ies NATIONAL CENTER FOR EDUCATION STATISTICS
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U. S. Department of Education
NCES 2008-016

# Highlights From PISA 2006:

## Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context

PISA
Program for International Student Assessment

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December 2007

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# Executive Summary

The Program for International Student Assessment (PISA) is a system of international assessments that measures 15-year-olds' performance in reading literacy, mathematics literacy, and science literacy every 3 years. PISA, first implemented in 2000, is sponsored by the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of 30 member countries. In 2006, fifty-seven jurisdictions participated in PISA, including 30 OECD jurisdictions and 27 non-OECD jurisdictions.

Each PISA data collection effort assesses one of the three subject areas in depth. In this third cycle, PISA 2006, science literacy was the subject area assessed in depth. The PISA assessment measures student performance on a combined science literacy scale and on three science literacy subscales: *identifying scientific issues, explaining phenomena scientifically,* and *using scientific evidence*. Combined science literacy scores are reported on a scale from 0 to 1,000 with a mean set at 500 and a standard deviation of 100.

This report focuses on the performance of U.S. students in the major subject area of science literacy as assessed in PISA 2006.[1] Achievement in the minor subject area of mathematics literacy in 2006 is also presented.[2] Differences in achievement by selected student characteristics are covered in the final section.

Key findings from the report include:

- Fifteen-year-old students in the United States had an average score of 489 on the combined science literacy scale, lower than the OECD average score of 500. U.S. students scored lower on science literacy than their peers in 16 of the other 29 OECD jurisdictions and 6 of the 27 non-OECD jurisdictions. Twenty-two jurisdictions (5 OECD jurisdictions and 17 non-OECD jurisdictions) reported lower scores compared to the United States in science literacy.
- When comparing the performance of the highest achieving students—those at the 90th percentile—there was no measurable difference between the average score of U.S. students (628) compared to the OECD average (622) on the combined science literacy scale. Twelve jurisdictions (9 OECD jurisdictions and 3 non-OECD jurisdictions) had students at the 90th percentile with higher scores than the United States on the combined science literacy scale.
- U.S. students also had lower scores than the OECD average score for two of the three content area subscales (*explaining phenomena scientifically* (486 versus 500) and *using scientific evidence* (489 versus 499)). There was no measurable difference in the performance of U.S. students compared with the OECD average on the *identifying scientific issues* subscale (492 versus 499).

[1] A total of 166 schools and 5,611 students participated in the assessment. The overall weighted school response rate was 69 percent before the use of replacement schools. The final weighted student response rate was 91 percent.

[2] PISA 2006 reading literacy results are not reported for the United States because of an error in printing the test booklets. In several areas of the reading literacy assessment, students were incorrectly instructed to refer to the passage on the "opposite page" when, in fact, the necessary passage appeared on the previous page. Because of the small number of items used in assessing reading literacy, it was not possible to recalibrate the score to exclude the affected items. Furthermore, as a result of the printing error, the mean performance in mathematics and science may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B.

- Along with scale scores, PISA 2006 uses six proficiency levels to describe student performance in science literacy, with level 6 being the highest level of proficiency. The United States had greater percentages of students below level 1 (8 percent) and at level 1 (17 percent) than the OECD average percentages on the combined science literacy scale (5 percent below level 1 and 14 percent at level 1).
- In 2006, the average U.S. score in mathematics literacy was 474, lower than the OECD average score of 498. Thirty-one jurisdictions (23 OECD jurisdictions and 8 non-OECD jurisdictions) scored higher, on average, than the United States in mathematics literacy in 2006. In contrast, 20 jurisdictions (4 OECD jurisdictions and 16 non-OECD jurisdictions) scored lower than the United States in mathematics literacy in 2006.
- When comparing the performance of the highest achieving students—those at the 90th percentile—U.S. students scored lower (593) than the OECD average (615) on the mathematics literacy scale. Twenty-nine jurisdictions (23 OECD jurisdictions and 6 non-OECD jurisdictions) had students at the 90th percentile with higher scores than the United States on the mathematics literacy scale.
- There was no measurable difference on the combined science literacy scale between 15-year-old male (489) and female (489) students in the United States. In contrast, the OECD average was higher for males (501) than females (499) on the combined science literacy scale.
- On the combined science literacy scale, Black (non-Hispanic) students (409) and Hispanic students (439) scored lower, on average, than White (non-Hispanic) students (523), Asian (non-Hispanic) students (499), and students of more than one race (non-Hispanic) (501). Hispanic students, in turn, scored higher than Black (non-Hispanic) students, while White (non-Hispanic) students scored higher than Asian (non-Hispanic) students.

# Acknowledgments

This report reflects the contributions of many individuals. The authors wish to thank all those who assisted with PISA 2006, from the design stage through the creation of this report. At NCES, the project was reviewed by Eugene Owen and Marilyn Seastrom. Sampling and data collection were conducted by RTI International. The members of the PISA 2006 Expert Panel (noted in appendix D) lent their time and expertise toward reviewing the project. All data tables, figures, and text presented in the report were reviewed by Anindita Sen, Martin Hahn, Gillian Hampden-Thompson, Lydia Malley, Steve Hocker, Aparna Sundaram, and Siri Warkentien at the Education Statistics Services Institute (ESSI). We also thank our colleagues at the American Institutes for Research (AIR) who assisted with data analyses and the preparation of the report. Finally, the authors wish to thank the many principals, teachers, and students who gave generously of their time to participate in PISA 2006.

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# Introduction

## PISA in Brief

The Program for International Student Assessment (PISA) is a system of international assessments that measures 15-year-olds' performance in reading literacy, mathematics literacy, and science literacy every 3 years. PISA was first implemented in 2000 (figure 1).

PISA is sponsored by the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of 30 member countries. In 2006, fifty-seven jurisdictions participated in PISA, including 30 OECD countries referred to throughout as jurisdictions and 27 non-OECD jurisdictions (figure 2 and table 1).

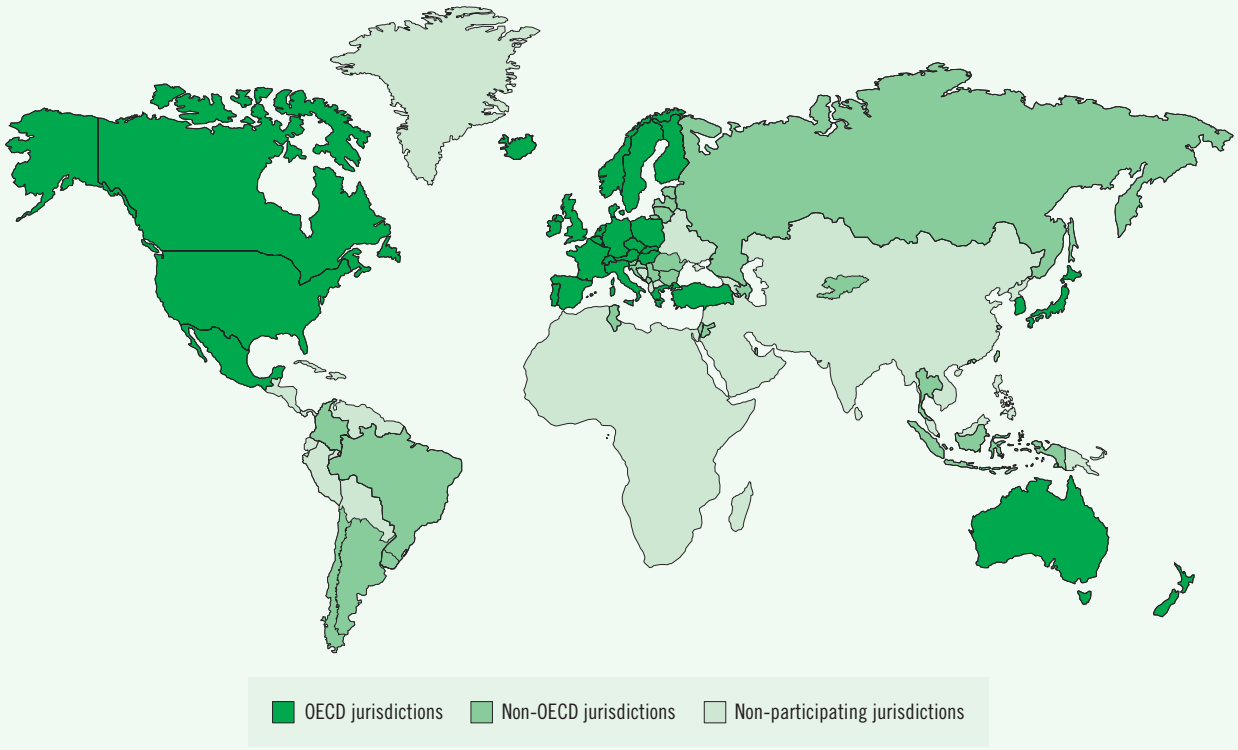
Each PISA data collection effort assesses one of the three subject areas in depth (considered the major subject area), even as all three are assessed in each cycle (the other two subjects are considered minor subject areas for that assessment year). This allows participating jurisdictions to have an ongoing source of achievement data in every subject area. In this third cycle, PISA 2006, science literacy was the subject area assessed in depth. In 2009, PISA will focus on reading literacy, which was also assessed as the major subject area in 2000.

**Figure 1. PISA administration cycle**

| Assessment year | 2000 | 2003 | 2006 | 2009 | 2012 | 2015 |
|---|---|---|---|---|---|---|
| Subjects assessed | **READING**<br>Mathematics<br>Science | Reading<br>**MATHEMATICS**<br>Science<br>Problem solving | Reading<br>Mathematics<br>**SCIENCE** | **READING**<br>Mathematics<br>Science | Reading<br>**MATHEMATICS**<br>Science | Reading<br>Mathematics<br>**SCIENCE** |

NOTE: Each subject area is tested in all assessment cycles of the Program for International Student Assessment (PISA). The subject in all capital letters is the major subject area for that cycle.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

## Figure 2. Jurisdictions that participated in PISA 2006




SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

## Table 1. Participation in PISA, by jurisdiction: 2000, 2003, and 2006

| Jurisdiction | 2000 | 2003 | 2006 |
|---|---|---|---|
| *OECD jurisdictions* | | | |
| Australia | • | • | • |
| Austria | • | • | • |
| Belgium | • | • | • |
| Canada | • | • | • |
| Czech Republic | • | • | • |
| Denmark | • | • | • |
| Finland | • | • | • |
| France | • | • | • |
| Germany | • | • | • |
| Greece | • | • | • |
| Hungary | • | • | • |
| Iceland | • | • | • |
| Ireland | • | • | • |
| Italy | • | • | • |
| Japan | • | • | • |
| Korea, Republic of | • | • | • |
| Luxembourg | • | • | • |
| Mexico | • | • | • |
| Netherlands | • | • | • |
| New Zealand | • | • | • |
| Norway | • | • | • |
| Poland | • | • | • |
| Portugal | • | • | • |
| Slovak Republic | | • | • |
| Spain | • | • | • |
| Sweden | • | • | • |
| Switzerland | • | • | • |
| Turkey | | • | • |
| United Kingdom | • | • | • |
| **United States** | • | • | • |

| Jurisdiction | 2000 | 2003 | 2006 |
|---|---|---|---|
| *Non-OECD jurisdictions* | | | |
| Argentina | | | • |
| Azerbaijan | | | • |
| Brazil | • | • | • |
| Bulgaria | | | • |
| Chile | | | • |
| Chinese Taipei | | | • |
| Colombia | | | • |
| Croatia | | | • |
| Estonia | | | • |
| Hong Kong-China | | • | • |
| Indonesia | | • | • |
| Israel | | | • |
| Jordan | | | • |
| Kyrgyz Republic | | | • |
| Latvia | • | • | • |
| Liechtenstein | • | • | • |
| Lithuania | | | • |
| Macao-China | | • | • |
| Qatar | | | • |
| Republic of Montenegro[1] | | • | • |
| Republic of Serbia[1] | | • | • |
| Romania | | | • |
| Russian Federation | • | • | • |
| Slovenia | | | • |
| Thailand | | • | • |
| Tunisia | | • | • |
| Uruguay | | • | • |

[1] The Republics of Montenegro and Serbia were a united jurisdiction under the PISA 2003 assessment.
NOTE: A "•" indicates that the jurisdiction participated in the Program for International Student Assessment (PISA) in the specific year. Highlighted are jurisdictions that participated in PISA in all 3 years. Because PISA is principally an Organization for Economic Cooperation and Development (OECD) study, non-OECD jurisdictions are displayed separately from the OECD jurisdictions.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2000, 2003, and 2006.

This report focuses on the performance of U.S. students in the major subject area of science literacy as assessed in PISA 2006. Achievement in the minor subject area of mathematics literacy in 2006 is also presented,[1] as are differences in achievement by selected student characteristics.

## The Unique Contribution of PISA

The United States has conducted surveys of student achievement at a variety of grade levels and in a variety of subject areas through the National Assessment of Educational Progress (NAEP) for many years. NAEP provides a regular benchmark for states and the nation and a means to monitor progress in achievement over time.

To provide a critical external perspective on the achievement of U.S. students through comparisons with students of other nations, the United States participates at the international level in PISA, the Progress in International Reading Literacy Study (PIRLS), and the Trends in International Mathematics and Science Study (TIMSS).[2] TIMSS and PIRLS seek to measure students' mastery of specific knowledge, skills, and concepts and are designed to reflect curriculum frameworks in the United States and other participating jurisdictions.

PISA provides a unique and complementary perspective to these studies by not focusing explicitly on curricular outcomes, but on the application of knowledge in reading, mathematics, and science to problems with a real-life context (OECD 1999). The framework for each subject area is based on concepts, processes, and situations or contexts (OECD 2006). For example, for science literacy, the concepts included are physics, chemistry, biological sciences, and earth and space sciences. The processes are centered on the ability to acquire, interpret, and act on evidence such as describing scientific phenomena and interpreting scientific evidence. The situations or contexts are those (either personal or educational) in which students might encounter scientific concepts and processes. Assessment items are then developed on the basis of these descriptions (see appendix A for examples).

PISA uses the terminology of "literacy" in each subject area to denote its broad focus on the application of knowledge and skills. For example, PISA seeks to assess whether15-year-olds are scientifically literate, or to what extent they can apply scientific knowledge and skills to a range of different situations they may encounter in their lives. Literacy itself refers to a continuum of skills—it is not a condition that one has or does not have (i.e., literacy or illiteracy). Rather, each person's skills place that person at a particular point on the literacy continuum (OECD 2006).

The target age of 15 allows jurisdictions to compare outcomes of learning as students near the end of compulsory schooling. PISA's goal is to answer the question "what knowledge and skills do students have at age 15?" taking into account schooling and other factors that may influence their performance. In this way, PISA's achievement scores represent a "yield" of learning at age 15, rather than a direct measure of attained curriculum knowledge at a particular grade level, because 15-year-olds in the United States and elsewhere come from several grade levels (figure 3 and table C-1).

## How PISA 2006 Was Conducted

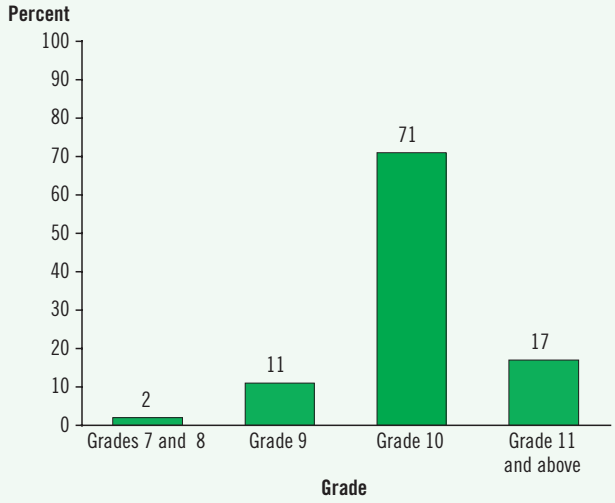
PISA 2006 was sponsored by the OECD and carried out at the international level through a contract with the PISA Consortium, led by the Australian Council for Educational Research (ACER).[3] The National Center for Education Statistics (NCES) of the Institute of Education Sciences at the U.S. Department of Education was responsible for the implementation of PISA in the United States. Data collection in the United States was carried out through

[1] PISA 2006 reading literacy results are not reported for the United States because of an error in printing the test booklets. In several areas of the reading literacy assessment, students were incorrectly instructed to refer to the passage on the "opposite page" when, in fact, the necessary passage appeared on the previous page. Because of the small number of items used in assessing reading literacy, it was not possible to recalibrate the score to exclude the affected items. Furthermore, as a result of the printing error, the mean performance in mathematics and science may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B.

[2] The United States has also participated in international comparative assessments of civics knowledge and skills (CivEd 1999) and adult literacy (International Adult Literacy Survey [IALS 1994] and Adult Literacy and Lifeskills Survey [ALL 2003]).

[3] The PISA Consortium consists of ACER, the National Institute for Educational Policy Research (NIER, Japan), Westat (USA), the Netherlands National Institute for Educational Measurement (CITO), and the Educational Testing Service (ETS, USA).

**Figure 3. Percentage distribution of U.S. 15-year-old students, by grade level: 2006**




NOTE: Detail may not sum to totals because of rounding.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

a contract with RTI International. An expert panel (see appendix D for a list of members) provided input on the development and dissemination of PISA in the United States.

PISA 2006 was a 2-hour paper-and-pencil assessment of 15-year-olds collected from nationally representative samples in participating jurisdictions. Like other large-scale assessments, PISA was not designed to provide individual student scores, but rather national and group estimates of performance. In PISA 2006, every student answered science items. Not every student answered both reading and mathematics items as these were distributed across different versions of the test booklets (for more information on PISA 2006's design, see the technical notes in appendix B).

PISA 2006 was administered between September and November 2006. The U.S. sample included both public and private schools, randomly selected and weighted to be representative of the nation.[4] In total, 166 schools and 5,611 students participated in PISA 2006 in the United States. The overall weighted school response rate was 69 percent before the use of replacement schools. The final weighted student response rate was 91 percent[5] (see the technical notes in appendix B for additional details on sampling, administration, response rates, and other issues).

This report provides results for the United States in relation to the other jurisdictions participating in PISA 2006, distinguishing OECD jurisdictions and non-OECD jurisdictions. All differences described in this report have been tested for statistical significance at the .05 level. Additional information on the statistical procedures used in this report is provided in the technical notes in appendix B. For further results from PISA 2006, see the OECD publication *PISA 2006: Science Competencies for Tomorrow's World* (Vols. 1 and 2) available at http://www.pisa.oecd.org (OECD, 2007a, 2007b).

[4] The sample frame data for the United States for public schools were from the 2003–04 Common Core of Data (CCD), and the data for private schools were from the 2003–04 Private School Universe Survey (PSS). Any school containing at least one 7th- through 12th-grade class as of school year 2003–04 was included in the school sampling frame.

[5] Response rates reported here are based on the formula used in the international report and are not consistent with NCES standards. A more conservative way to calculate the response rate would be to include replacement schools that participated in the denominator as well as the numerator, and to add replacement schools that were hard refusals to the denominator. This results in a response rate of 67.5 percent.

# U.S. Performance in Science Literacy

PISA's major focus in 2006 was science literacy. Science literacy is defined as

> *an individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen (OECD 2006, p.12).*

In the PISA 2006 science literacy assessment, students completed exercises designed to assess their performance in using a range of scientific competencies, grouped and described as "competency clusters." These clusters—identifying scientific issues, explaining phenomena scientifically, using scientific evidence—describe sets of skills students may use for scientific investigation. PISA 2006 provides scores on three subscales based on these competency clusters in addition to providing a combined science literacy score.

- **Identifying scientific issues** includes recognizing issues that are possible to investigate scientifically; identifying keywords to search for scientific information; and recognizing the key features of a scientific investigation.
- **Explaining phenomena scientifically** covers applying knowledge of science in a given situation; describing or interpreting phenomena scientifically and predicting changes; and identifying appropriate descriptions, explanations, and predictions.
- **Using scientific evidence** includes interpreting scientific evidence and making and communicating conclusions; identifying the assumptions, evidence, and reasoning behind conclusions; and reflecting on the societal implications of science and technological developments.

Sample science literacy items (and examples of student responses for each item) for each competency cluster are shown in appendix A.

Combined science literacy scores are reported on a scale from 0 to 1,000 with a mean set at 500 and a standard deviation of 100.[6] Fifteen-year-old students in the United States had an average score of 489 on the combined science literacy scale, lower than the OECD average score of 500 (tables 2 and C-2). U.S. students scored lower in science literacy than their peers in 16 of the other 29 OECD jurisdictions and 6 of the 27 non-OECD jurisdictions. Twenty-two jurisdictions (5 OECD jurisdictions and 17 non-OECD jurisdictions) reported lower scores than the United States in science literacy.

When comparing the performance of the highest achieving students—those at the 90th percentile—there was no measurable difference between the average score of U.S. students (628) compared to the OECD average (622) on the combined science

[6] The combined science literacy scale is made up of all items in the three subscales. However, the combined science scale and the three subscales are each computed separately through Item Response Theory (IRT) models. Therefore, the combined science scale score is not the average of the three subscale scores. For details on the computation of the science literacy scale and subscales see Adams (in press).

## Table 2. Average scores of 15-year-old students on combined science literacy scale and science literacy subscales, by jurisdiction: 2006

| Combined science literacy scale | | Science literacy subscales | | | | | |
|---|---|---|---|---|---|---|---|
| | | Identifying scientific issues | | Explaining phenomena scientifically | | Using scientific evidence | |
| Jurisdiction | Score | Jurisdiction | Score | Jurisdiction | Score | Jurisdiction | Score |
| OECD average | 500 | OECD average | 499 | OECD average | 500 | OECD average | 499 |
| *OECD jurisdictions* | | *OECD jurisdictions* | | *OECD jurisdictions* | | *OECD jurisdictions* | |
| Finland | 563 | Finland | 555 | Finland | 566 | Finland | 567 |
| Canada | 534 | New Zealand | 536 | Canada | 531 | Japan | 544 |
| Japan | 531 | Australia | 535 | Czech Republic | 527 | Canada | 542 |
| New Zealand | 530 | Netherlands | 533 | Japan | 527 | Korea, Republic of | 538 |
| Australia | 527 | Canada | 532 | New Zealand | 522 | New Zealand | 537 |
| Netherlands | 525 | Japan | 522 | Netherlands | 522 | Australia | 531 |
| Korea, Republic of | 522 | Korea, Republic of | 519 | Australia | 520 | Netherlands | 526 |
| Germany | 516 | Ireland | 516 | Germany | 519 | Switzerland | 519 |
| United Kingdom | 515 | Belgium | 515 | Hungary | 518 | Belgium | 516 |
| Czech Republic | 513 | Switzerland | 515 | United Kingdom | 517 | Germany | 515 |
| Switzerland | 512 | United Kingdom | 514 | Austria | 516 | United Kingdom | 514 |
| Austria | 511 | Germany | 510 | Korea, Republic of | 512 | France | 511 |
| Belgium | 510 | Austria | 505 | Sweden | 510 | Ireland | 506 |
| Ireland | 508 | Czech Republic | 500 | Switzerland | 508 | Austria | 505 |
| Hungary | 504 | France | 499 | Poland | 506 | Czech Republic | 501 |
| Sweden | 503 | Sweden | 499 | Ireland | 505 | Hungary | 497 |
| Poland | 498 | Iceland | 494 | Belgium | 503 | Sweden | 496 |
| Denmark | 496 | Denmark | 493 | Denmark | 501 | Poland | 494 |
| France | 495 | **United States** | **492** | Slovak Republic | 501 | Luxembourg | 492 |
| Iceland | 491 | Norway | 489 | Norway | 495 | Iceland | 491 |
| **United States** | **489** | Spain | 489 | Spain | 490 | Denmark | 489 |
| Slovak Republic | 488 | Portugal | 486 | Iceland | 488 | **United States** | **489** |
| Spain | 488 | Poland | 483 | **United States** | **486** | Spain | 485 |
| Norway | 487 | Luxembourg | 483 | Luxembourg | 483 | Slovak Republic | 478 |
| Luxembourg | 486 | Hungary | 483 | France | 481 | Norway | 473 |
| Italy | 475 | Slovak Republic | 475 | Italy | 480 | Portugal | 472 |
| Portugal | 474 | Italy | 474 | Greece | 476 | Italy | 467 |
| Greece | 473 | Greece | 469 | Portugal | 469 | Greece | 465 |
| Turkey | 424 | Turkey | 427 | Turkey | 423 | Turkey | 417 |
| Mexico | 410 | Mexico | 421 | Mexico | 406 | Mexico | 402 |
| *Non-OECD jurisdictions* | | *Non-OECD jurisdictions* | | *Non-OECD jurisdictions* | | *Non-OECD jurisdictions* | |
| Hong Kong-China | 542 | Hong Kong-China | 528 | Hong Kong-China | 549 | Hong Kong-China | 542 |
| Chinese Taipei | 532 | Liechtenstein | 522 | Chinese Taipei | 545 | Liechtenstein | 535 |
| Estonia | 531 | Slovenia | 517 | Estonia | 541 | Chinese Taipei | 532 |
| Liechtenstein | 522 | Estonia | 516 | Slovenia | 523 | Estonia | 531 |
| Slovenia | 519 | Chinese Taipei | 509 | Macao-China | 520 | Slovenia | 516 |
| Macao-China | 511 | Croatia | 494 | Liechtenstein | 516 | Macao-China | 512 |
| Croatia | 493 | Macao-China | 490 | Lithuania | 494 | Latvia | 491 |
| Latvia | 490 | Latvia | 489 | Croatia | 492 | Croatia | 490 |
| Lithuania | 488 | Lithuania | 476 | Latvia | 486 | Lithuania | 487 |
| Russian Federation | 479 | Russian Federation | 463 | Russian Federation | 483 | Russian Federation | 481 |
| Israel | 454 | Israel | 457 | Bulgaria | 444 | Israel | 460 |
| Chile | 438 | Chile | 444 | Israel | 443 | Chile | 440 |
| Republic of Serbia | 436 | Republic of Serbia | 431 | Republic of Serbia | 441 | Uruguay | 429 |
| Bulgaria | 434 | Uruguay | 429 | Jordan | 438 | Republic of Serbia | 425 |
| Uruguay | 428 | Bulgaria | 427 | Chile | 432 | Thailand | 423 |
| Jordan | 422 | Thailand | 413 | Romania | 426 | Bulgaria | 417 |
| Thailand | 421 | Romania | 409 | Uruguay | 423 | Romania | 407 |
| Romania | 418 | Jordan | 409 | Thailand | 420 | Republic of Montenegro | 407 |
| Republic of Montenegro | 412 | Colombia | 402 | Republic of Montenegro | 417 | Jordan | 405 |
| Indonesia | 393 | Republic of Montenegro | 401 | Azerbaijan | 412 | Indonesia | 386 |
| Argentina | 391 | Brazil | 398 | Indonesia | 395 | Argentina | 385 |
| Brazil | 390 | Argentina | 395 | Brazil | 390 | Colombia | 383 |
| Colombia | 388 | Indonesia | 393 | Argentina | 386 | Tunisia | 382 |
| Tunisia | 386 | Tunisia | 384 | Tunisia | 383 | Brazil | 378 |
| Azerbaijan | 382 | Azerbaijan | 353 | Colombia | 379 | Azerbaijan | 344 |
| Qatar | 349 | Qatar | 352 | Qatar | 356 | Qatar | 324 |
| Kyrgyz Republic | 322 | Kyrgyz Republic | 321 | Kyrgyz Republic | 334 | Kyrgyz Republic | 288 |

■ Average is higher than the U.S. average  □ Average is not measurably different from the U.S. average  ▫ Average is lower than the U.S. average

NOTE: The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member jurisdictions. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD jurisdictions are displayed separately from those of the OECD jurisdictions and are not included in the OECD average. Jurisdictions are ordered on the basis of average scores, from highest to lowest within the OECD jurisdictions and non-OECD jurisdictions. Combined science literacy scores are reported on a scale from 0 to 1,000. Because of an error in printing the test booklets, the United States mean performance may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B. Score differences as noted between the United States and other jurisdictions (as well as between the United States and the OECD average) are significantly different at the .05 level of statistical significance.

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

literacy scale (table C-3). Twelve jurisdictions (9 OECD jurisdictions and 3 non-OECD jurisdictions) had students at the 90th percentile with higher scores than the United States on the combined science literacy scale.

At the other end of the distribution, among low-achieving students at the 10th percentile, U.S. students scored lower (349) than the OECD average (375) on the combined science literacy scale. Thirty jurisdictions (21 OECD jurisdictions and 9 non-OECD jurisdictions) had students at the 10th percentile with higher scores than the United States on the combined science literacy scale.

U.S. students also had lower scores than the OECD average score for two of the three scientific literacy subscales (*explaining phenomena scientifically* (486 versus 500) and *using scientific evidence* (489 versus 499)). Twenty-five jurisdictions (19 OECD and 6 non-OECD jurisdictions) had a higher average score than the United States on the *explaining phenomena scientifically* subscale, and 20 jurisdictions (14 OECD and 6 non-OECD jurisdictions) had a higher average score than the United States on the *using scientific evidence* subscale. There was no measurable difference in the performance of U.S. students compared with the OECD average on the *identifying scientific issues* subscale (492 versus 499). However, 18 jurisdictions (13 OECD and 5 non-OECD jurisdictions) scored higher than the United States on the *identifying scientific issues* subscale.

Along with scale scores, PISA 2006 also uses six proficiency levels (levels 1 through 6, with level 6 being the highest level of proficiency) to describe student performance in science literacy (see

**Exhibit 1. Description of general competencies and tasks students should be able to do, by proficiency level for the combined science literacy scale: 2006**

| Proficiency level | Task descriptions |
|---|---|
| Level 1 | At level 1, students have such a limited scientific knowledge that it can only be applied to a few familiar situations. They should be able to present scientific explanations that are obvious and follow concretely from given evidence. |
| Level 2 | At level 2, students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They should be capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving. |
| Level 3 | At level 3, students should be able to identify clearly described scientific issues in a range of contexts. They should be able to select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level should be able to interpret and use scientific concepts from different disciplines and apply them directly. They should be able to develop short communications using facts and make decisions based on scientific knowledge. |
| Level 4 | At level 4, students should be able to work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They should be able to select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level should be able to reflect on their actions and communicate decisions using scientific knowledge and evidence. |
| Level 5 | At level 5, students should be able to identify the scientific components of many complex life situations; apply both scientific concepts and knowledge about science to these situations; and should be able to compare, select, and evaluate appropriate scientific evidence for responding to life situations. Students at this level should be able to use well-developed inquiry abilities, link knowledge appropriately, and bring critical insights to these situations. They should be able to construct evidence-based explanations and arguments based on their critical analysis. |
| Level 6 | At level 6, students should be able to consistently identify, explain, and apply scientific knowledge and knowledge about science in a variety of complex life situations. They should be able to link different information sources and explanations and use evidence from those sources to justify decisions. They should be able to clearly and consistently demonstrate advanced scientific thinking and reasoning, and they are willing to use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level should be able to use scientific knowledge and develop arguments in support of recommendations and decisions that center on personal, social, or global situations. |

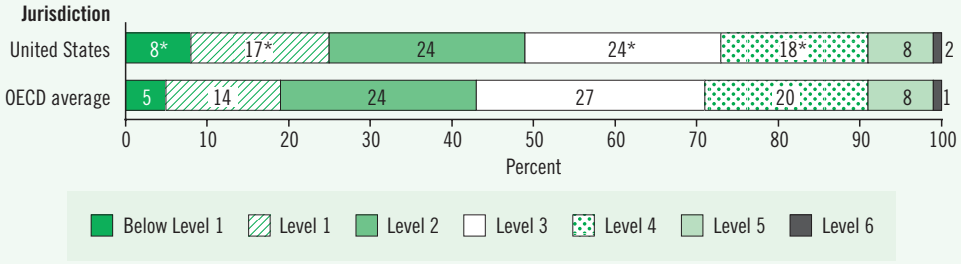
NOTE: To reach a particular proficiency level, a student must correctly answer a majority of items at that level. Students were classified into science literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (a score less than or equal to 334.94); level 1 (a score greater than 334.94 and less than or equal to 409.54); level 2 (a score greater than 409.54 and less than or equal to 484.14); level 3 (a score greater than 484.14 and less than or equal to 558.73); level 4 (a score greater than 558.73 and less than or equal to 633.33); level 5 (a score greater than 633.33 and less than or equal to 707.93); and level 6 (a score greater than 707.93).
SOURCE: Organization for Economic Cooperation and Development (OECD). (2006). *Assessing Scientific, Reading and Mathematical Literacy: A Framework for PISA 2006.* Paris: Author; Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

exhibit 1 for descriptions of the proficiency levels). An additional level (below level 1) encompasses students whose skills cannot be described using these proficiency levels. The proficiency levels describe what students at each level should be able to do and allow comparisons of the percentages of students in each jurisdiction who perform at different levels of science literacy (see the technical notes in appendix B for more information about how levels were set).

The United States had greater percentages of students at or below level 1 than the OECD average percentages (figure 4, table C-5) on the combined science literacy scale. The United States also had lower percentages of students at levels 3 and 4 than the OECD average percentages. The percentages of U.S. students performing at levels 2, 5, and 6 were not measurably different from the OECD averages.

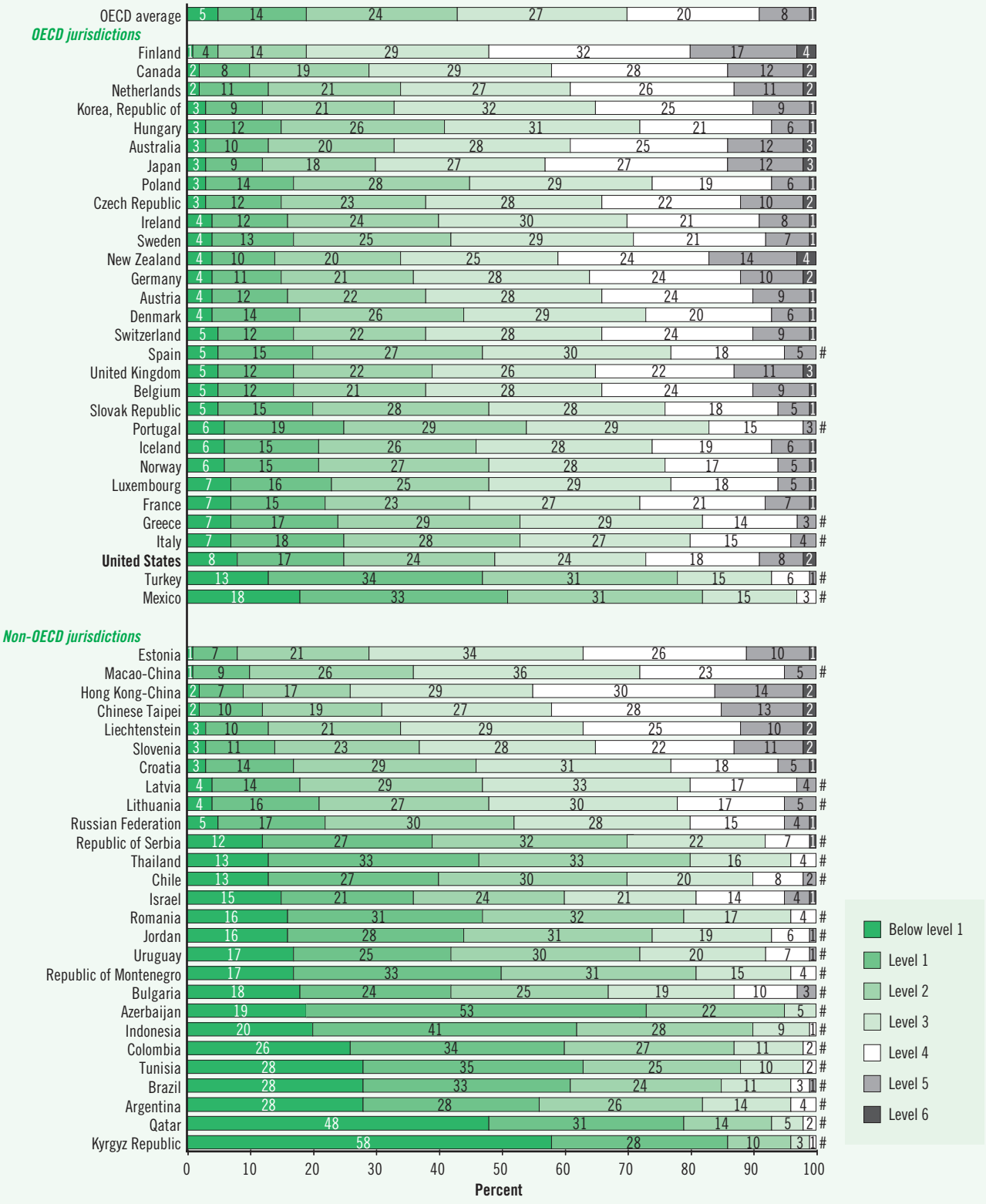
In combined science literacy in 2006, six of the other 56 jurisdictions (Australia, Canada, Finland, Japan, New Zealand, and the United Kingdom—all OECD jurisdictions) had a higher percentage of students at level 6 than the United States (figure 5, table C-5). In contrast, 19 jurisdictions had a higher percentage of students below level 1 than the United States (2 of these—Mexico and Turkey—were OECD jurisdictions). Nineteen jurisdictions (the same 2 OECD jurisdictions and 17 non-OECD jurisdictions) also had a higher percentage of students at level 1 than the United States.

**Figure 4. Percentage distribution of 15-year-old students in the United States and OECD jurisdictions on combined science literacy scale, by proficiency level: 2006**




* *p< .05.* Significantly different from the corresponding OECD average percentage at the .05 level of statistical significance.
NOTE: To reach a particular proficiency level, a student must correctly answer a majority of items at that level. Students were classified into science literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (a score less than or equal to 334.94); level 1 (a score greater than 334.94 and less than or equal to 409.54); level 2 (a score greater than 409.54 and less than or equal to 484.14); level 3 (a score greater than 484.14 and less than or equal to 558.73); level 4 (a score greater than 558.73 and less than or equal to 633.33); level 5 (a score greater than 633.33 and less than or equal to 707.93); and level 6 (a score greater than 707.93). The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member jurisdictions. Because of an error in printing the test booklets, the United States mean performance may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B. Detail may not sum to totals because of rounding.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

**Figure 5. Percentage distribution of 15-year-old students on combined science literacy scale, by proficiency level and jurisdiction: 2006**




# Rounds to zero.

NOTE: To reach a particular proficiency level, a student must correctly answer a majority of items at that level. Students were classified into science literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (a score less than or equal to 334.94); level 1 (a score greater than 334.94 and less than or equal to 409.54); level 2 (a score greater than 409.54 and less than or equal to 484.14); level 3 (a score greater than 484.14 and less than or equal to 558.73); level 4 (a score greater than 558.73 and less than or equal to 633.33); level 5 (a score greater than 633.33 and less than or equal to 707.93); and level 6 (a score greater than 707.93). The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member jurisdictions. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD jurisdictions are displayed separately from those of the OECD jurisdictions and are not included in the OECD average. Jurisdictions are ordered on the basis of percentages below level 1, from lowest to highest within the OECD jurisdictions and non-OECD jurisdictions. Because of an error in printing the test booklets, the United States mean performance may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B. Detail may not sum to totals because of rounding.

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

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# U.S. Performance in Mathematics Literacy

In PISA 2006, mathematics literacy is defined as

> *an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen (OECD, 2006, p.12).*

In 2006, the average U.S. score in mathematics literacy was 474 on a scale from 0 to 1,000, lower than the OECD average score of 498 (tables 3 and C-7). Thirty-one jurisdictions (23 OECD jurisdictions and 8 non-OECD jurisdictions) had a higher average score than the United States in mathematics literacy in 2006. In contrast, 20 jurisdictions (4 OECD jurisdictions and 16 non-OECD jurisdictions) scored lower than the United States in mathematics literacy in 2006.

When comparing the performance of the highest achieving students—those at the 90th percentile—U.S. students scored lower (593) than the OECD average (615) on the mathematics literacy scale (table C-8). Twenty-nine jurisdictions (23 OECD jurisdictions and 6 non-OECD jurisdictions) had students at the 90th percentile with higher scores than the United States on the mathematics literacy scale.

At the other end of the distribution, among low-achieving students at the 10th percentile, U.S. students scored lower (358) than the OECD average (379) on the mathematics literacy scale. Twenty-six jurisdictions (18 OECD jurisdictions and 8 non-OECD jurisdictions) had students at the 10th percentile with higher scores than the United States on the mathematics literacy scale.

There was no measurable change in either the U.S. mathematics literacy score from 2003 to 2006 (483 versus 474) or the U.S. position compared to the OECD average, although scores in 11 other jurisdictions did change (table C-7). Four jurisdictions saw their average mathematics literacy scores increase (two non-OECD jurisdictions, Brazil and Indonesia, and two OECD jurisdictions, Greece and Mexico). The United States scored higher than all four of these jurisdictions in both 2003 and 2006. Seven jurisdictions' scores (including 6 OECD jurisdictions) were lower in 2006 than 2003 in mathematics literacy, although the U.S. position compared to these seven jurisdictions did not change between 2003 and 2006.

## Table 3. Average scores of 15-year-old students on mathematics literacy scale, by jurisdiction: 2006

| Jurisdiction | Mathematics literacy scale Score |
|---|---|
| OECD average | 498 |
| ***OECD jurisdictions*** | |
| Finland | 548 |
| Korea, Republic of | 547 |
| Netherlands | 531 |
| Switzerland | 530 |
| Canada | 527 |
| Japan | 523 |
| New Zealand | 522 |
| Belgium | 520 |
| Australia | 520 |
| Denmark | 513 |
| Czech Republic | 510 |
| Iceland | 506 |
| Austria | 505 |
| Germany | 504 |
| Sweden | 502 |
| Ireland | 501 |
| France | 496 |
| United Kingdom | 495 |
| Poland | 495 |
| Slovak Republic | 492 |
| Hungary | 491 |
| Luxembourg | 490 |
| Norway | 490 |
| Spain | 480 |
| **United States** | **474** |
| Portugal | 466 |
| Italy | 462 |
| Greece | 459 |
| Turkey | 424 |
| Mexico | 406 |
| ***Non-OECD jurisdictions*** | |
| Chinese Taipei | 549 |
| Hong Kong-China | 547 |
| Macao-China | 525 |
| Liechtenstein | 525 |
| Estonia | 515 |
| Slovenia | 504 |
| Lithuania | 486 |
| Latvia | 486 |
| Azerbaijan | 476 |
| Russian Federation | 476 |
| Croatia | 467 |
| Israel | 442 |
| Republic of Serbia | 435 |
| Uruguay | 427 |
| Thailand | 417 |
| Romania | 415 |
| Bulgaria | 413 |
| Chile | 411 |
| Republic of Montenegro | 399 |
| Indonesia | 391 |
| Jordan | 384 |
| Argentina | 381 |
| Colombia | 370 |
| Brazil | 370 |
| Tunisia | 365 |
| Qatar | 318 |
| Kyrgyz Republic | 311 |

- Average is higher than the U.S. average
- Average is not measurably different from the U.S. average
- Average is lower than the U.S. average

NOTE: The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member jurisdictions. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD jurisdictions are displayed separately from those of the OECD jurisdictions and are not included in the OECD average. Jurisdictions are ordered on the basis of average scores, from highest to lowest within the OECD jurisdictions and non-OECD jurisdictions. Mathematics literacy scores are reported on a scale from 0 to 1,000. Because of an error in printing the test booklets, the United States mean performance may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B. Score differences as noted between the United States and other jurisdictions (as well as between the United States and the OECD average) are significantly different at the .05 level of statistical significance.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

# Differences in Performance by Selected Student Characteristics

This section provides information about student performance on PISA 2006 by various characteristics (sex and racial/ethnic background). Because PISA 2006's emphasis was on science literacy, the focus in this section is on performance in this area. The results cannot be used to establish a cause-and-effect relationship between being a member of a group and achievement in PISA 2006. Student performance can be affected by a complex mix of educational and other factors that are not examined here.

## Sex

In the United States, no measurable difference was observed between the scores for 15-year-old males (489) and females (489) on the combined science literacy scale (figure 6, table C-9). Males had a higher average score than females in 8 jurisdictions (6 OECD jurisdictions and 2 non-OECD jurisdictions), while females had a higher average score than males in 12 jurisdictions (2 OECD jurisdictions and 10 non-OECD jurisdictions). The OECD average was higher for males (501) than females (499) on the combined science literacy scale.

In the United States, no measurable difference was found in the percentage of U.S. females (1.5 percent) and males (1.6 percent) scoring at level 6 (the highest level) on the combined science literacy scale (table C-10). Again, the percentages of U.S. females scoring at (16.2 percent) or below (6.8 percent) level 1 (the lowest levels) did not measurably differ from those for their male peers (8.3 percent below level 1 and 17.4 percent at level 1) on the combined science literacy scale.

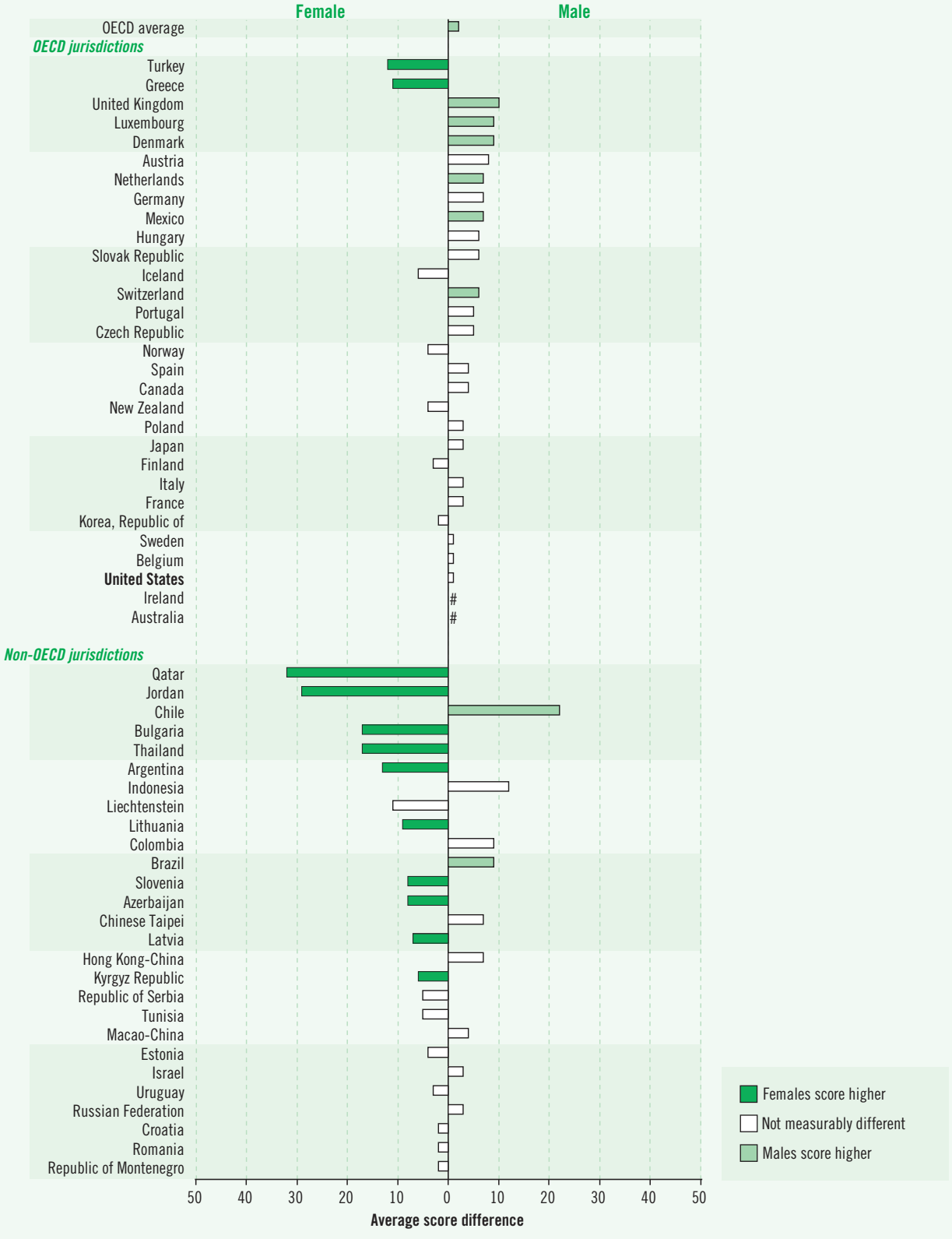
On average across the OECD jurisdictions, females scored higher than males on the *identifying scientific issues* subscale (508 versus 490) and the *using scientific evidence* subscale (501 versus 498), while males scored higher than females on the *explaining phenomena scientifically* subscale (508 versus 493) (table C-11). In the United States, females had a higher average score than males on the *identifying scientific issues* subscale (500 versus 484), while males had a higher average score than females on the *explaining phenomena scientifically* subscale (492 versus 480).[7] There was no measurable difference between U.S. 15-year-old males and females on the *using scientific evidence* subscale (486 versus 491).

## Race/Ethnicity

Racial and ethnic groups vary by country, so it is not possible to compare their performance internationally. Thus, this section refers only to the 2006 findings for the United States.

[7] The effect size of the difference between two means can be calculated by dividing the raw difference in means by the pooled standard deviation of the comparison groups (see appendix B for an explanation). The effect size of the difference in achievement on the *identifying scientific issues* subscale between U.S. 15-year-old male and female students in 2006 was -.16. The effect size of the difference in achievement on the *explaining phenomena scientifically* subscale between U.S. 15-year-old male and female students in 2006 was .12.

**Figure 6. Difference in average scores between 15-year-old male and female students on combined science literacy scale, by jurisdiction: 2006**




# Rounds to zero.

NOTE: Each bar above represents the average score difference between males and females on the combined science literacy scale. The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member jurisdictions. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD jurisdictions are displayed separately from those of OECD jurisdictions and are not included in the OECD average. Jurisdictions are ordered on the basis of score differences between males and females, from largest to smallest within the OECD jurisdictions and non-OECD jurisdictions. Because of an error in printing the test booklets, the United States mean performance may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B. Score differences between males and females are statistically significant at the .05 level of significance.

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

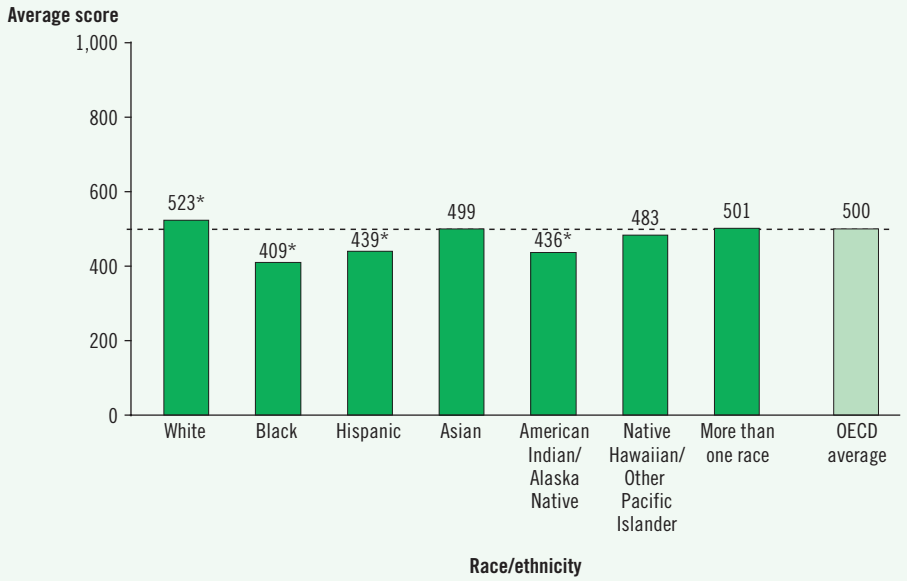
On the combined science literacy scale, Black (non-Hispanic) students and Hispanic students scored lower, on average, than White (non-Hispanic) students, Asian (non-Hispanic) students, and students of more than one race (non-Hispanic) (figure 7, table C-12).[8] On average, Hispanic students scored higher than Black (non-Hispanic) students, while White (non-Hispanic) students scored higher than Asian (non-Hispanic) students. This pattern of performance on PISA 2006 by race/ethnicity is similar to that found in PISA 2000 and PISA 2003 (Lemke et al. 2001, 2004).

On the combined science literacy scales, Black (non-Hispanic) students, Hispanic students, and American Indian/Alaska Native (non-Hispanic) students scored below the OECD average, while scores for White (non-Hispanic) students were above the OECD average. On average, the mean scores of White (non-Hispanic), Asian (non-Hispanic), and students of more than one race (non-Hispanic) were in the PISA level 3 proficiency range for the combined science literacy scale; the mean scores of Hispanic, American Indian/Alaska Native (non-Hispanic), and Native Hawaiian/Other Pacific Islander (non-Hispanic) students were in the level 2 proficiency range; and the mean score for Black (non-Hispanic) students was at the top of the level 1 proficiency range.[9]

[8] The effect size of the difference in achievement on the combined science literacy scale between White and Black and between White and Hispanic 15-year-old students in 2006 was 1.23 and .88, respectively.

[9] To reach a particular proficiency level, a student must correctly answer a majority of items at that level. Students were classified into science literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (a score less than or equal to 334.94); level 1 (a score greater than 334.94 and less than or equal to 409.54); level 2 (a score greater than 409.54 and less than or equal to 484.14); level 3 (a score greater than 484.14 and less than or equal to 558.73); level 4 (a score greater than 558.73 and less than or equal to 633.33); level 5 (a score greater than 633.33 and less than or equal to 707.93); and level 6 (a score greater than 707.93).

**Figure 7. Average scores of U.S. 15-year-old students on combined science literacy scale, by race/ethnicity: 2006**




* *p*< .05. Significantly different from the OECD average at the .05 level of statistical significance.
NOTE: Black includes African American, and Hispanic includes Latino. Students who identified themselves as being of Hispanic origin were classified as Hispanic, regardless of their race. The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member jurisdictions. Because of an error in printing the test booklets, the United States mean performance may be misestimated by approximately 1 score point. The impact is below one standard error. For details see appendix B.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2006.

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# For Further Information

This report provides selected findings from PISA 2006 from a U.S. perspective. Readers may be interested in exploring other aspects of PISA's results. Additional findings are presented in the OECD report, *PISA 2006: Science Competencies for Tomorrow's World* (Vols. 1 and 2), which can be found at http://www.pisa.oecd.org (OECD, 2007a, 2007b). Data with which researchers can conduct their own analyses are also available at this site.

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