knowledge of light rays reflecting to identify the orientation of a hidden mirror, and explain why lightning is seen before thunder is heard. Students demonstrate basic knowledge of heat and temperature. They recognize what happens to gas and liquid molecules when temperature changes. In the context of an investigation, students explain the effect of temperature on diffusion. Students show an understanding of electrical circuits and properties of magnets and electromagnets. They explain which light bulbs in parallel and series arrangements are affected when one of them breaks. They also recognize how to increase the strength of an electromagnet.

○ **High** International Benchmark

550 In earth science, students demonstrate an understanding of Earth's processes, physical features, and resources. For example, they interpret a contour map to recognize a topographical representation of a mountain top, recognize a non-renewable energy source, and state a way that a volcanic eruption impacts the environment. Also, based on a graph of average monthly temperature, they recognize which city is most likely to be located at the equator. Students demonstrate an understanding of the solar system. They recognize the gravitational pull of the moon on Earth as the major cause of tides. They also recognize the main difference between planets and moons, and apply knowledge about rotation and day length to recognize which planet has the shortest day length.

Students demonstrate some scientific inquiry skills. They select and justify an appropriate experimental method. They combine and interpret information from various types of diagrams, contour maps, graphs, and tables; select relevant information, analyze and draw conclusions; and provide short explanations conveying scientific knowledge.

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SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Content Domain: Chemistry

Cognitive Domain: Reasoning

Description: Identifies a property of metals and describes how this property can be used to determine whether an unknown substance is a metal or nonmetal

Country	Percent Full Credit	
Japan	72 (2.4)	⬆
Slovenia	69 (2.2)	⬆
² Singapore	64 (2.0)	⬆
‡ England	61 (2.9)	⬆
³ Israel	58 (2.1)	⬆
Chinese Taipei	56 (2.5)	⬆
Hong Kong SAR	52 (2.5)	⬆
Kazakhstan	49 (2.8)	⬆
² United States	48 (1.4)	⬆
² Russian Federation	48 (2.1)	⬆
Hungary	46 (2.0)	⬆
Sweden	45 (2.4)	⬆
Jordan	45 (2.2)	⬆
Finland	44 (2.6)	⬆
¹ Lithuania	42 (1.9)	⬆
New Zealand	41 (2.7)	⬆
Ukraine	41 (2.6)	⬆
Iran, Islamic Rep. of	40 (2.0)	⬆
Australia	38 (2.0)	
International Avg.	**35 (0.3)**	
Norway	34 (2.3)	
Palestinian Nat'l Auth.	32 (2.1)	
Saudi Arabia	31 (2.3)	
Armenia	31 (2.1)	⬇
Korea, Rep. of	31 (1.6)	⬇
Bahrain	29 (1.8)	⬇
Turkey	29 (1.6)	⬇
Qatar	28 (2.1)	⬇
United Arab Emirates	24 (1.3)	⬇
Italy	24 (2.2)	⬇
Ghana	23 (1.9)	⬇
Romania	22 (2.3)	⬇
Macedonia, Rep. of	22 (2.4)	⬇
Lebanon	21 (2.3)	⬇
Thailand	20 (1.9)	⬇
Malaysia	18 (2.0)	⬇
Syrian Arab Republic	17 (2.0)	⬇
¹ Georgia	16 (2.0)	⬇
Tunisia	15 (1.4)	⬇
Oman	15 (1.1)	⬇
Chile	13 (1.4)	⬇
Indonesia	10 (1.1)	⬇
Morocco	7 (0.8)	⬇

David is given a sample of an unknown solid substance. He wants to know if the substance is a metal. Write down one property he can observe or measure and describe how this property could be used to help identify whether the substance is a metal.

Metals conduct electricity.

He could make a simple electrical circuit with the sample, a battery, and a light bulb. If the bulb lights when everything is connected correctly, the sample is probably a metal

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Ninth Grade Participants		
Botswana	22 (1.5)	⬇
South Africa	7 (0.7)	⬇
² Honduras	4 (0.9)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
¹ ² Massachusetts, US	65 (2.7)	⬆
¹ ³ North Carolina, US	56 (3.1)	⬆
¹ Minnesota, US	50 (3.4)	⬆
¹ ² Indiana, US	49 (2.8)	⬆
¹ ² Connecticut, US	47 (3.6)	⬆
¹ Colorado, US	47 (2.8)	⬆
¹ ² California, US	45 (3.4)	⬆
² Alberta, Canada	42 (2.1)	⬆
Dubai, UAE	41 (2.4)	⬆
¹ ² Florida, US	41 (3.4)	
Quebec, Canada	39 (2.1)	⬆
² Ontario, Canada	35 (2.6)	
¹ Alabama, US	35 (2.9)	
Abu Dhabi, UAE	19 (2.0)	⬇

⬆ Percent significantly higher than international average

⬇ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Country	Percent Correct	
Korea, Rep. of	82 (1.4)	⏶
Slovenia	80 (2.0)	⏶
[2] Russian Federation	77 (2.0)	⏶
[3] Israel	75 (2.0)	⏶
[2] Singapore	73 (1.8)	⏶
Finland	73 (2.0)	⏶
[2] United States	73 (1.5)	⏶
Sweden	72 (1.9)	⏶
Kazakhstan	71 (2.4)	⏶
New Zealand	70 (2.3)	⏶
Hungary	70 (2.1)	⏶
Norway	68 (2.8)	⏶
Bahrain	67 (2.1)	⏶
Ukraine	67 (2.6)	⏶
‡ England	65 (2.3)	⏶
Turkey	63 (1.7)	⏶
Saudi Arabia	63 (2.0)	⏶
Australia	62 (2.1)	⏶
United Arab Emirates	60 (1.3)	
Iran, Islamic Rep. of	60 (2.2)	
Armenia	59 (2.8)	
Romania	59 (1.9)	
[1] Lithuania	59 (2.5)	
International Avg.	58 (0.3)	
[1] Georgia	56 (2.2)	
Italy	56 (2.5)	
Chinese Taipei	56 (1.9)	
Malaysia	53 (2.2)	⏷
Hong Kong SAR	52 (2.2)	⏷
Chile	51 (2.2)	⏷
Oman	50 (1.8)	⏷
Japan	50 (2.3)	⏷
Macedonia, Rep. of	49 (2.4)	⏷
Qatar	47 (2.1)	⏷
Jordan	46 (1.9)	⏷
Thailand	41 (1.9)	⏷
Palestinian Nat'l Auth.	40 (1.8)	⏷
Syrian Arab Republic	37 (2.1)	⏷
Lebanon	37 (2.5)	⏷
Indonesia	35 (2.3)	⏷
Morocco	33 (1.6)	⏷
Tunisia	32 (2.1)	⏷
Ghana	31 (1.8)	⏷

Content Domain: Physics

Cognitive Domain: Knowing

Description: Recognizes what happens to molecules of a liquid as the liquid cools

What happens to the molecules of a liquid when the liquid cools?

●   They slow down.

Ⓑ   They speed up.

Ⓒ   They decrease in number.

Ⓓ   They decrease in size.

Country	Percent Correct	
Ninth Grade Participants		
South Africa	47 (1.8)	⏷
[2] Honduras	37 (2.3)	⏷
Botswana	36 (1.9)	⏷

Country	Percent Correct	
Benchmarking Participants		
[2] Alberta, Canada	86 (1.6)	⏶
[1][2] Massachusetts, US	86 (2.2)	⏶
[2] Ontario, Canada	83 (1.6)	⏶
[1][2] Florida, US	81 (3.6)	⏶
[1][2] Indiana, US	79 (2.7)	⏶
[1] Minnesota, US	79 (2.7)	⏶
[1] Colorado, US	76 (2.4)	⏶
[1][2] Connecticut, US	75 (2.4)	⏶
[1][3] North Carolina, US	71 (4.0)	⏶
[1][2] California, US	71 (2.3)	⏶
[1] Alabama, US	65 (3.4)	⏶
Quebec, Canada	65 (2.2)	⏶
Abu Dhabi, UAE	61 (2.1)	
Dubai, UAE	59 (2.2)	

⏶   Percent significantly higher than international average

⏷   Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Country	Percent Full Credit	
Finland	84 (1.4)	⬤
Chinese Taipei	81 (1.7)	⬤
Slovenia	70 (1.8)	⬤
² Singapore	68 (2.2)	⬤
² Russian Federation	67 (2.1)	⬤
Hungary	66 (2.3)	⬤
Hong Kong SAR	64 (2.5)	⬤
Norway	61 (2.2)	⬤
Australia	61 (2.4)	⬤
¹ Lithuania	60 (2.5)	⬤
Korea, Rep. of	60 (2.1)	⬤
² United States	59 (2.0)	⬤
Ukraine	57 (2.5)	⬤
‡ England	56 (2.8)	⬤
Italy	54 (2.2)	⬤
Japan	52 (2.2)	⬤
³ Israel	47 (2.7)	⬤
New Zealand	45 (2.7)	⬤
Sweden	43 (2.1)	⬤
International Avg.	38 (0.3)	
Kazakhstan	35 (3.2)	
Iran, Islamic Rep. of	31 (2.5)	▼
Turkey	31 (1.8)	▼
Romania	30 (2.2)	▼
Macedonia, Rep. of	28 (2.9)	▼
Malaysia	27 (1.8)	▼
¹ Georgia	25 (2.4)	▼
United Arab Emirates	23 (1.1)	▼
Thailand	22 (1.7)	▼
Chile	22 (1.5)	▼
Saudi Arabia	22 (2.2)	▼
Jordan	21 (1.7)	▼
Bahrain	21 (1.7)	▼
Armenia	20 (2.1)	▼
Qatar	18 (1.6)	▼
Syrian Arab Republic	17 (2.3)	▼
Palestinian Nat'l Auth.	15 (1.8)	▼
Lebanon	11 (1.7)	▼
Morocco	10 (0.8)	▼
Tunisia	10 (1.5)	▼
Indonesia	9 (1.2)	▼
Oman	9 (1.2)	▼
Ghana	4 (1.0)	▼

Content Domain: Earth Science

Cognitive Domain: Applying

Description: Interprets a contour map to recognize a topographical representation of a mountain top

Tiger Island

The diagram above shows a topographic map of Tiger Island. The lines on the map are contour lines that connect points at the same elevation. The elevations shown are in meters.

A. What geographical feature is found at point **X**? _mountain top_

The answer shown illustrates the type of student response that was given 1 of 1 points.

Country	Percent Full Credit	
Ninth Grade Participants		
Botswana	22 (1.8)	▼
South Africa	8 (0.9)	▼
² Honduras	7 (1.4)	▼

Country	Percent Full Credit	
Benchmarking Participants		
¹ ² Massachusetts, US	82 (2.5)	⬤
¹ Minnesota, US	70 (2.9)	⬤
¹ Colorado, US	65 (3.0)	⬤
¹ ³ North Carolina, US	63 (2.5)	⬤
¹ ² Indiana, US	61 (3.7)	⬤
¹ ² Connecticut, US	60 (2.7)	⬤
² Alberta, Canada	58 (2.5)	⬤
Quebec, Canada	57 (2.2)	⬤
¹ ² Florida, US	51 (4.3)	⬤
² Ontario, Canada	50 (2.5)	⬤
¹ ² California, US	45 (2.3)	⬤
¹ Alabama, US	38 (4.5)	
Dubai, UAE	30 (1.6)	▼
Abu Dhabi, UAE	23 (2.1)	▼

⬤ Percent significantly higher than international average

▼ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Eighth Grade TIMSS 2011 Advanced International Benchmark

Exhibit 2.30 presents the detailed description of eighth grade performance at the Advanced International Benchmark. At this benchmark, students communicated an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science. They also combined information from several sources to solve problems and draw conclusions, and could provide written explanations to communicate scientific knowledge.

● Advanced International Benchmark

625 *Summary*

Students communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science. Students demonstrate some conceptual knowledge about cells and the characteristics, classification, and life processes of organisms. They communicate an understanding of the complexity of ecosystems and adaptations of organisms, and apply an understanding of life cycles and heredity. Students also communicate an understanding of the structure of matter and physical and chemical properties and changes and apply knowledge of forces, pressure, motion, sound, and light. They reason about electrical circuits and properties of magnets. Students apply knowledge and communicate understanding of the solar system and Earth's processes, structures, and physical features. They understand basic features of scientific investigation. They also combine information from several sources to solve problems and draw conclusions, and they provide written explanations to communicate scientific knowledge.

In biology, students demonstrate some knowledge of concepts related to cells and their functions and the characteristics, classification, and life processes of organisms. For example, they recognize a function of the cell membrane and state a life function of a single-celled organism other than taking in nutrients. They also recognize an organism in which oxygen and carbon dioxide are exchanged through the skin. Students apply an understanding of life cycles and heredity in practical situations. They describe an investigation to find out how fertilizer affects the growth of plants, apply knowledge about heredity to explain why offspring have traits like their parents, and recognize and describe an example of asexual reproduction. Students demonstrate understanding of the complexity of ecosystems and adaptations of organisms to their environment. They demonstrate some appreciation of the impact of human population growth on the environment and know some animal adaptations needed for survival, including both physical and behavioral characteristics. They also apply knowledge of competition to explain the importance of removing weeds from a field where crops are sown.

In chemistry, students demonstrate an understanding of the structure and the physical and chemical properties of matter. For example, they recognize that protons, neutrons, and electrons make up atoms and that atoms make up molecules; recognize what happens to atoms in an object if the shape of the object changes; and classify examples of matter as elements, compounds, or mixtures. Students apply knowledge of expansion of water during freezing and of density to explain why oil floats on water. In the context of an investigation of an irregularly shaped object, they describe the measurements needed to find the volume of the object. Students communicate understanding of physical and chemical changes. They recognize the graph that most likely shows the effect of temperature on solubility and recognize an everyday process that is an example of a physical change. Students describe what might be observed when a chemical reaction takes place. They identify which everyday liquids can neutralize a base and recognize a property common to both acids and bases. They apply knowledge of conservation of mass during neutralization and other chemical reactions.

TIMSS 2011
Science **8th Grade**

● **Advanced** International Benchmark

625 In physics, students demonstrate a good understanding of states of matter and phase change. For example, students identify from a list of characteristics or properties those that change or remain the same as a liquid changes into a gas. Using knowledge that only gases fill an available space, they infer the spacing of particles in different samples of matter. Students can reason about electrical circuits and properties of magnets. They recognize how the arrangement of components in an electrical circuit affects the battery life and brightness of a light bulb. Students describe how to use a magnet to determine whether a metal bar is a magnet and recognize the relationship between the strength of a magnet and the number of paper clips it attracts. Students apply knowledge of forces, pressure, and motion. They explain the relationship between the orientation of a rectangular block and the pressure it exerts on the ground. Students apply knowledge of sound and light in everyday situations. They predict the effect of removing air from an enclosed jar on the propagation of sound in the jar, and, on a diagram of a person looking through a periscope, draw the path and direction of a light ray passing through it.

In earth science, students apply knowledge and communicate their understanding of Earth's processes, structures, and physical features. For example, they explain how planting trees and terraced farming affects soil erosion. Given a diagram showing weather conditions at different elevations on a mountain, they identify the most likely location of a jungle. They also show understanding of the conditions under the Earth's surface by explaining why water from an artesian well can be hot, and state what fossil evidence would support the idea that two continents were once joined. Students apply knowledge and communicate understanding of the solar system. They recognize why the moon appears to change shape during the month and how a shadow changes as the sun moves. They also explain why an object's weight is less on the Moon than on Earth.

Students understand basic aspects of scientific investigation. In an experimental situation, they identify which variables to control and can design an investigation. They compare information from several sources, combine information to predict and draw conclusions, and interpret information in diagrams, maps, graphs, and tables to solve problems. They provide written explanations to communicate scientific knowledge.

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Exhibit 2.31 presents Example Item 8, which requires students to communicate their understanding of an important concept in chemistry, in this instance by describing the kinds of changes that take place during a chemical reaction. To receive full credit for this constructed response item, students were required to describe two kinds of changes. On average across countries, only 24 percent of students were able to do so.

Example Item 9 in Exhibit 2.32 asks students to demonstrate their understanding of a complex, abstract concept in physics by recognizing that the force of gravity acts on a person regardless of position and movement. On average internationally, 32 percent of the eighth grade students answered this item correctly, although as with many example items, there was great variation across countries, ranging from 13 to 63 percent correct.

The TIMSS 2011 Science Framework describes scientific inquiry as a cross-cutting theme in the TIMSS science assessment. Eighth grade students are expected to be able to propose explanations of scientific phenomena based on evidence. Example Item 10 displayed in Exhibit 2.33, an item from the earth science domain, asks students to present fossil evidence to support the idea that two continents were once joined. Students found this item challenging. On average across the countries, only 18 percent of students were able to provide a correct answer.

Exhibit 2.31: Advanced International Benchmark – Example Item 8

Country	Percent Full Credit	
‡ England	59 (2.6)	⬤
New Zealand	50 (2.5)	⬤
² United States	46 (1.5)	⬤
Chinese Taipei	44 (2.0)	⬤
² Russian Federation	44 (2.4)	⬤
² Singapore	44 (1.9)	⬤
Australia	42 (2.3)	⬤
United Arab Emirates	37 (1.3)	⬤
Finland	36 (2.3)	⬤
Hong Kong SAR	35 (1.9)	⬤
Norway	32 (2.5)	⬤
Japan	30 (2.1)	⬤
Saudi Arabia	30 (2.1)	⬤
Syrian Arab Republic	30 (2.4)	⬤
Slovenia	30 (2.1)	⬤
Jordan	28 (2.0)	⬤
Ukraine	27 (2.5)	
International Avg.	24 (0.3)	
Bahrain	23 (1.4)	
³ Israel	23 (2.0)	
Korea, Rep. of	23 (1.6)	
Lebanon	22 (2.3)	
Qatar	22 (2.2)	
¹ Lithuania	21 (1.9)	
Palestinian Nat'l Auth.	21 (1.8)	
Sweden	18 (1.5)	▼
Tunisia	18 (1.6)	▼
Kazakhstan	17 (2.0)	▼
Romania	17 (1.6)	▼
Oman	17 (1.4)	▼
Iran, Islamic Rep. of	17 (1.7)	▼
Hungary	15 (1.4)	▼
Armenia	14 (1.5)	▼
Malaysia	10 (1.2)	▼
Italy	9 (1.3)	▼
Turkey	8 (1.2)	▼
Thailand	8 (1.3)	▼
Chile	7 (0.9)	▼
Indonesia	6 (0.9)	▼
Macedonia, Rep. of	5 (1.1)	▼
Morocco	4 (0.5)	▼
¹ Georgia	3 (1.0)	▼
Ghana	1 (0.4)	▼

Content Domain: Chemistry

Cognitive Domain: Knowing

Description: Describes two things that might be observed as a chemical reaction takes place

Ahmet put some powder into a test tube. He then added liquid to the powder and shook the test tube. A chemical reaction took place.

Describe two things he might observe as the chemical reaction took place.

1. A temperature change

2. gas bubbles

The answer shown illustrates the type of student response that was given 2 of 2 points.

Country	Percent Full Credit	
Ninth Grade Participants		
Botswana	11 (1.0)	▼
South Africa	8 (0.8)	▼
² Honduras	8 (1.3)	▼

Country	Percent Full Credit	
Benchmarking Participants		
¹ Minnesota, US	53 (2.6)	⬤
¹ ² Massachusetts, US	52 (3.4)	⬤
¹ ² Indiana, US	51 (3.2)	⬤
¹ Colorado, US	51 (3.7)	⬤
¹ ³ North Carolina, US	47 (3.8)	⬤
Quebec, Canada	44 (2.2)	⬤
¹ ² California, US	44 (3.6)	⬤
¹ ² Florida, US	42 (3.8)	⬤
Dubai, UAE	39 (1.8)	⬤
Abu Dhabi, UAE	39 (2.4)	⬤
¹ Alabama, US	38 (4.1)	⬤
¹ ² Connecticut, US	37 (3.7)	⬤
² Alberta, Canada	37 (2.3)	⬤
² Ontario, Canada	32 (2.3)	⬤

⬤   Percent significantly higher than international average

▼   Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( )   Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

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Country	Percent Correct	
Korea, Rep. of	63 (2.0)	⬤
Finland	59 (2.1)	⬤
[3] Israel	54 (2.3)	⬤
Japan	49 (2.1)	⬤
Sweden	49 (2.1)	⬤
Slovenia	47 (2.7)	⬤
[2] Singapore	45 (1.7)	⬤
Hungary	45 (2.3)	⬤
[‡] England	43 (2.9)	⬤
[1] Lithuania	42 (2.3)	⬤
Ukraine	40 (2.3)	⬤
[2] Russian Federation	38 (2.6)	⬤
[2] United States	37 (1.4)	⬤
Hong Kong SAR	36 (2.3)	⬤
Chinese Taipei	35 (2.0)	
Turkey	34 (1.9)	
Palestinian Nat'l Auth.	34 (2.1)	
Norway	32 (2.2)	
International Avg.	**32 (0.3)**	
Jordan	30 (1.9)	
Armenia	30 (2.3)	
Australia	30 (2.5)	
New Zealand	29 (2.0)	
United Arab Emirates	28 (1.2)	▾
Italy	26 (2.2)	▾
Qatar	26 (2.5)	▾
Lebanon	26 (2.1)	▾
Bahrain	25 (1.9)	▾
Syrian Arab Republic	25 (2.0)	▾
Ghana	22 (1.7)	▾
Kazakhstan	22 (2.4)	▾
Oman	22 (1.4)	▾
Thailand	22 (1.6)	▾
Iran, Islamic Rep. of	22 (1.7)	▾
Romania	22 (1.9)	▾
Saudi Arabia	20 (1.6)	▾
Macedonia, Rep. of	20 (2.0)	▾
[1] Georgia	20 (2.4)	▾
Chile	19 (1.4)	▾
Morocco	16 (1.2)	▾
Malaysia	16 (1.4)	▾
Tunisia	16 (2.0)	▾
Indonesia	13 (1.5)	▾

Content Domain: Physics

Cognitive Domain: Applying

Description: Recognizes that the force of gravity acts on a person regardless of position and movement

The figure shows a parachute jumper in four positions.

1. In the aircraft before the jump

2. In freefall immediately after jumping before parachute opens

3. Falling to the ground after the parachute opens

4. On the ground just after landing

In which of the positions does the force of gravity act on the jumper?

Ⓐ Position 2 only.

Ⓑ Positions 2 and 3 only.

Ⓒ Positions 1, 2 and 3 only.

⬤ Positions 1, 2, 3, and 4.

Country	Percent Correct	
Ninth Grade Participants		
Botswana	– –	
South Africa	27 (1.4)	▾
[2] Honduras	24 (1.6)	▾

Country	Percent Correct	
Benchmarking Participants		
[1][2] Connecticut, US	51 (2.9)	⬤
[1] Minnesota, US	49 (3.7)	⬤
[2] Alberta, Canada	44 (2.4)	⬤
[1][2] Massachusetts, US	43 (3.3)	⬤
[2] Ontario, Canada	43 (2.3)	⬤
[1][2] Florida, US	42 (4.1)	⬤
[1][2] Indiana, US	38 (3.5)	
[1][3] North Carolina, US	38 (3.3)	
[1] Colorado, US	36 (2.9)	
Quebec, Canada	33 (2.0)	
[1][2] California, US	33 (2.8)	
[1] Alabama, US	32 (3.7)	
Dubai, UAE	27 (2.0)	▾
Abu Dhabi, UAE	26 (2.0)	▾

⬤ Percent significantly higher than international average

▾ Percent significantly lower than international average

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

A dash (–) indicates comparable data not available.

Country	Percent Full Credit	
Iran, Islamic Rep. of	48 (2.3)	⬤
Japan	43 (2.2)	⬤
Italy	38 (2.6)	⬤
[2] United States	37 (1.7)	⬤
[3] Israel	34 (2.2)	⬤
Chinese Taipei	32 (2.1)	⬤
[2] Russian Federation	31 (2.1)	⬤
Slovenia	29 (2.2)	⬤
Korea, Rep. of	28 (1.8)	⬤
‡ England	28 (2.8)	⬤
New Zealand	27 (2.2)	⬤
Australia	27 (2.2)	⬤
Sweden	24 (1.5)	⬤
[1] Lithuania	23 (1.8)	⬤
[2] Singapore	22 (1.6)	⬤
Romania	21 (2.2)	
Kazakhstan	20 (2.4)	
Ukraine	20 (2.2)	
Norway	20 (2.0)	
Hong Kong SAR	19 (2.2)	
International Avg.	18 (0.3)	
Finland	18 (1.6)	
Jordan	17 (1.7)	
Chile	15 (1.4)	⬇
United Arab Emirates	15 (1.0)	⬇
Syrian Arab Republic	13 (1.8)	⬇
Hungary	12 (1.3)	⬇
Oman	10 (0.9)	⬇
Macedonia, Rep. of	9 (1.4)	⬇
Turkey	8 (1.2)	⬇
Armenia	8 (1.2)	⬇
[1] Georgia	8 (1.4)	⬇
Thailand	8 (1.1)	⬇
Palestinian Nat'l Auth.	7 (0.9)	⬇
Qatar	6 (1.2)	⬇
Indonesia	5 (0.8)	⬇
Morocco	5 (0.7)	⬇
Malaysia	5 (0.7)	⬇
Bahrain	5 (0.6)	⬇
Lebanon	3 (0.8)	⬇
Saudi Arabia	3 (0.8)	⬇
Tunisia	2 (0.6)	⬇
Ghana	– –	

Content Domain: Earth Science

Cognitive Domain: Reasoning

Description: States what fossil evidence would support the idea that two continents were once joined

Two continents are separated by water.

Geologists are looking for evidence that the two continents were once joined.

What fossil evidence would support this idea?

> The same species of extinct animals are found on the two continents

The answer shown illustrates the type of student response that was given 1 of 1 points.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Country	Percent Full Credit	
Ninth Grade Participants		
South Africa	10 (0.8)	⬇
[2] Honduras	3 (0.9)	⬇
Botswana	2 (0.6)	⬇

Country	Percent Full Credit	
Benchmarking Participants		
[1] [2] Massachusetts, US	58 (3.7)	⬤
[1] Minnesota, US	53 (3.4)	⬤
[1] [3] North Carolina, US	46 (4.0)	⬤
[2] Alberta, Canada	46 (1.8)	⬤
[1] Colorado, US	44 (3.1)	⬤
[1] [2] Indiana, US	41 (3.9)	⬤
[1] [2] Connecticut, US	38 (3.7)	⬤
[1] [2] Florida, US	35 (4.2)	⬤
[1] [2] California, US	32 (2.5)	⬤
[2] Ontario, Canada	29 (2.2)	⬤
Quebec, Canada	21 (1.9)	
[1] Alabama, US	19 (3.0)	
Dubai, UAE	16 (1.5)	
Abu Dhabi, UAE	15 (1.9)	

⬤ Percent significantly higher than international average

⬇ Percent significantly lower than international average

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