NCES
National Center for Education Statistics

International Outcomes of Learning in Mathematics Literacy and Problem Solving

PISA 2003 Results From the U.S. Perspective

Highlights

PISA USA

U.S. Department of Education
Institute of Education Sciences
NCES 2005-003

NCES International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results From the U.S. Perspective 2004

International Outcomes of Learning in Mathematics Literacy and Problem Solving:

PISA 2003 Results From the U.S. Perspective

Highlights

December 2004

U.S. Department of Education
Institute of Education Sciences
NCES 2005–003

Mariann Lemke
National Center for Education Statistics

Anindita Sen
Erin Pahlke
Lisette Partelow
David Miller
Education Statistics Services Institute

Trevor Williams
David Kastberg
Leslie Jocelyn
Westat

U.S. Department of Education
Rod Paige
Secretary

Institute of Education Sciences
Grover J. Whitehurst
Director

National Center for Education Statistics
Robert Lerner
Commissioner

The National Center for Education Statistics (NCES) is the primary federal entity for collecting, analyzing, and reporting data related to education in the United States and other nations. It fulfills a congressional mandate to collect, collate, analyze, and report full and complete statistics on the condition of education in the United States; conduct and publish reports and specialized analyses of the meaning and significance of such statistics; assist state and local education agencies in improving their statistical systems; and review and report on education activities in foreign countries.

NCES activities are designed to address high priority education data needs; provide consistent, reliable, complete, and accurate indicators of education status and trends; and report timely, useful, and high quality data to the U.S. Department of Education, the Congress, the states, other education policymakers, practitioners, data users, and the general public.

We strive to make our products available in a variety of formats and in language that is appropriate to a variety of audiences. You, as our customer, are the best judge of our success in communicating information effectively. If you have any comments or suggestions about this or any other NCES product or report, we would like to hear from you. Please direct your comments to:

National Center for Education Statistics
Institute of Education Sciences
U.S. Department of Education
1990 K Street NW
Washington, DC 20006-5651

December 2004

The NCES World Wide Web Home Page is http://nces.ed.gov
The NCES World Wide Electronic Catalog is http://nces.ed.gov/pubsearch

Suggested Citation

Lemke, M., Sen, A., Pahlke, E., Partelow, L., Miller, D., Williams, T., Kastberg, D., Jocelyn, L. (2004). *International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results From the U.S. Perspective.* (NCES 2005–003). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

For ordering information on this report, write:

U.S. Department of Education
ED Pubs
P.O. Box 1398
Jessup, MD 20794-1398

Call toll free 1-877-4ED-PUBS or order online at http://www.edpubs.org

Content Contact:
Mariann Lemke, (202) 502-7314
E-mail: Mariann.Lemke@ed.gov

Summary

The Program for International Student Assessment (PISA) is a system of international assessments that measures 15-year-olds' capabilities in reading literacy, mathematics literacy, and science literacy every 3 years. PISA was first implemented in 2000 and is carried out by the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of industrialized countries. Each PISA data-collection effort assesses one subject area in depth, even as all three are assessed in each cycle so that participating countries have an ongoing source of achievement data in every subject area (figure 1). In addition to the major subject areas of reading literacy, mathematics literacy, and science literacy, PISA also measures general or cross-curricular competencies such as learning strategies. In this second cycle, PISA 2003, mathematics literacy was the subject area assessed in depth, along with the new cross-curricular area of problem solving. Major findings for 2003 in mathematics literacy and problem solving are provided here, as well as brief discussions of student performance in reading literacy and science literacy and changes in performance between 2000 and 2003.

U.S. Performance in Mathematics Literacy and Problem Solving

In 2003, U.S. performance in mathematics literacy and problem solving was lower than the average performance for most OECD countries (tables 2 and 3). The United States also performed below the OECD average on each mathematics literacy subscale representing a specific content area (*space and shape, change and relationships, quantity,* and *uncertainty*). This is somewhat different from the PISA 2000 results, when reading literacy was the major subject area, which showed the United States performing at the OECD average (Lemke et al. 2001).

Along with scale scores, PISA 2003 also uses six proficiency levels (levels 1 through 6, with level 6 being the highest level of proficiency) to describe student performance in mathematics literacy (exhibit 5) and three proficiency levels (levels 1 through 3, with level 3 being the highest level of proficiency) to describe student performance in problem solving (exhibit 9). In mathematics literacy, the United States had greater percentages of students below level 1 and at levels 1 and 2 than the OECD average percentages (figure 5, table B-6). The United States also had a lower percentage of students at levels 4, 5, and 6 than the OECD average percentages. Results for each of the four mathematics content areas followed a similar pattern. In problem solving, the United States also had greater percentages of students below level 1 and at level 1 than the OECD average percentages, and a lower percentage of students at levels 2 and 3 than the OECD average percentages (figure 8, table B-15).

This is also somewhat different from the PISA 2000 reading literacy results, which showed that while the percentages of U.S. students performing at level 1 and below were not measurably different from the OECD averages, the United States had a greater percentage of students performing at the highest level (level 5) compared to the OECD average (Lemke et al. 2001). In mathematics literacy and problem solving in 2003, even the highest U.S. achievers (those in the top 10 percent in the United States) were outperformed on average by their OECD counterparts (figures 4 and 7, tables B-4 and B-13).

There were no measurable changes in the U.S. scores from 2000 to 2003 on either the *space and shape* subscale or the *change and relationships* subscale, the only content areas for which trend data from 2000 to 2003 are available (table B-11). In both 2000 and 2003, about two-thirds of the other participating OECD countries outperformed the United States in these content areas.

U.S. Performance in Reading Literacy and Science Literacy

The U.S. average score in reading literacy was not measurably different from the OECD average in 2000 or 2003 (figure 9, table B-16), nor was there any measurable change in the U.S. reading literacy score from 2000 to 2003.

The U.S. score was below the OECD average science literacy score in 2003 (figure 9, table B-17). There was no measurable change in the U.S. science literacy score from 2000 to 2003.

Differences in Performance by Selected Student Characteristics

Sex

Males outperformed females in mathematics literacy in the United States and in two-thirds of the other countries (figure 10, table B-18). Within the United States, greater percentages of male students performed at level 6 (the highest level) than female students in mathematics literacy, but larger percentages of females were not seen at lower levels (below level 1 and levels 1 through 5; table B-19). In other words, differences in the overall scores between males and females in the United States were due at least in part to the fact that a higher percentage of males were found among the highest performers, not to a higher percentage of females found among the lowest performers.

In the majority of the PISA 2003 countries (32 out of 39 countries), including the United States, there were no measurable differences in problem-solving scores by sex (figure 10, table B-21). However, females outscored their male peers in problem solving in six of the seven remaining participating countries, as well as at the OECD average. Males outscored females in problem solving in Macao-China.

Socioeconomic Background

In 2003, a few countries showed stronger relationships between socioeconomic background (as measured by parental occupational status) and student performance than the United States, while more showed weaker relationships. In 2003, the relationship between socioeconomic background and student performance in mathematics literacy was stronger in 5 countries (Belgium, Czech Republic, Germany, Hungary, and Poland) than in the United States, while 11 countries had weaker relationships (table B-25). Three of the same five countries (Belgium, Germany, and Hungary) had stronger relationships between socioeconomic background and problem-solving performance than the United States, while 12 had weaker relationships.

Race/Ethnicity

In the United States in PISA 2003, Blacks and Hispanics scored lower on average than Whites, Asians, and students of more than one race in mathematics literacy and problem solving (figure 11, table B-26). Hispanic students, in turn, outscored Black students. In both mathematics literacy and problem solving, the average scores for Blacks and Hispanics were below the OECD average scores, while scores for Whites were above the OECD average scores.

For further results from PISA 2003, see the Organization for Economic Cooperation and Development (OECD) publication *Learning for Tomorrow's World — First Results From PISA 2003*, available at http://www.pisa.oecd.org (OECD 2004). A technical report for PISA 2003—which describes in detail all the procedures used in the design, data collection, quality control, and analysis for the study, as well as the PISA 2003 data itself—will also be made available at that site.

Acknowledgments

The authors of this report cannot take full credit for its production. Many people contributed to making this report possible, and the authors wish to thank all those who have assisted with various aspects of the report, including data analysis, reviews, and design.

Members of the Trends in International Mathematics and Science Study-Program for International Student Assessment (TIMSS-PISA) expert panel provided valuable input on issues related to communication and dissemination. Members are listed in appendix C.

We also wish to thank the technical reviewers, Marilyn Seastrom, Devon Carlson, and Zeyu Xu, and other reviewers (Mary Lindquist, Jeremy Kilpatrick, Joan Ferrini-Mundy, and Dana Kelly) for their comments. Thanks are also owed to Brian Henigin, Michael Stock, and Tracey Summerall of Westat for their design work.

Members of the PISA international management team, including the Australian Council for Educational Research (ACER) and the Organization for Economic Cooperation and Development (OECD), graciously assisted with data analysis and documentation questions. In particular, we would like to gratefully acknowledge the assistance of Claudia Tamassia, Andreas Schleicher, and Claire Shewbridge at the OECD.

Finally, we wish to especially thank the students, schools, and principals who participated in PISA 2003. Their time and effort provide us with data to look beyond our borders and gain valuable insight into our own educational practices.

Table of Contents

List of Tables

List of Reference Tables

List of Figures

List of Exhibits

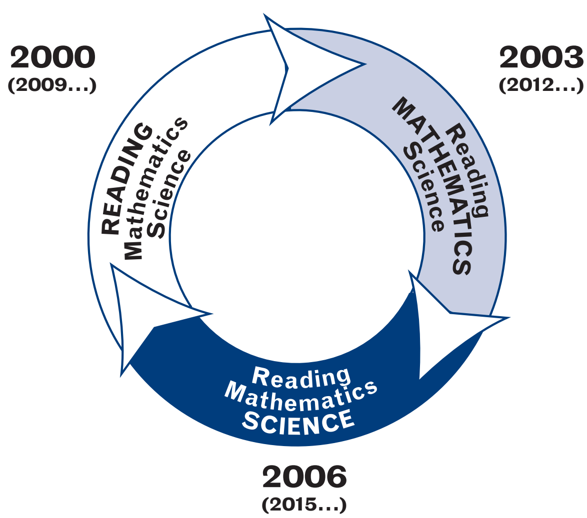
Introduction

PISA in Brief

The Program for International Student Assessment (PISA) is a system of international assessments that measures 15-year-olds' capabilities 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 industrialized nations. In 2003, 41 countries participated in PISA, including 30 OECD countries and 11 non-OECD countries (table 1). Of those 41 countries, comparisons for 39 countries (29 OECD countries and 10 non-OECD countries) are provided in this report. Data for one country, Brazil, were not available at the time of report production, and data for one other, the United Kingdom, are not discussed due to low response rates.

Figure 1. Program for International Student Assessment (PISA) cycle



NOTE: The subject in all capital letters in each assessment cycle is the major domain for that cycle.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Table 1. Participation in the Program for International Student Assessment (PISA), by country: 2000 and 2003

Country	2000	2003
Organization for Economic Cooperation and Development (OECD) countries		
Australia	•	•
Austria	•	•
Belgium	•	•
Canada	•	•
Czech Republic	•	•
Denmark	•	•
Finland	•	•
France	•	•
Germany	•	•
Greece	•	•
Hungary	•	•
Iceland	•	•
Ireland	•	•
Italy	•	•
Japan	•	•
Korea, Republic of	•	•
Luxembourg	•	•
Mexico	•	•
Netherlands[1]	•	•
New Zealand	•	•
Norway	•	•
Poland	•	•
Portugal	•	•
Slovak Republic		•
Spain	•	•
Sweden	•	•
Switzerland	•	•
Turkey		•
United Kingdom[2]	•	•
United States	•	•
Non-OECD countries		
Brazil[3]	•	•
Hong Kong-China		•
Indonesia		•
Latvia	•	•
Liechtenstein	•	•
Macao-China		•
Russian Federation	•	•
Serbia and Montenegro		•
Thailand		•
Tunisia		•
Uruguay		•

[1]Due to low response rates, PISA 2000 data for the Netherlands are not discussed in this report. For information on the results for the Netherlands, see OECD (2001).
[2]Due to low response rates, PISA 2003 data for the United Kingdom are not discussed in this report.
[3]Although Brazil participated in PISA 2003, its data were not available in time for production of this report.
NOTE: A "•" indicates that the country participated in PISA in the specific year. Because PISA is principally an OECD study, non-OECD countries are displayed separately from the OECD countries.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2000 and 2003.

Each PISA data-collection effort assesses one subject area in depth, even as all three are assessed in each cycle so that participating countries have an ongoing source of achievement data in every subject area. In addition to the reading literacy, mathematics literacy, and science literacy, PISA also measures general or cross-curricular competencies such as learning strategies. In this second cycle, PISA 2003, mathematics literacy was the subject area assessed in depth, along with the new cross-curricular area of problem solving. In 2006, PISA will focus on science literacy. Results from PISA 2000, which focused on reading literacy, are described in Lemke et al. (2001) and Organization for Economic Cooperation and Development (OECD) (2001). In addition, a series of thematic reports exploring topics related to reading literacy in greater depth are available through http://www.pisa.oecd.org (see also the PISA resources and publications section of this report for information about PISA publications).

This report focuses on the performance of U.S. students in the two major areas assessed in 2003, mathematics literacy and problem solving. Achievement in the minor domains of reading literacy and science literacy in 2003 is also presented, and differences in achievement by selected student characteristics are covered in the final section.

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.

In order to provide a critical external perspective on the achievement of U.S. students through comparisons to 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).[1] 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 countries.

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 assessment area is based upon content, processes, and situations or contexts. For example, for mathematics literacy, the content is made up of major mathematical ideas, such as *space and shape* and *uncertainty*. The processes describe what strategies students use to solve mathematics problems, such as making connections or performing simple calculations. The situations or contexts refer to the kinds of places in which students might encounter mathematical problems, such as personal or educational. Assessment items are then developed based on these descriptions.

PISA uses the terminology of "literacy" in each subject area to denote its broad focus on application of knowledge and skills; that is, PISA seeks to ask if 15-year-olds are mathematically literate, or to what extent they can apply mathematical 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), but rather each person's skills place them in a particular place on the literacy continuum.

[1] 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]).

The target age of 15 allows countries 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, since 15-year-olds in the United States and elsewhere come from several grade levels and are enrolled in a variety of classes (figures 2 and 3, tables B-1 and B-2).

How PISA 2003 Was Conducted

PISA 2003 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).[2] 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 a contract with Westat. A review panel (see appendix C for a list of members) provides input on the development and dissemination of PISA (and TIMSS) in the United States.

PISA 2003 was a 2-hour paper-and-pencil assessment of 15-year-olds collected from nationally representative samples in participating countries. Like other large-scale assessments, PISA was not designed to provide individual student scores, but rather national and sub-national estimates of performance. Every student in PISA 2003 was assessed in mathematics literacy; reading, problem solving, and science questions were spread among students (for more information on PISA 2003's design, see the technical notes in appendix A).

PISA 2003 was administered between March and May 2003. The U.S. sample included both public and private schools, randomly selected and weighted to be representative of the nation.[3] In the United States, to improve response rates (a response rate of approximately 50 percent was projected for the end of the data collection period) and better accommodate school schedules, a second testing window was opened from September through November 2003. In total, 262 schools and 5,456 students participated in PISA 2003 in the United States. An overall weighted school response rate of 65 percent before the use of replacement schools and a weighted student response rate of 83 percent was achieved after testing in the second window was complete (see technical notes in appendix A for additional details on sampling, administration, response rates, and other issues).

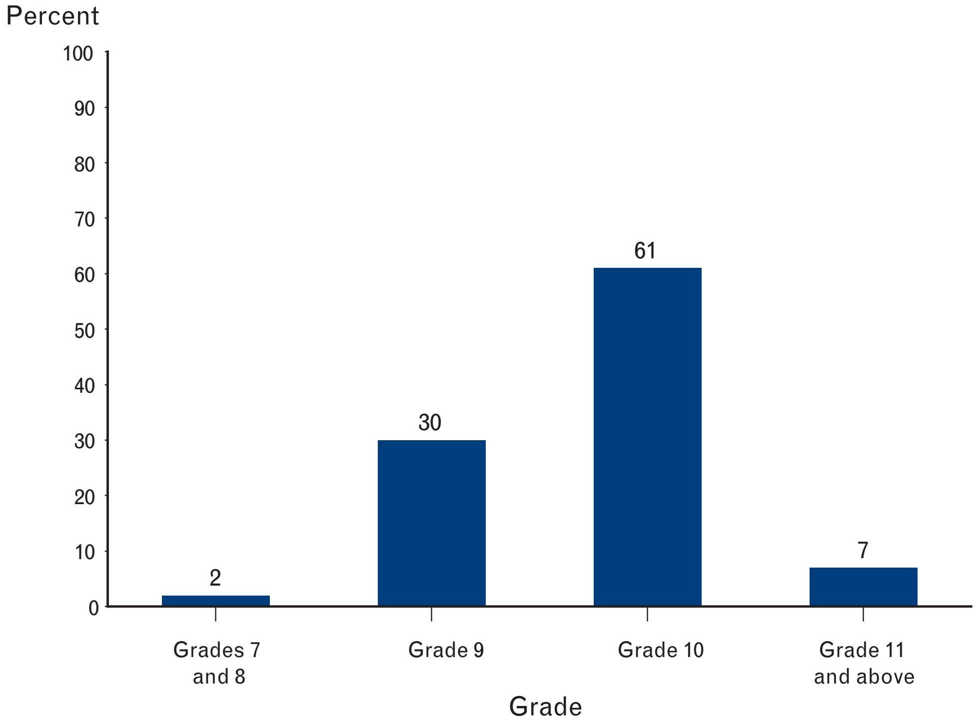
For further results from PISA 2003, see the Organization for Economic Cooperation and Development (OECD) publication *Learning for Tomorrow's World — First Results From PISA 2003*, available at http://www.pisa.oecd.org (OECD 2004). A technical report for PISA 2003—which describes in detail all the procedures used in the design, data collection, quality control, and analysis for the study, as well as the PISA 2003 data itself—is also available at that site.

This report provides results for the United States in relation to the other countries participating in PISA 2003, distinguishing OECD countries and non-OECD countries. All differences described in this report have been tested for statistical significance at the .05 level. Additional information on statistical procedures used in this report is provided in the technical notes.

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

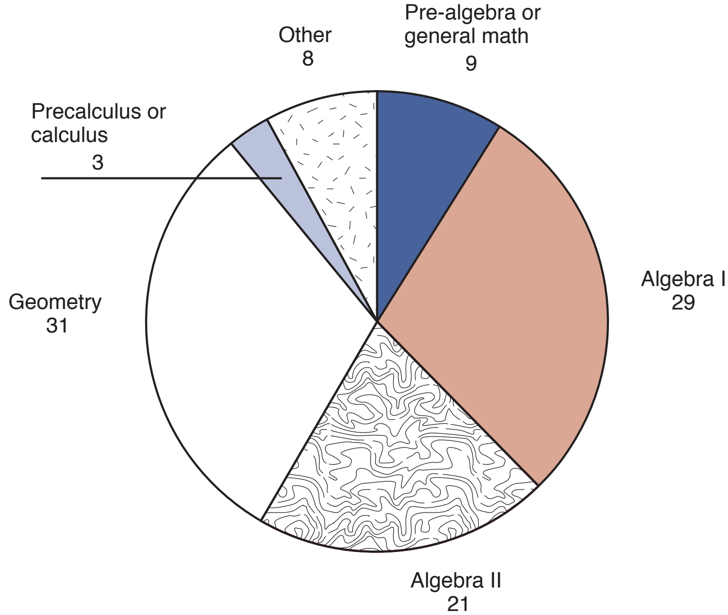
[3] The sample frame data for the United States for public schools were from the Common Core of Data (CCD), and the data for private schools were from the Private School Survey (PSS). Any school containing at least one 7th- through 12th-grade class as of the school year 2000–01 was included on the school sampling frame.

Figure 2. Percentage distribution of U.S. 15-year-old students, by grade: 2003



NOTE: Detail may not sum to totals because of rounding.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Figure 3. Percentage distribution of U.S. 15-year-old students, by type of mathematics class: 2003



NOTE: Type of class refers to the mathematics class in which the student was enrolled at the time of assessment. Detail may not sum to totals because of rounding.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

U.S. Performance in Mathematics Literacy

PISA's major focus in 2003 was mathematics literacy. 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 judgements 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 2003, p.24)*

PISA's emphasis is on the ability to apply a range of knowledge and skills to a variety of problems with real-life contexts. In the PISA 2003 mathematics literacy assessment, students completed exercises designed to assess their capabilities in using a range of mathematical competencies, grouped and described as "competency clusters." These clusters—reproduction, connections, and reflection—describe sets of skills students may use to solve problems. The reproduction cluster involves the reproduction of the practiced material and performing routine operations. The connections cluster calls for integration and connection of material, and the modest extension of practiced material. The reflection cluster relates to students' abilities in advanced reasoning, argumentation, abstraction, generalization, and modeling applied to new contexts.

The problems themselves were designed to come from the variety of situations (personal, educational/occupational, public, or scientific) that students encounter, and to have a real-life context. The mathematical content of the problems was drawn from four overarching ideas: *space and shape, change and relationships, quantity,* and *uncertainty*. These overarching ideas represent a way to organize mathematical content broadly and encompass many traditional curricular areas such as algebra or geometry (see also Steen 1990).

- *Space and shape* includes recognizing shapes and patterns, describing, encoding, and decoding visual information, understanding dynamic changes to shapes, understanding similarities and differences and relative positions, and understanding the relationship between visual representations and real shapes and images.
- *Change and relationships* covers the representation of change, including mathematical functions such as linear, exponential, or logistic, as well as data analysis needed to specify relationships or translate between representations.
- *Quantity* focuses on quantitative reasoning (including number sense, estimating, mental arithmetic, understanding meaning of operations, having a feel for the magnitude of numbers, and computations) and understanding of numerical patterns, counts, and measures.
- *Uncertainty* includes the two related topics of data and chance, or statistics and probability, including data analysis and graphic and numeric representations of data.

A comparative analysis of the NAEP, PISA, and TIMSS mathematics assessments sponsored by NCES found that the 2003 PISA mathematics literacy assessment used far fewer multiple-choice items than NAEP or TIMSS. PISA also had a much stronger content focus on the "data" area (which often deals with using charts and graphs), which fits with PISA's emphasis on using materials with a real-world context (see technical notes for more information on the results of the assessment comparisons).[4]

[4]See Neidorf, T.S., Binkley, M., Gattis, K., and Nohara, D. (forthcoming) and the technical notes in appendix A for more information. Other comparative analyses focus on assessments of science and reading in PISA, NAEP, TIMSS, and PIRLS. See Neidorf, T.S., Binkley, M., and Stephens, M. (forthcoming); Binkley, M., and Kelly, D. (2003); Binkley, M., Afflerbach, P., and Kelly, D. (forthcoming); and Nohara, D. (2001).

Sample mathematics literacy items for each of these areas and student responses are shown here. For more information about the mathematics literacy domain, refer to *The PISA 2003 Assessment Framework: Mathematics, Reading, Science, and Problem Solving Knowledge and Skills* (OECD 2003). Additional mathematics literacy sample items can be found at http://nces.ed.gov/surveys/pisa, in the PISA 2003 framework document referenced above, in *Measuring Student Knowledge and Skills: The PISA 2000 Assessment of Reading, Mathematical and Scientific Literacy* (OECD 2000) and in *Sample Tasks from the PISA 2000 Assessment: Reading, Mathematical and Scientific Literacy* (OECD 2002).

Exhibit 1. Space and shape sample item: 2003

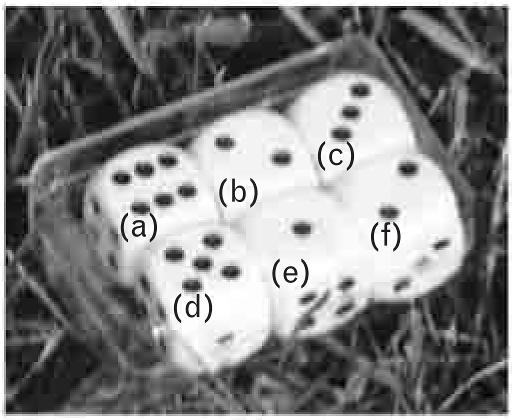
Cubes

Question 20: CUBES

M145Q01

In this photograph you see six dice, labeled (a) to (f). For all dice there is a rule:

The total number of dots on two opposite faces of each die is always seven.



Write in each box the number of dots on the **bottom** face of the dice corresponding to the photograph.

(a)	(b)	(c)
1	5	4
2	6	5
(d)	(e)	(f)

RESULTS:

U.S. percent correct................62.7
OECD percent correct............68.0
Item difficulty: Level 2
Situation: Occupational
Competency: Reproduction

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 2. Change and relationships sample item: 2003

The Best Car

A car magazine uses a rating system to evaluate new cars, and gives the award of "The Car of the Year" to the car with the highest total score. Five new cars are being evaluated, and their ratings are shown in the table.

Car	Safety Features (S)	Fuel Efficiency (F)	External Appearance (E)	Internal Fittings (T)
Ca	3	1	2	3
M2	2	2	2	2
Sp	3	1	3	2
N1	1	3	3	3
KK	3	2	3	2

The ratings are interpreted as follows:

3 points = Excellent
2 points = Good
1 point = Fair

Question 5: THE BEST CAR

M704Q01

To calculate the total score for a car, the car magazine uses the following rule, which is a weighted sum of the individual score points:

$$\text{Total Score} = (3 \times S) + F + E + T$$

Calculate the total score for Car "Ca". Write your answer in the space below.

Total score for "Ca": 15

RESULTS:

U.S. percent correct................ 74.6
OECD percent correct............. 72.9
Item difficulty: Level 2
Situation: Public
Competency: Reproduction

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 2. Change and relationships sample item: 2003—Continued

The Best Car

Question 6: THE BEST CAR

M704Q02

The manufacturer of car "Ca" thought the rule for the total score was unfair.

Write down a rule for calculating the total score so that Car "Ca" will be the winner.

Your rule should include all four of the variables, and you should write down your rule by filling in positive numbers in the four spaces in the equation below.

Total score = ...3... × S + ...1... × F + ...1... × E + ...3... × T.

3S + F + E + 3T

ca = 21
m2 = 16
Sp = 19
NI = 18
KK = 20

RESULTS:
U.S. percent correct................20.2
OECD percent correct............25.4
Item difficulty: Level 5
Situation: Public
Competency: Reflection

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 3. Quantity sample item: 2003

Exchange Rate

Mei-Ling from Singapore was preparing to go to South Africa for 3 months as an exchange student. She needed to change some Singapore dollars (SGD) into South African rand (ZAR).

Question 14: EXCHANGE RATE M413Q02 - 0 1 9

On returning to Singapore after 3 months, Mei-Ling had 3 900 ZAR left. She changed this back to Singapore dollars, noting that the exchange rate had changed to:

1 SGD = 4.0 ZAR

How much money in Singapore dollars did Mei-Ling get?

Answer: 975

RESULTS:

U.S. percent correct....................67.8
OECD percent correct................73.9
Item difficulty: Level 2
Situation: Public
Competency: Reproduction

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 3. Quantity sample item: 2003—Continued

Exchange Rate

Question 15: EXCHANGE RATE M413Q03 - 01 02 11 99

During these 3 months the exchange rate had changed from 4.2 to 4.0 ZAR per SGD.

Was it in Mei-Ling's favor that the exchange rate now was 4.0 ZAR instead of 4.2 ZAR, when she changed her South African rand back to Singapore dollars? Give an explanation to support your answer.

if 4.0 . . . then 3900/4 = 975

if 4.2 . . . then 3900/4.2 = 928.57

Yes because she would receive more money.

RESULTS:

U.S. percent correct................37.2
OECD percent correct............40.3
Item difficulty: Level 4
Situation: Public
Competency: Reflection

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

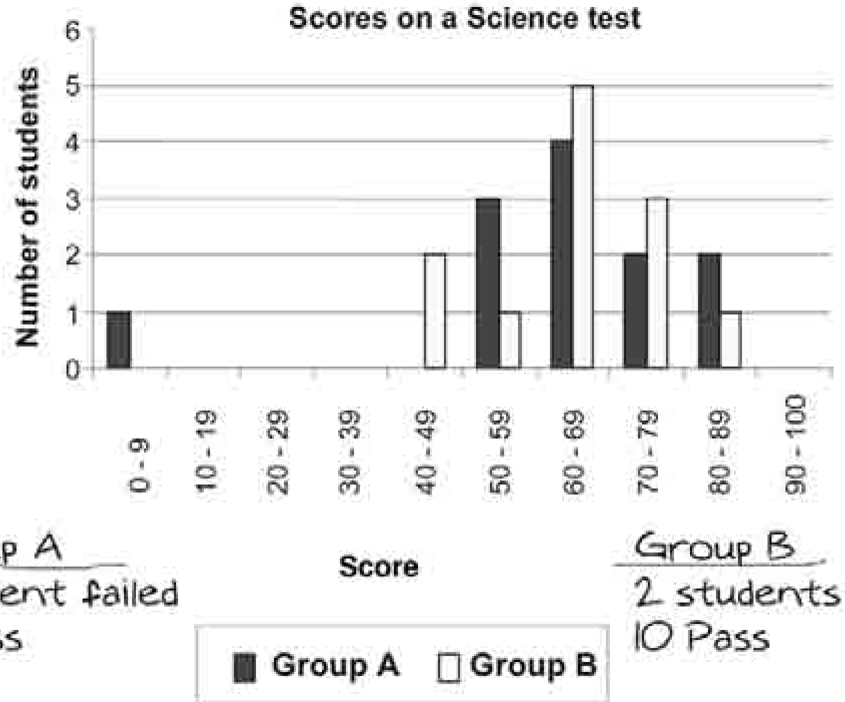
Exhibit 4. Uncertainty sample item: 2003

Test Scores

Question 32: TEST SCORES M513Q01 - 0 1 9

The diagram below shows the results on a Science test for two groups, labeled as Group A and Group B.

The mean score for Group A is 62.0 and the mean for Group B is 64.5. Students pass this test when their score is 50 or above.



Group A
1 student failed
11 Pass

Group B
2 students failed
10 Pass

Looking at the diagram, the teacher claims that Group B did better than Group A in this test.

The students in Group A don't agree with their teacher. They try to convince the teacher that Group B may not necessarily have done better.

Give one mathematical argument, using the graph, that the students in Group A could use.

Group A could argue that 11 people from their group passed, and only 10 from group B did.

RESULTS:

U.S. percent correct 39.8
OECD percent correct 32.2
Item difficulty: Level 5
Situation: Educational
Competency: Connections

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Combined mathematics literacy scores are reported on a scale with a mean of 500 and standard deviation of 100.[5] Fifteen-year-old students in the United States had an average score of 483 on the combined mathematics literacy scale, lower than the OECD average score of 500 (tables 2 and B-3). U.S. students were less mathematically literate than their peers in 20 of the other 28 OECD countries and 3 of the 10 non-OECD countries. Eleven countries (5 OECD countries and 6 non-OECD countries) reported lower scores compared to the United States in mathematics literacy.

U.S. students also had lower scores than the OECD average scores for each of the four content area subscales (*space and shape, change and relationships, quantity*, and *uncertainty*). Twenty-four countries (20 OECD and 4 non-OECD countries) outperformed the United States on the *space and shape* subscale, 21 countries (18 OECD and 3 non-OECD countries) outperformed the United States on the *change and relationships* subscale, 26 countries (23 OECD and 3 non-OECD countries) outscored the United States on the *quantity* subscale, and 19 countries (16 OECD and 3 non-OECD countries) outscored the United States on the *uncertainty* subscale.

[5]Because the average was set for the combined mathematics literacy scale, average scores for the mathematics literacy subscales differ slightly from 500. PISA 2000 mathematics literacy scores were re-scaled using the greater detail in PISA 2003 data in order to provide a more complete measure of achievement than that available in 2000. See technical notes in appendix A for more information on scaling. PISA's intent for each subject area is to draw baseline information for describing changes and trends in achievement from the cycle in which that subject area is the major domain. The use of minor domains allows PISA to provide indicative information about changes in performance over time; however, changes in a subject area are best measured from the cycle in which it is the major domain. Thus, changes in reading literacy achievement are based upon PISA 2000 data, when reading literacy was the major domain, and changes in mathematics literacy scores, in turn, are based upon this 2003 cycle. Science literacy scores from 2000 and 2003 may be re-scaled based up on the much greater detail for science literacy which will be available in 2006.

Table 2. Average combined mathematics literacy scores and subscale scores of 15-year-old students, by country: 2003

Combined mathematics literacy		Mathematics subscales: Space and shape		Mathematics subscales: Change and relationships	
Country	Score	Country	Score	Country	Score
OECD average	**500**	**OECD average**	**496**	**OECD average**	**499**
OECD countries		OECD countries		OECD countries	
Finland	544	Japan	553	Netherlands	551
Korea	542	Korea	552	Korea	548
Netherlands	538	Switzerland	540	Finland	543
Japan	534	Finland	539	Canada	537
Canada	532	Belgium	530	Japan	536
Belgium	529	Czech Republic	527	Belgium	535
Switzerland	527	Netherlands	526	New Zealand	526
Australia	524	New Zealand	525	Australia	525
New Zealand	523	Australia	521	Switzerland	523
Czech Republic	516	Canada	518	France	520
Iceland	515	Austria	515	Czech Republic	515
Denmark	514	Denmark	512	Iceland	509
France	511	France	508	Denmark	509
Sweden	509	Slovak Republic	505	Germany	507
Austria	506	Iceland	504	Ireland	506
Germany	503	Germany	500	Sweden	505
Ireland	503	Sweden	498	Austria	500
Slovak Republic	498	Poland	490	Hungary	495
Norway	495	Luxembourg	488	Slovak Republic	494
Luxembourg	493	Norway	483	Norway	488
Poland	490	Hungary	479	Luxembourg	487
Hungary	490	Spain	476	**United States**	**486**
Spain	485	Ireland	476	Poland	484
United States	**483**	**United States**	**472**	Spain	481
Portugal	466	Italy	470	Portugal	468
Italy	466	Portugal	450	Italy	452
Greece	445	Greece	437	Greece	436
Turkey	423	Turkey	417	Turkey	423
Mexico	385	Mexico	382	Mexico	364
Non-OECD countries		Non-OECD countries		Non-OECD countries	
Hong Kong-China	550	Hong Kong-China	558	Hong Kong-China	540
Liechtenstein	536	Liechtenstein	538	Liechtenstein	540
Macao-China	527	Macao-China	528	Macao-China	519
Latvia	483	Latvia	486	Latvia	487
Russian Federation	468	Russian Federation	474	Russian Federation	477
Serbia and Montenegro	437	Serbia and Montenegro	432	Serbia and Montenegro	419
Uruguay	422	Thailand	424	Uruguay	417
Thailand	417	Uruguay	412	Thailand	405
Indonesia	360	Indonesia	361	Tunisia	337
Tunisia	359	Tunisia	359	Indonesia	334

See notes at end of table.

Table 2. Average combined mathematics literacy scores and subscale scores of 15-year-old students, by country: 2003—Continued

Mathematics subscales			
Quantity		Uncertainty	
Country	Score	Country	Score
OECD average	**501**	**OECD average**	**502**
OECD countries		OECD countries	
Finland	549	Netherlands	549
Korea	537	Finland	545
Switzerland	533	Canada	542
Belgium	530	Korea	538
Netherlands	528	New Zealand	532
Canada	528	Australia	531
Czech Republic	528	Japan	528
Japan	527	Iceland	528
Australia	517	Belgium	526
Denmark	516	Ireland	517
Germany	514	Switzerland	517
Sweden	514	Denmark	516
Iceland	513	Norway	513
Austria	513	Sweden	511
Slovak Republic	513	France	506
New Zealand	511	Czech Republic	500
France	507	Austria	494
Ireland	502	Poland	494
Luxembourg	501	Germany	493
Hungary	496	Luxembourg	492
Norway	494	**United States**	**491**
Spain	492	Hungary	489
Poland	492	Spain	489
United States	**476**	Slovak Republic	476
Italy	475	Portugal	471
Portugal	465	Italy	463
Greece	446	Greece	458
Turkey	413	Turkey	443
Mexico	394	Mexico	390
Non-OECD countries		Non-OECD countries	
Hong Kong-China	545	Hong Kong-China	558
Liechtenstein	534	Macao-China	532
Macao-China	533	Liechtenstein	523
Latvia	482	Latvia	474
Russian Federation	472	Russian Federation	436
Serbia and Montenegro	456	Serbia and Montenegro	428
Uruguay	430	Thailand	423
Thailand	415	Uruguay	419
Tunisia	364	Indonesia	385
Indonesia	357	Tunisia	363

■ Average is significantly higher than the U.S. average
□ Average is not significantly different than the U.S. average
■ Average is significantly lower than the U.S. average

NOTE: Statistical comparisons between the U.S. average and the Organization for Economic Cooperation and Development (OECD) average take into account the contribution of the U.S. average toward the OECD average. The OECD average is the average of the national averages of the OECD member countries with data available. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD countries are displayed separately from those of the OECD countries and are not included in the OECD average. Due to low response rates, data for the United Kingdom are not discussed in this report.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

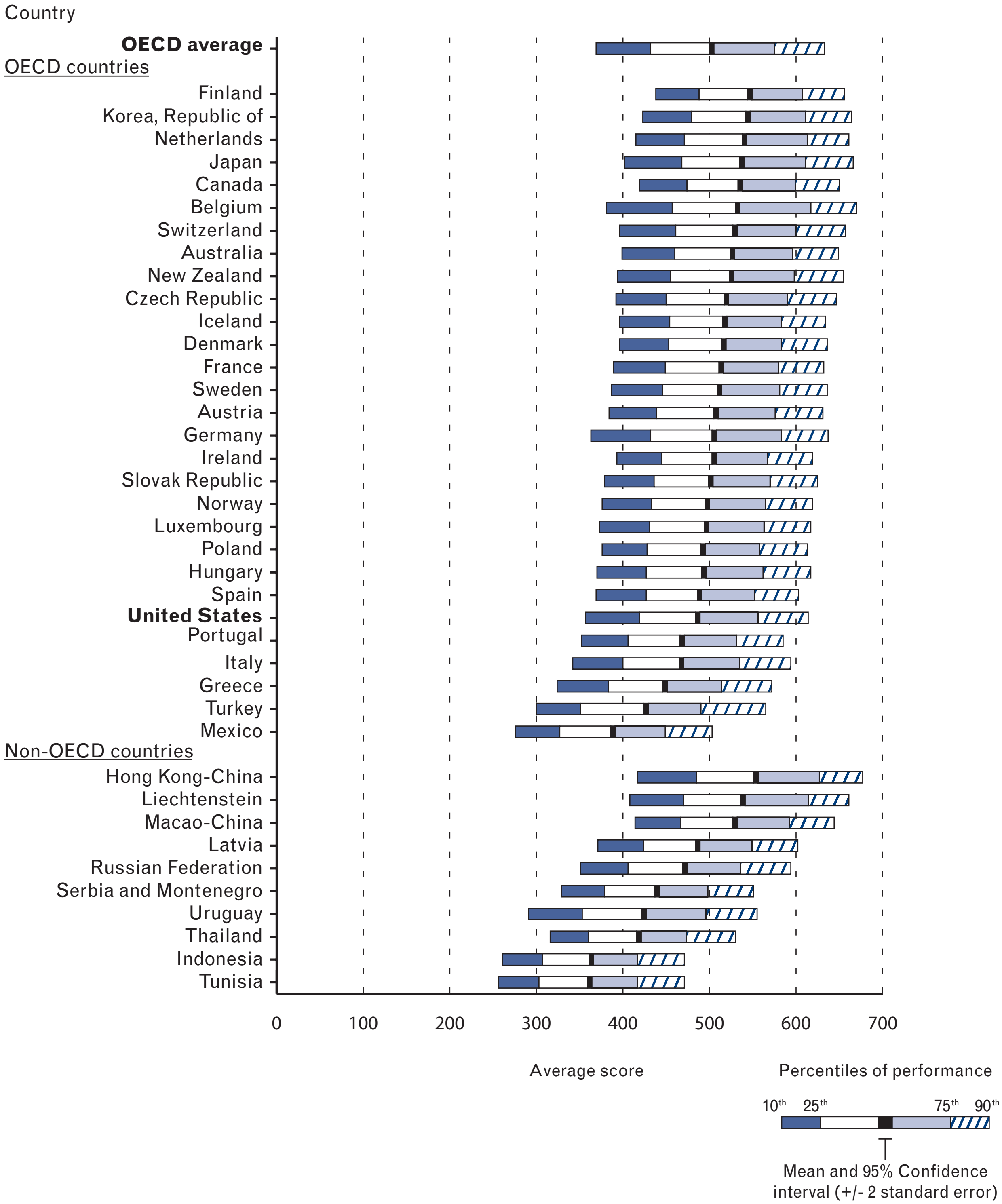
On average, the highest U.S. achievers (those in the top 10 percent of U.S. students) were outperformed by their OECD counterparts (figure 4, table B-4). To be in the top 10 percent in the United States, students had to score 607 or higher, while on average across the OECD countries, students would have had to score 628 or higher to be in the top 10 percent. Scores for the top 10 percent of students within countries ranged from 466 or better in Indonesia and Tunisia to 672 or better in Hong Kong-China. Low performers in the United States (those in the bottom 10 percent) had a cutoff score of 356 or lower, which was lower than the cutoff score of 369 or lower for the OECD average. There was approximately a 251 point score difference, or about two and a half standard deviations, between the cutoff scores for the top 10 percent and the bottom 10 percent of 15-year-old students for mathematics literacy in the United States, compared to about a 259 point difference using the OECD average scores.

The standard deviation (which measures the spread of scores around the average) for the United States (95), in fact, was lower than the OECD average standard deviation of 100 (table B-5). Sixteen countries (10 OECD and 6 non-OECD countries) showed less variation in performance than the United States, while three countries (Belgium, Germany, and Uruguay) had larger standard deviations.

Along with scale scores, PISA 2003 also uses six proficiency levels (levels 1 through 6, with level 6 being the highest level of proficiency) to describe student performance in mathematics literacy (exhibit 5). 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 can do and allow comparisons of the percentages of students in each country who perform at different levels of mathematics literacy (see technical notes in appendix A for more information about how levels were set).

The U.S. average score of 483 on the combined mathematics literacy scale was just above the bottom cut point for level 3; the OECD average score of 500 was near the midpoint of level 3 (table 2, exhibit 5). The cutoff score of 607 for U.S. high performers (those in the top 10 percent in the United States) placed it just into level 5; the OECD score for high performers was near the midpoint of level 5. The cutoff U.S. score of 356 for low performers (those in the bottom 10 percent) was below level 1, while the OECD cutoff score of 369 for the bottom 10 percent was a level 1 score (figure 4, exhibit 5).

Figure 4. Distribution of combined mathematics literacy scores of 15-year-old students, by country: 2003



NOTE: The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD countries are displayed separately from those of the OECD countries and are not included in the OECD average. Due to low response rates, data for the United Kingdom are not discussed in this report.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 5. Description of proficiency levels for combined mathematics literacy: 2003

Proficiency level	Task descriptions
Level 1	At Level 1 students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. They are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. They can perform actions that are obvious and follow immediately from the given stimuli.
Level 2	At Level 2 students can interpret and recognize situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formula, procedures, or conventions. They are capable of direct reasoning and making literal interpretations of the results.
Level 3	At Level 3 students can execute clearly described procedures, including those that require sequential decisions. They can select and apply simple problem solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They can develop short communications reporting their interpretations, results, and reasoning.
Level 4	At Level 4 students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic, linking them directly to aspects of real-world situations. Students at this level can utilize well-developed skills and reason flexibly, with some insight, in these contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments, and actions.
Level 5	At Level 5 students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare, and evaluate appropriate problem solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterizations, and insight pertaining to these situations. They can reflect on their actions and formulate and communicate their interpretations and reasoning.
Level 6	At Level 6 students can conceptualize, generalize, and utilize information based on their investigations and modeling of complex problem situations. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understandings along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for attacking novel situations. Students at this level can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situations.

NOTE: In order to reach a particular level, a student must have been able to correctly answer a majority of items at that level. Students were classified into mathematics literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (*a score less than or equal to 357.77*); level 1 (*a score greater than 357.77 and less than or equal to 420.07*); level 2 (*a score greater than 420.07 and less than or equal to 482.38*); level 3 (*a score greater than 482.38 and less than or equal to 544.68*); level 4 (*a score greater than 544.68 and less than or equal to 606.99*); level 5 (*a score greater than 606.99 and less than or equal to 669.3*); level 6 (*a score greater than 669.3*).

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

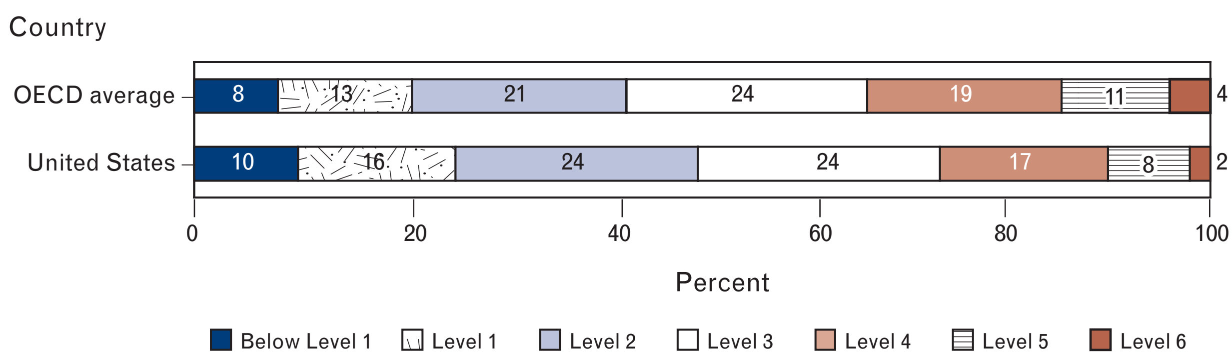
The United States had greater percentages of students below level 1 and at levels 1 and 2 than the OECD average percentages (figure 5, table B-6). The United States also had a lower percentage of students at levels 4, 5, and 6, than the OECD average percentages. This is somewhat different from the 2000 results, when reading literacy was the major domain. PISA 2000 results showed that while the percentages of U.S. students performing at level 1 and below were not measurably different from the OECD averages, the United States had a greater percentage of students performing at the highest level (level 5) compared to the OECD average (Lemke et al. 2001).

In mathematics literacy in 2003, half (19) of the other 38 countries had a higher percentage of students at level 6 than the United States, including 16 OECD countries and 3 non-OECD countries (Hong Kong-China, Liechtenstein, and Macao-China) (figure 6, table B-6). In contrast, nine countries had a higher percentage of students below level 1 than the United States (four of these nine—Greece, Italy, Mexico, and Turkey—were OECD countries). These same nine countries, as well as the Russian Federation and Portugal, had more students at level 1 than the United States.

The United States had a lower percentage of students at level 6 than the OECD average for each of the four content area subscales (*space and shape, change and relationships, quantity,* and *uncertainty*) and a smaller percentage than the OECD average at level 4 and level 5 on three of the four subscales (exceptions were for *uncertainty* at level 5 and *change and relationships* at level 4) (tables B-7 through B-10).

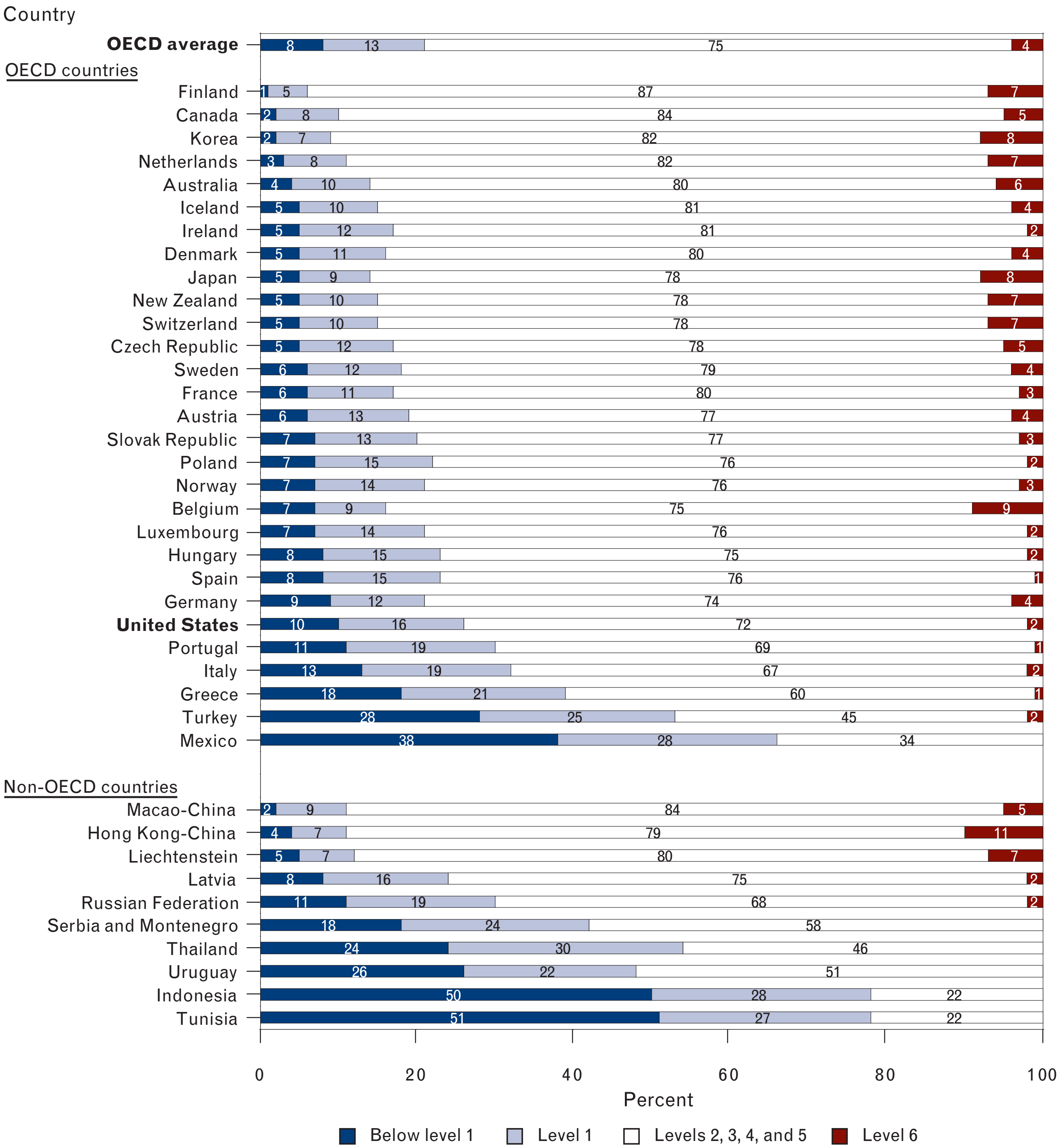
The United States also had a higher percentage of students at level 1 than the OECD average on each of the four subscales and more at level 2 for all subscales except *uncertainty*. On the *quantity* and *uncertainty* subscales, the United States also had greater percentages of students than the OECD average percentages below level 1.

Figure 5. Percentage distribution of 15-year-old students in the OECD countries and the United States on the combined mathematics literacy scale, by proficiency level: 2003



NOTE: In order to reach a particular proficiency level, a student must have been able to correctly answer a majority of items at that level. Students were classified into mathematics literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (*a score less than or equal to 357.77*); level 1 (*a score greater than 357.77 and less than or equal to 420.07*); level 2 (*a score greater than 420.07 and less than or equal to 482.38*); level 3 (*a score greater than 482.38 and less than or equal to 544.68*); level 4 (*a score greater than 544.68 and less than or equal to 606.99*); level 5 (*a score greater than 606.99 and less than or equal to 669.3*); level 6 (*a score greater than 669.3*). The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available. Detail may not sum to totals because of rounding.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Figure 6. Percentage distribution of 15-year-old students on the combined mathematics literacy scale, by proficiency level and country: 2003



NOTE: In order to reach a particular proficiency level, a student must have been able to correctly answer a majority of items at that level. Students were classified into mathematics literacy levels according to their scores. Exact cut point scores are as follows: below level 1 (*a score less than or equal to 357.77*); level 1 (*a score greater than 357.77 and less than or equal to 420.07*); level 2 (*a score greater than 420.07 and less than or equal to 482.38*); level 3 (*a score greater than 482.38 and less than or equal to 544.68*); level 4 (*a score greater than 544.68 and less than or equal to 606.99*); level 5 (*a score greater than 606.99 and less than or equal to 669.3*); level 6 (*a score greater than 669.3*). The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available. Because PISA is principally an OECD study, the results for non-OECD countries are displayed separately from those of the OECD countries and are not included in the OECD average. Due to low response rates, data for the United Kingdom are not discussed in this report. Detail may not sum to totals because of rounding.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Changes in Mathematics Literacy Performance From 2000 to 2003

Because mathematics literacy was a minor domain in 2000, items from only two content areas (*space and shape* and *change and relationships*) were administered in that assessment cycle. As a result, it is not possible to describe changes since 2000 for the combined mathematics literacy scale or for the other two content areas (*quantity* or *uncertainty*). Rather, changes can only be discussed for the two content areas represented in 2000 and 2003 (*space and shape* and *change and relationships*). Data from 2000 were re-scaled using 2003 mathematics literacy data in order to make these comparisons.[6] Comparisons were available only for OECD countries common to both the 2000 and 2003 cycle (28 countries) but results for the United Kingdom and the Netherlands are not discussed here due to low response rates for the United Kingdom in 2003 and the Netherlands in 2000. In total, results for 26 OECD countries were available for comparisons and are discussed here.

There were no measurable changes in the U.S. scores from 2000 to 2003 on either the *space and shape* subscale or the *change and relationships* subscale (table B-11). In both 2000 and 2003, about two-thirds of the other countries outperformed the United States on these scales. Eighteen of the other 25 OECD countries outscored the United States on the *space and shape* scale in 2003 (compared to 19 in 2000); 17 OECD countries outscored the United States on the *change and relationships* scale in 2003 (compared to 14 in 2000).

Five countries had their scores improve on the *space and shape* subscale. Four of the five countries with improved scores on the *space and shape* subscale also showed improvements on the *change and relationships* scale (Belgium, Czech Republic, Luxembourg, and Poland; Italy improved its score on the *space and shape* scale but not on the *change and relationships* scale).

Of the five countries that showed increases on the *space and shape* subscale, Belgium and the Czech Republic already outperformed the United States in 2000 and also improved their scores in 2003. Italy, despite its improvement in score, was not measurably different from the United States in either year. Poland, which was not measurably different from the United States in 2000, outscored the United States in 2003, and Luxembourg, which scored below the United States in 2000, also outscored the United States in 2003.

Two countries (Mexico and Iceland) showed decreased scores from 2000 to 2003 on the *space and shape* scale. Despite these decreases in performance, there was no change in the relative position of either country compared to the United States: that is, Iceland outperformed the United States in 2000 and 2003 on the *space and shape* subscale, and Mexico performed worse than the United States in 2000 and 2003.

Of the other 25 OECD countries, 11 had their scores improve from 2000 to 2003 on the *change and relationships* subscale, while no country had a decrease. Of the 11 countries that improved from 2000 to 2003, several already outperformed the United States in 2000: Belgium, Canada, Denmark, Finland, and Korea all scored higher than the United States in 2000 on the *change and relationships* subscale. Several other countries were not measurably different from the United States in 2000, but outperformed the United States in 2003 (Czech Republic, Germany, Hungary). Three countries (Luxembourg, Poland, and Spain) had lower scores than the United States in 2000 on the *change and relationships* subscale, but were not measurably different from the United States in 2003. Portugal, despite its improvement in score, still scored lower than the United States in 2000 and 2003.

[6]For more information on scaling, see the technical notes in appendix A.

U.S. Performance in Problem Solving

As noted, one of PISA's major goals is to assess skills that cut across traditional curricular areas. In 2003, PISA assessed students' abilities in problem solving.[7]

Problem solving is defined as:

> *...an individual's capacity to use cognitive processes to confront and resolve real, cross-disciplinary situations where the solution is not immediately obvious, and where the literacy domains or curricular areas that might be applicable are not within a single domain of mathematics, science, or reading. (OECD 2003, p. 156).*

Students completed exercises that assessed their capabilities in using reasoning processes not only to draw conclusions but to make decisions, to troubleshoot (i.e., to understand the reasons for malfunctioning of a system or device), or to analyze the procedures and structures of a complex system (such as a simple kind of programming language). Problem-solving items required students to apply various reasoning processes, such as inductive and deductive reasoning, reasoning about cause and effects, or combinatorial reasoning (i.e., systematically comparing all the possible variations which can occur in a well-described situation). Students were also assessed in their skills in working toward a solution and communicating the solution to others through appropriate representations. Sample problem-solving items and student responses are shown here.

For more information about the problem-solving framework, please refer to *The PISA 2003 Assessment Framework: Mathematics, Reading, Science, and Problem Solving Knowledge and Skills* (OECD 2003). Additional released problem-solving items can be found at http://nces.ed.gov/surveys/pisa.

[7]PISA 2003's problem-solving assessment focused explicitly on problem-solving skills, using a variety of contexts, disciplines, and problem types. The items used to measure problem solving in PISA 2003 were different from other items, such as those measuring mathematics literacy. Problem solving can also be embedded within measures of content areas such as mathematics or science, however. TIMSS 2003, for example, incorporated an explicit aspect of problem solving and inquiry into the description of desired outcomes for mathematics and science. A review of mathematics and science items in PISA and TIMSS showed that 38 percent of eighth-grade TIMSS 2003 mathematics items and 48 percent of PISA 2003 mathematics literacy items measured some aspect of problem solving; additionally, 26 percent of eighth-grade TIMSS 2003 science items and 49 percent of PISA science literacy items measured problem-solving skills (Dossey, O'Sullivan, and McCrone forthcoming).

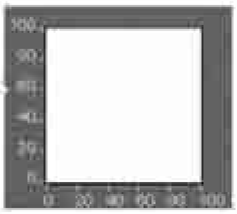
Exhibit 6. Problem-solving sample item 1: 2003

Design By Numbers©[1]

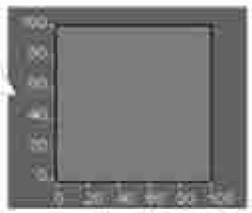
Design by Numbers is a design tool for generating graphics on computers. Pictures can be generated by giving a set of commands to the program.

Study carefully the following example commands and pictures before answering the questions.

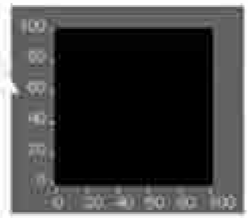
Paper 0



Paper 50

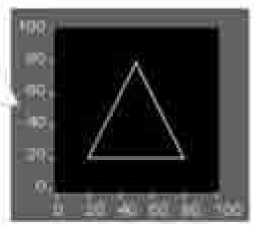


Paper 100



Paper 0
Pen 100
Line 20 0 80 60

Paper 100
Pen 0
Line 20 20 80 20
Line 80 20 50 80
Line 50 80 20 20

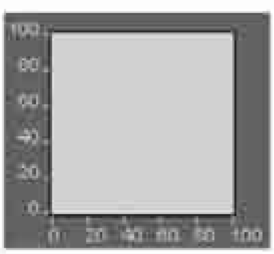


Question 4: DESIGN BY NUMBERS

X412Q01

Which of the following commands generated the graphic shown below?

A Paper 0
B Paper 20
C Paper 50
D Paper 75



RESULTS:
U.S. percent correct 41.3
OECD percent correct 50.3
Item difficulty: Level 2
Problem Type: System analysis and design

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

[1]Design by Numbers was developed by the Aesthetics and Computation Group at the MIT Media Laboratory. Copyright 1999, Massachusetts Institute of Technology. The program can be downloaded from http://dbn.media.mit.edu.

Exhibit 6. Problem-solving sample item 1: 2003—Continued

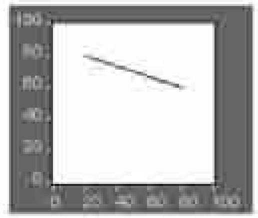
Design By Numbers

X412Q02

Question 5: DESIGN BY NUMBERS

Which of the following set of commands generated the graphic shown below?

A	Paper 100	Pen 0	Line 80 20 80 60
B	Paper 0	Pen 100	Line 80 20 60 80
C	Paper 100	Pen 0	Line 20 80 80 60
D	Paper 0	Pen 100	Line 20 80 80 60

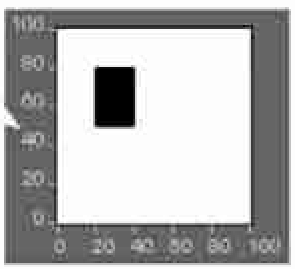


RESULTS:
U.S. percent correct...............46.6
OECD percent correct............48.3
Item difficulty: Level 2
Problem Type: System analysis and design

Question 6: DESIGN BY NUMBERS X412Q03 - 0 1 2 9

The following shows an example of the "Repeat" command.

```
Paper 0
Pen 100
Repeat A 50 80
{
 Line 20 A 40 A
}
```



The command "Repeat A 50 80" tells the program to repeat the actions in brackets { }, for successive values of A from A=50 to A=80.

Write commands to generate the following graphic:

Paper 0

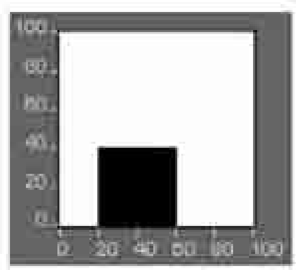
Pen 100

Repeat A 0 40

{

Line 20 A 60 A

}



RESULTS:
U.S. percent correct...............31.4
OECD percent correct............39.6
Item difficulty: Level 2
Problem Type: System analysis and design

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

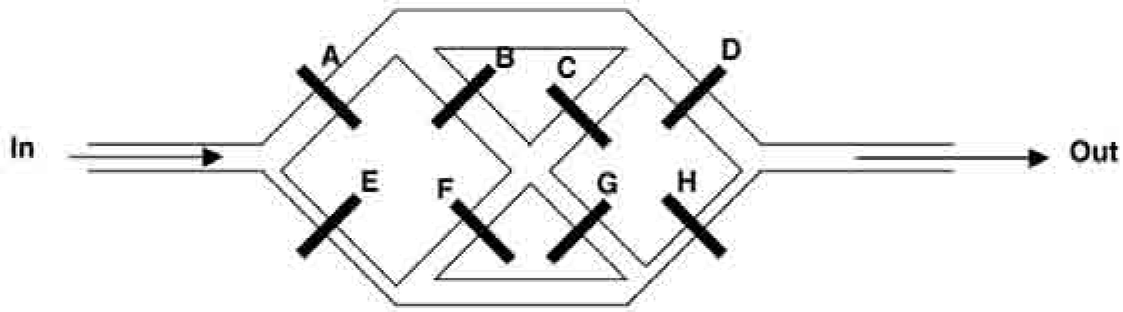
Exhibit 7. Problem-solving sample item 2: 2003

Irrigation

Below is a diagram of a system of irrigation channels for watering sections of crops. The gates A to H can be opened and closed to let the water go where it is needed. When a gate is closed no water can pass through it.

This is a problem about finding a gate which is stuck closed, preventing water from flowing through the system of channels.

Figure 1: A system of irrigation channels



Michael notices that the water is not always going where it is supposed to.
He thinks that one of the gates is stuck closed, so that when it is switched to "open", it does not open.

Question 17: IRRIGATION

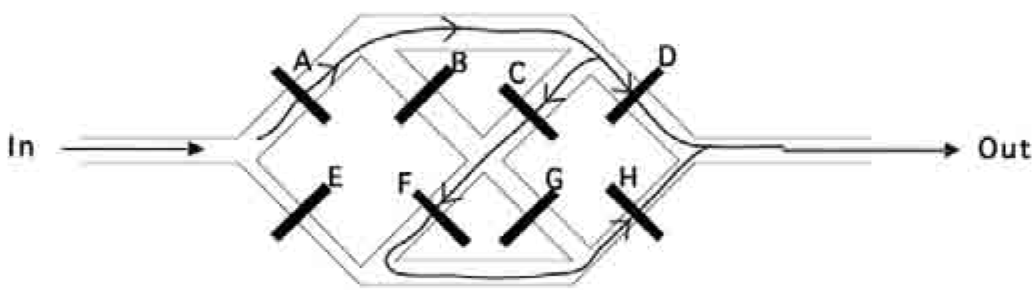
X603Q01 - 0 1 9

Michael uses the settings given in Table 1 to test the gates.

Table 1: Gate Settings

A	B	C	D	E	F	G	H
Open	Closed	Open	Open	Closed	Open	Closed	Open

With the gate settings as given in Table 1, **on the diagram below** draw all the possible paths for the flow of water. Assume that all gates are working according to the settings.



RESULTS:
U.S. percent correct................58.2
OECD percent correct............62.9
Item difficulty: Level 1
Problem Type: Trouble Shooting

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 7. Problem-solving sample item 2: 2003—Continued

Irrigation

Question 18: IRRIGATION

X603Q02

Michael finds that, when the gates have the Table 1 settings, no water flows through, indicating that at least one of the gates set to "open" is stuck closed.

Decide for each problem case below whether the water will flow through all the way. Circle "Yes" or "No" in each case.

Problem Case	Will water flow through all the way?
Gate **A** is stuck closed. All other gates are working properly as set in Table 1.	Yes / No
Gate **D** is stuck closed. All other gates are working properly as set in Table 1.	Yes / No
Gate **F** is stuck closed. All other gates are working properly as set in Table 1.	Yes / No

RESULTS:
U.S. percent correct 44.6
OECD percent correct 51.3
Item difficulty: Level 2
Problem Type: Trouble Shooting

Question 19: IRRIGATION

X603Q03 - 0 1 9

Michael wants to be able to test whether **gate D** is stuck closed.

In the following table, show settings for the gates to test whether **gate D** is stuck closed when it is set to "open".

Settings for gates (each one "open" or "closed")

A	B	C	D	E	F	G	H
open	closed	closed	open	closed	closed	closed	closed

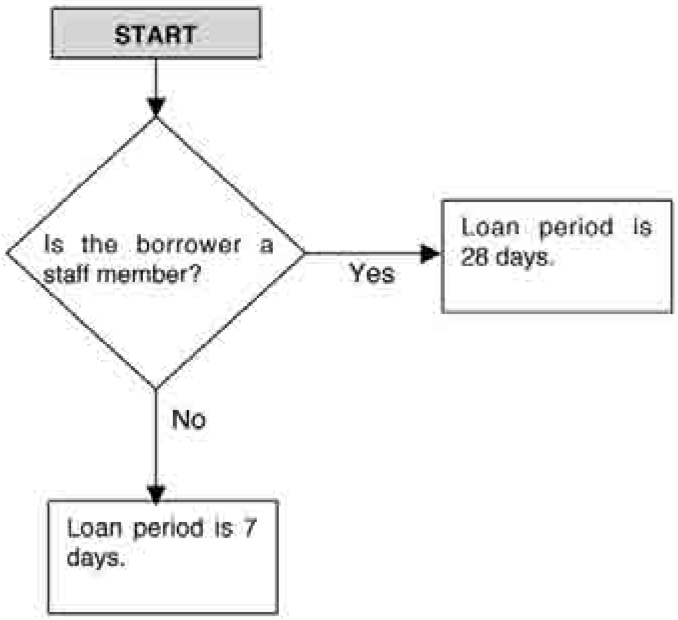
RESULTS:
U.S. percent correct 51.5
OECD percent correct 54.4
Item difficulty: Level 2
Problem Type: Trouble Shooting

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Exhibit 8. Problem-solving sample item 3: 2003

Library System

The **John Hobson High School** library has a simple system for lending books: for staff members the loan period is 28 days, and for students the loan period is 7 days. The following is a decision tree diagram showing this simple system:



The **Greenwood High School** library has a similar, but more complicated, lending system:

- All publications classified as "Reserved" have a loan period of 2 days.
- For books (not including magazines) that are **not** on the reserved list, the loan period is 28 days for staff, and 14 days for students.
- For magazines that are **not** on the reserved list, the loan period is 7 days for everyone.
- Persons with any overdue items are not allowed to borrow anything.

Question 13: LIBRARY SYSTEM

X402Q01

You are a student at **Greenwood High School**, and you do not have any overdue items from the library. You want to borrow a book that is **not** on the reserved list. How long can you borrow the book for?

Answer: ....14.......... days.

RESULTS:

U.S. percent correct..............75.3
OECD percent correct............74.8
Item difficulty: Level 1
Problem Type: System analysis and design

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

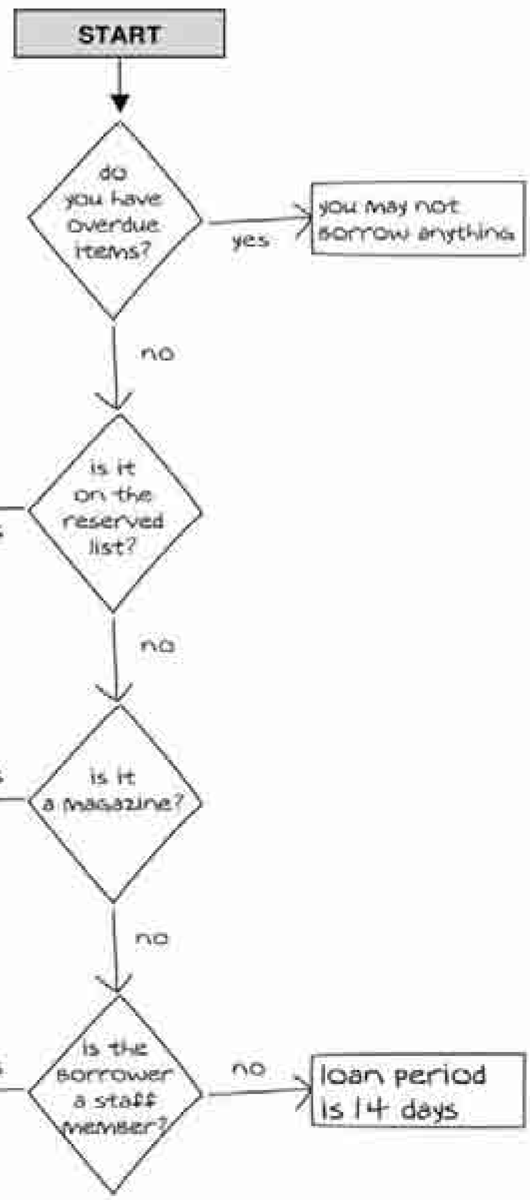
Exhibit 8. Problem-solving sample item 3: 2003—Continued

Library System

Question 14: LIBRARY SYSTEM

X402Q02 - 01 02 11 12 21 22 23 31 99

Develop a decision tree diagram for the **Greenwood High School Library** system so that an automated checking system can be designed to deal with book and magazine loans at the library. Your checking system should be as efficient as possible (i.e. it should have the least number of checking steps). Note that each checking step should have only **two** outcomes and the outcomes should be labeled appropriately (e.g. "Yes" and "No").



RESULTS:

U.S. percent correct...............13.5
OECD percent correct............14.3
Item difficulty: Level 3
Problem Type: System analysis and design

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Problem-solving scores are reported on a scale with a mean of 500 and standard deviation of 100. Fifteen-year-old students in the United States had an average score of 477 on the problem-solving scale, lower than the OECD average score of 500 (table 3, table B-12). U.S. students scored lower in problem solving than their peers in 25 of the other 38 countries (22 OECD and 3 non-OECD countries). Eight countries (3 OECD—Greece, Mexico, and Turkey—and 5 non-OECD countries) reported lower scores compared to the United States in problem solving. Three OECD country scores (and two non-OECD country scores) were not measurably different from the U.S. average score in problem solving.

On average, U.S. high achievers for problem solving (those scoring in the top 10 percent in the United States) were outperformed by their OECD counterparts (figure 7, table B-13). To be in the top 10 percent of students in the United States, students needed at least a score of 604, while they needed a score of 446 or better in Tunisia but 675 or better in Japan. Low performers in the United States (those in the bottom 10 percent) scored 347 or lower, which was lower than the cutoff score of 368 or lower for the OECD average. There was approximately a 256 point score difference, or two and a half standard deviations, between the cutoff scores for the top 10 percent (604) and the bottom 10 percent (347) of 15-year-old students for problem solving in the United States.

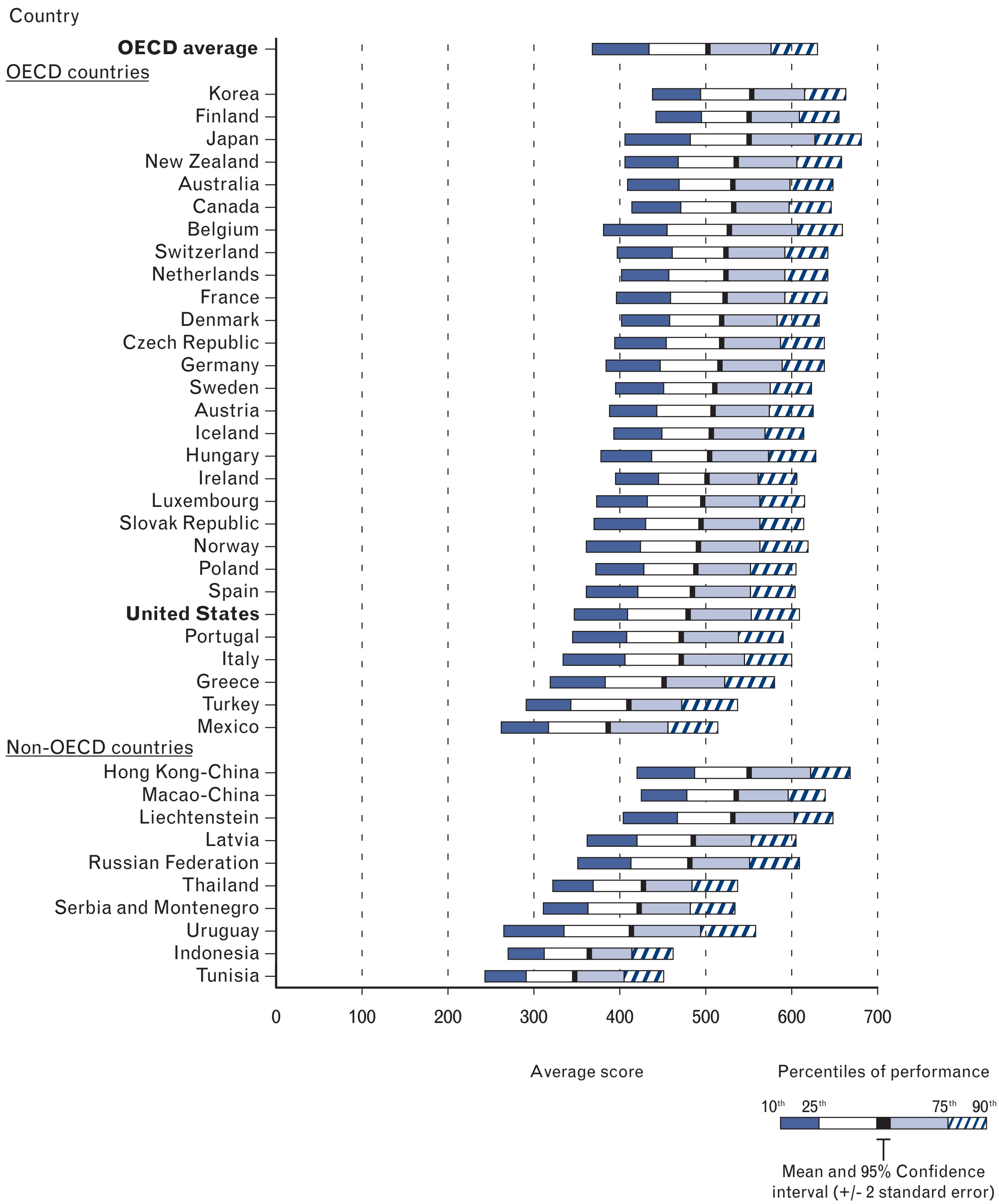
Table 3. Average scores of 15-year-old students on the problem-solving scale, by country: 2003

Country	
OECD average	**500**
OECD countries	
Korea	550
Finland	548
Japan	547
New Zealand	533
Australia	530
Canada	529
Belgium	525
Switzerland	521
Netherlands	520
France	519
Denmark	517
Czech Republic	516
Germany	513
Sweden	509
Austria	506
Iceland	505
Hungary	501
Ireland	498
Luxembourg	494
Slovak Republic	492
Norway	490
Poland	487
Spain	482
United States	**477**
Portugal	470
Italy	470
Greece	449
Turkey	408
Mexico	384
Non-OECD countries	
Hong Kong-China	548
Macao-China	532
Liechtenstein	529
Latvia	483
Russian Federation	479
Thailand	425
Serbia and Montenegro	420
Uruguay	411
Indonesia	361
Tunisia	345

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

NOTE: Statistical comparisons between the U.S. average and the Organization for Economic Cooperation and Development (OECD) average take into account the contribution of the U.S. average toward the OECD average. The OECD average is the average of the national averages of the OECD member countries with data available. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD countries are displayed separately from those of the OECD countries and are not included in the OECD average. Due to low response rates, data for the United Kingdom are not discussed in this report.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Figure 7. Distribution of problem-solving scores of 15-year-old students, by country: 2003



NOTE: The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD countries are displayed separately from those of the OECD countries and are not included in the OECD average. Due to low response rates, data for the United Kingdom are not discussed in this report.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Of the 38 other participating countries, 22 countries (including 16 OECD countries) had less variation (as measured by standard deviation) in performance in problem solving than the United States, while 3 countries (Belgium, Japan, and Uruguay) showed greater variation in performance (table B-14). The U.S. variation in performance was not measurably different from the OECD average variation.

Along with scale scores, PISA 2003 also uses three proficiency levels (levels 1 through 3, with level 3 being the highest level of proficiency) to describe student performance in problem solving. An additional level (below level 1) encompasses students whose skills cannot be described using these proficiency levels (exhibit 9). The proficiency levels describe what students at each level can do and allow comparisons of the percentages of students in each country who performed at different levels in problem solving (see appendix A for more information about how levels were set).

Exhibit 9. Description of proficiency levels for problem solving: 2003

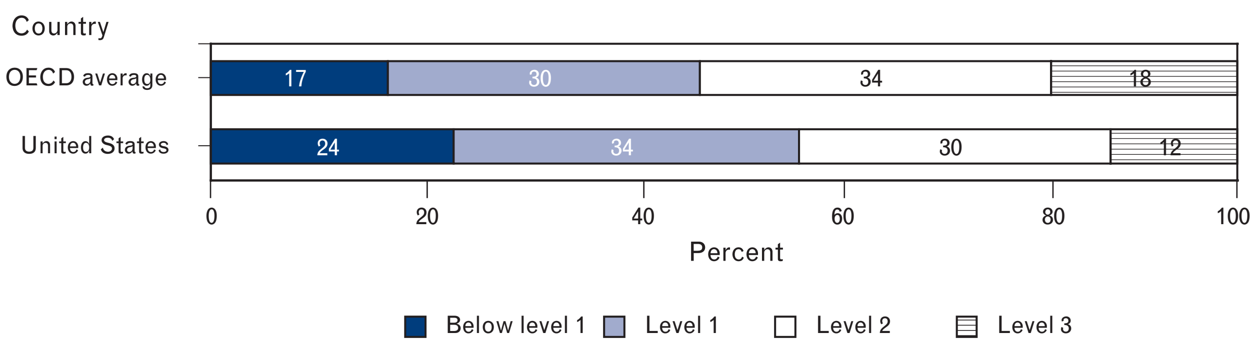
Proficiency level	Task descriptions
Level 1	At Level 1 students can solve problems where they have to deal with a single data source containing discrete, well-defined information. They understand the nature of a problem and consistently locate and retrieve information related to the major features of the problem. Level 1 students may be able to transform the information in the problem to present the problem differently (e.g., take information from a table to create a drawing or graph). Also, students may be able to apply information to check a limited number of well-defined conditions within the problem. However, Level 1 students are generally incapable of dealing with multi-faceted problems involving more than one data source or requiring the student to reason with the information provided.
Level 2	At Level 2 students use reasoning and analytic processes and solve problems requiring decision-making skills. Level 2 students apply various types of reasoning (inductive and deductive reasoning, reasoning about causes and effects, or combinatorial reasoning, that is, systematically comparing all possible variations in well-described situations) to analyze situations and to solve problems that require students to make a decision among well-defined alternatives. To analyze a system or make decisions, Level 2 students combine and synthesize information from a variety of sources. Students may need to combine various forms of representations (e.g., a formalized language, numerical information, and graphical information), handle unfamiliar representations (e.g., statements in a proto-programming language or flow diagrams related to a mechanical or structural arrangement of components), or draw inferences based on two or more sources of information.
Level 3	At Level 3 students do not only analyze a system and make decisions, they also represent the underlying relationships in a problem and relate these to the solution. Level 3 students approach problems systematically, construct their own representations and verify that their solution satisfies all requirements of the problem. These students communicate their solutions to others using written statements and other representations.

NOTE: In order to reach a particular proficiency level, a student must have been able to correctly answer a majority of items at that level. Students were classified into problem-solving levels according to their scores. Exact cut point scores are as follows: below level 1 (*a score less than or equal to 404.06*); level 1 (*a score greater than 404.06 and less than or equal to 498.08*); level 2 (*a score greater than 498.08 and less than or equal to 592.10*); level 3 (*a score greater than 592.10*).
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

The U.S. average score of 477 on the problem-solving scale placed it at level 1, while the OECD average score was at level 2 (table B-12, exhibit 9). The cutoff score of 604 for U.S. high performers (those in the top 10 percent in the United States) equated to a level 3 score, while the U.S. cutoff score of 347 for low performers (those in the bottom 10 percent) was below level 1 (table B-13, exhibit 9).

Twenty-four percent of U.S. students scored below level 1, 34 percent at level 1, 30 percent at level 2, and 12 percent at level 3 (figure 8, table B-15). The United States had greater percentages of students below level 1 and at level 1 than the OECD average percentages. The United States also had a lower percentage of students at levels 2 and 3 than the OECD average percentages. Four countries (Finland, Hong Kong-China, Japan, and Korea) had 30 percent or more of their students performing at level 3 in problem solving, compared with 12 percent for the United States and 18 percent for the OECD average.

Figure 8. Percentage distribution of 15-year-old students in the OECD countries and the United States on the problem-solving scale, by proficiency level: 2003



NOTE: In order to reach a particular proficiency level, a student must have been able to correctly answer a majority of items at that level. Students were classified into problem-solving levels according to their scores. Exact cut point scores are as follows: below level 1 *(a score less than or equal to 404.06)*; level 1 *(a score greater than 404.06 and less than or equal to 498.08)*; level 2 *(a score greater than 498.08 and less than or equal to 592.10)*; level 3 *(a score greater than 592.10).* The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available. Detail may not sum to totals because of rounding.

SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

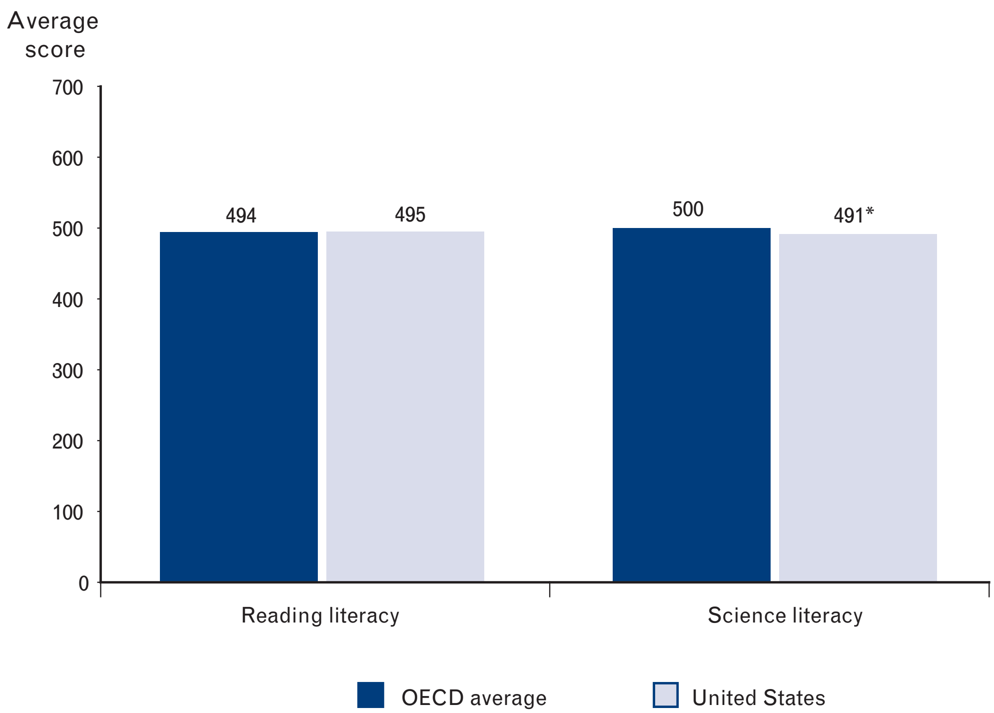
U.S. Performance in Reading Literacy and Science Literacy

Of the 41 countries that participated in PISA 2003, 32 also participated in PISA 2000. Changes in reading literacy and science literacy are reported for 29 of these 32 countries.[8]

In 2003, the average U.S. score in reading literacy was 495, not measurably different from the OECD average of 494 (figure 9, table B-16). Eleven countries (including 9 OECD countries) among the other 38 countries outperformed the United States in reading literacy in 2003.

There was no measurable change in either the U.S. reading literacy score from 2000 to 2003 or the U.S. position compared to the OECD average, although scores in 12 other countries did change (table B-16).[9] Four countries saw their average reading literacy scores increase (two non-OECD countries, Latvia and Liechtenstein, and two OECD countries, Luxembourg and Poland). The United States outperformed all four of these countries in 2000; in 2003, scores for Latvia and Poland were not measurably different from the U.S. scores in reading literacy, while Liechtenstein outscored the United States in 2003. Despite an increase in Luxembourg's average reading literacy score, the United States outperformed it in 2000 and 2003.

Figure 9. Average reading literacy and science literacy scores of 15-year-old students in the OECD countries and the United States: 2003



* Average is significantly different from OECD average.
NOTE: The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

[8] Due to low response rates, data for the Netherlands were not discussed for PISA 2000; data for PISA 2003 for the United Kingdom are also not discussed due to low response rates; data for Brazil were not available at the time of production for this report.

[9] Large standard errors for the United States in 2000 may account at least in part for the fact that U.S. reading literacy and science literacy scores were not measurably different from 2000 to 2003 and that the scores were not different from the OECD averages in 2000.

Eight countries' scores (including seven OECD countries) were lower in 2003 than 2000 in reading literacy. Decreases in two of these eight countries' scores resulted in a change relative to the United States. Japan, which outperformed the United States in reading literacy in 2000, was not measurably different in 2003, while Spain, which did not perform measurably differently in 2000, performed worse than the United States in 2003.

In 2003, the U.S. average score in science literacy was 491, lower than the OECD average of 500 (figure 9, table B-17). Eighteen countries (including 15 OECD countries) outscored the United States in science in 2003.

There was no measurable difference between the U.S. average science literacy score of 499 in 2000 and 491 in 2003, although the relative position of the United States compared to the OECD average did change (the U.S. science literacy score in 2000 was not measurably different from the OECD average, while in 2003 the U.S. score was below the OECD average). Seventeen countries showed changes in their scores from 2000 to 2003—5 countries (all OECD countries) had lower scores in 2003 than in 2000 and 12 countries (including 9 OECD countries) had higher scores (table B-17). The OECD average score in science literacy was 500 in 2000 and 2003.

Of the 12 countries whose science literacy scores improved between 2000 and 2003, 8 also improved their performance relative to the United States. Belgium, the Czech Republic, France, Germany, Liechtenstein, and Switzerland did not perform differently from the United States in 2000 but outscored the United States in 2003. Latvia and the Russian Federation scored below the U.S. average in 2000 but were not measurably different in 2003. Of the five countries whose science literacy scores decreased between 2000 and 2003, two (Canada and Korea) continued to outperform the United States, one (Norway) was not measurably different in either year, one (Mexico) performed below the U.S. average in both years, and one (Austria) went from outscoring the United States to not being measurably different from the United States.

Differences in Performance by Selected Student Characteristics

This section provides information about how students with various characteristics (males and females, students of different races and from different socioeconomic backgrounds) performed on PISA 2003. Because PISA 2003's emphasis was on mathematics literacy and problem solving, the focus in this section is on performance in these areas.[10] This report does not address possible changes in performance for these groups from 2000 to 2003.

When considering these results, it is important to bear in mind that there need not be a cause-and-effect relationship between being a member of a group and achievement in PISA 2003. Student performance can be affected by a complex mix of educational and other factors that are not examined here.

Sex

Fifteen-year-old females in the United States scored 480 on the combined mathematics literacy scale, which was lower than the average male score of 486 (figure 10, table B-18). Males also outperformed females in 25 other countries (20 OECD countries and 5 non-OECD countries), a pattern evident in the OECD average scores of 494 for females and 506 for males. Iceland was the only country in which females scored higher in mathematics literacy than males.

Within the United States, greater percentages of male students performed at level 6 (the highest level) than female students in mathematics literacy, but larger percentages of females were not seen at lower levels (below level 1 and levels 1 through 5, table B-19). In other words, differences in the overall scores between males and females in the United States were due at least in part to the fact that a greater percentage of males were found among the highest performers, not to a greater percentage of females found among the lowest performers.

On average across the OECD countries, males outperformed females on each of the four mathematics literacy subscales (table B-20). In the United States, differences between males and females were evident only on the *space and shape* subscale.

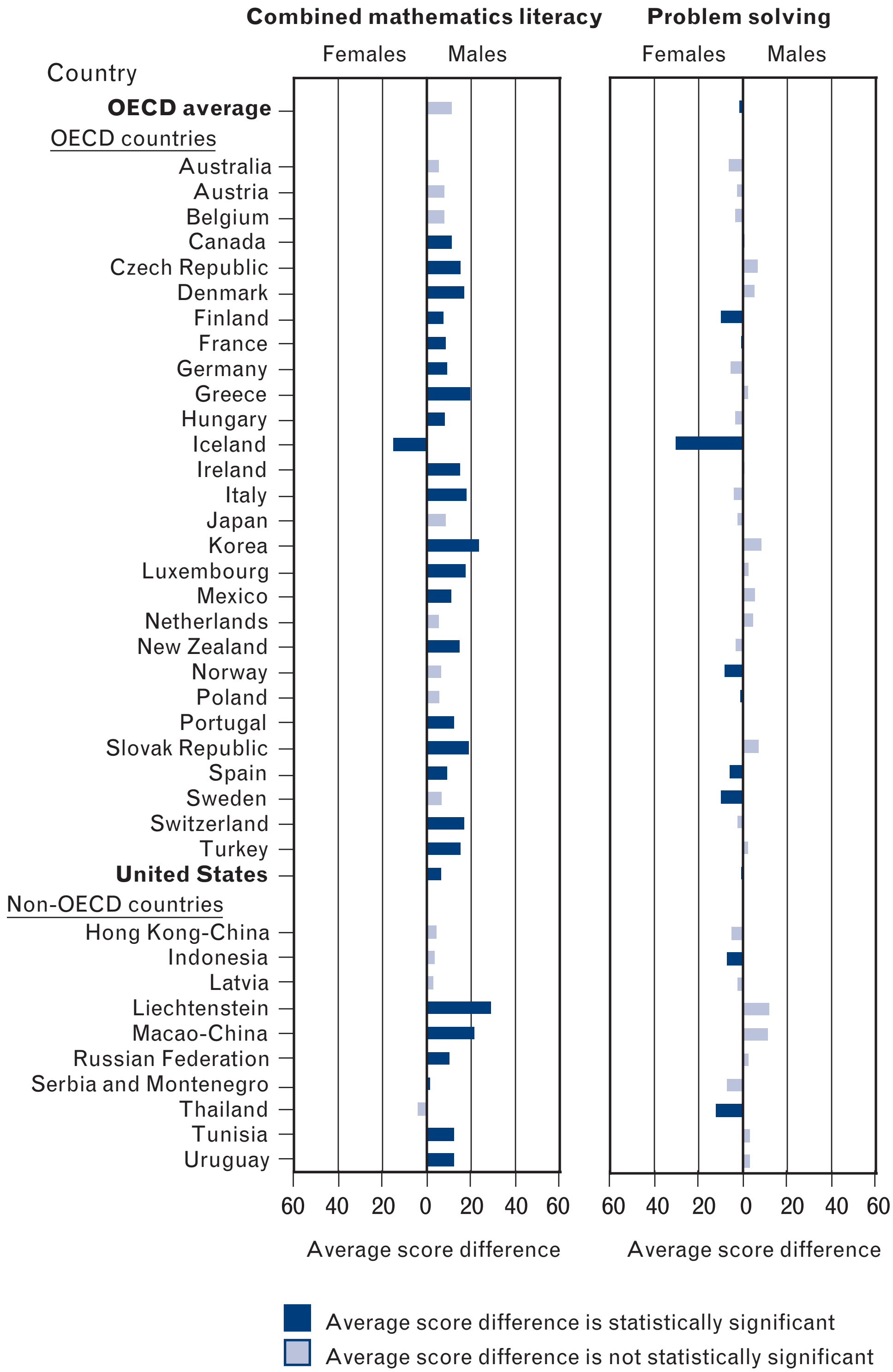
In the majority of the PISA 2003 countries (32 out of 39 countries), including the United States, there were no measurable differences in problem-solving scores by sex (figure 10, table B-21). However, females outscored their male peers in problem solving in six of the remaining seven participating countries (including four OECD countries), as well as at the OECD average. Males outscored females in problem solving in Macao-China.

As in 2000, females in the United States and nearly every other participating country outscored males in reading literacy in 2003 (table B-22). Only Liechtenstein showed no statistical difference between males and females in 2003, although there was a difference in favor of females in 2000.

There was no measurable difference between the performance of U.S. males and females in science literacy in PISA 2000 or PISA 2003, and scores for neither group changed between 2000 and 2003. Thirteen countries showed differences between males and females in 2003 (12 OECD countries and the Russian Federation). Eleven of the 13 countries showed differences in favor of males, but in Finland and Iceland females outperformed males.

[10] Information on performance in reading literacy and science literacy by sex and race/ethnicity is provided, however.

Figure 10. Differences in average scores of 15-year-old students on the combined mathematics literacy scale and in problem solving, by sex and country: 2003



NOTE: Each bar above represents the average score difference between males and females on combined mathematics literacy and problem solving. The Organization for Economic Cooperation and Development (OECD) average is the average of the national averages of the OECD member countries with data available. Because the Program for International Student Assessment (PISA) is principally an OECD study, the results for non-OECD countries are displayed separately from those of the OECD countries and are not included in the OECD average. Due to low response rates, data for the United Kingdom are not discussed in this report.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

Socioeconomic Status

The measure of student socioeconomic status (SES) used in PISA 2003 is based on the occupational status of the student's father or mother (whichever was higher) as reported by the student. Parental occupation was coded based on the International Standard Classification of Occupations (ISCO) (International Labor Organization 1990). Occupational codes were in turn mapped onto an internationally comparable index of occupational status, the International Socioeconomic Index (ISEI), developed by Ganzeboom, De Graaf, and Treiman (1992). Using the index, students were assigned numbers ranging from about 16 to 90 based on their parents' occupations, so that they were arrayed on a continuum from low to high socioeconomic status, rather than placed into discrete categories. Typical occupations among parents of 15-year-olds with between 16 and 35 points on the ISEI scale include small-scale farmer, metalworker, mechanic, taxi or truck driver, and waiter/waitress. Between 35 and 53 index points, the most common occupations are bookkeeping, sales, small business management, and nursing. As the required skills increase, so does the status of the occupation. Between 54 and 70 points, typical occupations are marketing management, teaching, civil engineering, and accountant. Finally, between 71 and 90 points, the top international quarter of the index, occupations include medicine, university teaching, and law (OECD 2001).

The average ISEI index score for the United States in 2003 was 55, higher than that of all but two countries (Norway and Iceland) (table B-23). Low ISEI students in the United States were also comparatively better off in terms of socioeconomic status than most of their OECD peers. U.S. students with low ISEI (those in the bottom 25 percent in the United States) had an average index value of 33, which was higher than the index values for low ISEI students in 35 of the other 38 PISA 2003 countries (including 25 OECD countries). Two countries (Japan and Norway) reported higher average index values for low ISEI students compared to the United States.

Within the United States, students with low ISEI values were outperformed in mathematics literacy by their peers with higher ISEI values (table B-24). Moreover, U.S. students with low ISEI values were outperformed by their peers with low ISEI values in 22 of the 39 PISA 2003 countries (including 18 OECD countries) for mathematics literacy. Students with the highest ISEI background in the United States (those in the top quarter) were outperformed by high ISEI students from 20 other countries (including 19 OECD countries) in mathematics literacy.

The overall linkage of ISEI to mathematics literacy and problem solving can be examined by the specific change in score on the combined mathematics literacy scale in response to a one standard deviation change in the ISEI index score for each country. A greater increase in the average achievement score in a country implies a stronger relationship between socioeconomic status and performance in that country.

For example, in the United States, a one standard deviation change in the ISEI index was associated with an average difference of 30 points on the combined mathematics literacy and 31 points on the problem-solving scale (table B-25). In Macao-China, socioeconomic background differences in achievement were at a minimum—one standard deviation's difference on the ISEI index was associated with a 10 point difference on the combined mathematics literacy scale and a 12 point difference on the problem-solving scale. By contrast, among students in Hungary, a one standard deviation change in ISEI score was associated with about a 41 point difference in both mathematics literacy and problem-solving achievement scores. Twelve countries (including six OECD countries) had a weaker relationship between ISEI and problem-solving performance than the United States, while three countries (Belgium, Germany, and Hungary) had a stronger one. Belgium, Germany, and Hungary also had stronger relationships between ISEI and mathematical literacy than the United States, as did the Czech Republic and Poland. Eleven countries (including 6 OECD countries) had weaker relationships.

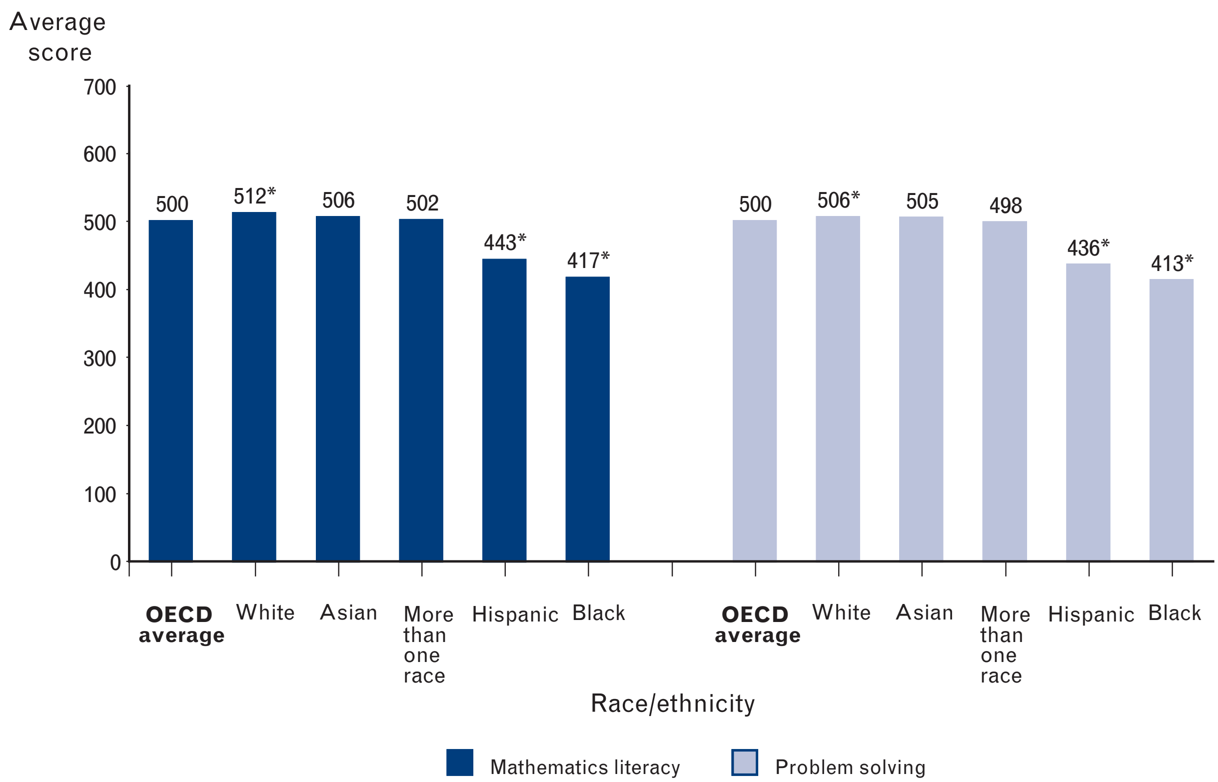
Race/Ethnicity

Racial and ethnic groups vary between countries, so it is not possible to compare their performance across countries on international assessments. Thus, this section refers only to 2003 findings for the United States. Throughout this section, "White" refers to White, non-Hispanic students, "Black" to Black, non-Hispanic students, "Asian" to Asian, non-Hispanic students, and "Hispanic" to Hispanic students of any race. Results for two groups (American Indian or Alaska Native and Hawaiian or Other Pacific Islander) are not shown separately because small sample sizes did not allow for accurate estimates.

In both mathematics literacy and problem solving, Blacks and Hispanics scored lower, on average, than Whites, Asians, and students of more than one race (figure 11, table B-26). Hispanic students, in turn, outscored Black students. This pattern of performance on PISA 2003 by race/ethnicity is similar to that found in PISA 2000 and on the National Assessment of Educational Progress (NAEP) (Braswell, Daane, and Grigg 2003; Lemke et al. 2001).

In both mathematics literacy and problem solving, the average scores for Blacks and Hispanics were below the respective OECD average scores, while scores for Whites were above the OECD average scores. Students who were White, Asian, and of more than one race scored at level 3 in mathematics literacy, compared to level 2 for Hispanic students and level 1 for Black students (figure 11, exhibit 5). In problem solving, average scores for Whites and Asians placed them in level 2, while Black, Hispanic, and students of more than one race scored at level 1 (figure 11, exhibit 9).

Figure 11. Average scores of U.S. 15-year-old students on the combined mathematics literacy scale and in problem solving, by race/ethnicity: 2003



* Average is significantly different from OECD average.
NOTE: Reporting standards not met for American Indian/Alaska Native and Native Hawaiian/Other Pacific Islander. Black includes African American and Hispanic includes Latino. Racial categories exclude Hispanic origin.
SOURCE: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), 2003.

For Further Information

This report provides selected findings from PISA 2003 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 on PISA 2003 and further results will be published in a series of OECD thematic reports on PISA 2003. Data with which researchers can conduct their own analyses are also available at http://www.pisa.oecd.org.

References

Adams, R. (Ed.). (forthcoming). *PISA 2003 Technical Report.* Paris: Organization for Economic Cooperation and Development.

Adams, R. (Ed.). (2002). *PISA 2000 Technical Report*. Paris: Organization for Economic Cooperation and Development.

Binkley, M., Afflerbach, P., and Kelly, D. (forthcoming). *A Content Comparison of the NAEP and PISA Reading Assessments* (NCES 2005–110). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Binkley, M., and Kelly, D. (2003). *A Content Comparison of the NAEP and PIRLS Fourth-Grade Reading Assessments* (NCES 2003–10). U.S. Department of Education. Washington, DC: National Center for Education Statistics Working Paper.

Braswell, J.S., Daane, M.C., and Grigg, W.S. (2003). *The Nation's Report Card: Mathematics Highlights 2003* (NCES 2004–451). U.S. Department of Education. National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

Dossey, J., O'Sullivan, C., and McCrone, S. (forthcoming). *Problem Solving in International Comparative Assessments* (NCES 2005–107). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Ferraro, D., Czuprynski, J., and Williams, T. (forthcoming). *U.S. 2003 PISA Nonresponse Bias Analysis.* (2005–102). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Ganzeboom, H.B.G., De Graaf, P., Treiman, D.J. (with De Leeuw, J.). (1992). A Standard International Socio-Economic Index of Occupational Status. *Social Science Research*, *21*(1): 1-56.

Ganzeboom, H.B.G., and Treiman, D.J. (1996). Internationally Comparable Measures of Occupational Status for the 1988 International Standard Classification of Occupations. *Social Science Research, 25*(3): 201-239.

International Labor Organization. (1990). ISCO-88: International Standard Classification of Occupations. Geneva: Author.

Lemke, M., Calsyn, C., Lippman, L., Jocelyn, L., Kastberg, D., Liu, Y.Y., Roey, S., Williams, T., Kruger, T., Bairu, G. (2001). *Outcomes of Learning: Results from the 2000 Program for International Student Assessment of 15-Year-Olds in Reading, Mathematics, and Science Literacy* (NCES 2002–115). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

Neidorf, T.S., Binkley, M., Gattis, K., and Nohara, D. (forthcoming). *A Content Comparison of the National Assessment of Educational Progress (NAEP), Trends in International Mathematics and Science Study (TIMSS), and Program for International Student Assessment (PISA) 2003 Mathematics Assessments.* (NCES 2005–112). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Neidorf, T.S., Binkley, M., and Stephens, M. (forthcoming). *A Content Comparison of the National Assessment of Educational Progress (NAEP) 2000 and Trends in International Mathematics and Science Study (TIMSS) 2003 Science Assessments* (NCES 2005–106). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Nohara, D. (2001). *A Comparison of the National Assessment of Educational Progress (NAEP), the Third International Mathematics and Science Study-Repeat (TIMSS-R), and the Programme for International Student Assessment (PISA)* (NCES 2001–07). U.S. Department of Education. Washington, DC: National Center for Education Statistics Working Paper.

Organization for Economic Cooperation and Development (OECD). (1999). *Measuring Student Knowledge and Skills: A New Framework for Assessment*. Paris: Author.

Organization for Economic Cooperation and Development (OECD). (2000). *Measuring Student Knowledge and Skills: The PISA 2000 Assessment of Reading, Mathematical and Scientific Literacy*. Paris: Author.

Organization for Economic Cooperation and Development (OECD). (2001). *Knowledge and Skills for Life: First Results from the OECD Programme for International Student Assessment*. Paris: Author.

Organization for Economic Cooperation and Development (OECD). (2002). *Sample Tasks for the PISA 2000 Assessment: Reading, Mathematical and Scientific Literacy*. Paris: Author.

Organization for Economic Cooperation and Development (OECD). (2003). *The PISA 2003 Assessment Framework: Mathematics, Reading, Science and Problem Solving Knowledge and Skills*. Paris: Author.

Organization for Economic Cooperation and Development (OECD). (2004). *Learning for Tomorrow's World — First Results From PISA 2003*. Paris: Author.

Organization for Economic Cooperation and Development (OECD). (2004). *Problem Solving for Tomorrow's World — First Measures of Cross-Curricular Skills From PISA 2003*. Paris: Author.

Raudenbush, S. W. and Bryk, A. S. (2002). *Hierarchical Linear Models: Applications and Data Analysis Methods (2nd ed.)*. Newbury Park, CA: Sage Publications.

Steen, L. A. (Ed.). (1990). *On the Shoulders of Giants: New Approaches to Numeracy*. Washington, DC: National Academy Press.

Westat. (2000). *WesVar 4.0 User's Guide*. Rockville, MD: Author.

Wilson, M. and Xie, Y. (2004). *Report on the Imperial Versus Metric Study*. BEAR Research Report, Berkeley, CA: University of California. Available at http://bear.berkeley.edu/pub.html.