

# Chapter 1

## International Student Achievement in Science

Chapter 1 summarizes achievement for eighth- and fourth-grade students on the TIMSS 2003 science assessment for each of the participating countries. It also shows trends in student performance at the eighth grade for those countries that also participated in TIMSS 1995 and 1999. At the fourth grade, trends are presented for those countries that participated in the 1995 assessment (no assessment was conducted at the fourth grade in 1999). Achievement differences by gender at both grades also are provided.

### How Do Countries Differ in Science Achievement?

The first page of Exhibit 1.1 presents the distribution of student achievement<sup>1</sup> for the 46 countries and four benchmarking entities that participated at the eighth grade in TIMSS 2003 and the second page presents the distribution of student achievement for the 25 countries and three benchmarking entities that participated at the fourth grade.<sup>2</sup> Countries are shown in decreasing order of average (mean) scale score, together with an indication of whether the country average is

- 1 TIMSS used item response theory (IRT) methods to summarize the achievement results on a scale with a mean of 500 and a standard deviation of 100. Given the matrix-sampling approach, scaling averages students' responses in a way that accounts for differences in the difficulty of different subsets of items. It allows students' performances to be summarized on a common metric even though individual students responded to different items in the science test. For more detailed information, see the "IRT Scaling and Data Analysis" section of Appendix A.
- 2 Argentina was unable to complete the necessary steps on schedule for their data to appear in this report. Because the characteristics of their samples are not completely known, achievement results for Syria at the eighth grade and Yemen at the fourth grade are presented in Appendix F.

significantly higher or lower than the international average. The international average of 474 at the eighth grade was obtained by averaging across the mean scores for each of the 46 participating countries. The mean scores for the four benchmarking participants were not included in calculating the average.<sup>3</sup> At the fourth grade, the international average of 489 was obtained by averaging across the mean scores for the 25 participating countries. It should be noted that the results for the eighth and fourth grades are not directly comparable. While the scales for the two grades are expressed in the same numerical units, they are not directly comparable in terms of being able to say how much achievement or learning at one grade equals how much achievement or learning at the other grade. Comparisons only can be made in terms of relative performance.<sup>4</sup>

At the eighth grade, with such a large number of participating countries, it is not surprising that the results reveal substantial differences in science achievement between the highest- and lowest-performing countries, from an average of 578 for Singapore to 244 for South Africa. Twenty-four countries (including England) and the four benchmarking participants had average science achievement that was significantly above the international average and 18 countries had average achievement below the international average. Bulgaria, Jordan, Moldova, and Romania performed about the same as the international average. At the fourth grade, the range in achievement was from 565 in Singapore to 304 in Morocco. Sixteen countries and the three benchmarking participants performed above the international average. Moldova and Slovenia performed at about the international average. Seven countries had achievement below the international average.

For both the eighth and fourth grades, Exhibit 1.1 illustrates the broad range of achievement both within and across the countries assessed. It shows a graphical representation of the distribution of student performance within each country. Achievement for each country is shown for the 25th and 75th percentiles as well as for the 5th and 95th percentiles.<sup>5</sup> Each percentile point indicates the percent-

3 Even though England worked very hard to meet the TIMSS sampling requirements and adjustments were made to make the results representative, it did not meet the school participation rates as specified in the guidelines and consequently its results are shown below a line.

4 Since the TIMSS scales were developed using IRT technology, like all such scales, the eighth- and fourth-grade scales cannot be described in absolute terms.

5 Tables of the percentile values and standard deviations for all countries are presented in Appendix D.

age of students performing below and above that point on the scale. For example, 25 percent of the eighth-grade students in each country performed below the 25th percentile for that country, and 75 percent performed above the 25th percentile. The range between the 25th and 75th percentiles represents performance by the middle half of the students. In most countries, the range of performance for the middle group was between 80 and 120 scale-score points. In contrast, performance at the 5th and 95th percentiles represents the extremes in both lower and higher achievement. The range of performance between these two score points, which includes 90 percent of the population, is more variable and is between 200 and 300 points in most countries. The dark boxes at the midpoints of the distributions show the 95 percent confidence intervals around the average achievement in each country.<sup>6</sup>

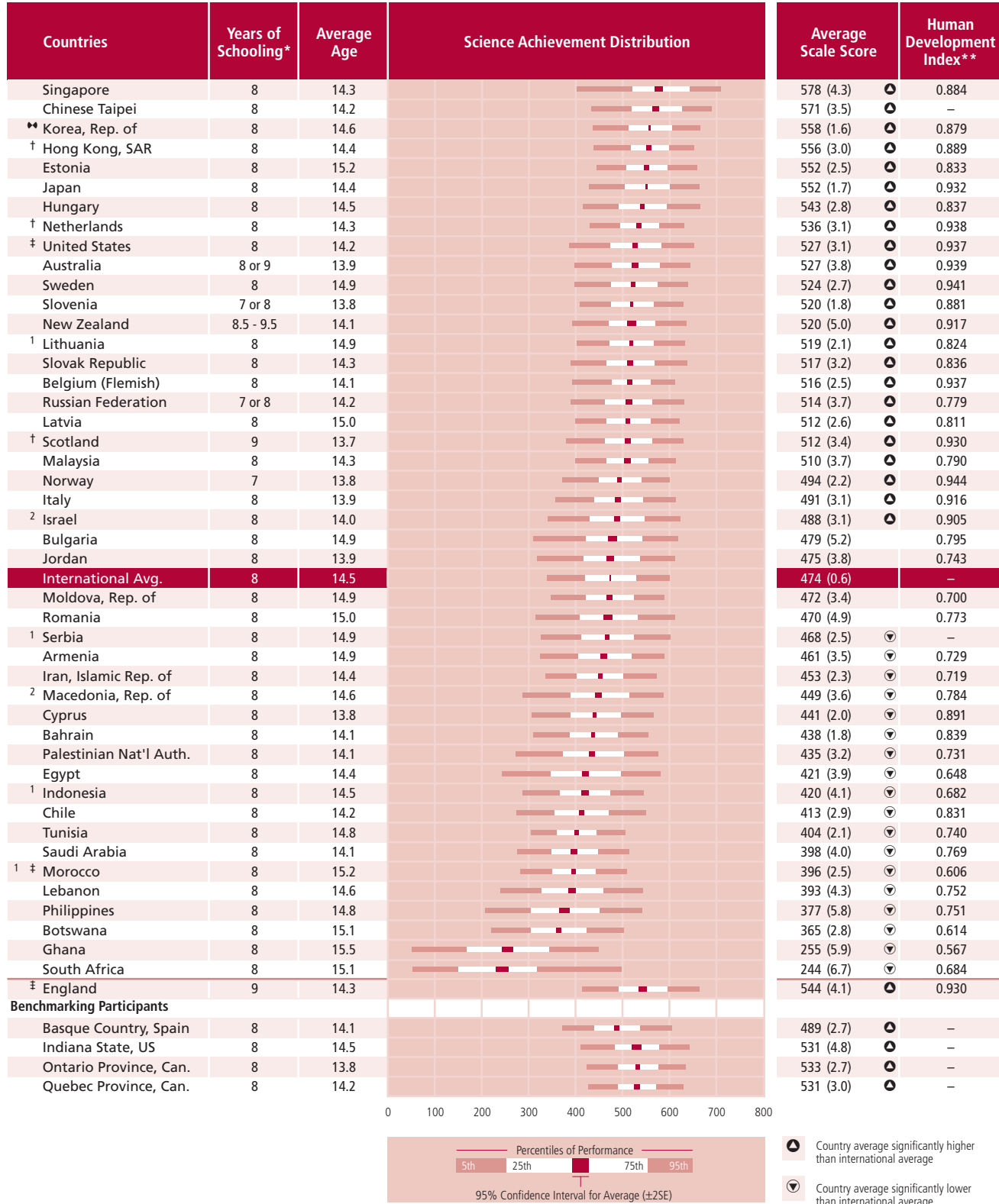
As well as showing the wide spread of student achievement within each country, the percentiles also provide a perspective on the size of the differences among countries. Even though average performance generally differed very little between one country and the next higher- or lower-performing country, the range in performance across the participating countries was very large at both grades. For example, Singaporean students had the highest average achievement at both grades, with their average eighth-grade performance exceeding performance at the 95th percentile in the lower-performing countries such as Botswana, Ghana, and South Africa. Similarly at the fourth grade, average performance in Singapore exceeded performance at the 95th percentile in Tunisia and Morocco. This means that only the most proficient students in the lower-performing countries approached the level of achievement of Singaporean students of average proficiency.

To aid in interpretation, Exhibit 1.1 also includes the years of formal schooling and average age of the students in each country. Equivalence of chronological age does not necessarily mean that students have received the same number of years of formal schooling or studied the same curriculum. For example, as described in the introduction, countries have different policies about the age at which

<sup>6</sup> See the “IRT Scaling and Data Analysis” section of Appendix A for more details about calculating standard errors and confidence intervals for the TIMSS statistics.



Exhibit 1.1: Distribution of Science Achievement

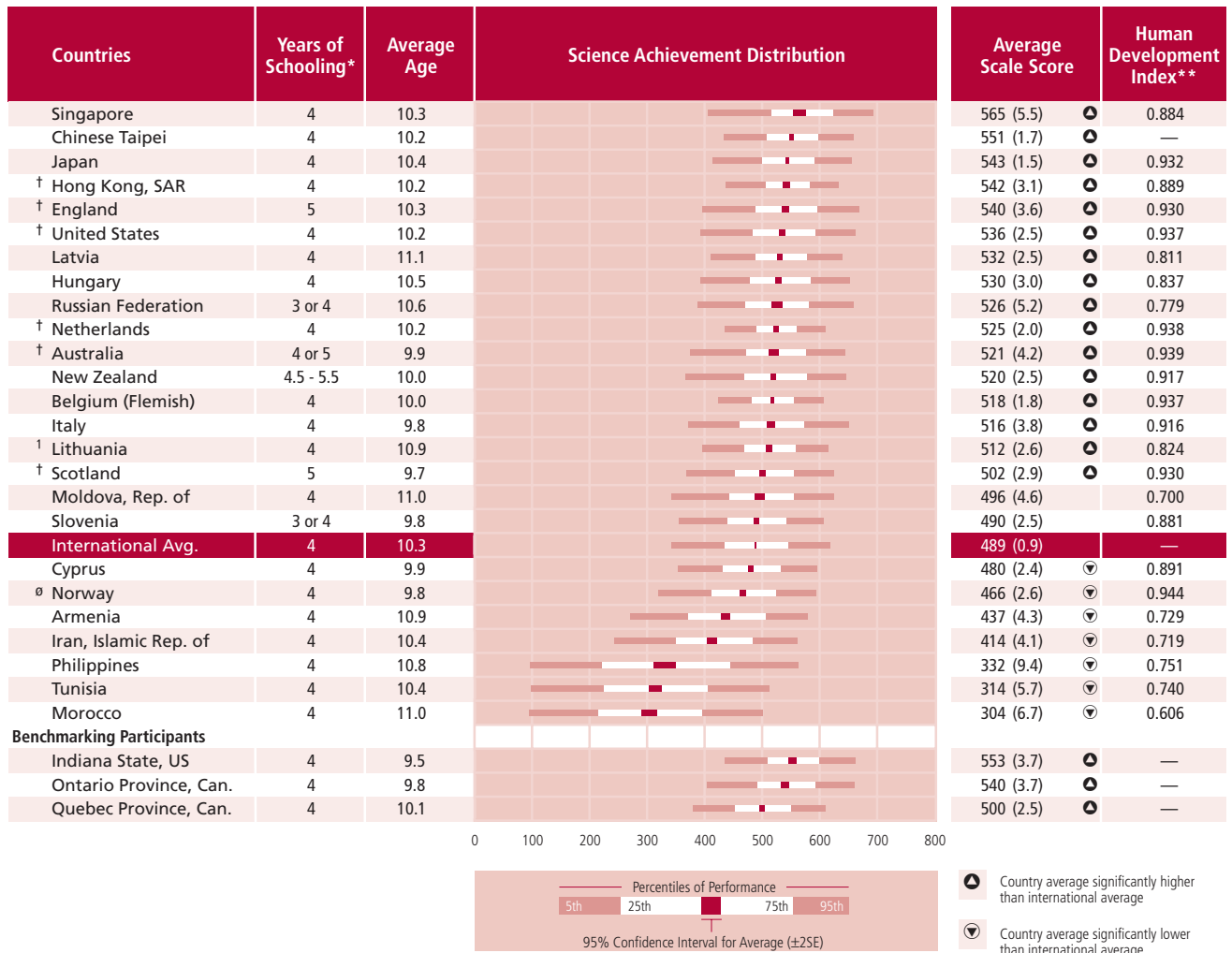


SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

\* Represents years of schooling counting from the first year of ISCED Level 1.  
 \*\* Taken from United Nations Development Programme's *Human Development Report 2003*, p. 237-240.  
 † Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).  
 ‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).  
 ‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).  
 2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).  
 ♦♦ Korea tested the same cohort of students as other countries, but later in 2003, at the beginning of the next school year.  
 ( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.  
 A dash (–) indicates comparable data are not available.

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<sup>1</sup> National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

<sup>o</sup> Norway: 4 years of formal schooling, but First Grade is called "First grade/Preschool."

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (—) indicates comparable data are not available.

students begin formal schooling and different policies about promotion and retention from grade to grade.

At the eighth grade, the aim was that the students assessed would have had eight years of formal schooling. Most notably, students in Norway, most of Slovenia, and parts of the Russian Federation had fewer years of formal schooling than their counterparts in other countries, while those in England, Scotland, New Zealand, and parts of Australia had more years of schooling. Even though the students assessed at the eighth grade typically averaged between 14 and 15 years old, the variety of countries assessed and their situations also resulted in a considerable range in the average age of the students assessed. To illustrate how education policies can affect the interaction between age and number of years of schooling, it is interesting to note that Scotland, one of the few countries with an additional year of schooling, starts formal schooling at an early age and had the youngest students assessed – 13.7 years old on average. Other countries assessing students younger than 14 years old included Slovenia, Norway, and Cyprus with 13.8 and Australia, Jordan, and Italy with 13.9. Students in the Balkans and some Eastern European countries start school later and tended to be older, particularly in Estonia with an average of 15.2. Students also were older in several African countries including Botswana and South Africa both averaging 15.1, Morocco averaging 15.2, and Ghana averaging 15.5. In these countries, it is not unusual for students to start school at an older age and also, perhaps, to find it necessary to interrupt their schooling.

At the fourth grade, the aim was to assess students having had four years of formal schooling and this was the case for the most part. However, some students in Slovenia and parts of the Russian Federation had only three years of formal schooling, and students in England and Scotland as well as some in Australia and New Zealand had five years. In terms of chronological age, students in most countries averaged between 10 and 11 years old. Consistent with the patterns at the eighth grade, students were somewhat younger in Scotland, averaging

9.7 years old; Italy, Slovenia, and Norway, averaging 9.8; and Australia, and Cyprus, averaging 9.9. The students in the Balkan and Eastern European countries were somewhat older, especially in Latvia with an average age of 11.1.

As a reminder that not all countries are equally well equipped to meet the challenge of educating their young people, Exhibit 1.1 includes the value for each country on the Human Development Index provided by the United Nations Development Programme (UNDP).<sup>7</sup> The index has a minimum value of 0 and a maximum of 1.0. Countries with high values on the index enjoy long life expectancy, high levels of school enrollment and adult literacy, and a good standard of living as measured by per capita GDP. For example, TIMSS countries with index values greater than 0.9 included Australia, Belgium (Flemish), England, Israel, Italy, Japan, New Zealand, Norway, The Netherlands, Scotland, Sweden, and the United States. All have average eighth-grade science achievement above the international average. However, not all countries above the international average had an index value as high as this.

Exhibit 1.2 shows how a country's average achievement in science compares to achievement in the other countries. This figure shows whether or not the differences in average achievement between pairs of countries are statistically significant. Selecting a country of interest and reading across the table, a circle with a triangle pointing up indicates significantly higher performance than the comparison country listed across the top; absence of a symbol indicates no significant difference in performances; and a circle with triangle pointing down indicates significantly lower performance.

The data in Exhibit 1.2 reinforce the point that, when ordered by average achievement, adjacent countries usually did not significantly differ from each other, although the differences in achievement between the high-performing and low-performing countries were very large. Because of this wide range in performance, the pattern for a

<sup>7</sup> Human Development Report 2003, p. 237-240.

Exhibit 1.2: Multiple Comparisons of Average Science Achievement



Instructions: Read across the row for a country to compare performance with the countries listed along the top of the chart. The symbols indicate whether the average achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the average achievement of the two countries.

Table with 47 rows (countries) and 47 columns (comparison countries). The table contains symbols indicating statistical significance: upward arrows for higher achievement, downward arrows for lower achievement, and empty cells for no significant difference.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Note: 5% of these comparisons would be statistically significant by chance alone.



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Iran, Islamic Rep. of Macedonia, Rep. of Cyprus Bahrain Palestinian Nat'l Auth. Egypt Indonesia Chile Tunisia Saudi Arabia Morocco Lebanon Philippines Botswana Ghana South Africa	Basque Country, Spain Indiana State, US Ontario Province, Can. Quebec Province, Can.	Countries
▲	▲	Singapore
▲	▲	Chinese Taipei
▲	▲	Korea, Rep. of
▲	▲	Hong Kong, SAR
▲	▲	Estonia
▲	▲	Japan
▲	▲	England
▲	▲	Hungary
▲	▲	Netherlands
▲	▲	United States
▲	▲	Australia
▲	▼	Sweden
▲	▼	Slovenia
▲	▼	New Zealand
▲	▼	Lithuania
▲	▼	Slovak Republic
▲	▼	Belgium (Flemish)
▲	▼	Russian Federation
▲	▼	Latvia
▲	▼	Scotland
▲	▼	Malaysia
▲	▼	Norway
▲	▼	Italy
▲	▼	Israel
▲	▼	Bulgaria
▲	▼	Jordan
▲	▼	Moldova, Rep. of
▲	▼	Romania
▲	▼	Serbia
▲	▼	Armenia
▲	▼	Iran, Islamic Rep. of
▲	▼	Macedonia, Rep. of
▲	▼	Cyprus
▲	▼	Bahrain
▲	▼	Palestinian Nat'l Auth.
▲	▼	Egypt
▲	▼	Indonesia
▲	▼	Chile
▲	▼	Tunisia
▲	▼	Saudi Arabia
▲	▼	Morocco
▲	▼	Lebanon
▲	▼	Philippines
▲	▼	Botswana
▲	▼	Ghana
▲	▼	South Africa
▲	▼	<b>Benchmarking Participants</b>
▲	▼	Basque Country, Spain
▲	▼	Indiana State, US
▲	▼	Ontario Province, Can.
▲	▼	Quebec Province, Can.

- ▲ Average achievement significantly higher than comparison country
- ▼ Average achievement significantly lower than comparison country

Note: 5% of these comparisons would be statistically significant by chance alone.

Exhibit 1.2: Multiple Comparisons of Average Science Achievement

Instructions: Read across the row for a country to compare performance with the countries listed along the top of the chart. The symbols indicate whether the average achievement of the country in the row is significantly lower than that of the comparison country significantly higher than that of the comparison country, or if there is no statistically significant difference between the average achievement of the two countries.

Countries	Singapore	Chinese Taipei	Japan	Hong Kong, SAR	England	United States	Latvia	Hungary	Russian Federation	Netherlands	Australia	New Zealand	Belgium (Flemish)	Italy	Lithuania	Scotland	Moldova, Rep. of	Slovenia	Cyprus	Norway	Armenia	Iran, Islamic Rep. of	Philippines	Tunisia	Morocco	Indiana State, US	Ontario Province, Can.	Quebec Province, Can.
Singapore		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Chinese Taipei	▼		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Japan	▼	▼				▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Hong Kong, SAR	▼	▼				▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
England	▼	▼				▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
United States	▼	▼	▼							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Latvia	▼	▼	▼	▼	▼					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Hungary	▼	▼	▼	▼	▼					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Russian Federation	▼	▼	▼	▼	▼					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Netherlands	▼	▼	▼	▼	▼	▼	▼						▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Australia	▼	▼	▼	▼	▼	▼	▼									▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
New Zealand	▼	▼	▼	▼	▼	▼	▼								▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Belgium (Flemish)	▼	▼	▼	▼	▼	▼	▼	▼							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Italy	▼	▼	▼	▼	▼	▼	▼	▼	▼													▲	▲	▲	▲	▲	▲	
Lithuania	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼												▲	▲	▲	▲	▲	▲	
Scotland	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼											▲	▲	▲	▲	▲	▲	
Moldova, Rep. of	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼										▲	▲	▲	▲	▲	▲	
Slovenia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼									▲	▲	▲	▲	▲	▲	
Cyprus	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼								▲	▲	▲	▲	▲	▲	
Norway	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼							▲	▲	▲	▲	▲	▲	
Armenia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼						▲	▲	▲	▲	▲	▲	
Iran, Islamic Rep. of	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼					▲	▲	▲	▲	▲	▲	
Philippines	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼				▲	▲	▲	▲	▲	▲	
Tunisia	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼			▲	▲	▲	▲	▲	▲	
Morocco	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		▲	▲	▲	▲	▲	▲	
<b>Benchmarking Participants</b>																												
Indiana State, US		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Ontario Province, Can.	▼	▼						▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Quebec Province, Can.	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	

▲ Average achievement significantly higher than comparison country

▼ Average achievement significantly lower than comparison country

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Note: 5% of these comparisons would be statistically significant by chance alone.

number of countries was one of having lower mean achievement than some countries, about the same mean achievement as other countries, and higher mean achievement than a third group of countries.

At the eighth grade, Singapore and Chinese Taipei were the top-performing countries having significantly higher mean achievement than the rest of the participating countries. The Republic of Korea also performed very well, with mean science achievement higher than all of the other participating countries except Singapore, Chinese Taipei, and Hong Kong SAR. Hong Kong SAR, Estonia and Japan had significantly higher achievement than most other participating countries, as did England, Hungary, and the Netherlands. Singapore was the top-performing country at the fourth grade, with higher average science achievement than all other participants. With the exception of Singapore, Chinese Taipei had higher average achievement than the rest of the participating countries. Japan, Hong Kong SAR, and England had significantly higher average achievement than the other participating countries. The United States, Latvia, Hungary, and the Russian Federation also performed better, on average, than most of the other countries.

### **How Has Science Achievement Changed Since 1995 and 1999?**

Exhibit 1.3 shows the countries that have comparable data from previous TIMSS assessments at the eighth and fourth grades. At the eighth grade, 35 countries and three of the benchmarking participants have data from one or both of the previous TIMSS assessments conducted in 1995 and 1999. Well over half of the countries and two of the benchmarking entities, the Canadian provinces of Ontario and Quebec, have participated in all three TIMSS assessments. Of these, 18 countries as well as Ontario and Quebec have trends in science achievement for their eighth-grade students across three points in time – 1995, 1999, and 2003. For several three-time participants, not all the results are presented because they were not strictly comparable. For example, changes in policy about age of school entry complicated trend data



Exhibit 1.3: Trends in Science Achievement

Countries	Average Scale Score	1999 to 2003 Difference	1995 to 2003 Difference	Science Achievement Distribution	Average Age
<b>Singapore</b>					
2003	578 (4.3)				14.3
1999	568 (8.0)	10 (9.1)			14.4
1995	580 (5.5)		-3 (7.0)		14.5
<b>Chinese Taipei</b>					
2003	571 (3.5)				14.2
1999	569 (4.4)	2 (5.5)			14.2
<b>Korea, Rep. of</b>					
2003	558 (1.6)				14.6
1999	549 (2.6)	10 (3.1) ▲			14.4
1995	546 (2.0)		13 (2.6) ▲		14.2
<b>Hong Kong, SAR</b>					
2003	556 (3.0)				14.4
1999	530 (3.7)	27 (4.8) ▲			14.2
1995	510 (5.8)		46 (6.6) ▲		14.2
<b>Japan</b>					
2003	552 (1.7)				14.4
1999	550 (2.2)	3 (2.8)			14.4
1995	554 (1.8)		-2 (2.5)		14.4
<b>Hungary</b>					
2003	543 (2.8)				14.5
1999	552 (3.7)	-10 (4.7) ▼			14.4
1995	537 (3.1)		6 (4.2)		14.3
<b>Netherlands</b>					
2003	536 (3.1)				14.3
1999	545 (6.9)	-9 (7.6)			14.2
1995	541 (6.0)		-6 (6.8)		14.4
<b>United States</b>					
2003	527 (3.1)				14.2
1999	515 (4.6)	12 (5.6) ▲			14.2
1995	513 (5.6)		15 (6.4) ▲		14.2
<b>Australia</b>					
2003	527 (3.8)				13.9
1995	514 (3.9)		13 (5.5) ▲		13.9
<b>Sweden</b>					
2003	524 (2.7)				14.9
1995	553 (4.4)		-28 (5.2) ▼		14.9
<b>Slovenia</b>					
2003	520 (1.8)				13.8
1995	514 (2.7)		7 (3.3) ▲		13.8
<b>New Zealand</b>					
2003	520 (5.0)				14.1
1999	510 (4.9)	10 (7.0)			14.0
1995	511 (4.9)		9 (7.0)		14.0
<b>Lithuania</b>					
2003	519 (2.1)				14.9
1999	488 (4.1)	31 (4.6) ▲			15.2
1995	464 (4.0)		56 (4.6) ▲		14.3
<b>Slovak Republic</b>					
2003	517 (3.2)				14.3
1999	535 (3.3)	-18 (4.6) ▼			14.3
1995	532 (3.3)		-15 (4.7) ▼		14.3

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

- ▲ Country average significantly higher than international average
- ▼ Country average significantly lower than international average

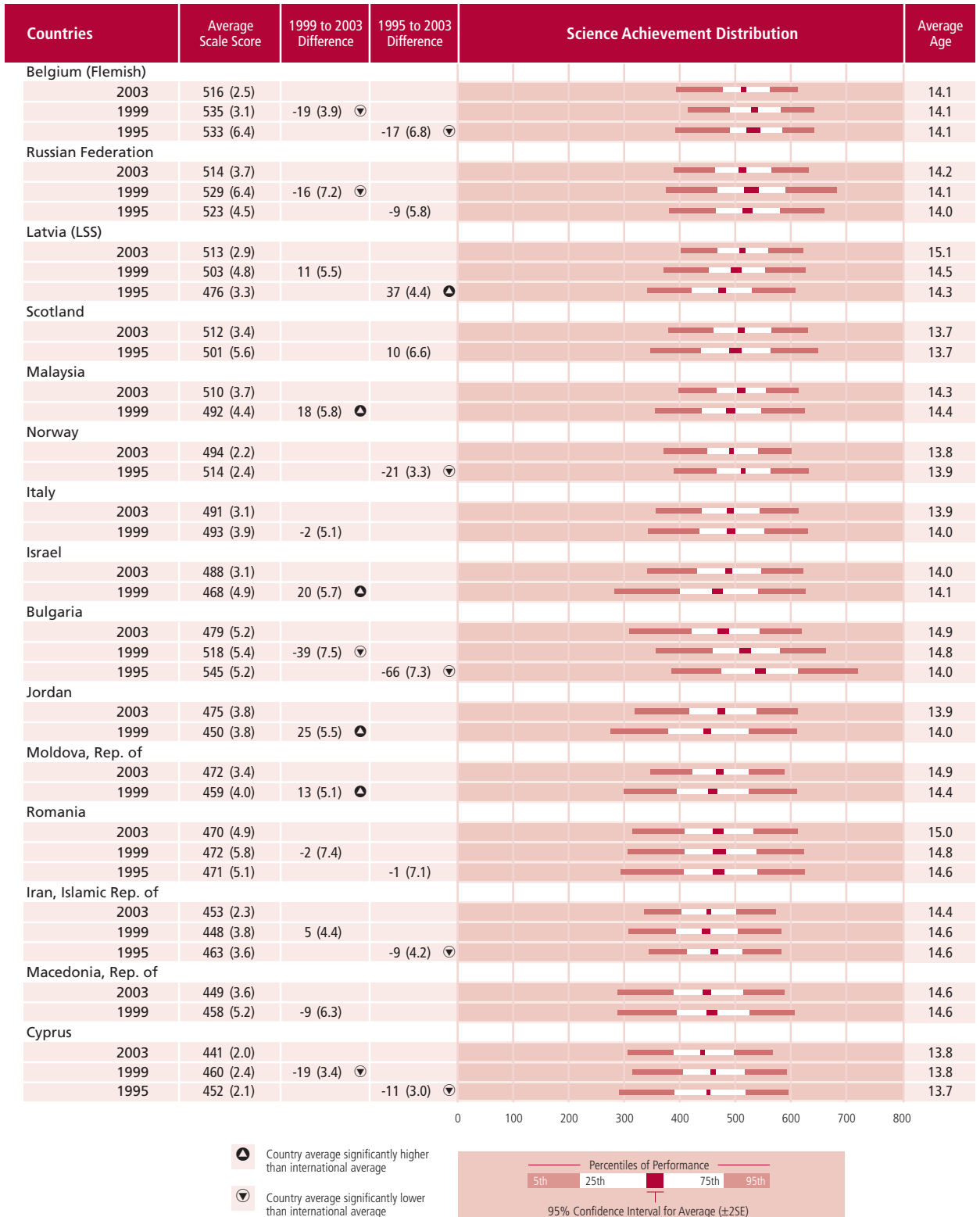
0 100 200 300 400 500 600 700 800



Trend notes: Because of differences in population coverage, 1999 data are not shown for Australia and Slovenia, and 1995 data are not shown for Israel, Italy, and South Africa. Korea tested later in 2003 than in 1999 and 1995, at the beginning of the next school year. Similarly, Lithuania tested later in 1999 than in 2003 and 1995. Data for Latvia in this exhibit include Latvian-speaking schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Exhibit 1.3: Trends in Science Achievement (Continued...)

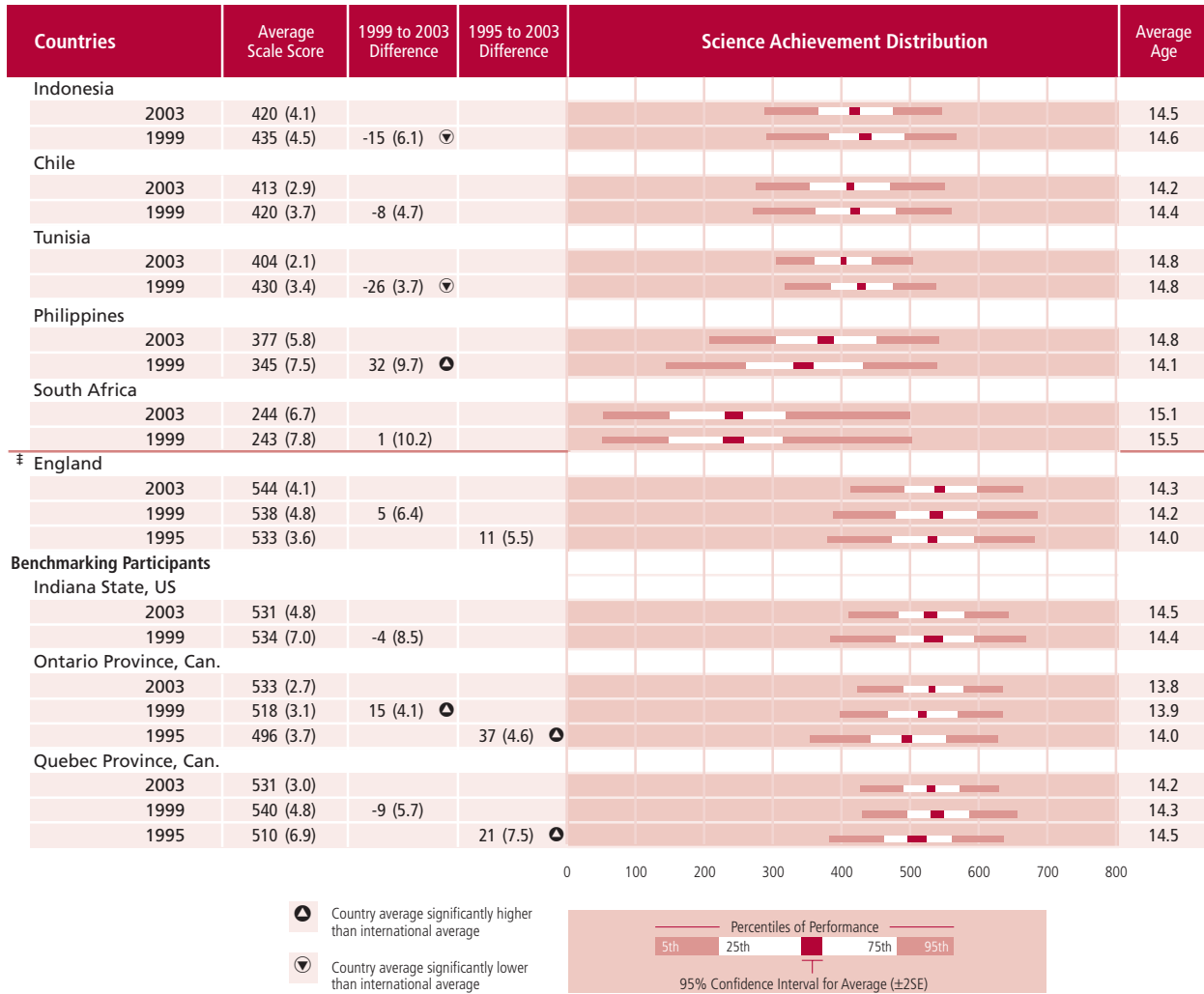


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Exhibit 1.3: Trends in Science Achievement (...Continued)



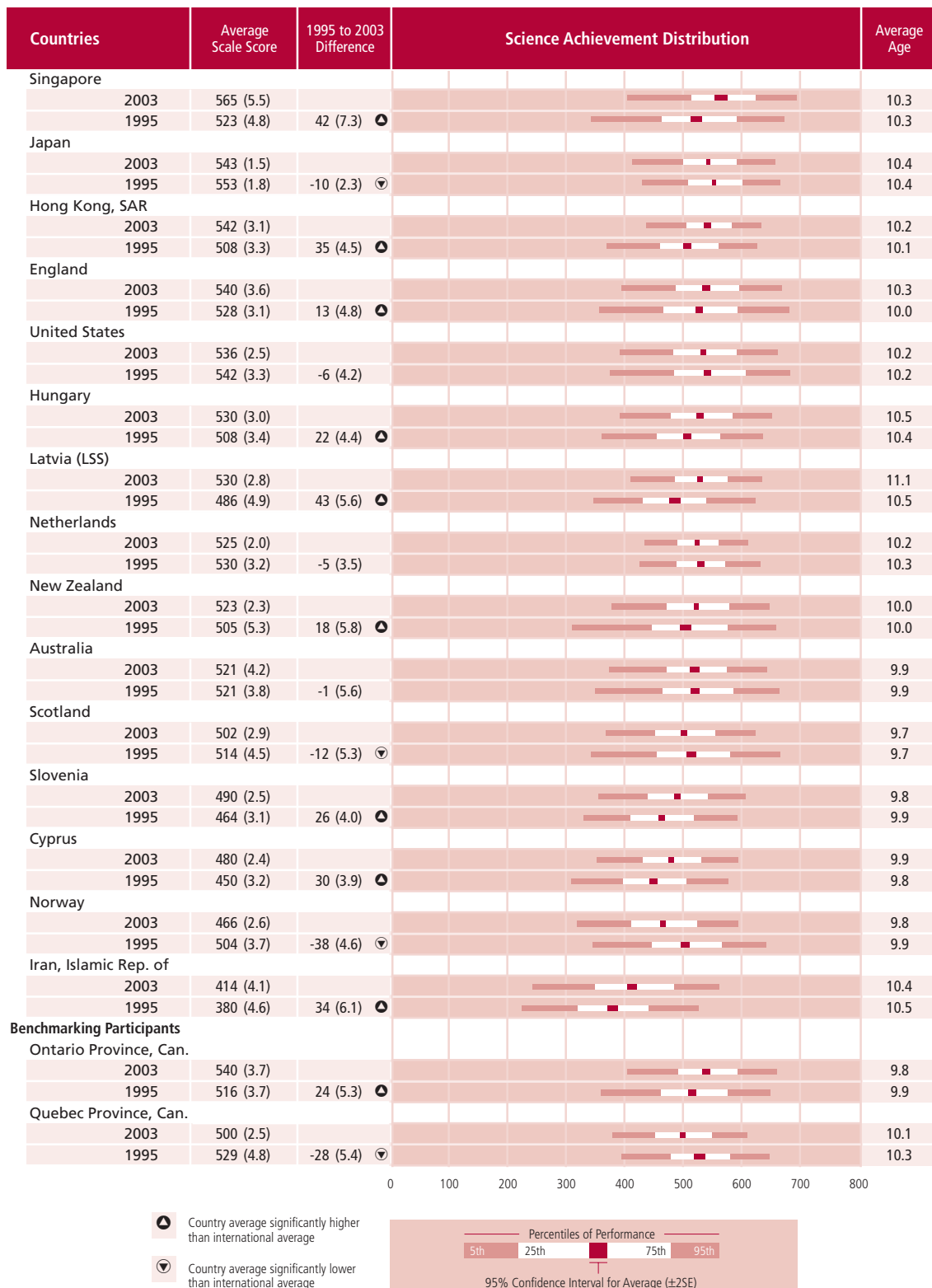
SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

Trend notes: Because of differences in population coverage, 1999 data are not shown for Australia and Slovenia, and 1995 data are not shown for Israel, Italy, and South Africa. Korea tested later in 2003 than in 1999 and 1995, at the beginning of the next school year. Similarly, Lithuania tested later in 1999 than in 2003 and 1995. Data for Latvia in this exhibit include Latvian-speaking schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Exhibit 1.3: Trends in Science Achievement



SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Trend notes: Because of differences between 1995 and 2003 in population coverage, 1995 data are not shown for Italy. Data for Latvia in this exhibit include Latvian-speaking schools only. To be comparable with 1995, 2003 data for New Zealand in this exhibit include students in English medium instruction only (98% of the estimated population).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

collection in Australia and Slovenia so their 1999 data are not shown. Also, the 1995 data are not shown for Israel, Italy, and South Africa since the characteristics of their samples were not completely known in that first assessment. Twelve countries and the U.S. state of Indiana can monitor changes in performance between 1999 and 2003, and five countries including Australia, Sweden, Slovenia, Scotland, and Norway, between 1995 and 2003. At the fourth grade, 15 of the TIMSS 2003 countries as well as Ontario and Quebec also participated in TIMSS 1995. Since TIMSS was not conducted at the fourth grade in 1999, these participants can track changes in student achievement over an eight-year period, between 1995 and 2003.

For the countries participating in assessments prior to TIMSS 2003, Exhibit 1.3 shows the results and the differences in average achievement between the years.<sup>8</sup> Countries are presented in descending order according to their average achievement in TIMSS 2003. At the eighth grade, a number of participants had significantly higher achievement in TIMSS 2003 than in previous assessments. Most notably, Korea, Hong Kong SAR, the United States, Lithuania, and Ontario have shown a pattern of improvement from assessment to assessment with significant change over the eight-year period. Malaysia, Israel, Jordan, Moldova, and the Philippines showed significant improvement from 1999 to 2003. Australia and Slovenia did not participate in 1999, but showed improvement from 1995 to 2003. Latvia (LSS) and Quebec showed improvement from 1995 to 2003 but not from 1999. Countries showing a decrease at the eighth grade in TIMSS 2003, from 1995, 1999, or both, included Hungary, Sweden, the Slovak Republic, Belgium (Flemish), the Russian Federation, Norway, Bulgaria, Iran, Cyprus, Indonesia, and Tunisia.

At the fourth grade, many countries had significant increases in average achievement between 1995 and 2003. Participants showing improved performance included Singapore, Hong Kong SAR, England, Hungary, Latvia (LSS), New Zealand, Slovenia, Cyprus, Iran, and

8 TIMSS used IRT methods to place the TIMSS 2003 results on the same scales that were developed for 1995 and also used for 1999 at the eighth grade. See Appendix A for more detailed information.



Ontario. Several participants showed significant declines, including Japan, Scotland, Norway, and Quebec.

A number of countries showed remarkable changes in science achievement over the eight-year period covered by the TIMSS assessments, some of which may be the result of societal or educational changes during this time. For example, the political changes in Eastern Europe more than a decade ago spawned far-reaching educational reform initiatives that have changed the face of education in many countries in the region. The achievement growth in Latvia and Lithuania as well as the strong performance of Estonia in its first TIMSS appearance may reflect the efforts at improvement in those countries. In contrast, countries in the region where reform efforts seem to have been less successful include Bulgaria, the Russian Federation, the Slovak Republic, each of which show decreases over the period.

### **What Are the Gender Differences in Science Achievement?**

Exhibit 1.4 shows gender differences in eighth- and fourth-grade mathematics achievement in 2003. It presents average achievement separately for girls and boys for each of the TIMSS 2003 countries, as well as the difference between the means. Countries are shown in increasing order of this gender difference. The gender difference for each country is shown by a bar indicating the amount of the difference, whether the direction of the difference favored girls or boys, and whether the difference is statistically significant (indicated by a darkened bar).

On average, across all countries, boys outperformed girls at the eighth grade by six scale-score points (477 vs. 471), although the situation varied considerably from country to country. In eleven countries, including Egypt, Iran, Chinese Taipei, Botswana, South Africa, Lebanon, Singapore, Estonia, Cyprus, the Philippines, and New Zealand, the gender difference was not significant. Countries where the gender difference favored girls included Macedonia, Moldova, Armenia, the Palestinian National Authority, Saudi Arabia, Jordan, and Bahrain.

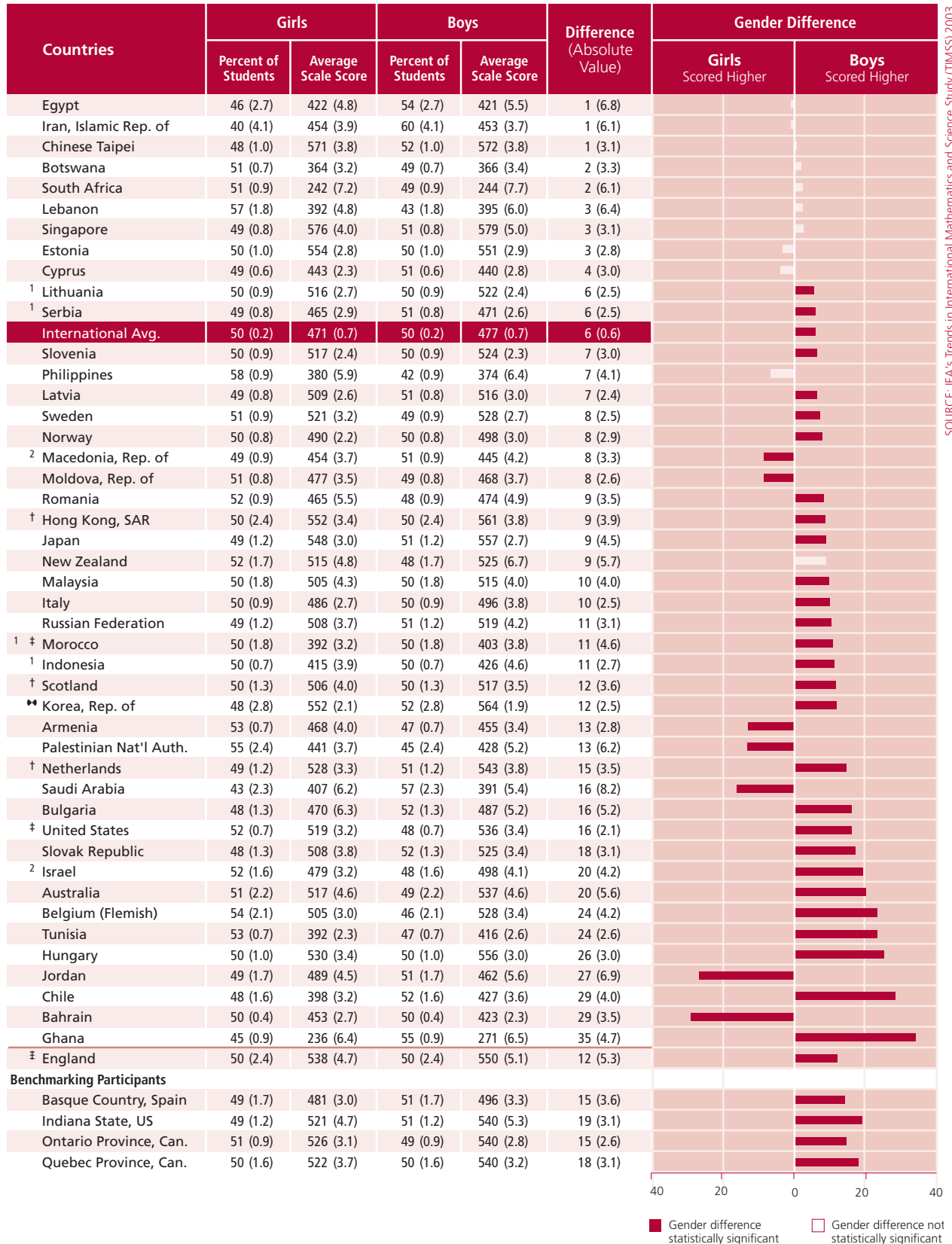
However, in the majority of participants (33), boys outperformed girls, often by a substantial margin. For example, countries where the gender difference was 20 points or more included Israel, Australia, Belgium (Flemish), Tunisia, Hungary, Chile, and Ghana. At the fourth grade, the average difference internationally was negligible. However, girls had significantly higher average achievement in Armenia, Moldova, the Philippines, and Iran. Boys had higher average achievement in the United States, Chinese Taipei, Cyprus, the Netherlands, and Scotland.

Achievement differences between TIMSS 2003 and 1995 and 1999 are presented separately for girls and for boys in Exhibit 1.5. At the eighth grade, girls showed a seven-point improvement, on average, since 1999, however, boys showed no improvement. Fifteen participants showed significant improvement for girls, and just eight for boys. Both boys and girls had significantly higher achievement in 2003 than in previous assessments in Hong Kong SAR, Israel, Jordan, Latvia (LSS), Lithuania, Malaysia, the Philippines, the United States, and Ontario. Girls but not boys showed improved performance compared to 1999 in Iran, Korea, Moldova, Singapore, and England. Only in Australia and Quebec did boys show improvement and girls not. Both boys and girls had significantly lower average achievement in TIMSS 2003 in Belgium (Flemish), Bulgaria, Cyprus, Norway, the Slovak Republic, Sweden, and Tunisia. In Indonesia, Macedonia, and the Russian Federation, the boys, but not the girls, had a significant decrease.

At the fourth grade, both boys and girls improved performance significantly on average since 1995 (17 points for girls and 9 points for boys). Both genders improved in Cyprus, Hong Kong SAR, Hungary, Iran, Latvia (LSS), New Zealand, Singapore, Slovenia, and Ontario. In England, only girls improved. Both boys and girls showed declines in Japan, Norway, and Quebec. Boys but not girls showed declines in the Netherlands and the United States.



Exhibit 1.4: Average Science Achievement by Gender

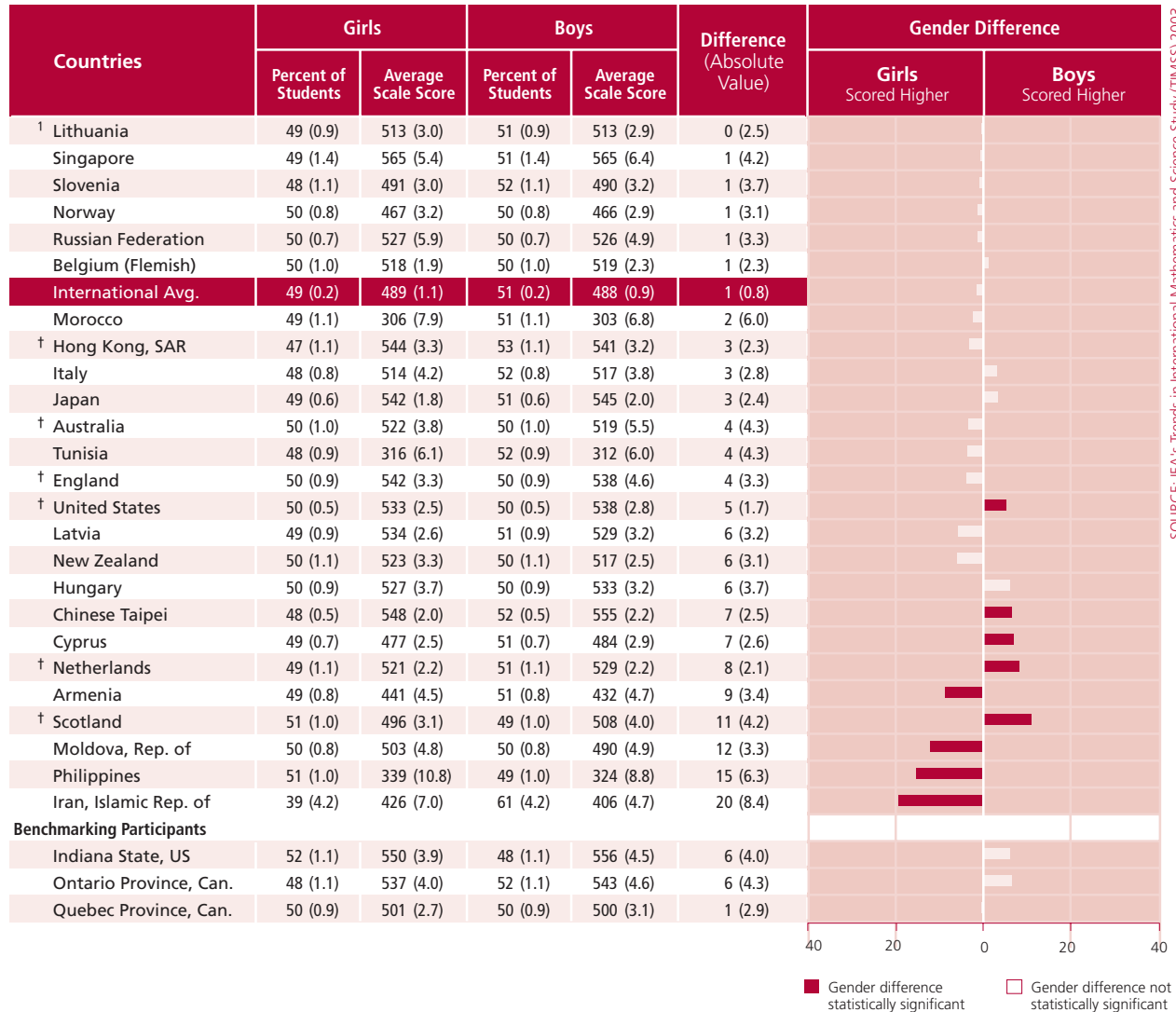


SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).  
<sup>‡</sup> Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).  
<sup>‡</sup> Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).  
 2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).  
<sup>\*\*</sup> Korea tested the same cohort of students as other countries, but later in 2003, at the beginning of the next school year.  
 ( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Exhibit 1.4: Average Science Achievement by Gender



SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

<sup>1</sup> National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

## Exhibit 1.5: Trends in Average Science Achievement by Gender



Countries	Girls			Boys			
	2003 Average Scale Score	1999 to 2003 Difference	1995 to 2003 Difference	2003 Average Scale Score	1999 to 2003 Difference	1995 to 2003 Difference	
Australia	517 (4.6)	--	10 (6.0)	537 (4.6)	--	18 (7.1)	▲
Belgium (Flemish)	505 (3.0)	-21 (5.4) ▼	-19 (9.2) ▼	528 (3.4)	-16 (7.9) ▼	-14 (9.7)	▼
Bulgaria	470 (6.3)	-41 (8.6) ▼	-78 (8.8) ▼	487 (5.2)	-38 (8.3) ▼	-56 (7.6)	▼
Chile	398 (3.2)	-11 (5.6)	◇ ◇	427 (3.6)	-5 (6.2)	◇ ◇	
Chinese Taipei	571 (3.8)	10 (5.5)	◇ ◇	572 (3.8)	-6 (6.6)	◇ ◇	
Cyprus	443 (2.3)	-11 (4.2) ▼	-11 (3.6) ▼	440 (2.8)	-26 (4.2) ▼	-11 (3.8)	▼
Hong Kong, SAR	552 (3.4)	29 (5.7) ▲	60 (7.4) ▲	561 (3.8)	24 (6.2) ▲	36 (7.4) ▲	▲
Hungary	530 (3.4)	-10 (5.5)	5 (4.8)	556 (3.0)	-10 (5.4)	7 (4.7)	
Indonesia	415 (3.9)	-12 (7.7)	◇ ◇	426 (4.6)	-18 (6.7) ▼	◇ ◇	
Iran, Islamic Rep. of	454 (3.9)	24 (6.9) ▲	6 (7.0)	453 (3.7)	-7 (5.7)	-22 (5.8)	▼
Israel	479 (3.2)	18 (6.8) ▲	--	498 (4.1)	23 (7.0) ▲	--	
Italy	486 (2.7)	1 (4.9)	--	496 (3.8)	-7 (7.2)	--	
Japan	548 (3.0)	5 (4.0)	3 (3.5)	557 (2.7)	0 (4.1)	-7 (3.6)	▼
Jordan	489 (4.5)	29 (6.8) ▲	◇ ◇	462 (5.6)	20 (8.3) ▲	◇ ◇	
Korea, Rep. of	552 (2.1)	14 (4.4) ▲	22 (3.2) ▲	564 (1.9)	5 (4.0)	6 (3.4)	▲
Latvia (LSS)	511 (3.2)	16 (5.9) ▲	48 (5.0) ▲	515 (3.3)	5 (6.0)	25 (5.4)	▲
Lithuania	516 (2.7)	38 (5.2) ▲	64 (5.2) ▲	522 (2.4)	23 (5.6) ▲	45 (5.1) ▲	▲
Macedonia, Rep. of	454 (3.7)	-4 (7.1)	◇ ◇	445 (4.2)	-13 (6.6) ▼	◇ ◇	
Malaysia	505 (4.3)	17 (7.1) ▲	◇ ◇	515 (4.0)	18 (7.1) ▲	◇ ◇	
Moldova, Rep. of	477 (3.5)	22 (5.7) ▲	◇ ◇	468 (3.7)	3 (6.2)	◇ ◇	
Netherlands	528 (3.3)	-8 (8.0)	0 (6.5)	543 (3.8)	-11 (8.2)	-11 (8.3)	
New Zealand	515 (4.8)	9 (7.0)	18 (7.5) ▲	525 (6.7)	11 (9.7)	1	
Norway	490 (2.2)	◇ ◇	-16 (3.4) ▼	498 (3.0)	◇ ◇	-25 (4.8)	▼
Philippines	380 (5.9)	29 (10.2) ▲	◇ ◇	374 (6.4)	35 (11.3) ▲	◇ ◇	
Romania	465 (5.5)	-3 (8.0)	2 (7.7)	474 (4.9)	-1 (8.0)	-4 (7.5)	
Russian Federation	508 (3.7)	-11 (8.0)	-7 (5.9)	519 (4.2)	-21 (7.3) ▼	-12 (6.4)	
Scotland	506 (4.0)	◇ ◇	19 (6.6) ▲	517 (3.5)	◇ ◇	3 (7.5)	
Singapore	576 (4.0)	19 (8.8) ▲	3 (7.8)	579 (5.0)	1 (10.9)	-8 (8.6)	
Slovak Republic	508 (3.8)	-17 (5.0) ▼	-12 (5.7) ▼	525 (3.4)	-21 (5.6) ▼	-20 (4.7)	▼
Slovenia	517 (2.4)	--	13 (3.8) ▲	524 (2.3)	--	0 (4.0)	
South Africa	242 (7.2)	8 (11.6)	--	244 (7.7)	-9 (10.8)	--	
Sweden	521 (3.2)	◇ ◇	-26 (6.0) ▼	528 (2.7)	◇ ◇	-31 (5.5)	▼
Tunisia	392 (2.3)	-25 (3.9) ▼	◇ ◇	416 (2.6)	-26 (4.5) ▼	◇ ◇	
United States	519 (3.2)	14 (5.8) ▲	14 (6.3) ▲	536 (3.4)	11 (6.3)	16 (6.9)	▲
‡ England	538 (4.7)	16 (7.9) ▲	15 (6.3) ▲	550 (5.1)	-4 (7.3)	7 (8.0)	
<b>International Avg.</b>	<b>486 (0.7)</b>	<b>7 (1.2) ▲</b>	<b>3 (1.3) ▲</b>	<b>495 (0.8)</b>	<b>0 (1.2)</b>	<b>-5 (1.4) ▼</b>	
<b>Benchmarking Participants</b>							
Indiana State, US	521 (4.7)	-3 (8.4)	◇ ◇	540 (5.3)	-5 (9.3)	◇ ◇	
Ontario Province, Can.	526 (3.1)	17 (4.7) ▲	38 (4.7) ▲	540 (2.8)	13 (4.3) ▲	35 (5.5) ▲	▲
Quebec Province, Can.	522 (3.7)	-14 (7.7)	16 (8.5)	540 (3.2)	-5 (5.6)	26 (8.1) ▲	▲

▲ 2003 significantly higher

▼ 2003 significantly lower

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

Trend notes: Because of differences in population coverage, 1999 data are not shown for Australia and Slovenia, and 1995 data are not shown for Israel, Italy, and South Africa. Korea tested later in 2003 than in 1999 and 1995, at the beginning of the next school year. Similarly, Lithuania tested later in 1999 than in 2003 and 1995. Data for Latvia in this exhibit include Latvian-speaking schools only.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (-) indicates comparable data are not available.

A diamond (◇) indicates the country did not participate in the assessment.

## Exhibit 1.5: Trends in Average Science Achievement by Gender



Countries	Girls		Boys	
	2003 Average Scale Score	1995 to 2003 Difference	2003 Average Scale Score	1995 to 2003 Difference
Australia	522 (3.8)	4 (5.2)	519 (5.5)	-5 (7.2)
Cyprus	477 (2.5)	32 (3.9)	484 (2.9)	29 (4.9)
England	542 (3.3)	17 (4.8)	538 (4.6)	8 (6.0)
Hong Kong, SAR	544 (3.3)	43 (4.8)	541 (3.2)	27 (5.1)
Hungary	527 (3.7)	26 (5.2)	533 (3.2)	17 (5.0)
Iran, Islamic Rep. of	426 (7.0)	48 (8.8)	406 (4.7)	23 (8.6)
Japan	542 (1.8)	-5 (2.7)	545 (2.0)	-14 (2.8)
Latvia (LSS)	534 (3.0)	46 (6.4)	526 (3.7)	40 (6.5)
Netherlands	521 (2.2)	3 (3.9)	529 (2.2)	-14 (4.2)
New Zealand	526 (3.2)	15 (5.7)	521 (2.3)	22 (7.4)
Norway	467 (3.2)	-30 (4.9)	466 (2.9)	-43 (5.8)
Scotland	496 (3.1)	-16 (5.6)	508 (4.0)	-9 (6.7)
Singapore	565 (5.4)	45 (8.0)	565 (6.4)	39 (8.3)
Slovenia	491 (3.0)	33 (4.6)	490 (3.2)	21 (5.3)
United States	533 (2.5)	-3 (4.6)	538 (2.8)	-10 (4.3)
<b>International Avg.</b>	<b>514 (1.1)</b>	<b>17 (1.4)</b>	<b>514 (1.1)</b>	<b>9 (1.6)</b>
<b>Benchmarking Participants</b>				
Ontario Province, Can.	537 (4.0)	24 (5.8)	543 (4.6)	25 (6.2)
Quebec Province, Can.	501 (2.7)	-24 (5.7)	500 (3.1)	-32 (7.1)

▲ 2003 significantly higher than 1995

▼ 2003 significantly lower than 1995

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Trend notes: Because of differences between 1995 and 2003 in population coverage, 1995 data are not shown for Italy. Data for Latvia in this exhibit include Latvian-speaking schools only. To be comparable with 1995, 2003 data for New Zealand in this exhibit include students in English medium instruction only (98% of the estimated population).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

