

# the condition of education 2007



## INDICATOR 17

# International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

The indicator and corresponding tables are taken directly from *The Condition of Education 2007*. Therefore, the page numbers may not be sequential.

Additional information about the survey data and supplementary notes can be found in the full report. For a copy of *The Condition of Education 2007*, visit the NCES website (<http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2007064>) or contact ED PUBs at 1-877-4ED-PUBS.

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# Academic Outcomes

## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

*U.S. 4th- and 8th-graders performed above the international averages in knowing mathematical facts, procedures, and concepts; in applying mathematical knowledge and understanding; and in mathematical reasoning.*

The Trends in International Mathematics and Science Study (TIMSS) conducted in 2003 assessed students' mathematics performance in 25 countries at grade 4 and 46 countries at grade 8. In addition to reporting overall mathematics scores, TIMSS developed scales in three mathematics cognitive domains: *knowing* facts, procedures, and concepts needed to solve mathematical problems; *applying* knowledge of facts, skills, and procedures to create representations and solve routine problems; and *reasoning* to solve more complex, nonroutine problems through logical thinking.<sup>1</sup>

At grade 4, U.S. students scored above the international average of all 25 countries in the mathematics cognitive domains of knowing, applying, and reasoning (see supplemental table 17-1). U.S. 4th-graders performed relatively better in knowing than in applying and reasoning: U.S. students outperformed students in 17 countries in knowing, 11 countries in applying, and 12 countries in reasoning.

Among the participating countries with a high value on the United Nations Development Program's Human Development Index (HDI),<sup>2</sup> U.S. 4th-graders, on average, outperformed their peers in Australia, Italy, New Zealand, Norway, Scotland, and Slovenia across the

three domains. Fourth-graders in Belgium (Flemish), Chinese Taipei, Hong Kong SAR, Japan, and Singapore outperformed U.S. students, on average, across all three cognitive domains. Students in England and the Netherlands outperformed U.S. 4th-graders in applying and reasoning, but not in knowing.

Like their 4th-grade counterparts, U.S. 8th-graders scored above the international average of all 46 countries in all three mathematics cognitive domains and relatively better in knowing than in applying and reasoning (see supplemental table 17-2). U.S. 8th-graders outperformed students in 31 countries in knowing, 25 countries in applying, and 27 countries in reasoning.

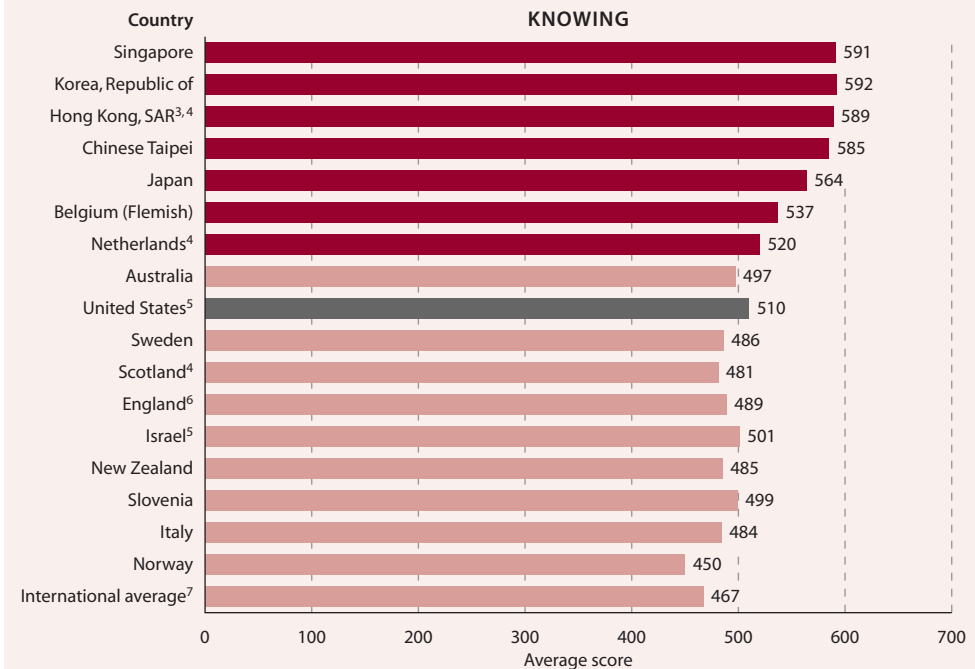
Among the high-HDI-value participating countries, U.S. 8th-graders, on average, outperformed their peers in Italy, Norway, and Slovenia across the three domains (see the figure on pages 43–44). U.S. students outperformed their peers in an additional five countries in the knowing domain and in one country in the reasoning domain. Eighth-graders in Belgium (Flemish), Chinese Taipei, Hong Kong SAR, Japan, Korea, Netherlands, and Singapore outperformed their U.S. peers, on average, across all three cognitive domains.

<sup>1</sup> The cognitive domain scales were created to have the same mean and standard deviation as the overall TIMSS 2003 mathematics achievement scales: a mean of 495 and standard deviation of 100 at grade 4 and a mean of 467 and standard deviation of 100 at grade 8.

<sup>2</sup> The *Human Development Index* (HDI) ranks countries along three dimensions of human development: life expectancy at birth; the adult literacy rate and gross enrollment for primary, secondary, and tertiary education; and gross domestic product (GDP) per capita (using purchasing power parity [PPP] indices). The index has a minimum value of 0 and a maximum value of 1. Countries with high index values enjoy long life expectancy, high levels of school enrollment and adult literacy, and a good standard of living. For this indicator, a high index value is 0.9 or above. The index is explained in detail in the United Nations Development Program's (UNDP) *Human Development Report 2005*, available at <http://hdr.undp.org/reports/global/2005/>. Though Chinese Taipei is not assigned an HDI value in the UNDP report, it is included here because it is a high-achieving country in mathematics.



**INTERNATIONAL MATHEMATICS PERFORMANCE: Average mathematics cognitive domain scores of 8th-grade students in knowing, applying, and reasoning, by country: 2003**



<sup>3</sup> Hong Kong is a Special Administrative Region (SAR) of the People's Republic of China.

<sup>4</sup> Met international guidelines for participation rates only after replacement schools were included.

<sup>5</sup> Nearly satisfied guidelines for sample participation rates after replacement schools were included.

<sup>6</sup> Did not satisfy guidelines for sample participation rates. Less than 50 percent of original schools participated.

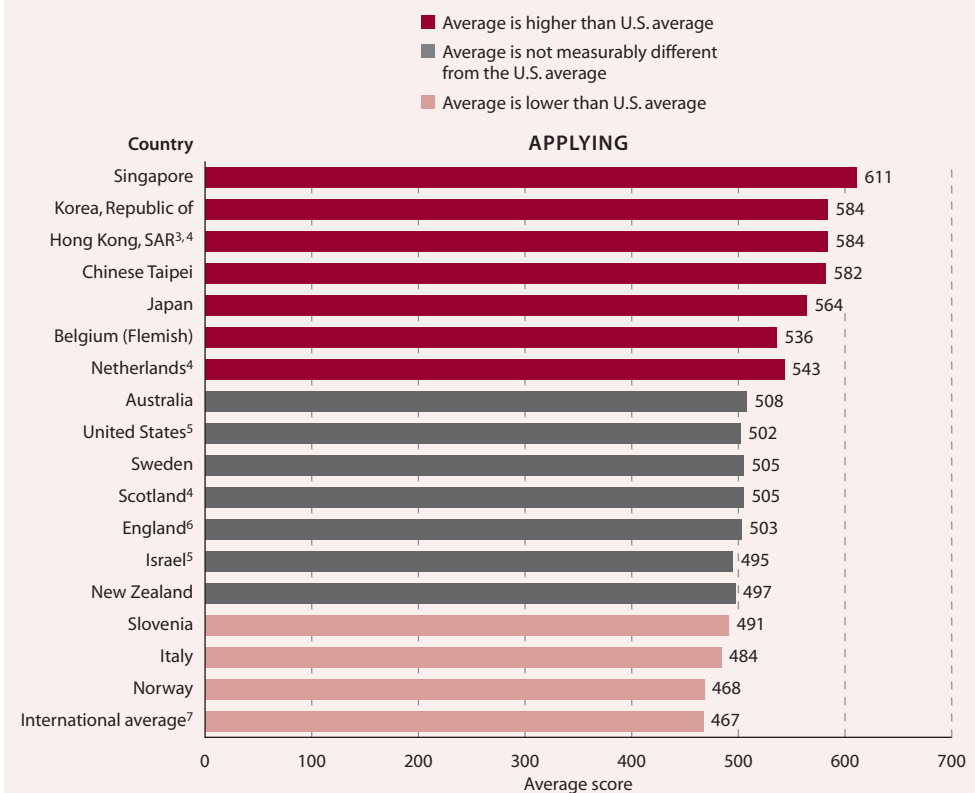
<sup>7</sup> The international average reflects the results of all participating countries, not just those shown in the figures. See supplemental tables 17-1 and 17-2 for the full results.

NOTE: Countries are ordered based on the overall 2003 mathematics average scores. Countries were required to sample students in the upper of the two grades that contained the largest number of 9-year-olds and 13-year-olds. In the United States and most countries, this corresponds to grades 4 and 8, respectively. Participants were scored on a 1,000-point scale. The international standard deviation is 100.

SOURCE: Mullis, I.V.S., Martin, M.O., and Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings From a Developmental Project*, exhibits 2.1–2.6, data from the International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2003.

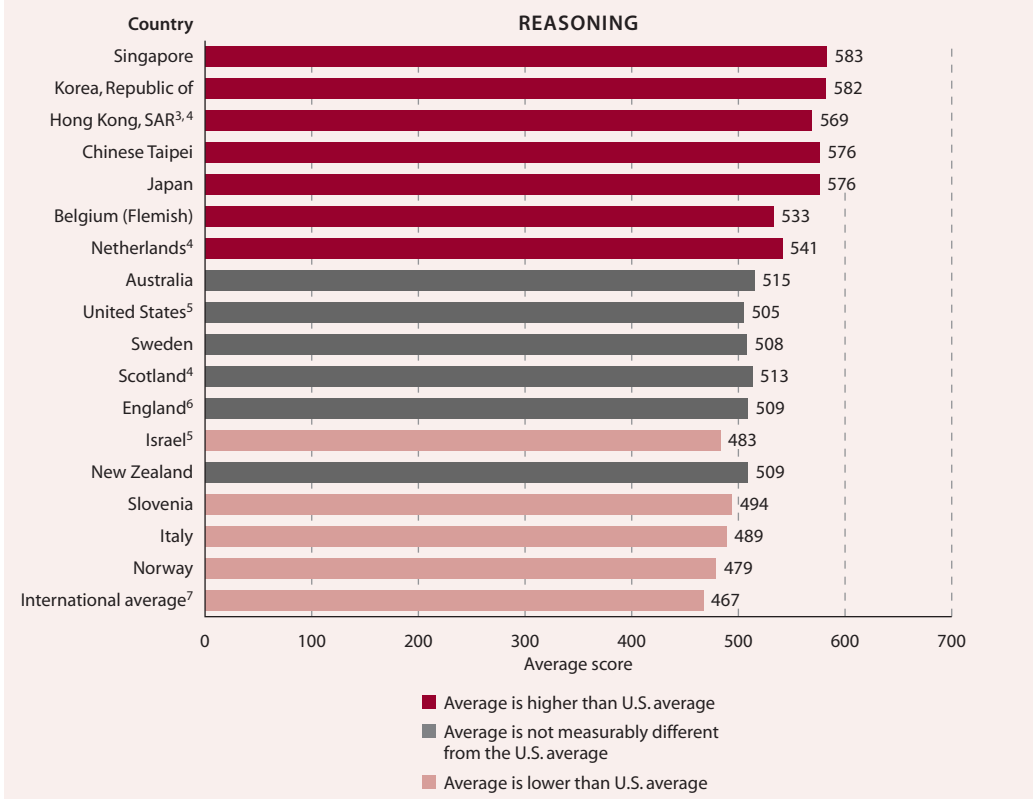


FOR MORE INFORMATION:  
 Supplemental Note 5  
 Supplemental Tables 17-1,  
 17-2  
 UNDP 2005





**INTERNATIONAL MATHEMATICS PERFORMANCE: Average mathematics cognitive domain scores of 8th-grade students in knowing, applying, and reasoning, by country: 2003—Continued**



<sup>3</sup> Hong Kong is a Special Administrative Region (SAR) of the People's Republic of China.

<sup>4</sup> Met international guidelines for participation rates only after replacement schools were included.

<sup>5</sup> Nearly satisfied guidelines for sample participation rates after replacement schools were included.

<sup>6</sup> Did not satisfy guidelines for sample participation rates. Less than 50 percent of original schools participated.

<sup>7</sup> The international average reflects the results of all participating countries, not just those shown in the figures. See supplemental tables 17-1 and 17-2 for the full results.

NOTE: Countries are ordered based on the overall 2003 mathematics average scores. Countries were required to sample students in the upper of the two grades that contained the largest number of 9-year-olds and 13-year-olds. In the United States and most countries, this corresponds to grades 4 and 8, respectively. Participants were scored on a 1,000-point scale. The international standard deviation is 100.

SOURCE: Mullis, I.V.S., Martin, M.O., and Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings From a Developmental Project*, exhibits 2.1–2.6, data from the International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2003.

FOR MORE INFORMATION:

- Supplemental Note 5
- Supplemental Tables 17-1, 17-2
- UNDP 2005



## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

Table 17-1. Average mathematics scores of 4th-grade students in knowing, applying, and reasoning, by country: 2003

Country	Knowing	Applying	Reasoning
International average	495	495	495
Armenia	447	462	445
Australia <sup>1</sup>	501	490	507
Belgium (Flemish) <sup>2</sup>	558	546	541
Chinese Taipei	565	561	563
Cyprus	500	510	516
England <sup>1</sup>	534	526	537
Hong Kong, SAR <sup>1,3</sup>	574	577	564
Hungary <sup>2</sup>	517	530	524
Iran, Islamic Rep. of <sup>2</sup>	404	391	400
Italy	514	494	499
Japan	564	566	562
Latvia	517	545	531
Lithuania <sup>4</sup>	519	542	526
Moldova, Rep. of	500	507	494
Morocco	360	349	368
Netherlands <sup>1</sup>	530	541	535
New Zealand	493	486	503
Norway	448	446	468
Philippines	385	364	359
Russian Federation <sup>2</sup>	513	542	526
Scotland <sup>1</sup>	484	487	498
Singapore	626	595	574
Slovenia	470	477	485
Tunisia	338	348	340
<b>United States<sup>1</sup></b>	<b>528</b>	<b>505</b>	<b>519</b>

<sup>1</sup> Met international guidelines for participation rates only after replacement schools were included.

<sup>2</sup> National defined population covers less than 95 percent of the national desired population.

<sup>3</sup> Hong Kong is a Special Administrative Region (SAR) of the People's Republic of China.

<sup>4</sup> National desired population does not cover all of the international desired population.

NOTE: Countries were required to sample students in the upper of the two grades that contained the largest number of 9-year-olds and 13-year-olds. In the United States and most countries, this corresponds to grades 4 and 8, respectively. Participants were scored on a 1,000-point scale. The international standard deviation is 100.

SOURCE: Mullis, I.V.S., Martin, M.O., and Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings From a Developmental Project*, exhibits 2.1–2.6, data from the International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study, 2003.

## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

Table 17-2. Average mathematics scores of 8th-grade students in knowing, applying, and reasoning, by country: 2003

Country	Knowing	Applying	Reasoning
International average	467	467	467
Armenia	480	478	468
Australia	497	508	515
Bahrain	401	398	424
Belgium (Flemish)	537	536	533
Bulgaria	486	471	471
Botswana	372	369	353
Chile	386	391	409
Chinese Taipei	585	582	576
Cyprus	466	457	455
Egypt	411	404	400
England <sup>1</sup>	489	503	509
Estonia	538	528	523
Ghana	232	293	313
Hong Kong, SAR <sup>2,3</sup>	589	584	569
Hungary <sup>4</sup>	536	523	529
Indonesia <sup>5</sup>	422	408	406
Iran, Islamic Rep. of <sup>4</sup>	405	416	417
Israel <sup>4</sup>	501	495	483
Italy	484	484	489
Japan	564	564	576
Jordan	428	422	433
Korea, Rep. of	592	584	582
Latvia	518	504	500
Lebanon	447	426	410
Lithuania <sup>5</sup>	511	499	489
Macedonia, Rep. of <sup>4</sup>	447	428	438
Malaysia	506	512	503
Moldova, Rep. of	466	457	453
Morocco <sup>5,6</sup>	386	384	391
Netherlands <sup>3</sup>	520	543	541
New Zealand	485	497	509
Norway	450	468	479
Palestinian Nat'l Auth.	391	388	404
Philippines	388	378	358
Romania	485	475	458
Russian Federation <sup>4</sup>	519	503	496
Saudi Arabia	315	338	348
Scotland <sup>3</sup>	481	505	513
Serbia <sup>5</sup>	495	467	468
Singapore	591	611	583
Slovak Republic	517	502	504
Slovenia	499	491	494
South Africa	261	269	287

See notes at end of table.

## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

**Table 17-2. Average mathematics scores of 8th-grade students in knowing, applying, and reasoning, by country: 2003—Continued**

Country	Knowing	Applying	Reasoning
Sweden	486	505	508
Tunisia	399	419	399
<b>United States<sup>6</sup></b>	<b>510</b>	<b>502</b>	<b>505</b>

<sup>1</sup> Did not satisfy guidelines for sample participation rates. Less than 50 percent of original schools participated.

<sup>2</sup> Hong Kong is a Special Administrative Region (SAR) of the People's Republic of China.

<sup>3</sup> Met international guidelines for participation rates only after replacement schools were included.

<sup>4</sup> National defined population covers less than 95 percent of the national desired population.

<sup>5</sup> National desired population does not cover all of the international desired population.

<sup>6</sup> Nearly satisfied guidelines for sample participation rates after replacement schools were included.

NOTE: Countries were required to sample students in the upper of the two grades that contained the largest number of 9-year-olds and 13-year-olds. In the United States and most countries, this corresponds to grades 4 and 8, respectively. Participants were scored on a 1,000-point scale. The international standard deviation is 100.

SOURCE: Mullis, I.V.S., Martin, M.O., and Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings From a Developmental Project*, exhibits 2.1–2.6, data from the International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study, 2003.

## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

Table S17-1. Standard errors for the average mathematics scores of 4th-grade students in knowing, applying, and reasoning, by country: 2003

Country	Knowing	Applying	Reasoning
International average	0.7	0.7	0.7
Armenia	3.7	3.2	3.1
Australia	3.8	3.8	3.6
Belgium (Flemish)	2.1	2.1	2.2
Chinese Taipei	2.2	1.9	2.2
Cyprus	2.8	2.8	2.4
England	4.5	4.1	3.5
Hong Kong, SAR	3.3	3.3	3.7
Hungary	3.3	3.4	3.2
Iran, Islamic Rep. of	4.0	3.8	3.4
Italy	3.9	3.6	4.0
Japan	2.1	2.1	1.7
Latvia	2.9	3.3	3.2
Lithuania	2.7	2.9	3.1
Moldova, Rep. of	5.2	4.8	4.9
Morocco	4.4	4.5	4.4
Netherlands	2.2	2.6	2.9
New Zealand	2.2	2.3	2.2
Norway	2.1	2.2	2.1
Philippines	6.9	7.5	7.4
Russian Federation	5.3	4.7	4.8
Scotland	3.0	3.5	3.1
Singapore	6.5	5.9	6.1
Slovenia	2.6	2.8	2.6
Tunisia	4.2	4.6	4.2
<b>United States</b>	<b>2.5</b>	<b>2.6</b>	<b>2.5</b>

SOURCE: Mullis, I.V.S., Martin, M.O., and Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings From a Developmental Project*, exhibits 2.1–2.6, data from the International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study, 2003.



## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

Table S17-2. Standard errors for the average mathematics scores of 8th-grade students in knowing, applying, and reasoning, by country: 2003

Country	Knowing	Applying	Reasoning
International average	0.5	0.5	0.5
Armenia	2.9	3.0	2.8
Australia	4.0	4.8	4.0
Bahrain	2.3	1.6	2.2
Belgium (Flemish)	2.5	2.7	2.8
Botswana	2.8	2.7	3.7
Bulgaria	4.1	4.7	3.9
Chile	3.2	3.3	3.5
Chinese Taipei	4.5	4.6	4.2
Cyprus	2.0	1.6	1.7
Egypt	3.4	3.4	3.6
England	4.0	4.8	4.7
Estonia	2.7	2.9	3.0
Ghana	5.9	4.0	4.0
Hong Kong, SAR	3.3	3.2	3.1
Hungary	3.1	3.4	3.1
Indonesia	4.3	4.9	4.3
Iran, Islamic Rep. of	2.6	2.5	2.8
Israel	3.1	3.6	3.3
Italy	3.2	3.2	2.9
Japan	1.9	2.2	1.8
Jordan	4.7	4.2	3.7
Korea, Rep. of	2.1	2.2	1.7
Latvia	2.8	3.4	3.4
Lebanon	3.2	3.3	3.0
Lithuania	2.7	2.8	2.6
Macedonia, Rep. of	3.8	3.8	3.7
Malaysia	3.9	4.4	3.4
Moldova, Rep. of	4.1	3.9	4.0
Morocco	2.8	2.9	3.2
Netherlands	3.1	3.7	3.8
New Zealand	4.8	5.3	5.2
Norway	2.1	2.7	2.8
Palestinian Nat'l Auth.	3.7	3.2	2.7
Philippines	5.2	4.8	5.8
Romania	4.9	5.0	4.5
Russian Federation	3.4	3.7	3.6
Saudi Arabia	4.6	3.6	4.3
Scotland	3.2	3.9	3.4
Serbia	2.7	2.9	2.6
Singapore	3.1	3.6	3.5
Slovak Republic	3.3	3.7	3.2
Slovenia	2.2	2.3	2.5
South Africa	5.4	5.3	5.0

See notes at end of table.

## International Comparisons of Mathematics Cognitive Domains of 4th- and 8th-Graders

**Table S17-2. Standard errors for the average mathematics scores of 8th-grade students in knowing, applying, and reasoning, by country: 2003—Continued**

Country	Knowing	Applying	Reasoning
Sweden	2.1	2.8	3.3
Tunisia	3.0	2.3	2.7
<b>United States</b>	<b>2.8</b>	<b>3.4</b>	<b>3.3</b>

SOURCE: Mullis, I.V.S., Martin, M.O., and Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings From a Developmental Project*, exhibits 2.1–2.6, data from the International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study, 2003.