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Introduction

PISA – AN OVERVIEW

PISA 2006 – focus on science

Are students well prepared to meet the challenges of the future? Are they able to analyse, reason and communicate their ideas effectively? Have they found the kinds of interests they can pursue throughout their lives as productive members of the economy and society? The OECD Programme for International Student Assessment (PISA) seeks to provide some answers to these questions through its surveys of key competencies of 15-year-old students. PISA surveys are administered every three years in the OECD member countries and a group of partner countries, which together make up close to 90% of the world economy.[1]

PISA assesses the extent to which students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in society, focusing on student competencies in the key subject areas of reading, mathematics and science. PISA seeks to assess not merely whether students can reproduce what they have learned, but also to examine how well they can extrapolate from what they have learned and apply their knowledge in novel settings, ones related to school and non-school contexts. This report presents the results of the most recent PISA survey held in 2006.

PISA 2006 focused on students' competency in science. In today's technology-based societies, understanding fundamental scientific concepts and theories and the ability to structure and solve scientific problems are more important than ever. Yet the percentage of students in some OECD countries who are studying science and technology in universities has dropped markedly over the past 15 years. The reasons for this are varied, but some research suggests that student attitudes towards science, may play an important role (OECD, 2006a). PISA 2006 therefore assessed not only science knowledge and skills, but also the attitudes which students have towards science, the extent to which they are aware of the life opportunities that possessing science competencies may open, and the science learning opportunities and environments which their schools offer.

The PISA surveys

PISA focuses on young people's ability to use their knowledge and skills to meet real-life challenges. This orientation reflects a change in the goals and objectives of curricula themselves, which are increasingly concerned with what students can do with what they learn at school and not merely with whether they have mastered specific curricular content.

Key features driving the development of PISA have been its:

- Policy orientation, which connects data on student learning outcomes with data on students' characteristics and on key factors shaping their learning inside and outside school in order to draw attention to differences in performance patterns and to identify the characteristics of schools and education systems that have high performance standards.
- Innovative "literacy" concept, which is concerned with the capacity of students to apply knowledge and skills in key subject areas and to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations.
- Relevance to lifelong learning, which does not limit PISA to assessing students' curricular and cross-curricular competencies, but also asks them to report on their own motivation to learn, their beliefs about themselves and their learning strategies.
- Regularity, which enables countries to monitor their progress in meeting key learning objectives.

- Breadth of geographical coverage and collaborative nature, which in PISA 2006 encompasses the 30 OECD member countries and 27 partner countries and economies.

The relevance of the knowledge and skills measured by PISA is confirmed by recent studies tracking young people in the years after they have been assessed by PISA. Studies in Australia, Canada and Denmark display a strong relationship between the performance in reading on the PISA 2000 assessment at age 15 and the chance of a student completing secondary school and of carrying on with post-secondary studies at age 19. For example, Canadian students who had achieved reading proficiency Level 5 at age 15 were 16 times more likely to be enrolled in post-secondary studies when they were 19 years old than those who had not reached the reading proficiency Level 1 (see Box 6.1).

PISA is the most comprehensive and rigorous international programme to assess student performance and to collect data on the student, family and institutional factors that can help to explain differences in performance. Decisions about the scope and nature of the assessments and the background information to be collected are made by leading experts in participating countries and are steered jointly by governments on the basis of shared, policy-driven interests. Substantial efforts and resources are devoted to achieving cultural and linguistic breadth and balance in the assessment materials. Stringent quality assurance mechanisms are applied in translation, sampling and data collection. As a consequence, the results of PISA have a high degree of validity and reliability, and can significantly improve understanding of the outcomes of education in the world's economically most developed countries, as well as in a growing number of countries at earlier stages of economic development.

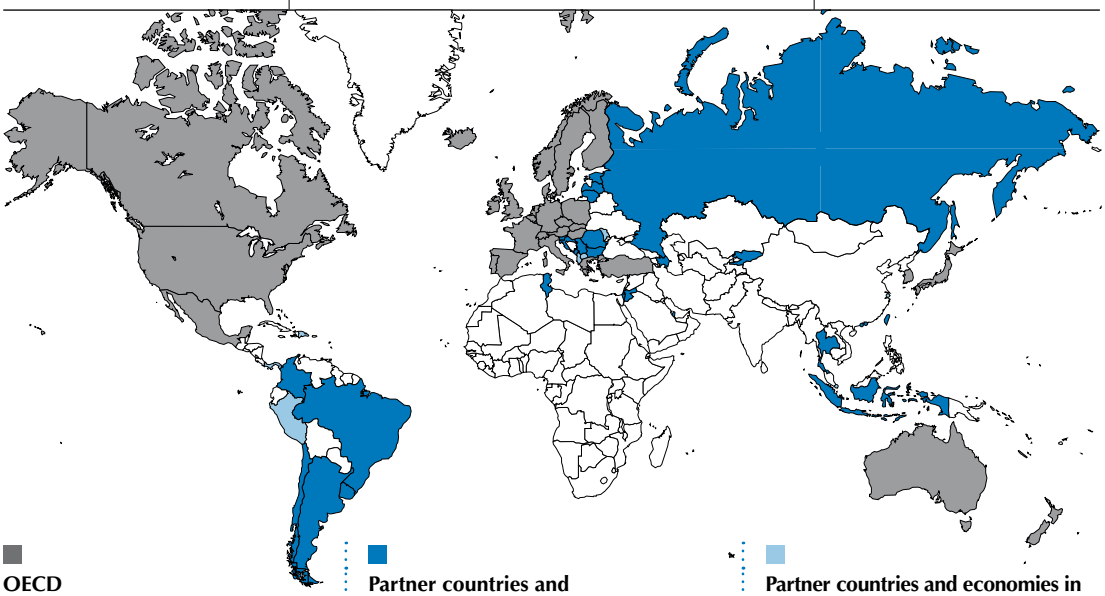
Together with the PISA 2000 and PISA 2003 surveys, PISA 2006 completes the first cycle of assessment in the three major subject areas – reading, mathematics and science. PISA is now conducting a second cycle of surveys, beginning in 2009 with reading as the major subject and continuing in 2012 (mathematics) and 2015 (science).

Although PISA was originally created by the governments of OECD countries, it has now become a major assessment tool in regions around the world. Beyond the OECD member countries, the survey has been conducted or is planned in:

- East and Southeast Asia: Shanghai-China, Hong Kong-China, Indonesia, Macao-China, Singapore, Chinese Taipei and Thailand
- Central and Eastern Europe[2] and Central Asia: Albania, Azerbaijan, Bulgaria, Croatia, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Romania, the Russian Federation, Serbia and Slovenia
- The Middle East: Israel, Jordan and Qatar
- Central and South America: Argentina, Brazil, Chile, Colombia, the Dominican Republic, Panama, Peru and Uruguay
- North Africa: Tunisia

Across the world, policy makers are using PISA findings to: gauge the knowledge and skills of students in their own country in comparison with those of the other participating countries; establish benchmarks for educational improvement, for example, in terms of the mean scores achieved by other countries or their capacity to provide high levels of equity in educational outcomes and opportunities; and understand relative strengths and weaknesses of their education systems. The interest in PISA is illustrated by the many reports produced in participating countries,[3] the numerous references to the results of PISA in public debates and the intense media attention shown to PISA throughout the world.

Figure 1.1
A map of PISA countries and economies



OECD countries

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

Partner countries and economies in PISA 2006

Argentina
Azerbaijan
Brazil
Bulgaria
Chile
Colombia
Croatia
Estonia
Hong Kong-China
Indonesia
Israel
Jordan
Kyrgyzstan
Latvia
Liechtenstein
Lithuania
Macao-China
Montenegro
Qatar
Romania
Russian Federation
Serbia
Slovenia
Chinese Taipei
Thailand
Tunisia
Uruguay

Partner countries and economies in previous PISA surveys or in PISA 2009

Albania
Shanghai-China
Dominican Republic
Macedonia
Moldova
Panama
Peru
Singapore
Trinidad and Tobago

The results of PISA 2006 are presented in two volumes. This is Volume 1; it summarises the performance of students in PISA 2006 and uses the information gathered to analyse what factors may relate to success in education. Volume 2 contains the data tables generated from the PISA 2006 database that have been used as a basis for the analysis included in this volume. A detailed description of the methodology employed in the implementation of PISA will be presented in the *PISA 2006 Technical Report* (OECD, forthcoming).

The remainder of this chapter looks at:

- What PISA measures (overall and within each assessment area), the methods that were employed and the target population that is involved;
- What is distinctive about PISA 2006, including the extent to which the repeat of the survey allows for comparisons across time (PISA 2000, PISA 2003 and PISA 2006);
- How the report is organised.

Box 1.1 **Key features of PISA 2006**

Content

- Although the main focus of PISA 2006 was science, the survey also covered reading and mathematics. PISA considers students' knowledge in these areas not in isolation, but in relation to their ability to reflect on their knowledge and experience and to apply them to real world issues. The emphasis is on the mastery of processes, the understanding of concepts and the ability to function in various situations within each assessment area.
- The PISA 2006 survey also, for the first time, sought information on students' attitudes to science by including questions on attitudes within the test itself, rather than only through a complementary questionnaire.

Methods

- Around 400 000 students were randomly selected to participate in PISA 2006, representing about 20 million 15-year-olds in the schools of the 57 participating countries.
- Each participating student spent two hours carrying out pencil-and-paper tasks. In three countries, some students were given additional questions via computer.
- PISA contained tasks requiring students to construct their own answers as well as multiple-choice questions. These were typically organised in units based on a written passage or graphic, of the kind that students might encounter in real life.
- Students also answered a questionnaire that took about 30 minutes to complete and focused on their personal background, their learning habits and their attitudes to science, as well as on their engagement and motivation.
- School principals completed a questionnaire about their school that included demographic characteristics as well as an assessment of the quality of the learning environment at school.

Outcomes

- A profile of knowledge and skills among 15-year-olds in 2006, consisting of a detailed profile for science, and an update for reading and mathematics.
- Contextual indicators relating performance results to student and school characteristics.
- An assessment of students' attitudes to science.
- A knowledge base for policy analysis and research.
- Trend data on changes in student knowledge and skills in reading and mathematics.

Future assessments

- The PISA 2009 survey will return to reading as the major assessment area, while PISA 2012 will focus on mathematics and PISA 2015 once again on science.
- Future tests will also assess students' capacity to read and understand electronic texts – reflecting the importance of information and computer technologies in modern societies.

WHAT PISA MEASURES AND HOW

A framework and conceptual underpinning for each assessment area in PISA was developed by international experts from participating countries and, following consultation, agreed upon by governments of the participating countries (OECD, 1999; OECD, 2003; and OECD, 2006a). The framework starts with the concept of literacy, which is concerned with the capacity of students to extrapolate from what they have learned, and to apply their knowledge in novel settings, and students' capacity to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations.

The concept of literacy used in PISA is much broader than the historical notion of the ability to read and write. Furthermore, it is measured on a continuum, not as something that an individual either has or does not have. It may be necessary or desirable for some purposes to define a point on a literacy continuum below which levels of competence are considered inadequate, but the underlying continuum is important.

The acquisition of literacy is a lifelong process – taking place not just at school or through formal learning, but also through interactions with family, peers, colleagues and wider communities. Fifteen-year-olds cannot be expected to have learned everything they will need to know as adults, but they should have a solid foundation of knowledge in areas such as reading, mathematics and science. In order to continue learning in these subject areas and to apply their learning to the real world, they also need to understand fundamental processes and principles and to use these flexibly in different situations. It is for this reason that PISA measures the ability to complete tasks relating to real life, depending on a broad understanding of key concepts, rather than limiting the assessment to the understanding of subject-specific knowledge.

As well as assessing competencies in the three key subject areas, PISA aims to examine students' learning strategies, their competencies in areas such as problem-solving skills that cross disciplines and their interests in different topics. This was first done in PISA 2000 by asking students about motivation and other aspects of their attitudes towards learning, their familiarity with computers and, under the heading "self-regulated learning", aspects of their strategies for managing and monitoring their own learning. In PISA 2003, these elements were further developed and complemented with an assessment of cross-curricular problem-solving knowledge and skills. The assessment of students' motivations and attitudes continued in PISA 2006, with special attention being given to students' attitudes to and interest in science. This is further elaborated in a later section of this chapter and in detail in Chapter 3.

Performance in PISA: what is measured

PISA 2006 defines *scientific literacy* and develops its science assessment tasks and questions within a framework of four interrelated aspects, namely the:

- Knowledge or structure of knowledge that students need to acquire (*e.g.* familiarity with scientific concepts);
- Competencies that students need to apply (*e.g.* carrying out a particular scientific process);
- Contexts in which students encounter scientific problems and relevant knowledge and skills are applied (*e.g.* making decisions in relation to personal life, understanding world affairs); and
- Attitudes and dispositions of students towards science.

The frameworks for assessing science, reading and mathematical literacy in 2006 are described in full in *Assessing Scientific, Reading and Mathematical Literacy: A Framework for PISA 2006* (OECD, 2006a), and summarised in Chapters 2 and 6 of this report. Figure 1.2 below also summarises the core definition of each assessment area and how the first three of the above four dimensions are developed in each case.

Figure 1.2
Summary of the assessment areas in PISA 2006

	Science	Reading	Mathematics
Definition and its distinctive features	The extent to which an individual: ▪ Possesses scientific knowledge and uses that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues. ▪ Understands the characteristic features of science as a form of human knowledge and enquiry. ▪ Shows awareness of how science and technology shape our material, intellectual and cultural environments. ▪ Engages in science-related issues and with the ideas of science, as a reflective citizen. *Scientific literacy* requires an understanding of scientific concepts, as well as the ability to apply a scientific perspective and to think scientifically about evidence.	The capacity of an individual to understand, use and reflect on written texts in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society. In addition to decoding and literal comprehension, *reading literacy* involves reading, interpretation and reflection, and the ability to use reading to fulfil one's goals in life. The focus of PISA is on reading to learn rather than learning to read, and hence students are not assessed on the most basic reading skills.	The capacity of an individual 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. *Mathematical literacy* is related to wider, functional use of mathematics; engagement includes the ability to recognise and formulate mathematical problems in various situations.
Knowledge domain	*Knowledge of science,* such as: ▪ "Physical systems" ▪ "Living systems" ▪ "Earth and space systems" ▪ "Technology systems" *Knowledge about science,* such as: ▪ "Scientific enquiry" ▪ "Scientific explanations"	The form of reading materials: ▪ *Continuous texts* including different kinds of prose such as narration, exposition, argumentation ▪ *Non-continuous texts* including graphs, forms and lists	Clusters of relevant mathematical areas and concepts: ▪ *Quantity* ▪ *Space and shape* ▪ *Change and relationships* ▪ *Uncertainty*
Competencies involved	Type of scientific task or process: ▪ *Identifying scientific issues* ▪ *Explaining scientific phenomena* ▪ *Using scientific evidence*	Type of reading task or process: ▪ Retrieving information ▪ Interpreting texts ▪ Reflecting and evaluating of texts	Competency clusters define skills needed for mathematics: ▪ *Reproduction* (simple mathematical operations) ▪ *Connections* (bringing together ideas to solve straightforward problems) ▪ *Reflection* (wider mathematical thinking)
Context and situation	The area of application of science, focusing on uses in relation to personal, social and global settings such as: ▪ "Health" ▪ "Natural resources" ▪ "Environment" ▪ "Hazard" ▪ "Frontiers of science and technology"	The use for which the text is constructed: ▪ *Private* (*e.g.* a personal letter) ▪ *Public* (*e.g.* an official document) ▪ *Occupational* (*e.g.* a report) ▪ *Educational* (*e.g.* school-related reading)	The area of application of mathematics, focusing on uses in relation to personal, social and global settings such as: ▪ *Personal* ▪ *Educational and occupational* ▪ *Public* ▪ *Scientific*

The PISA instruments: how measurement takes place

As in the earlier PISA surveys, the assessment instruments in PISA 2006 were developed around units of assessment. A unit consists of stimulus material including texts, tables and/or graphs, followed by questions on various aspects of the text, table or graph, with the questions constructed so that the tasks students had to undertake were as close as possible to tasks likely to be encountered in the real world.

The questions varied in format, but in each of the assessment areas of science, reading and mathematics about 40% of the questions required students to construct their own responses, either by providing a brief answer (short-response questions) or by constructing a longer response (open-constructed response questions), allowing for the possibility of divergent individual responses and an assessment of students' justification of their viewpoints. Partial credit was given for partly correct or less sophisticated answers, with questions assessed by trained specialists using detailed scoring guides which gave direction on the codes to assign to various responses. To ensure consistency in the coding process, a proportion of the questions were coded independently by four coders. In addition, a sub-sample of student responses from each country was coded by an independent panel of centrally trained expert coders in order to verify that the coding process was carried out in equivalent ways across countries. The results show that consistent coding was achieved across countries. For details on the coding process and the reliability of scores within and across countries, see Annex A6 and the *PISA 2006 Technical Report* (OECD, forthcoming).

A further 8% of the test questions required students to construct their own responses, based on a predefined set of possible responses (closed-constructed response questions), which were scored as either correct or incorrect. The remaining 52% of questions were asked in multiple-choice format, in which students made either one choice from among four or five given alternatives or a series of choices by circling one of two optional responses (for example "yes" or "no", or "agree" or "disagree") in relation to each of a number of different propositions or statements (complex multiple-choice questions).

As elaborated further below and in Chapter 2, the PISA 2006 science assessment also included 32 questions relating to students' attitudes to science. These questions generally required students to indicate their preferences or opinions. There were no right or wrong answers to these questions. Chapter 3 offers further information on how the answers to these questions were used.

The total assessment time of 390 minutes was organised in different combinations in 13 test booklets with each individual being tested for 120 minutes. The total time across all the booklets devoted to the assessment of science was 210 minutes (54% of the total), 120 minutes were devoted to mathematics (31% of the total) and 60 minutes to reading (15% of the total). Each student was randomly assigned one of the 13 test booklets.

The PISA student population

In order to ensure the comparability of the results across countries, PISA devoted great attention to assessing comparable target populations. Differences between countries in the nature and extent of pre-primary education and care, in the age of entry to formal schooling, and in the structure of the education system do not allow school grades to be defined so that they are internationally comparable. Valid international comparisons of educational performance, therefore, need to define their populations with reference to a target age. PISA covers students who are aged between 15 years 3 months and 16 years 2 months at the time of the assessment and who have completed at least 6 years of formal schooling, regardless of the type of institution in which they are enrolled and of whether they are in full-time or part-time education, of whether they attend academic or vocational programmes, and of whether they attend public or private

schools or foreign schools within the country. (For an operational definition of this target population, see the *PISA 2006 Technical Report,* [OECD, forthcoming].) The use of this age in PISA, across countries and over time, allows the performance of students to be compared in a consistent manner before they complete compulsory education.

As a result, this report is able to make statements about the knowledge and skills of individuals born in the same year and still at school at 15 years of age, but having differing educational experiences, both within and outside school. The number of school grades in which these students are to be found depends on a country's policies on school entry and promotion. Furthermore, in some countries, students in the PISA target population represent different education systems, tracks or streams.

Stringent technical standards were established for the definition of national target populations and for permissible exclusions from this definition (for more information, see the PISA website *www.pisa.oecd.org*). It was also required that the overall exclusion rate within a country be kept below 5%, to ensure that under reasonable assumptions any distortions in national mean scores would remain within plus or minus 5 score points, *i.e.* typically within the order of magnitude of two standard errors of sampling (Box 1.2). Exclusion could take place at the school level or within schools. In PISA, there are several reasons why a school or a student could be excluded. Exclusions at school level might result from removing a small, remote geographical region due to inaccessibility or size, or because of organisational or operational factors. Exclusions at the student level might occur because of intellectual disability or limited proficiency in the language of the test.

In 34 out of the 57 countries participating in PISA 2006, the percentage of school-level exclusions amounted to less than 1%, and it was less than 3% in all countries except Canada (4.3%) and the United States (3.3%). When exclusions within schools of students who met the internationally established exclusion criteria (see below), are also taken into account, the exclusion rates increase slightly. However, the overall exclusion rate remains below 2% in 32 participating countries, below 4% in 51 participating countries and below 6% in all countries, except Canada (6.35%) and Denmark (6.07%).

Restrictions on the level of exclusions of various types were as follows in PISA 2006:

- School-level exclusions for inaccessibility, feasibility or other reasons were required not to exceed 0.5% of the total number of students in the international PISA target population. Schools on the school sampling frame that had only one or two eligible students were not allowed to be excluded from the frame. However, if, based on the frame, it was clear that the percentage of students in these schools would not cause a breach of the 0.5% allowable limit, then such schools could be excluded in the field, if at that time, they still only had one or two PISA eligible students.
- School-level exclusions for students with intellectual or functional disabilities, or students with limited proficiency in the language of the PISA test, were required not to exceed 2% of students.
- Within-school exclusions for students with intellectual or functional disabilities or students with limited language proficiency were required not to exceed 2.5% of students.

Within schools in PISA 2006, students who could be excluded were:

- Intellectually disabled students, defined as students who are considered in the professional opinion of the school principal, or by other qualified staff members, to be intellectually disabled, or who have been tested psychologically as such. This category includes students who are emotionally or mentally unable

to follow even the general instructions of the test. Students were not to be excluded solely because of poor academic performance or normal discipline problems.

- Students with functional disabilities, defined as students who are permanently physically disabled in such a way that they cannot perform in the PISA testing situation. Students with functional disabilities who could perform were to be included in the testing.
- Students with limited proficiency in the language of the PISA test, defined as students who had received less than one year of instruction in the language(s) of the test.

Box 1.2 **Population coverage and the exclusion of students**

The PISA test aims to be as inclusive as possible. For the definition of national target populations, PISA excludes 15-year-olds not enrolled in educational institutions. In the remainder of this report the term "15-year-olds" is used as to denote the PISA student population. Coverage of the target population of 15-year-olds within education is very high compared with other international surveys: relatively few schools were excluded from participation because of, for example, geographical remoteness. Also, within schools, exclusions of students remained below 2% in most and below 6.4% in all countries.

This high level of coverage contributes to the comparability of the assessment results. For example, even assuming that the excluded students would have systematically scored worse than those who participated, and that this relationship is moderately strong, an exclusion rate in the order of 5% would likely lead to an overestimation of national mean scores of less than 5 score points. Moreover, in most cases the exclusions were inevitable. If the correlation between the propensity of exclusions and student performance is 0.3, resulting mean scores would likely be overestimated by 1 score point if the exclusion rate is 1%, by 3 score points if the exclusion rate is 5%, and by 6 score points if the exclusion rate is 10%. If the correlation between the propensity of exclusions and student performance is 0.5, resulting mean scores would be overestimated by 1 score point if the exclusion rate is 1%, by 5 score points if the exclusion rate is 5%, and by 10 score points if the exclusion rate is 10%. For this calculation, a model was employed that assumes a bivariate normal distribution for the propensity to participate and performance. For details see the *PISA 2003 Technical Report* (OECD, 2005a).

The specific sample design and size for each country was designed to maximise sampling efficiency for student-level estimates. In OECD countries, sample sizes ranged from 3 789 students in Iceland to over 30 000 students in Mexico. Countries with large samples have often implemented PISA both at national and regional/state levels (*e.g.* Australia, Belgium, Canada, Germany, Italy, Mexico, Spain, Switzerland and the United Kingdom). The selection of samples was monitored internationally and accompanied by rigorous standards for the participation rate (both among schools selected by the international contractor and among students within these schools) to ensure that the PISA results reflect the skills of the 15-year-old students in participating countries. Countries were also required to administer the test to students in identical ways to ensure that students receive the same information prior to and during the test (Box 1.3).

Box 1.3 How a PISA test is typically carried out in a school

When a school has been selected to participate in PISA, a School Co-ordinator is appointed. The School Co-ordinator compiles a list of all 15-year-olds in the school and sends this list to the PISA National Centre in the country, which randomly selects 35 students to participate. The School Co-ordinator then contacts the students who have been selected for the sample and obtains the necessary permissions from parents. The testing session is usually conducted by a Test Administrator who is trained and employed by the National Centre. The Test Administrator contacts the School Co-ordinator to schedule administration of the assessment. The School Co-ordinator ensures that the students attend the testing sessions – this can sometimes be difficult because students may come from different grades and different classes. The Test Administrator's primary tasks are to ensure that each test booklet is distributed to the correct student and to introduce the tests to the students. After the test is over, the Test Administrator collects the test booklets and sends them to the National Centre for coding.

In PISA 2006, 13 different booklets were developed. In each group of 35 students, no more than three students were given the same booklet. Booklets were allocated to individual students according to a random selection process. The Test Administrator's intoduction came from a prescribed text so that all students in different schools and countries received exactly the same instructions. Before starting the actual test, the students were asked to do a practice question from their booklets. The testing session was divided into two parts – the two-hour-long test and the questionnaire session. The length of the questionnaire session varied across countries, depending on the options chosen for inclusion, but generally was about 30 minutes. Students were usually given a short break half-way through the test and again before they did the questionnaire.

WHAT IS DIFFERENT ABOUT THE PISA 2006 SURVEY?

A detailed understanding of student performance in and attitudes to science

With more than one-half of the assessment time devoted to science, PISA 2006 can report in much greater detail on science performance than was the case in PISA 2000 and PISA 2003. As well as calculating overall performance scores, it is possible to report separately on different science competencies and to establish for each performance scale conceptually grounded proficiency levels that relate student performance scores to what students are able to do. Students received scores for their capacity in each of the three science competencies *(identifying scientific issues, explaining phenomena scientifically* and *using scientific evidence)*. This is different from the case for mathematics in PISA 2003, where the main distinction was by content areas *(quantity, space and shape, change and relationships,* and *uncertainty).*

In keeping with the latest research and thinking on science education (*e.g.* Bybee 1997; Fensham, 2000; Law, 2002; Mayer and Kumano, 2002), PISA 2006 also asked students about their attitudes to science within the context of the science questions themselves. The aim of this is to better understand students' views on particular science issues and to generalise these results into measures of students' interest in science and for the value they place on scientific enquiry.

One further innovative element of PISA 2006, piloted in a field trial by Australia, Austria, Denmark, Iceland, Ireland, Japan, Korea, Norway, Portugal, Scotland, the Slovak Republic and Chinese Taipei, was the extension of the science assessment to include a computer-delivered element. The aim of this was to

administer questions that would be difficult to deliver in a paper and pencil test – the relevant questions included video footage, simulations and animations. This also reduced the amount of reading required so that the students' science capacity was assessed more directly. To ensure international comparability the computer test was given to the students on a set of standard laptop computers that had been loaded with the test. These computers were taken from school to school by a specially trained test administrator. Results are available for the three countries that completed the main study: Denmark, Iceland and Korea.

The development of a computer-based assessment component helped with the development of PISA science questions and the creation of several procedures has already proved useful in the development of the 2009 survey, including faster translation processes and automated coding procedures. This experience has placed PISA at the forefront of comparative international computer-delivered testing and the majority of OECD countries will participate in a computer-based assessment of reading in the PISA 2009 survey.

A comparison of change over time

Above all, PISA is a monitoring instrument. Every three years, it measures student knowledge and skills in the three assessment areas, covering each of these areas once as a major focus and twice as a minor focus in the three surveys administered across a nine-year cycle. The basic survey design remains constant, to allow comparability from one PISA assessment to the next. In the long term, this will allow countries to relate policy changes to improvements in educational standards and to learn more about how their changes in educational outcomes compare to international benchmarks.

After a first glimpse of change over time from PISA 2000 to PISA 2003, PISA 2006 offers information about performance trends in reading since PISA 2000, when the first full assessment of reading took place, as well as performance trends in mathematics since PISA 2003 when the first full assessment of mathematics took place. For science, the PISA 2006 survey has been the first full science assessment and will establish the basis for monitoring future trends.

The introduction of new background information about students

Background questionnaires completed by students and school principals provide essential information for PISA's analysis. For PISA 2006, these questionnaires were further refined and deepened. In particular:

- They explored the organisation of school science teaching and provided further information on student attitudes to science.
- Students in thirty-nine countries[4] completed an optional PISA questionnaire providing information about where students have access to computers, how often they use them and for what purposes. (A similar questionnaire was administered in PISA 2003, with the results published in *Are Students Ready for a Technology Rich World?: What PISA Studies Tell Us,* [OECD, 2006b].)
- Sixteen countries implemented a parent questionnaire, which was completed by the parents of students selected to do the PISA assessment.[5] The questionnaire collected information about parents' investment in their children's education and their views on science-related issues and careers.

ORGANISATION OF THE REPORT

Chapters 2 to 5 consider the science results for PISA 2006 and use them to analyse a range of factors associated with performance. Chapter 6 extends the analysis to performance in reading and mathematics and how this has changed over time. The following outlines the function and content of each of the chapters:

- *Chapter 2 gives a profile of student performance in science.* It begins by setting the results in the context of how performance in science is defined, measured and reported, and then examines what students are able do in science. After a summary picture of performance, each of the three science competency

areas is examined separately since results vary in important ways across the three. There then is further analysis of the different science content areas and a consideration of gender differences associated with the different competencies and content areas. Any comparison of the outcomes of education systems needs to account for countries' social and economic circumstances and the resources that they devote to education. To address this, the chapter also interprets the results within countries' economic and social contexts.

- *Chapter 3 builds a profile of student engagement in science.* The chapter begins with an analysis of the extent to which students support scientific inquiry and whether they value science. Next students' self-beliefs are described in terms of their perceived capacity to handle scientific tasks effectively and to overcome difficulties in solving scientific problems. This is followed by a description of students' interest in science including such aspects as their engagement in science-related issues, their willingness to acquire scientific knowledge and skills, and their consideration of science-related careers. This is followed by a discussion of students' perceptions and attitudes regarding environmental issues. Where possible, the chapter examines how these different aspects of engagement relate to student performance.
- *Chapter 4 examines the extent and ways in which student learning outcomes depend on the socio-economic context of families and schools, which is an important measure of equity in learning opportunities.* It starts by examining more closely the performance variation shown in Chapter 2, in particular the extent to which the overall variation in student performance relates to differences in the results achieved by different schools. The chapter then looks at how factors such as immigrant status and socio-economic background affect student and school performance, and the role that education policy can play in moderating the impact of these factors.
- *Chapter 5 seeks to address what schools and school policies can do to raise overall student performance and, at the same time, moderate the impact that socio-economic background has on student performance, thus promoting a more equitable distribution of learning opportunities.* The chapter looks, in turn, at school policies and practices, with respect to school admittance, school selectivity, and ability grouping; characteristics of school funding and governance; the role for parental choice and parental expectations on schools; aspects of school accountability; school autonomy in various areas; and selected human, material and educational resources and their distribution among schools. Under each of these headings, the chapter separately examines the relevant features of school policies and practices and institutional characteristics. It also considers: how the relevant factors play out in the countries attaining both an above-average level of student performance and a below-average impact of socio-economic background on learning outcomes; the relationship of the factors with student performance before and after accounting for socio-economic background factors; and the joint relationship of the factors with the impact which socio-economic background has on performance, in order to examine the contribution of each factor to equity in the distribution of educational opportunities.
- *Chapter 6 considers student performance in reading and mathematics in PISA 2006* and examines changes in reading and mathematics performance since earlier PISA assessments.

Following the chapters, a technical annex addresses the construction of the questionnaire indices, discusses sampling issues, documents quality assurance procedures and the process followed for the development of the assessment instruments, and provides data on the reliability of coding. Many of the issues covered in the technical annex will be elaborated in greater detail in the *PISA 2006 Technical Report* (OECD, forthcoming).

A Reader's Guide is also found after this chapter, to aid in the interpretation of the tables and figures accompanying the report.

Volume 2 of this report contains the data tables underlying the various chapters.

Notes

1. The GDP of the countries that took part in PISA 2006 represents 86% of the 2006 world GDP. Some of the entities represented in this report are referred to as partner economies. This is because they are not strictly national entities.

2. This report uses the terms Macedonia, Moldova, Montenegro and Serbia to refer the former Yugoslav Republic of Macedonia, the Republic of Moldova, the Republic of Montenegro and the Republic of Serbia.

3. Visit *www.pisa.oecd.org* for links to countries' national PISA websites and national PISA reports.

4. The PISA 2006 ICT familiarity questionnaire was administered in Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, Creece, Hungary, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Poland, Portugal, Korea, the Slovak Republic, Spain, Sweden, Switzerland and Turkey, as well as in the partner countries/economies Bulgaria, Chile, Colombia, Croatia, Jordan, Latina, Lithuania, Macao-China, Montenegro, Qatar, the Russian Federation, Serbia, Slovenia, Thailand and Uruguay.

5. The PISA 2006 parent questionnaire was administered in Denmark, Germany, Iceland, Italy, Luxembourg, New Zealand, Poland, Portugal, Korea and Turkey, as well as in the partner countries/economies Bulgaria, Colombia, Croatia, Hong Kong-China, Macao-China and Qatar.

Reader's Guide

Data underlying the figures

The data referred to in Chapters 2 to 6 of this report are presented in Volume 2 and, with additional detail, on the PISA website (*www.pisa.oecd.org*). Five symbols are used to denote missing data:

a The category does not apply in the country concerned. Data are therefore missing.

c There are too few observations to provide reliable estimates (*i.e.* there are fewer than 30 students or less than 3% of students for this cell or too few schools for valid inferences).

m Data are not available. These data were collected but subsequently removed from the publication for technical reasons.

w Data have been withdrawn at the request of the country concerned.

x Data are included in another category or column of the table.

Calculation of international averages

An OECD average was calculated for most indicators presented in this report. In the case of some indicators, a total representing the OECD area as a whole was also calculated:

- The OECD average takes the OECD countries as a single entity, to which each country contributes with equal weight. For statistics such as percentages or mean scores, the OECD average corresponds to the arithmetic mean of the respective country statistics.
- The OECD total takes the OECD countries as a single entity, to which each country contributes in proportion to the number of 15-year-olds enrolled in its schools (see Annex A3 for data). It illustrates how a country compares with the OECD area as a whole.

In this publication, the OECD total is generally used when references are made to the overall situation in the OECD area. Where the focus is on comparing performance across education systems, the OECD average is used. In the case of some countries, data may not be available for specific indicators, or specific categories may not apply. Readers should, therefore, keep in mind that the terms OECD average and OECD total refer to the OECD countries included in the respective comparisons.

Rounding of figures

Because of rounding, some figures in tables may not exactly add up to the totals. Totals, differences and averages are always calculated on the basis of exact numbers and are rounded only after calculation.

All standard errors in this publication have been rounded to two decimal places. Where the value 0.00 is shown, this does not imply that the standard error is zero, but that it is smaller than 0.005.

Reporting of student data

The report uses "15-year-olds" as shorthand for the PISA target population. PISA covers students who are aged between 15 years 3 months and 16 years 2 months at the time of the assessment and who have completed at least 6 years of formal schooling, regardless of the type of institution in which they are enrolled and of whether they are in full-time or part-time education, of whether they attend academic or vocational programmes, and of whether they attend public or private schools or foreign schools within the country.

Reporting of school data

The principals of the schools in which students were assessed provided information on their schools' characteristics by completing a school questionnaire. Where responses from school principals are presented in this publication, they are weighted so that they are proportionate to the number of 15-year-olds enrolled in the school.

Abbreviations used in this report

The following abbreviations are used in this report:

GDP	Gross Domestic Product
ISCED	International Standard Classification of Education
PPP	Purchasing power parity
SD	Standard deviation
SE	Standard error

Further documentation

For further information on the PISA assessment instruments and the methods used in PISA, see the *PISA 2006 Technical Report* (OECD, forthcoming) and the PISA website (*www.pisa.oecd.org*).

This report uses the OECD's StatLinks service. Below each table and chart is a url leading to a corresponding Excel workbook containing the underlying data. These urls are stable and will remain unchanged over time. In addition, readers of the *PISA 2006: Science Competencies for Tomorrow's World* e-book will be able to click directly on these links and the workbook will open in a separate window.

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