OECD PISA

OECD Programme for International Student Assessment

Achievement of 15-year-olds in England:

PISA 2006 National Report

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Executive summary

1 Background and overview

1.1 The Programme for International Student Assessment (PISA) is a survey of the educational achievement of 15-year-olds organised by the Organisation for Economic Co-operation and Development (OECD).

1.2 In England, Wales and Northern Ireland, PISA 2006 was carried out on behalf of the respective governments by the National Foundation for Educational Research (NFER). Scotland participated separately.

1.3 Results for the United Kingdom as a whole are included in the international PISA report published by OECD. The four parts of the UK contribute to this result in proportion to their populations.

1.4 The survey takes place every three years. The first was in 2000 and the second in 2003. PISA 2006 was the third survey.

1.5 A total of 57 countries participated in PISA 2006. This included 30 OECD member countries and 25 members of the European Union.

1.6 The Australian Council for Educational Research (ACER) leads the international consortium that designs and implements the survey on behalf of OECD.

1.7 Strict international quality standards are applied at all stages of the PISA survey to ensure equivalence in translation and adaptation of instruments, sampling procedures and survey administration in all participating countries.

1.8 The PISA survey assesses students in science, reading and mathematics. In each survey one of these is the main subject. Reading was the main subject in PISA 2000 and mathematics in PISA 2003. In PISA 2006 the main subject was science.

1.9 Science attainment is reported on three scales : *Identifying scientific issues, Explaining phenomena scientifically* and *Using scientific evidence*.

1.10 As well as tests for students, the PISA survey includes questionnaires for participating students and schools. In PISA 2006 these included some general background questions but mainly focused on attitudes to science and aspects of the teaching and learning of science.

2 The PISA survey in England

2.1 In England 169 schools and 4935 students participated in PISA 2006. This represented 89 per cent of sampled schools and 89 per cent of sampled students.

2.2 The weighted school response for the combined United Kingdom sample was 88 per cent. This was just one per cent below the target participation rate. This was a great improvement on previous PISA surveys in the United Kingdom. The PISA sampling referee was satisfied that there was no evidence that this slight shortfall would lead to any bias in the results.

2.3 The student response in the United Kingdom exceeded the PISA requirement for participation of at least 80 per cent of sampled students. This was again an improvement on previous PISA surveys.

3 Student achievement in science

3.1 Seven countries had mean scores for science which were significantly higher than that of England. In thirteen countries the difference in mean scores to that in England was not statistically significant. Thirty-six countries had mean scores which were significantly lower than England.

3.2 The mean score for science in England was higher than the OECD average. This difference was statistically significant.

3.3 Of the seven countries with higher mean scores (where the difference was statistically significant), four were members of OECD and three of these were non-European (Canada, Japan and New Zealand). Fifteen OECD countries had mean scores significantly lower than England.

3.4 Two of the countries with mean scores significantly higher than England are in the European Union (Finland and Estonia). Fourteen EU countries were significantly lower than England.

3.5 Mean scores for different sub-scales were similar. This was a more consistent performance than that in many other countries which showed more variation in different aspects of scientific knowledge or skills.

3.6 England had the third highest proportion of students at the highest level of science attainment. Only New Zealand and Finland had a higher proportion at this level.

3.7 England had a wide spread of attainment compared with many other countries. As well as high achievers, England had a substantial ‘tail’ of low-scoring students. Only two PISA countries had a wider spread than England (New Zealand and Israel).

3.8 Males scored significantly higher than females. This was mainly due to a difference on one scale, *Explaining phenomena scientifically*. This scale covers knowledge of scientific content and theories. On the other two scales there was no statistically significant difference between males and females. Stronger performance of males on the *Explaining phenomena scientifically* scale was seen in the majority of participating countries.

4 Student achievement in mathematics

4.1 Mathematics was a minor subject in the PISA 2006 survey. A sub-sample of students was assessed in mathematics and there were fewer questions than in science. The results reported are estimates for the whole population, based on the performance of students who were presented with mathematics test items.

4.2 Eighteen countries had mean scores for mathematics which were significantly higher than that of England. In twelve countries the difference in mean scores to that in England was not statistically significant. Twenty-six countries had mean scores which were significantly lower than England.

4.3 The mean score for mathematics in England was not significantly different from the OECD average.

4.4 Of the eighteen countries with higher mean scores (where the difference was statistically significant), twelve were members of OECD. Seven OECD countries had mean scores significantly lower than England (Spain, United States, Portugal, Italy, Greece, Turkey and Mexico).

4.5 Seven of the countries with mean scores significantly higher than England are in the European Union (Finland, the Netherlands, Belgium, Estonia, Denmark, the Czech Republic and Slovenia). Six EU countries were significantly lower than England.

4.6 In contrast to science, the spread of attainment in mathematics was not large compared with other countries. While the proportion at the lowest levels was similar to the OECD average, the proportion at the highest levels was slightly below the OECD average.

4.7 Males scored significantly higher than females in mathematics. This was the case in 35 of the 57 participating countries.

5 Student achievement in reading

5.1 Reading was a minor subject in the PISA 2006 survey. A sub-sample of students was assessed in reading and there were fewer questions than in science. The results reported are estimates for the whole population, based on the performance of students who were presented with reading test items.

5.2 Seven countries had mean scores for reading which were significantly higher than that of England. These were Korea, Finland, Hong Kong, Canada, New Zealand, the Republic of Ireland and Australia. In eighteen countries the difference in mean score to that in England was not statistically significant. Thirty countries had mean scores which were significantly lower than England.

5.3 The mean score for reading in England was slightly above the OECD average. This difference was not statistically significant.

5.4 Of the seven countries with higher mean scores (where the difference was statistically significant), all but Hong Kong are members of OECD. Nine OECD countries had mean scores significantly lower than England.

5.5 Two of the countries with mean scores significantly higher than England are in the European Union (Finland and Republic of Ireland). Ten EU countries were significantly lower than England.

5.6 The spread of attainment in reading was wider than the OECD average, and only fourteen countries had a wider gap between the highest- and lowest-achieving students. The proportions at each of the PISA levels of attainment were similar to the average for OECD countries.

5.7 Females scored significantly higher than males in reading. This was the case in every participating country, but the gender gap was smaller in England than in most other countries.

6 Science in England: students and schools

6.1 Chapter 6 of the report discusses some of the data from the student questionnaire and the school questionnaire.

6.2 Students in England see science as valuable for understanding the world and improving living conditions. They see science as less valuable personally to themselves as individuals than it is to society, but acknowledge that it is important for them to do well in science.

6.3 Students are confident that they can do a variety of tasks related to science learning easily or with a bit of effort. They enjoy learning about science and think they do it relatively well, but feel learning and understanding science is not easy.

6.4 Students in England do not generally think science is fun and, outside of activities directly connected with their learning at school, do not often participate in science-related activities.

6.5 Most students in England report that they feel well informed about environmental issues. They are generally concerned about problems associated with these issues and they agree with measures to encourage sustainable development. However, there are some doubts about the extent to which they feel personally involved in these problems and are willing to make sacrifices to help conquer them.

6.6 Schools in England report slightly higher science teacher shortages than the average in OECD countries, but fewer shortages or inadequacies of educational resources.

7 PISA in the United Kingdom

7.1 Chapter 7 of the report compares some of the main outcomes of the PISA survey in England, Wales, Northern Ireland and Scotland.

7.2 In science, the average performance in all four parts of the UK was similar. The only statistically significant difference was that the mean score of students in Wales was significantly lower than that in England. Males outperformed females in England and Wales but not in Northern Ireland and Scotland. The widest spread of attainment between the highest- and lowest-scoring students in science was in Northern Ireland.

7.3 Performance in mathematics showed more variation across the UK countries than performance in science. The mean score of students in England and Scotland was significantly higher than that in Wales, and the mean score in Scotland was also significantly higher than the score in Northern Ireland. Males outperformed females in England, Wales and Scotland with a significant difference in the mean scores. In Northern Ireland the mean score of males was higher than that of females but the difference was not statistically significant. The widest spread of attainment in mathematics was again in Northern Ireland.

7.4 The average performance in reading in England, Scotland and Northern Ireland was similar. In Wales, the mean score was lower and this difference was statistically significant when compared with all three other countries. Females outperformed males in reading in all parts of the UK, as they did in every other country in the PISA survey. As with science and mathematics, the widest spread of performance was in Northern Ireland.

7.5 Students' reported attitudes towards aspects of science and science learning were remarkably similar across the UK. Where there were differences, the most common direction of difference was for students in Scotland to be less positive than those in the other parts of the UK. However, none of these differences was very large.

1 PISA – Background and overview

1.1 Introduction

The Programme for International Student Assessment (PISA) is a survey of educational achievement organised by the Organisation for Economic Co-operation and Development (OECD). In England, Wales and Northern Ireland, the survey is carried out on behalf of the respective governments by the National Foundation for Educational Research.

As a measure of educational outcomes PISA complements the other educational indicators gathered by OECD members to make international comparisons. It assesses the knowledge and skills of students aged fifteen, as they near the end of their schooling. Students are assessed on their competence to address real life challenges involving reading, mathematical and scientific literacy. This aim differentiates PISA from other student assessments which measure their mastery of school subjects.

PISA is carried out on a three-year cycle. The first PISA study was in 2000 (supplemented in 2002), and this was repeated in 2003 and 2006. The next survey will be in 2009. The survey was undertaken in 43 countries in the first cycle (32 in 2000 and 11 in 2002) and 41 countries in the second cycle (2003). In this, the third cycle, 57 countries participated, including all 30 OECD members. Each round focuses on one of the three areas of literacy in which knowledge and skills are assessed: reading, mathematics and science. The main focus for the 2006 round was science, with reading and mathematics as minor domains.

In England, Wales and Northern Ireland, students sat the two-hour assessment in November 2006 under test conditions, following the standardised procedures implemented by all countries. In Scotland, the PISA survey was carried out earlier in 2006. With the focus in this round on science, about two-thirds of the questions were on this subject. A proportion of the questions used in the two-hour test were ones used in previous rounds. This provides continuity between rounds that can act as a measure of change.

In addition to the PISA assessment, students completed a questionnaire. This student questionnaire provided information on students' economic and social backgrounds, study habits, and attitudes to science and to science learning. A school questionnaire was also completed by headteachers in participating schools. This provided information on the school's size, intake, resources and organisation, as well as science activities available in the school.

Age, rather than year group, is used as the defining factor for participation in the survey because of the variance of grade levels and in policies on grade promotion around the world. The students who took part were mainly in year 11 in England and Wales and year 12 in Northern Ireland. (These year groups are equivalent since year 1 in Northern Ireland corresponds to reception year in England and Wales.)

1.2 The development of the survey

The Australian Council for Educational Research (ACER) leads the international consortium that designs and implements the survey on behalf of the OECD. The 2006 survey built on the experiences of the two previous rounds. By using standardised survey procedures and tests, the survey aims to collect data from around the world that can be compared despite differences in language and culture.

The framework and specification for the survey were agreed internationally and both the consortium and participants submitted items for inclusion in the survey. After the questions were reviewed by an expert panel, countries were invited to comment on the difficulty, cultural appropriateness, and curricular and non-curricular relevance.

A field trial was carried out in every country in 2005 and the outcomes of this were used to finalise the contents and format of the main study instruments.

Strict international quality standards are applied to all stages of the PISA survey to ensure equivalence in translation and adaptation of instruments, sampling procedures and survey administration in all participating countries.

1.3 What PISA measures

This section briefly describes the purposes of the assessment of science, mathematics and reading in PISA 2006. A full description of the conceptual framework underlying the PISA assessment is provided in *Assessing Scientific, Reading and Mathematical Literacy: A Framework for PISA 2006* (OECD, 2006).

1.3.1 Science

'Scientific literacy' was the main focus of PISA 2006, and a subsidiary focus in 2000 and 2003. The term 'scientific literacy' is used to emphasise that the survey aims to measure not just science as it may be defined within the curriculum of participating countries, but the scientific understanding which is needed in adult life. PISA defines scientifically literate people as those who can identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues. Such people also understand the characteristic features of science as a form of human knowledge and enquiry, are aware of how science and technology shape their lives and environments, and are willing and able to engage in science-related issues and with the ideas of science, as a reflective citizen. PISA assessments measure not only scientific knowledge or concepts, but also understanding of scientific processes and contexts.

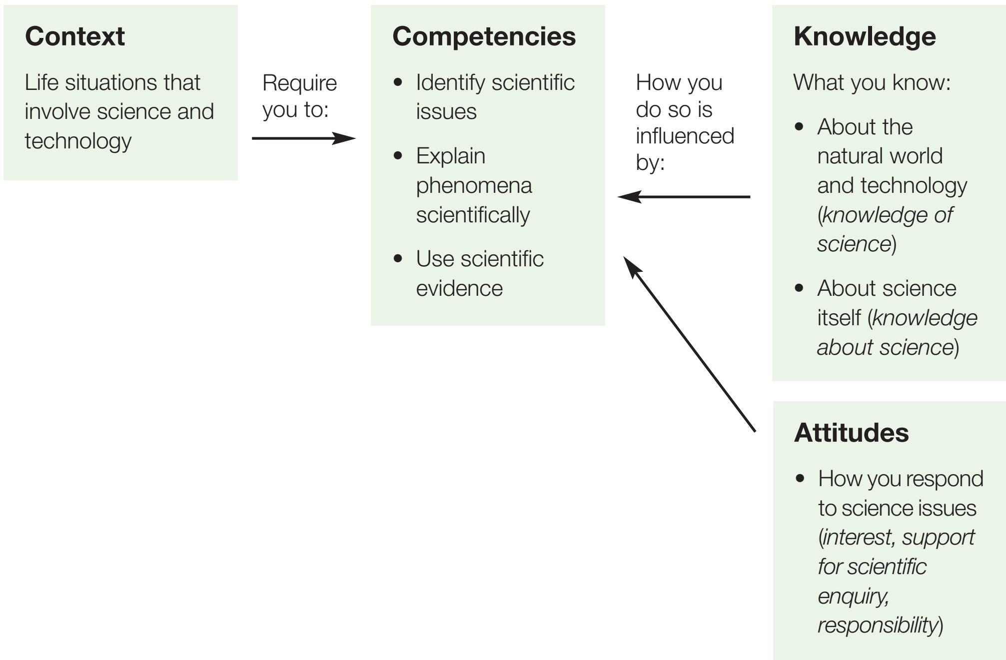
Scientific knowledge or concepts constitute the links that aid understanding of related phenomena. In PISA, while the scientific concepts are familiar (relating to physics, chemistry, biological sciences and earth and space sciences), students are asked to apply them to the content of the test items and not simply to recall facts.

Scientific processes are centred on the ability to acquire, interpret and act upon evidence. Three processes are identified in PISA: firstly, describing, explaining and predicting scientific phenomena; secondly, understanding scientific investigation; and, thirdly, interpreting scientific evidence and conclusions.

Scientific contexts concern the application of scientific knowledge and the use of scientific processes. The PISA assessment framework identifies three main areas: science in life and health, science in earth and environment, and science in technology.

In the PISA science assessment framework, 'scientific literacy' is embedded in four interrelated aspects: context, competencies, knowledge and attitudes, as shown in Figure 1.1 below.

Figure 1.1 The PISA science framework



The PISA international report (OECD, 2007) notes that traditional science teaching may often concentrate on the second of the three competencies (*Explaining phenomena scientifically*), which requires familiarity with key science knowledge and theories. Yet without being able first to recognise a science problem and then interpret findings in ways relevant to the real world, students are not fully scientifically literate. A student who has mastered a scientific theory but who is unable to weigh up evidence, for example, will make limited use of science in adult life. Thus the three competencies are a vital part of the process of becoming scientifically literate. The competencies are broken down as follows:

Identifying scientific issues

- Recognising issues that are possible to investigate scientifically
- Identifying keywords to search for scientific information
- Recognising the key features of a scientific investigation

Explaining phenomena scientifically

- Applying *knowledge of science* in a given situation
- Describing or interpreting phenomena scientifically and predicting changes
- Identifying appropriate descriptions, explanations and predictions

Using scientific evidence

- Interpreting scientific evidence and making and communicating conclusions
- Identifying the assumptions, evidence and reasoning behind conclusions
- Reflecting on the societal implications of science and technological developments

The two knowledge components follow from this. *Knowledge about science* covers two categories (scientific enquiry and scientific explanations), while *Knowledge of science* involves understanding fundamental scientific concepts and theories. These are each broken down as follows:

Knowledge about science – Scientific enquiry

- Origin (e.g. curiosity, scientific questions)
- Purpose (e.g. to produce evidence that helps answer scientific questions, current ideas/models/theories guide enquiries)
- Experiments (e.g. different questions suggest different scientific investigations, design)
- Data (e.g. quantitative [measurements], qualitative [observations])
- Measurement (e.g. inherent uncertainty, replicability, variation, accuracy/precision in equipment and procedures)
- Characteristics of results (e.g. empirical, tentative, testable, falsifiable, self-correcting)

Knowledge about science – Scientific explanations

- Types (e.g. hypothesis, theory, model, scientific law)
- Formation (e.g. existing knowledge and new evidence, creativity and imagination, logic)
- Rules (e.g. logically consistent, based on evidence, based on historical and current knowledge)
- Outcomes (e.g. new knowledge, new methods, new technologies, new investigations)

Knowledge of science (content) – Physical systems

- Structure of matter (e.g. particle model, bonds)
- Properties of matter (e.g. changes of state, thermal and electrical conductivity)
- Chemical changes of matter (e.g. reactions, energy transfer, acids/bases)
- Motions and forces (e.g. velocity, friction)

- Energy and its transformation (e.g. conservation, dissipation, chemical reactions)
- Interactions of energy and matter (e.g. light and radio waves, sound and seismic waves)

Knowledge of science (content) – Living systems

- Cells (e.g. structures and function, DNA, plant and animal)
- Humans (e.g. health, nutrition, disease, reproduction, sub systems [such as digestion, respiration, circulation, excretion, and their relationship])
- Populations (e.g. species, evolution, biodiversity, genetic variation)
- Ecosystems (e.g. food chains, matter, and energy flow)
- Biosphere (e.g. ecosystem services, sustainability)

Knowledge of science (content) – Earth and space systems

- Structures of the Earth systems (e.g. lithosphere, atmosphere, hydrosphere)
- Energy in the Earth systems (e.g. sources, global climate)
- Change in Earth systems (e.g. plate tectonics, geochemical cycles, constructive and destructive forces)
- Earth's history (e.g. fossils, origin and evolution)
- Earth in space (e.g. gravity, solar systems)

Knowledge of science (content) – Technology systems

- Role of science-based technology (e.g. solve problems, help humans meet needs and wants, design and conduct investigations)
- Relationships between science and technology (e.g. technologies contribute to scientific advancement)
- Concepts (e.g. optimisation, trade-offs, cost, risk, benefit)
- Important principles (e.g. criteria, constraints, cost, innovation, invention, problem solving)

The science questions were of three types: open constructed response items which required students to write longer answers; short open response which required answers of a few words; or closed response (e.g. multiple choice). Approximately a third were of the longer constructed type which required students to develop and explain their response. Such questions were generally two or three mark items.

1.3.2 Mathematics

Mathematics was the main subject in the 2003 PISA survey, and a minor subject in PISA 2000 and PISA 2006.

The PISA definition of mathematics is based on a concept of 'mathematical literacy'. PISA aims to assess students' ability to put their mathematical knowledge to functional use in different situations in adult life, rather than on a definition which is based on what is taught in participating countries.

PISA defines 'mathematical literacy' 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, 2006)

In order to be mathematically literate, students need to have factual knowledge of mathematics, skills to carry out mathematical operations and methods, and an ability to combine these elements creatively in response to external situations.

PISA recognises the limitations of using a timed assessment in collecting information about something as complex as mathematics in this large-scale survey, particularly in the case of PISA 2006 where mathematics was a minor subject with fewer questions than for science. It aims to tackle this by having a balanced range of questions that assess different elements of the student's mathematising process. This is the process where a student interprets a problem as mathematical and draws on their mathematical knowledge and skills to provide a sensible solution to the problem.

PISA prefers context-based questions which require the student to engage with the situation and decide how to solve the problem. Most value is placed on tasks that could be met in the real world in which a person would authentically use mathematics. Some more abstract questions that are purely mathematical are also included in the PISA survey.

Students were asked to show their responses to questions in different ways. About a third of the questions were open response which required the students to develop their own responses. These questions tended to assess broad mathematical constructs. A question in this category typically accepted several different responses as correct and worthy of marks. The rest of the questions were either multiple choice or simple open response questions, approximately the same number of each. These questions that tended to assess lower-order skills had only one correct response.

Mathematical processes

- *Mathematisation* PISA describes a five-step process that starts when the student engages with the problem and ends with the student providing an answer. During the process the student tries to identify the relevant mathematics, trims away the reality, solves the mathematical problem, and finally interprets the mathematical solution in terms of the real world problem.
- *Competency clusters* PISA considers competencies as the core of mathematics. Eight characteristics of mathematical competencies are identified: thinking and reasoning; argumentation; communication; modelling; problem posing and solving; representation; using symbolic, formal and technical language and operations; use of aids and tools. It is usually necessary to draw simultaneously on many of the competencies, therefore it would be artificial to test each competency individually. Instead, three broader competency

clusters were created. A test question in any of the three clusters can have elements of any of the eight underlying competencies, but the level of depth is different in different clusters.

– *The reproduction cluster*
  Questions in this cluster require the student to reproduce practised material and perform routine operations.

– *The connections cluster*
  Questions in this cluster require the student to integrate, connect and modestly extend practised material.

– *The reflection cluster*
  Questions in this cluster require the student to apply advanced reasoning, argumentation, abstraction, generalisation and modelling to new contexts. The questions usually require the student to integrate and connect materials from different mathematical curriculum strands.

Mathematical content

The mathematical content in PISA aims to mirror mathematics that is used in real-world situations. The tasks can be broadly categorised into four overarching ideas:

- *Space and shape* Includes shapes and patterns; visual information; position; space
- *Change and relationships* Includes functional thinking; linear, exponential, periodic and logistic growth
- *Quantity* Includes proportional reasoning; quantitative reasoning (number sense; meaning of operations; magnitude of numbers; elegant computations; mental arithmetic; estimations)
- *Uncertainty* Includes statistical thinking (variation); data production, analysis and representation; probability; inference

Since there is intrinsically a great deal of overlap between the categories of mathematical content, any overarching idea can intercept with any other overarching idea. For example, *Change and Relationships* can relate to number patterns (*Quantity*), the relationship between the three sides of a triangle (*Space and Shape*) or the proportion of favourable outcomes compared with all possible outcomes in rolling dice (*Uncertainty*).

Situations and context

'Mathematical literacy' is about *doing and using mathematics in situations that range from the everyday to the unusual, from simple to the complex* (OECD, 2006). Each question is set in one of four situations, 'personal' being considered closest to the student's everyday experience and 'scientific' being the least familiar. Within each situation, questions are set in various contexts:

- personal
- educational/occupational
- public
- scientific.

1.3.3 Reading

Reading was the main subject in the first PISA study in 2000 and a minor subject in PISA 2003 and PISA 2006.

Reading in PISA focuses on the ability of students to use information from texts in situations which they encounter in their life. The term 'reading literacy' is used in PISA and this is defined as *understanding, using and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential and to participate in society* (OECD, 2006).

The concept of 'reading literacy' in PISA is defined by three dimensions: the format of the reading material, the type of reading task or reading aspects, and the situation or the use for which the text was constructed.

The first dimension, the text format, divides the reading material or texts into continuous and non-continuous texts. Continuous texts are typically composed of sentences which are organised into paragraphs. Non-continuous texts are not organised in this type of linear format and may require, for example, interpretation of tables or diagrams. Such texts require a different reading approach to that needed with continuous text.

The second dimension is defined by three reading aspects: retrieval of information, interpretation of texts and reflection on and evaluation of texts. Tasks in which students retrieve information involve finding single or multiple pieces of information in a text. In interpretation tasks students are required to construct meaning and draw inferences from written information. The third type of task requires students to reflect on and evaluate texts. In these tasks students need to relate information in a text to their prior knowledge, ideas and experiences.

The third dimension is that of situation or context. The texts in the PISA assessment were categorised according to their content and the intended purpose of the text. There were four situations: reading for private use (personal), reading for public use, reading for work (occupational) and reading for education.

The reading items were of three types: open constructed response, short open response or closed response (e.g. multiple choice). Approximately half the questions were of the open response type, while the rest were closed response. Approximately a third were of the longer constructed type which required students to develop and explain their response. Such questions were generally two or three mark questions. The remainder of the open response questions required only short answers.

1.4 How proficiency is rated

PISA uses proficiency levels to describe the types of skills that students at each particular level are likely to demonstrate and tasks that they are able to complete. Test questions that focus on simple tasks are categorised at lower levels whereas those that are more demanding are categorised at higher levels. The question categorisations were based on both quantitative and qualitative analysis, taking into account question difficulty as well as expert views on the specific cognitive demands of each individual question. All PISA questions have been categorised in this manner.

Students described as being at a particular level not only demonstrate the knowledge and skills associated with that level but also the proficiencies required at lower levels. For example, all students proficient at Level 3 are also considered to be proficient at Levels 1 and 2. In science (see chapter 3) and mathematics (see Appendix B4) there are six levels, while in reading there are five levels (see Appendix C4). The proficiency level of a student is the highest level at which they answer more than half of the questions correctly.

The mean score for each scale was set to 500 among OECD countries, with each country contributing equally to the average. The reading scale was set to 500 in its first year in 2000. Similarly the mathematics scale was set to 500 in 2003. As PISA 2006 was the first survey in which science was the major domain, the science scale has been newly set to a mean of 500. The method by which these scales are derived is explained further in Appendix D and in the PISA Technical Report (OECD, 2005a).

As with any repeated measurement that uses samples it should be expected that the mean varies slightly from year to year without necessarily indicating any real change in the global level of literacy skills. This year the OECD average for reading is 492 and that for mathematics is 498. The table below shows the score points for each level in each subject.

	Below level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Science	below 335	335–410	410–484	484–559	559–633	633–708	above 708
Mathematics	below 358	358–420	420–482	482–545	545–607	607–669	above 669
Reading	below 335	335–407	407–480	480–553	553–626	above 626	

Every cycle of PISA focuses on a different subject. No one student is presented with all PISA questions. Instead, statistical methods are used to estimate the likelihood that the student would be able to answer questions correctly which they have not actually been presented with.

1.5 Survey administration

As mentioned above, the survey was carried out internationally on behalf of OECD by a PISA Consortium led by the Australian Council for Educational Research (ACER). The consortium was responsible for all aspects of procedures, including development of tests, questionnaires and administration manuals, decisions on sampling within countries and ensuring that all countries met rigorous quality standards. The consortium worked with the PISA National Centre within each country, through the National Project Manager (NPM). For England, Wales and Northern Ireland, the National Foundation for Educational Research (NFER) was the PISA National Centre.

The national centres were responsible for making local adaptations to instruments and manuals and for translation where necessary. NFER made appropriate adaptations to all PISA instruments and accompanying documentation. All materials were translated into Welsh and students in Wales were asked to choose the language in which they wished to complete tests and questionnaires.

National centres were also responsible for supplying the information necessary for sampling to be carried out. School samples were selected by the consortium, while student samples within schools were selected by NFER using software supplied by the consortium.

Test items were organised into thirteen test booklets with items repeated across booklets. Approximately a third of the total test items assessed science while the others were divided between reading and mathematics. All students were assessed in science, which was the main focus of PISA 2006. Random sub-samples of students were also assessed in mathematics and reading.

In addition to the tests, there were two questionnaires: one for students and the other for schools. There was also an optional parent questionnaire. This was included in the field trial in England, Wales and Northern Ireland in 2005. However, the response from parents was not sufficient to meet the stringent PISA sampling requirements. On advice from the PISA Consortium the parent questionnaire was not administered in the main study in 2006.

Tests and questionnaires were generally administered to students in a single session, with a two-hour testing period and approximately half an hour for completion of the student questionnaire. The total length of a survey session was around three and a half hours. The survey was administered by independent test administrators.

In each country participating in PISA, the minimum number of participating schools was 150, and the minimum number of students 4500. In the case of the UK and of some other countries, the number exceeds this. In some cases this is due to the need to over-sample some parts of the country (in the case of the UK, for example, to provide separate reliable results for England, Wales, Northern Ireland and Scotland). In some countries additional samples were drawn for other purposes. In very small countries with less than 150 schools the survey was done as a school census with all secondary schools included.

The students included in the PISA study are generally described as '15-year-olds', but there is a small amount of leeway in this definition depending on the time of testing. In the case of England, Wales and Northern Ireland the sample consisted of students aged from 15 years and three months to 16 years and two months at the beginning of the testing period.

Countries were required to carry out the survey during a six-week period between March and August 2006. However England, Wales and Northern Ireland were permitted to test outside this period because of the problems for schools caused by the overlap with the GCSE preparation and examination period. In England, Wales and Northern Ireland the survey took place in November-December 2006.

1.6 International comparisons

In many countries, PISA data is used to establish benchmarks for educational improvement based on the performance of particularly relevant comparison countries. It may also be of interest to identify countries that have reached high levels of equity in educational outcomes. The data may provide a common platform for different countries to exchange information and ideas. However, it is important to know what can reasonably be concluded from the data and which interpretations would be going beyond what can be reliably supported by the results. This sub-section reminds the reader of some basic statistical points that need to be kept in mind when comparing two sets of results.

PISA uses comprehensive guidelines and stringent checking procedures with the aim of guaranteeing that all data is collected in exactly the same way in every country. In practice, it is very difficult to guarantee that every aspect of the survey is carried out in exactly comparable ways across the world. When differences appear these are investigated by the PISA Consortium. In cases where there is no impact on the quality of the data it is included in the overall results, although in some cases a note is attached in the international report. In cases where the difference is considered to affect the quality of the data, and to make country comparisons unhelpful, the relevant data is excluded from the overall results. Again, any such instances are reported in the international report.

A different type of error that impacts on the results is sampling error. This is not a human error on the part of the people who carry out the analysis in different countries, but stems from the inherent variation of human populations which can never be summarised with absolute accuracy and affects virtually all research and data collection that makes use of sampling. Only if all 15-year-olds in all participating countries had taken part in PISA could it be stated with no error that the results are totally representative of the attainment of all students. In reality the data was collected from a sample of 15-year-olds. Therefore, the findings are the best estimation of how the total population would have answered. There are statistical methods to measure how good the estimation is. However, it is important to recognise that all data on human performance or attitudes that is collected in this way carries a margin of error. The comparison of very small differences between two sets of results are often meaningless because were they to be measured again it could well be that the results would turn out the other way round.

In addition to sampling error, another source of uncertainty is measurement error. This relates to the results obtained by each individual student, and takes account of variations in their score which are not directly due to underlying ability in the subject but are due to factors unrelated to ability. Both sources of uncertainty are allowed for in the detailed analysis of PISA data.

For the above reasons, this report focuses mainly on statistically significant differences between mean scores rather than the rank order of countries. These are differences which are unlikely to have been caused by random fluctuations due to the sources of error discussed above.

In some tables countries are presented in the order of their mean scores, but focusing solely on the order of countries can be misleading because sometimes the difference between two countries is very small and their order is arbitrary. Even if the differences seem large they may not be statistically significant. This is because tests for statistical significance take into account the spread of results as well as the mean scores (see Appendix D for a more complete explanation of the tests of statistical significance used in this report).

Significant differences between countries may be the result of a great number of factors, for some of which the data was not collected in the PISA survey. For example, differences in educational experiences in different countries could play a part, but so could a wide range of different out-of-school experiences. Similarly, it may be important to consider the cumulative effects of learning experiences in the longer term rather than simply considering country variations in the schooling of 15-year-olds.

1.7 Organisation of this report

Chapters 3, 4 and 5 describe student proficiency in the three assessment domains: science, mathematics and reading. Each chapter begins by presenting the results for student achievement in the context of achievement in other countries. Consideration is also given to differences in achievement of males and females.

Chapter 6 explores students' attitudes towards various aspects of science and science learning and the types of science activities in which they are involved. This chapter also includes some of the responses from the school questionnaire on science activities, teachers and resources in schools. Chapter 7 describes and discusses proficiency in science, mathematics and reading and attitudes to science in the four constituent parts of the United Kingdom.

The international tables and figures presented in this report include the results for the United Kingdom since these are reported in all international tables. In most cases, tables and figures include results for England, Wales, Northern Ireland and Scotland since these figures are referred to in Chapter 7.

More detailed analyses of student performance internationally can be found in the OECD report on PISA 2006 which includes results for the United Kingdom (OECD, 2007).

2 The PISA survey in England

2.1 Introduction

The National Foundation for Educational Research (NFER) was contracted to carry out the PISA 2006 study in England, Wales and Northern Ireland on behalf of the Department for Education and Skills (DfES – now DCSF) in England, the Department for Education in Northern Ireland (DENI) and the Welsh Assembly Government (WAG). Scotland participated in the study separately. The results from all parts of the UK are reported as a single United Kingdom result in the international PISA report, with the results from the separate parts of the UK reported in an annex.

2.2 The PISA sample

The first stage of sampling was agreement of the school stratification variables to be used for each country. Table 2.1 shows the variables which were used for sampling of schools in England for PISA 2006.

Table 2.1 Stratification variables for England

Variables	Levels
School type	• maintained selective • maintained non-selective • independent females • independent males • independent co-educational • student referral unit
GCSE performance band (based on % achieving grades A*-C: 20% bands)	• Band 1 (lowest) • Band 2 • Band 3 • Band 4 • Band 5 (highest) • Band not known
Region	• North • Midlands • South • Greater London
Local Authority	• Varies within region

Countries are allowed to exempt schools from the sampling frame if it is expected that the majority of students would not be eligible to participate in PISA. In England, special schools were excluded from the sampling frame on this basis.

Following agreement of the sampling plan and the establishment of population estimates in the age group, the list of all eligible schools and their populations was sent to the PISA Consortium. The consortium carried out the school sampling then sent the list of selected schools back to NFER.

The schools which had been selected in the sample were then invited to participate, and those which agreed were asked to supply details of all students who would be in Year 11 at the time of the beginning of the PISA survey period in November 2006. In addition they were asked to supply details of any who were born in the relevant period but were in other year groups.

When the student data was obtained from schools, the Keyquest software supplied by the PISA Consortium was used to randomly select 35 students within each school from those who met the PISA age definition.

The PISA study has strict sampling requirements regarding both the participation rate which is acceptable and the replacement of schools which decline. Within each country three separate samples are selected, the first being the main sample and the other two backup samples. In the backup samples each school is a replacement for a specific school in the main sample. So, if a main sample school declined to participate, there were two other schools which could be used as replacements for that school. In England, there were 190 schools in the main sample, with a corresponding number in each backup sample.

School recruitment was one of the main issues to which particular attention had to be given in PISA 2006. Due to the problems experienced in the 2003 PISA study, recruitment of schools in England was a particular priority. According to the PISA sampling rules, an acceptable school response in the main sample would be 85 per cent. If the response from the main sample meets this percentage, replacement of non-participating schools is not necessary. If the response from the main sample is below this percentage but above 65 per cent it is still possible to achieve an acceptable response by using replacement schools from the backup samples. However, the target then moves upwards – for example, with a main sample response of 70 per cent, the after-replacement target is 94 per cent.

There is also a response rate requirement for students within each school. It is possible for students to be excluded from participation and not counted within the total because they have special needs such that they could not participate, because they have limited language skills, or because they are no longer at the school. The remaining students are deemed eligible for PISA participation, and at least 50 per cent of these must participate for the school to be counted as a participating school.

In England, a total of 172 schools took part in PISA 2006. However, three schools did not achieve the required participation rate of at least 50 per cent of sampled students, so were not counted as participating schools. The final response rate for England was 77 per cent of main sample schools, and 89 per cent after replacement.

The international response rate for the United Kingdom is calculated based on the results for England, Wales, Northern Ireland and Scotland, with weighting according to the population in each country as well as school size. The school response rate for the England, Wales and Northern Ireland combined sample fell short of the participation requirements by just one per cent. This was a great improvement on the PISA surveys in 2000 and 2003, in which the UK sample did not meet the requirement for 65 per cent participation of main sample schools, and also fell considerably short of achieving the required after-replacement participation rate. Nevertheless, because the response was slightly below that required, NFER was asked to provide some analysis of the characteristics of responding and non-responding schools in England, Wales and Northern Ireland. This showed no significant differences and it was accepted by the PISA sampling referee that there was no evidence of possible bias in the sample as a result of school non-participation.

The final response requirement was for the total number of participating students, and the target here was for 80 per cent overall. This target was met in England with a student response of 89 per cent of sampled students (a total of 4935 students). The student response was similarly high in Wales and Northern Ireland, and the United Kingdom as a whole therefore achieved a satisfactory student response when the data was weighted according to the population.

2.3 PISA in the context of the National Curriculum

In this section, the definitions of the three PISA subject domains and the methods of assessment in the PISA survey are compared with those included in the National Curriculum in England. The aim is to estimate the extent to which the PISA assessments would be familiar to students in England and would match the content and style of what they had been learning at school.

2.3.1 Science

Overall there is a good match between the content areas and processes of science assessed in PISA 2006 and those specified in the National Curriculum for science. The content areas of *Earth and space, living systems, physical systems and technology systems* will be very familiar to GCSE students. Similarly the processes of scientific enquiry and the competencies of *Identifying scientific issues, Explaining phenomena scientifically* and *Using scientific evidence* are central to all science GCSE syllabuses.

Where differences are apparent between PISA and GCSE assessment of science these relate to the weightings given to different aspects. When compared to GCSE written components (excluding coursework) PISA assessments focus more on physical science topics and less on chemical science topics, as well as including a greater emphasis on scientific enquiry. However, the impact of these differences on student performance is likely to be modest.

There are, however, differences in the format of the questions and the type of challenge presented by the PISA assessment and the GCSE science examinations for which the students who took the tests were preparing. The PISA questions place a greater requirement on reading contextual information (although the contexts themselves do not present a barrier). There is also a greater proportion of open response items which require students to explain and develop their answers than is the case with some GCSE science papers.

Research commissioned by DfES in 2005 compared the PISA science and mathematics assessments with both key stage 3 tests and GCSE examinations. This research found that the main difference between PISA science questions and those with which students in England are likely to be familiar was in the amount of reading required, and concluded:

> *In PISA, the willingness of students to read the required amount of text, and their ability to do so, are likely to be the crucial factors.* (Ruddock *et al*. 2006:95)

It should be noted, however, that this research was based on analysis of questions from the 2000 and 2003 PISA surveys. The amount of reading required in science questions newly developed for PISA 2006 was somewhat less than in previous surveys.

Although the effects cannot be quantified, some students may find the style and demands of the PISA assessment unfamiliar. This may affect the performance of some students, especially those in lower ability bands who are accustomed to GCSE foundation tier test papers.

2.3.2 Mathematics

The concept of 'mathematical literacy' is defined in PISA 2006 as the capacity of students to analyse, reason and communicate effectively as they pose, solve and interpret mathematical problems in a variety of situations. There is a good match between these processes and those specified in the National Curriculum programmes of study for mathematics in the sections on *Using and Applying Mathematics* where problem solving, communicating and reasoning are identified as key features. Similarities can also be drawn between the PISA concepts of *quantity*, *shape and space*, *change and relationships* and *uncertainty* and those defined in the National Curriculum, namely *number and algebra*, *shape*, *space and measures* and *handling data*. The range of mathematical knowledge, skills and understanding therefore appears to be similar in PISA and the National Curriculum.

Differences are more apparent when looking at the weighting given to different aspects of mathematics on the papers. In PISA 2006 approximately two-thirds of the questions focus on the National Curriculum areas of *handling data and shape, space and measures* and there are few questions that focus solely on *number and algebra*. Furthermore the demand of the questions is quite high. The questions require students to read a larger amount of contextual information than is usual in most assessments with which students in England would be familiar.

There are also differences in the style of questions found on the PISA and GCSE assessments. The majority of the PISA questions place quite a high demand on the students' reading skills to extract and interpret information. In contrast, GCSE questions, whilst still set in context, tend to be shorter and do not generally require as much reading and interpretation. Some GCSE students may not be prepared for dealing with questions set within such long and complex contexts.

Ruddock et al (2006) compared the PISA science and mathematics assessments with both key stage 3 tests and GCSE examinations. This research found that the item formats most commonly used in PISA were likely to be familiar to most students. Students will have encountered items such as multiple choice, short answer or longer items which require more development and explanation of answers in either key stage 3 tests or GCSE papers, although the balance of item types in PISA, key stage 3 and GCSE varies. However, the main difference between PISA mathematics questions and those with which students in England are likely to be familiar was in the amount of contextualisation of questions and the amount of reading required.

Some students in England might therefore find the style and demands of the PISA test very challenging. This may make the questions less accessible, particularly to foundation tier GCSE candidates.

2.3.3 Reading

'Reading literacy' in PISA seeks to measure a young person's ability to understand, use and reflect on a range of written texts in situations they may encounter both inside and outside of school and in preparation for adult life and the world of work. It focuses, therefore, on just one of the three attainment targets for English in the National Curriculum as it does not seek to assess the skills of either Speaking and Listening or Writing.

The text types in PISA 2006 consisted mainly of non-fiction texts, including a number of non-continuous texts, such as charts, graphs, tables, maps and forms. Expository texts formed a high percentage of the eight units. In this respect, PISA differs from GCSE which also includes a wide range of literary texts, including drama, prose fiction and poetry. Nevertheless, the National Curriculum programme of study for reading specifies a range of non-fiction and non-literary texts and therefore students should be well equipped to deal effectively with the texts encountered in PISA.

The five processes measured by PISA, (*retrieving information, forming a broad general understanding, developing an interpretation, reflecting on and evaluating the content of a text* and *reflecting on and evaluating the form of a text*) correspond broadly with the assessment foci for reading in key stage 3 and the reading assessment objectives at key stage 4.

Question types in the PISA assessment of reading consist of closed response items such as multiple choice, short answer items requiring just a few words, and longer items which require more explanation and development of responses. In PISA 2006, ten of the 28 items were multiple choice items. There are few multiple choice questions in the English tests at the end of key stage 3 and none in GCSE English (which tends to require longer responses to texts than required by the PISA questions).

2.3.4 Summary

The PISA assessments aim to measure students' preparation for adult life, and as such they do not aim to match the curriculum of any participating country. Nevertheless, the match between the underlying focus of the assessment and the concepts and processes specified in the National Curriculum is of interest as it helps in the interpretation of the PISA results. The familiarity of students with the method of assessment is also relevant as it could potentially impact on their performance.

It appears that the definitions of the three subject areas of science, mathematics and reading in PISA do not differ markedly from those specified in the National Curriculum in England. There are some differences in the format of the science and mathematics assessment, with many questions requiring students to read and absorb a larger amount of contextual information than is common in either key stage 3 or GCSE assessment. In the reading assessment the tests are likely to appear more familiar to students, apart from a greater emphasis on non-fiction and non-continuous texts in the PISA tests, compared with GCSE which has a larger proportion of literary texts.

As far as the types of item are concerned, all are types which students will have encountered before in either key stage tests or GCSE papers. However, the balance of item types may be less familiar compared with the GCSE preparation which they would have been involved in at the time of the PISA survey. This and the relatively large reading demand of many of the science and mathematics questions may have made the tests less accessible to some students.

3 Student achievement in science in England

3.1 Introduction

This chapter reports the attainment of students in England in science. It draws on findings outlined in the international report (OECD, 2007) and places outcomes for England in the context of those findings. The international report includes outcomes for all 57 participating countries. While findings for all countries are reported in this chapter where relevant, most findings relate to a sub-sample of countries. The countries forming the comparison group include OECD countries, EU countries and others with a mean scale score for science of more than 430. Countries with a mean below this which are not in either the EU or OECD have been omitted as they are not so relevant for comparison purposes. Hence, the comparison group in this chapter for science comprises 44 countries (of whom 24 are EU members and 29 OECD members):

Australia	Finland*	*Latvia**	Republic of Ireland*
Austria*	France*	*Liechtenstein*	*Romania**
Belgium*	Germany*	*Lithuania**	*Russian Federation*
*Bulgaria**	Greece*	Luxembourg*	*Serbia*
Canada	*Hong Kong-China*	*Macao-China*	Slovak Republic*
Chile	Hungary*	Mexico	*Slovenia**
Chinese Taipei	Iceland	Netherlands*	Spain*
Croatia	*Israel*	New Zealand	Sweden*
Czech Republic*	Italy*	Norway	Switzerland
Denmark*	Japan	Poland*	Turkey
*Estonia**	Korea	Portugal*	United States

OECD countries (not italicised). *Countries not in OECD (italicised).* * EU countries

This is the third PISA cycle. The first, in 2000, assessed reading as its main focus, with mathematics and science as subsidiary subjects. In 2003, all three subjects were again assessed, with mathematics as the main focus. In 2006, science became the main focus for the first time.

Outcomes for England are derived from the international analysis carried out at 'sub-national' level (i.e. for the constituent countries within the UK), as well as from additional analysis conducted using the international dataset.

3.2 Achievement in science in England in relation to other countries

England's students achieved a mean score of 516 in science, above the OECD mean of 500. Only seven of the 56 other participating countries significantly outperformed

England in science (see Table 3.1). This places England among the higher achievers, although not in the topmost group.

Internationally, 13 countries performed at a level not significantly different from that of England, while the remaining 36 countries performed significantly less well. Tables 3.2 and 3.3 show the comparison group countries which performed similarly to England, and those whose performance was lower than England's. Further data can be found in Appendix A1 (significant differences between England and the comparison group countries) and Appendix A2 (mean scores and standard errors for England and the comparison group countries).

As Appendix A1 shows, only two of the countries that significantly outperformed England are EU members (Finland and Estonia). While eight EU countries did not perform significantly differently from England, 14 performed less well. Similarly, among OECD countries, only Finland, Canada, Japan and New Zealand outperformed England, ten performed similarly, and 15 performed less well. This indicates that England, while not among the highest-achieving group of countries internationally, compares well with other EU and OECD countries in terms of science achievement.

Table 3.1 Countries outperforming England in science (significant differences)

Country	Mean score	Country	Mean score
Finland*	563	*Estonia**	531
Hong Kong–China	542	Japan	531
Canada	534	New Zealand	530
Chinese Taipei	532		

Table 3.2 Countries not significantly different from England

Country	Mean score	Country	Mean score
Australia	527	Czech Republic*	513
Netherlands*	525	Switzerland	512
Liechtenstein	522	*Macao – China*	511
Korea	522	Austria*	511
*Slovenia**	519	Belgium*	510
Germany*	516	Republic of Ireland*	508
England	**516**	Hungary*	504

Table 3.3 Countries significantly below England

Country	Mean score	Country	Mean score
Sweden*	503	Luxembourg*	486
Poland*	498	*Russian Federation*	479
Denmark*	496	Italy*	475
France*	495	Portugal*	474
Croatia	493	Greece*	473
Iceland	491	*Israel*	454
*Latvia**	490	*Chile*	438
United States	489	*Serbia*	436
Slovak Republic*	488	*Bulgaria**	434
Spain*	488	Turkey	424
*Lithuania**	488	*Romania**	418
Norway	487	Mexico	410
		Plus 12 other countries	

OECD countries (not italicised). *Countries not in OECD (italicised).** EU countries

As noted in Chapter 1, the 'scientific literacy' assessment framework for PISA outlines not only knowledge to be assessed, but also key scientific skills. Three competencies are described (the ability to identify scientific issues, to explain phenomena scientifically and to use scientific evidence; see Section 1.3 for more information). Students' performance on each of these competencies was analysed separately, in addition to their overall performance. In some countries, students showed notably stronger or weaker performance in some of these areas, relative to their mean performance. If mean scores on one competency area are lower than on others, this could have implications for teaching and learning or might suggest that the balance of these areas in the curriculum should be evaluated.

England's highest score was attained on the *Explaining phenomena scientifically* scale, with a mean of 518, two scale points higher than its overall mean for science. On the *Identifying scientific issues* scale, England scored a mean of 515, close to its overall science mean of 516 scale points, and on *Using scientific evidence*, a mean of 514. It might be tempting to conclude from this that, in England, students are relatively strong in skills such as applying scientific knowledge, describing scientific phenomena and identifying appropriate explanations and predictions (i.e. *Explaining phenomena scientifically*) and relatively less strong in skills such as interpreting scientific evidence, understanding the assumptions behind them and reflecting on the impact of science and technology (*Using scientific evidence*). However, on all three scales, the differences from the mean for science are small, indicating that on average students in England performed in a similar way in all three areas.

More variation was seen in some other countries than in England (see Appendix A3). Large differences were not confined to lower-attaining countries. Even some of the seven countries which significantly outperformed England did not have consistent performance across the three competency areas (see Table 3.4 below). For example, Chinese Taipei scored 24 scale points lower than its mean on *Identifying scientific issues* but 13 points higher on *Explaining phenomena scientifically*. Hong Kong showed the same trends, to a less pronounced degree. Japanese students were stronger in *Using scientific evidence* (13 scale points higher than their mean), but weaker in *Identifying scientific issues* (nine scale points lower). Even Finland, at the top of the science performance scale overall, had a mean score in *Identifying scientific issues* which was 8 scale points lower than the overall mean. Conversely, students in New Zealand were relatively strong in *Identifying scientific issues* and *Using scientific evidence*, but relatively weak in *Explaining phenomena scientifically* (seven and eight points lower respectively).

In England, in contrast to some other countries, there was little variation across the three competencies, indicating that students achieved consistently in all the areas of science skills assessed. This suggests that students' learning is well balanced across these three competency areas.

Table 3.4 Differences between scale scores in countries outperforming England

		Difference from overall science mean		
	Overall science mean	Identifying scientific issues	Explaining phenomena scientifically	Using scientific evidence
Finland*	563	-8	3	4
Hong Kong-China	542	-14	7	0
Canada	534	-3	-4	7
Chinese Taipei	532	-24	13	-1
*Estonia**	531	-16	9	0
Japan	531	-9	-4	13
New Zealand	530	6	-8	6
England	**516**	**-1**	**3**	**-2**

OECD countries (not italicised). *Countries not in OECD (italicised).* * EU countries

Appendices A4 to A6 show the mean scores for each comparison group country on each of the three competency scales, while Appendices A7 to A9 summarise the statistically significant differences for these scales.

3.3 Distribution of performance in science

Of course, it is not enough simply to know how well students in England performed overall or that they performed consistently across the competencies assessed. It is also important for teaching and learning purposes to examine the spread in performance between the highest and lowest achievers.

The first way in which the spread of performance in each country can be examined is by looking at the distribution of scores. The figure in Appendix A10 shows the distribution of scores on the science scale overall in each country. The data underlying the figure can be found in Appendix A2, which shows the size of the difference between the highest and lowest attainers on the science scale overall in each country.

Appendix A10 shows the average score of students at each percentile. The fifth percentile is the score at which 5 per cent of students score lower, while the 95th percentile is the score at which 5 per cent score higher. This a better measure for comparing countries than using the lowest and highest students. Such a comparison may be affected by a small number of students in a country with very high or very low scores. Comparison of the 5th and the 95th percentiles gives a much better indication of the typical spread of attainment.

The average score of students in England at the fifth percentile was 336 while the score of those at the 95th percentile was 686, a difference of 350 scale points, which was exceeded by only two other comparison group countries (Israel and New Zealand). The average difference across the OECD countries was 311 scale points, indicating that England had a particularly wide spread of attainment.

The second way of examining the spread of attainment is by looking at performance on each of the six PISA proficiency levels. These levels are outlined in Figure 3.1 overleaf. Also shown in this figure are the cumulative percentages at each level for the OECD average and for England. Full information for the proportion of students at each level in all comparison countries is in Appendices A11 and A12.

Figure 3.1 shows that the proportion of students in England at each level was above the OECD average. The table in Appendix A12 shows the proportion at each level in all comparison countries.

In England, 4.9 per cent of students scored below PISA level 1, compared with an OECD average of 5.2 per cent. In the lower two levels combined, England has 16.7 per cent compared with an OECD average of 19.2 per cent. Although this compares well with the OECD average, it does not compare so well with the highest-scoring countries. In Finland, for example, only 4.1 per cent of students were in level 1 and below and in Hong Kong only 8.7 per cent. In all, 20 countries had fewer students at level 1 and below than England.

Balancing the number of low-attaining students, however, England has some high achievers. Three per cent of England's students achieved PISA level 6, one of the three highest proportions at this level, behind only New Zealand and Finland (4.0 and 3.9 per cent respectively). Combining the top two levels moves England down to eighth position, with 14 per cent in the top two levels, compared with Finland's 20.9 per cent and New Zealand's 17.6 per cent. Despite the drop, this is still a respectable position, given that 57 countries participated in PISA 2006. It does, however, again emphasise the relatively wide gap in England between the highest and lowest achievers.

As pointed out in the PISA international report, *investing in excellence may benefit all, because highly skilled individuals create innovations in various areas* (OECD, 2006). Whilst the proportion at the higher levels is an encouraging result for England, these findings indicate that there is still work to do in addressing variation in achievement, in order to maximise lower-achieving students' future ability to *participate fully in society and in the labour market* (OECD, 2006).

Findings presented earlier showed that England's students performed consistently across all three competency areas. Therefore, we might expect to see a similar pattern of

Figure 3.1 PISA science proficiency levels

Level	% at this level OECD	% at this level England	What students can typically do at each level
6	1.3% perform tasks at level 6	3.0% perform tasks at level 6	At Level 6, students can consistently identify, explain and apply scientific knowledge and knowledge about science in a variety of complex life situations. They can link different information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they are willing to use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social, or global situations.
5	9.0% perform tasks at least at level 5	14.0% perform tasks at least at level 5	At Level 5, students can identify the scientific components of many complex life situations, apply both scientific concepts and knowledge about science to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed enquiry abilities, link knowledge appropriately and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis.
4	29.3% perform tasks at least at level 4	36.1% perform tasks at least at level 4	At Level 4, students can work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They can select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level can reflect on their actions and they can communicate decisions using scientific knowledge and evidence.
3	56.7% perform tasks at least at level 3	61.8% perform tasks at least at level 3	At Level 3, students can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or enquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decisions based on scientific knowledge.
2	80.8% perform tasks at least at level 2	83.3% perform tasks at least at level 2	At Level 2, students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific enquiry or technological problem solving.
1	94.8% perform tasks at least at level 1	95.1% perform tasks at least at level 1	At Level 1, students have such a limited scientific knowledge that it can only be applied to a few, familiar situations. They can present scientific explanations that are obvious and follow explicitly from given evidence.

achievement for each competency at each proficiency level. Table 3.5 below shows the percentage of students in England at each level for each competency scale. The proficiency distribution for each scale is similar to that seen for science overall (most differences are within one percentage point of the percentage at that level for science overall). One exception is that England has a slightly higher number of students below level 1 on the *Using scientific evidence* scale (6.8 per cent compared with 4.9 per cent for science overall) and the spread of attainment is widest on this scale with 15.8 per cent in the top two levels.

Table 3.5 Percentage at each level in England for each science competency scale

	Below level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Science overall	4.9%	11.8%	21.5%	25.7%	22.1%	11.0%	3.0%
Identifying scientific issues	4.9%	11.1%	22.3%	26.5%	22.2%	10.3%	2.7%
Explaining phenomena scientifically	4.6%	12.5%	21.2%	25.0%	21.0%	11.7%	3.9%
Using scientific evidence	6.8%	12.4%	20.0%	23.8%	21.1%	11.8%	4.0%

3.4 Gender differences in science

Of the 57 participating countries, 21 had a statistically significant difference in gender performance on the science scale, nine favouring males and 12 favouring females (see Appendix A2).

In England, males significantly outperformed females, scoring a mean of 521 compared with 510, a significant difference of 11 scale points. This overall difference in the science scores of females and males is largely attributable to differential performance on the *Explaining phenomena scientifically* competency scale, where males scored a mean of 529 against the females' 507, a significant difference of 22 scale points. This indicates that males did better than females in such skills as applying their scientific knowledge, identifying or describing scientific phenomena and predicting changes.

This pattern of difference on the *Explaining phenomena scientifically* scale was seen in the majority of comparison group countries (see Appendix A5) and, in all but one case, it was males who scored significantly higher. The exception was Bulgaria, where females scored higher on this scale. Despite the prevalence of males scoring more highly than females in *Explaining phenomena scientifically*, it was noticeable that only two comparison group countries had larger differences than that in England: Chile and Luxembourg (34 and 25 scale points difference respectively). The OECD mean difference on this scale was 15 points.

For the other two competency scales (*Identifying scientific issues* and *Using scientific evidence*), there were no significant differences in England between the performance of males and females (see Appendices A4 and A6). On the *Using scientific evidence* scale, this finding is in line with those across the majority of the comparison group. Although the OECD average showed a small, significant difference in favour of females, only eight comparison group countries showed differential performance on this scale, all but one favouring females.

However, on the *Identifying scientific issues* scale, the pattern in England differed from most other countries. On this scale, where the OECD mean difference was 17 scale points, almost all comparison group countries showed statistically significant differences, and all favouring females. England was one of only four countries with no significant gender difference on this scale (the others were Israel, Chinese Taipei, and Chile).

3.5 Summary

This chapter has highlighted some positive findings for England in terms of its students' science attainment. England's students were among the higher achievers in the PISA 2006 science survey and they performed consistently across the three PISA competencies.

Two areas of concern were highlighted by the findings, however. England's males outperformed its females in terms of the application of science knowledge, and while this mirrored findings in other countries, it is nevertheless an inequality which needs to be addressed. Secondly, England has a wide range of achievement, exhibiting one of the largest differences between the mean scores of its highest and lowest achievers. While England is among the countries with the largest numbers of high-achieving students, this long tail of low achievement is a cause for concern. This is, of course, a problem that has not gone unnoticed, and was one of the prime motivating factors in the introduction of the new National Curriculum for science at key stages 3 and 4. It is hoped that the new curriculum will begin to address the issue, and will have a positive impact on the lowest achieving students over time.

4 Student achievement in mathematics in England

4.1 Introduction

This chapter explores attainment in mathematics. It draws on findings outlined in the international report (OECD, 2007) and places outcomes for England in the context of those findings. The international report includes outcomes for 57 participating countries.

Mathematics was a minor domain in the PISA 2006 survey. This means that not all students were assessed in this subject, and that the mathematics questions did not cover the subject as fully as in science which was the major domain. The results reported for mathematics are estimates for the whole population, based on the performance of students who were presented with mathematics test items. These estimates take into account information about how students with specific characteristics performed. The scores reported in this chapter therefore give a ‘snapshot’ of performance in mathematics rather than the fuller more rigorous assessment which is available for science (see OECD 2005a for full details of the analysis of minor domains in PISA).

The international report includes outcomes for all 57 participating countries. While findings for all countries are reported in this chapter where relevant, most findings relate to a sub-group of countries. The countries forming the comparison group include OECD countries, EU countries and other countries with relatively high scores. Since countries with very low scores are not so relevant for comparison purposes, those with a mean score for mathematics of less than 430 have been omitted from tables unless they are in OECD or the EU. This results in a comparison group of 44 countries as follows:

Australia	*Hong Kong-China*	Norway
Austria*	Hungary*	Poland*
Azerbaijan	Iceland	Portugal*
Belgium*	*Israel*	Republic of Ireland*
*Bulgaria**	Italy*	*Romania**
Canada	Japan	*Russian Federation*
Chinese Taipei	Korea	*Serbia*
Croatia	*Latvia**	Slovak Republic*
Czech Republic*	*Liechtenstein*	*Slovenia**
Denmark*	*Lithuania**	Spain*
*Estonia**	Luxembourg*	Sweden*
Finland*	*Macao-China*	Switzerland
France*	Mexico	Turkey
Germany*	Netherlands*	United States
Greece*	New Zealand	

OECD countries (not italicised). *Countries not in OECD (italicised).* * EU countries

Outcomes for the United Kingdom as a whole are set out in the international report (OECD, 2007). Outcomes for England are derived from the international analysis carried out at 'sub-national' level (i.e. for the constituent countries within the UK), as well as from additional analysis conducted using the international dataset.

4.2 Achievement in mathematics in England in relation to other countries

England's students achieved a mean score of 495 for mathematics, which was not statistically different from the OECD average of 498.

Internationally, 18 countries performed at a level significantly higher than England. In 12 countries, mathematics attainment was not significantly different from that of England, while 26 countries performed significantly less well. Table 4.1 below shows the countries which significantly outperformed England. Table 4.2 shows the countries whose performance was not significantly different from that of England while Table 4.3 shows the comparison countries which were significantly lower.

It should be noted that the test of statistical significance takes into account not just the mean score but also the error of measurement. This means that Slovenia's mean score was significantly higher than that of England while Austria's was not, despite the fact that the mean score of Austria was slightly higher than that of Slovenia. (See Section 1.6 for an explanation of how statistical significance should be interpreted in this report. Appendix D gives a more detailed account of the analysis.)

Of the 18 countries with mean scores significantly above England, only six (Chinese Taipei, Hong Kong, Macao, Liechtenstein, Estonia and Slovenia) are not OECD countries, and seven (Finland, Netherlands, Belgium, Estonia, Denmark, Czech Republic and Slovenia) are EU countries.

Full data can be found in Appendices B1 and B2.

Table 4.1 Countries outperforming England in mathematics (significant differences)

Country	Mean score	Country	Mean score
Chinese Taipei	549	Japan	523
Finland*	548	New Zealand	522
Hong Kong-China	547	Belgium*	520
Korea	547	Australia	520
Netherlands*	531	*Estonia**	515
Switzerland	530	Denmark*	513
Canada	527	Czech Republic*	510
Macao-China	525	Iceland	506
Liechtenstein	525	*Slovenia**	504

Table 4.2 Countries not significantly different from England

Country	Mean score	Country	Mean score
Austria*	505	Slovak Republic*	492
Germany*	504	Hungary*	491
Sweden*	502	Luxembourg*	490
Republic of Ireland*	501	Norway	490
France*	496	*Lithuania**	486
Poland*	495	*Latvia**	486
England	**495**		

Table 4.3 Countries significantly below England

Country	Mean score	Country	Mean score
Spain*	480	*Israel*	442
Azerbaijan	476	*Serbia*	435
Russian Federation	476	Turkey	424
United States	474	*Romania**	415
Croatia	467	*Bulgaria**	413
Portugal*	466	Mexico	406
Italy*	462		
Greece*	459	*plus 12 other countries*	

OECD countries (not italicised). *Countries not in OECD (italicised).* * EU countries

4.3 Distribution of performance in mathematics

It is important for teaching and learning purposes to know how wide the variation in performance was in England. Countries with similar mean scores may nevertheless have differences in the numbers of high or low attainers.

The first way in which the spread of performance in each country can be examined is by looking at the distribution of scores. The figure in Appendix B3 shows the distribution of scores on the mathematics scale in each country. The data underlying the figure can be found in Appendix B2, which shows the size of the difference between the average scores of the highest and lowest attainers (at the 5th and the 95th percentiles) on the mathematics scale in each country.

The fifth percentile is the score at which 5 per cent of students score lower, while the 95th percentile is the score at which 5 per cent score higher. This is a better measure for comparing countries than using the lowest- and highest-scoring students. Such a comparison may be affected by a small number of students in a country who have unusually high or low scores. Comparison of the 5th and the 95th percentiles gives a much better indication of the typical spread of attainment.

England's mean score at the fifth percentile was 350 while its mean score at the 95th percentile was 643, a difference of 293 scale points. This was slightly less than the OECD average difference, which was 300 scale points. About two-thirds of the OECD countries had a larger difference between the highest and lowest percentiles than England. This contrasts with science which, as reported in the previous chapter, had one of the widest distributions among PISA countries.

The second way of examining the spread of attainment is by looking at performance on each of the six PISA proficiency levels. These levels are outlined in Appendix B4. In all PISA countries there were some students at or below the lowest level of achievement (level 1), while in most countries (including all the comparison countries) at least some students achieved the highest level (level 6). See Appendices B5 and B6 for details of the proportions at each level in all comparison countries.

In England, six per cent of students scored below PISA level 1, which was slightly less than the OECD average of 7.7 per cent. (see Appendices B5 and B6). At level 1 or below, the OECD average was 21.3 per cent. England has 19.9 per cent at these levels. The proportion in the highest level is slightly below the OECD average of 3.3 per cent, at 2.5 per cent. In the top two levels combined, England is again slightly below the OECD average with 11.2 per cent compared with an OECD average of 13.3 per cent.

4.4 Gender differences in mathematics

Of the 57 participating countries, 36 had a statistically significant difference in gender performance, in 35 countries favouring males and in one (Qatar) favouring females. In England, there was a significant difference favouring males. The difference of 17 scale points between females and males was higher than the OECD average of 11 scale points. This was one of the highest differences within the 44 comparison countries with only three countries having a higher figure (see Appendix B2). These countries were Austria, Japan and Germany. The largest difference was 23 points in Austria.

It was not the case that countries with the highest overall mean scores necessarily had the lowest gender differences. Eleven out of the 18 countries that performed significantly better than England showed a significant gender difference in the mathematics scores, favouring males.

It is interesting to compare this pattern of male advantage with that found in other assessments in England. At key stage 4, males sit GCSE additional mathematics more frequently than females and a higher proportion of males achieve the top grades in this qualification. In 2007, 30 per cent of males achieved grade A* or A, compared with 22 per cent of females. However, only a relatively small number of students take this exam (6085 students in 2007). The more common GCSE mathematics qualification (693,475 students in 2007) shows no gender difference and 14 per cent of both males and females achieved grade A* or A (www.jcq.org.uk). The PISA 2006 cohort of students generally took their key stage 3 tests in 2005. Again, there were no gender differences with 26 per cent of boys achieving levels 7 or 8 and 25 per cent of girls doing so (www.standards.dfes.gov.uk).

It seems then that results from measures that are used regularly in England do not tell the same story about gender differences as the PISA survey. Interestingly, recent research which also used an international measure (Scholastic Aptitude Test SAT®) showed that males in England performed significantly better than females in the mathematics section of the test (Kirkup *et al.*, 2007).

4.5 Summary

England's performance in mathematics was not significantly different from the OECD average. Eighty per cent of students achieved level 2 or above which is what PISA describes as

> *a baseline level of mathematics proficiency … at which students begin to demonstrate the kind of literacy skills that enable them to actively use mathematics, which are considered fundamental for future development and use of mathematics.* (OECD, 2007)

Unlike in science and reading, in mathematics England had a relatively low difference between the score points of the lowest-scoring students and the highest-scoring students compared with other countries. Compared with the top performing countries in the world England was lacking in high achievers in mathematics. This contrasts with science, where students in England were much better represented in the highest levels.

Males performed significantly better than females in mathematics. This was a common pattern internationally, with more than half the PISA countries showing a similar difference. However, England did have one of the biggest gender differences. There did not seem to be any clear relationship between a country's mean score and whether it had a low or a high gender difference. This gender difference does not generally appear in tests that are regularly used in England, for example GCSE and key stage 3 tests, but it has been observed in at least one other study that uses international measures.

5 Student achievement in reading in England

5.1 Introduction

This chapter explores attainment in reading. It draws on findings outlined in the international report (OECD, 2007) and places outcomes for England in the context of those findings. The international report includes outcomes for 56 of the 57 participating countries. Reading attainment for the United States is omitted from the international report due to problems in the administration of the assessment.

Reading was a minor domain in the PISA 2006 survey. This means that not all students were assessed in this subject, and that the reading questions did not cover the subject as fully as in science which was the major domain. The results reported for reading are estimates for the whole population, based on the performance of students who were presented with reading test items. These estimates take into account information about how students with specific characteristics performed. The scores reported in this chapter therefore give a 'snapshot' of performance in reading rather than the fuller, more rigorous assessment which is available for science (see OECD 2005a for full details of the analysis of the reading data).

The international report includes outcomes for all 56 participating countries. While findings for all countries are reported in this chapter where relevant, most findings relate to a sub-group of countries. The countries forming the comparison group include OECD countries, EU countries and other countries with relatively high scores. Since countries with very low scores are not so relevant for comparison purposes, those with a mean score for reading of less than 430 have been omitted from tables unless they are in OECD or the EU. This results in a comparison group of 42 countries as follows:

Australia	Greece*	Netherlands*
Austria*	*Hong Kong-China*	New Zealand
Belgium*	Hungary*	Norway
*Bulgaria**	Iceland	Poland*
Canada	*Israel*	Portugal*
Chile	Italy*	Republic of Ireland*
Chinese Taipei	Japan	*Romania**
Croatia	Korea	*Russian Federation*
Czech Republic*	*Latvia**	Slovak Republic*
Denmark*	*Liechtenstein*	*Slovenia**
*Estonia**	*Lithuania**	Spain*
Finland*	Luxembourg*	Sweden*
France*	*Macao-China*	Switzerland
Germany*	Mexico	Turkey

OECD countries (not italicised). *Countries not in OECD (italicised).* *EU countries

In addition to the countries listed above, tables and figures in Appendix C include the data for all four parts of the United Kingdom.

Outcomes for the United Kingdom as a whole are set out in the international report (OECD, 2007). Outcomes for England are derived from the international analysis carried out at 'sub-national' level (i.e. for the constituent countries within the UK), as well as from additional analysis conducted using the international dataset.

5.2 Achievement in reading in England in relation to other countries

Students in England achieved a mean score of 496 for reading. The OECD average was 492, and this difference was not statistically significant.

Internationally, seven countries performed at a level significantly higher than England. In 18 countries, reading attainment was not significantly different from that of England, while the remaining 30 out of a total of 55 countries performed significantly less well. Table 5.1 below shows the countries which significantly outperformed England. Table 5.2 shows the countries whose performance was not significantly different from that of England while Table 5.3 shows the comparison countries which were significantly lower.

It should be noted that the test of statistical significance takes into account not just the mean score but also the error of measurement. This means that Iceland's mean score was significantly lower than that of England. The scores of Norway, the Czech Republic and Hungary were not significantly different to that of England, even though they were either lower or the same as the mean score of Iceland. (See Section 1.6 for an explanation of how statistical significance should be interpreted in this report. Appendix D gives a more detailed account of the analysis.)

Of the seven countries with mean scores significantly above England, it is interesting that three of the countries are English-speaking (Republic of Ireland, Australia and New Zealand), one has a substantial number of English speakers (Canada) and one has had a significant amount of influence from the UK on its education system in the past (Hong Kong). One might have expected more similarities between England and these countries than were found in this study, either because of similarities in the difficulties of reading in English or because of similarities in educational systems.

More information can be found in Appendix C1, which summarises significant differences in attainment between England and the comparison group countries, while Appendix C2 gives mean scores with standard errors for these countries.

Table 5.1 Countries outperforming England in reading (significant differences)

Country	Mean score	Country	Mean score
Korea	556	New Zealand	521
Finland*	547	Republic of Ireland*	517
Hong Kong-China	536	Australia	513
Canada	527		

Table 5.2 Countries not significantly different from England

Country	Mean score	Country	Mean score
Liechtenstein	510	Germany*	495
Poland*	508	Denmark*	494
Sweden*	507	*Slovenia**	494
Netherlands*	507	*Macao-China*	492
Belgium*	501	Austria*	490
*Estonia**	501	France*	488
Switzerland	499	Norway	484
Japan	498	Czech Republic*	483
Chinese Taipei	496	Hungary*	482
England	**496**		

Table 5.3 Countries significantly below England

Country	Mean score	Country	Mean score
Iceland	484	Greece*	460
*Latvia**	479	Turkey	447
Luxembourg*	479	*Chile*	442
Croatia	477	*Russian Federation*	440
Portugal*	472	*Israel*	439
*Lithuania**	470	Mexico	410
Italy*	469	*Bulgaria**	402
Slovak Republic*	466	*Romania**	396
Spain*	461	*plus 13 other countries*	

OECD countries (not italicised). *Countries not in OECD (italicised).* *EU countries

5.3 Distribution of performance in reading

It is important for teaching and learning purposes to know the spread of attainment between the highest- and lowest-scoring students. Countries with similar mean scores may nevertheless have differences in the numbers of high or low attainers. A country with a wide spread of attainment may have a long tail of under achievement as well as students who are achieving at the highest levels. A country with a lower spread may have fewer very high achievers but may also have fewer under achievers.

The first way in which the spread of performance in each country can be examined is by looking at the distribution of scores. The figure in Appendix C3 shows the distribution of scores on the reading scale in each country. The data underlying the figure can be found in Appendix C2, which shows the size of the difference between the average scores of the highest and lowest attainers (at the 5th and the 95th percentiles) on the reading scale in each country.

The fifth percentile is the score at which 5 per cent of students score lower, while the 95th percentile is the score at which 5 per cent score higher. This is a better measure for comparing countries than using the lowest- and highest-scoring students. Such a comparison may be affected by a small number of students in a country who have unusually high or low scores. Comparison of the 5^{th} and the 95^{th} percentiles gives a much better indication of the typical spread of attainment.

England displays relatively wide variation around its mean. England's score at the fifth percentile was 317 while its score at the 95^{th} percentile was 654, a difference of 337 scale points. This was larger than the OECD average difference of 324 scale points and only 14 countries had a wider distribution than England. These were the OECD countries Czech Republic, Belgium, Germany, Austria, Italy, Slovak Republic, New Zealand, Norway, France and Greece. Non-OECD countries with a higher scale point difference than England were Israel, Bulgaria and Chile.

Another approach to describing the spread of achievement in England is to examine the proportion of students at each level. As explained in Chapter 1 (Section 1.4) PISA reading attainment is described in terms of five levels of achievement. (See Appendix C4 for a full description of typical performance at each of these five levels.) In all PISA countries there were some students at or below the lowest level of achievement (level 1), while in most countries at least some students achieved the highest level (level 5). See Appendices C5 and C6 for details.

The proportions at each level in England are close to the OECD average. In England, 6.8 per cent of students scored below PISA level 1, while the OECD average was 7.4 per cent (see Appendices C5 and C6). At level 1 or below, the OECD average was 20 per cent. England has 19 per cent at these levels. Balancing this, however, England also has some high achievers. The proportion in the highest level is 9.2 per cent compared with an OECD average of 8.6 per cent. In the top two levels combined, England is again close to the OECD average with 29.8 per cent compared with an OECD average of 29.3 per cent.

Although the numbers scoring at each level compare well with the OECD average, they are nevertheless not a reason for complacency when compared with some other countries. The three highest-attaining countries have low numbers at level 1 or below: 5.8 per cent in Korea, 4.8 per cent in Finland and 7.1 per cent in Hong Kong, compared with England's figure of 19 per cent. England has a relatively long tail of underachievement when compared with the highest-scoring countries.

5.4 Gender differences in reading

Of the 56 participating countries which were reported, all had a statistically significant difference in gender performance, favouring females. In England, there was a difference of 29 scale points between females and males. This was lower than the OECD average of 38 scale points difference and was one of the lowest among the comparison countries, with only Chile, Chinese Taipei, the Netherlands and Macao-China having a smaller difference. The largest difference among OECD countries was a 57-point difference in Greece, while the largest among the non-OECD countries included in the comparison group was a 58-point difference in Bulgaria (see Appendix C2).

Higher attainment in reading of females is a common pattern in National Curriculum tests in England, and is also found in other international surveys such as the Progress in International Reading and Literacy Study (PIRLS). The PISA results confirm these findings. However, it is encouraging that the difference in England, while significant, is less than that in many other countries. This may reflect the concern which has been felt about this gender gap and the measures which have been taken to improve the reading proficiency of males.

5.5 Summary

England's performance in reading was not significantly different from the OECD average. England had a relatively large difference between the score points of the lowest-scoring students and the highest-scoring students compared with other countries. However, the proportion of students at each level of achievement was, as with the mean score, similar to the OECD average.

Females scored significantly higher than males, which was the case in every country which participated in the PISA study. However, this gender difference, while statistically significant, was not as large as that in the majority of other countries.

6 Science in England: students and schools

6.1 Introduction

This chapter reports on some preliminary explorations of responses to the school and student questionnaires. The main aim is to give a general overview of some of the main areas of responses, focusing only on frequencies. It is hoped that this may give rise to suggestions for areas which would repay deeper analysis and investigation.

The questionnaire completed by students asked a number of attitudinal questions aimed at capturing their views on science in terms of their values, scientific self-beliefs, motivations, orientation towards a science-related career and on the subject of environmental issues. The school questionnaire collected information on topics related to provision for science education.

The assessments and questionnaires used in the study aimed to be internationally equivalent. However, the attitudinal items are expected to be particularly liable to distortion because of the cultural, language and contextual differences between nations. International comparisons on attitudinal items therefore need to be made with caution. In this chapter, where OECD average figures are quoted, this is because they differed from the average response of students in England by five per cent or more. This difference is not necessarily significant statistically, but may indicate areas in which England differs from its OECD partners.

It should be noted that data based on students' self-reports may be affected by an impetus to give what they perceive as a socially desirable response, although there is no evidence that this was the case with the PISA questionnaire and any possible effect cannot be quantified.

6.2 The value of science

The student questionnaire asked students to what extent they agreed with a number of statements relating to the value of science to society and to them as individuals.

The percentage of students in England agreeing or agreeing strongly that science is valuable generally

- 94% of students agreed that science is important for helping us to understand the natural world.
- 90% of students agreed that advances in science and technology usually improve people's living conditions.
- 84% of students agreed that science is valuable to society.

- 82% of students agreed that advances in science and technology usually help improve the economy. *The OECD average is 87%*.
- 64% of students agreed that advances in science and technology usually bring social benefits. *The OECD average is 75%*.

The percentage of students in England agreeing or agreeing strongly that science is valuable personally

- 79% of students agreed that they find that science helps them to understand the things around them.
- 63% of students agreed that some concepts in science help them see how they relate to other people.
- 62% of students agreed that they will use science in many ways when they are adults.
- 61% of students agreed that when they leave school there will be many opportunities for them to use science.
- 55% of students agreed that science is very relevant to them.

In general, students considered science as something which helps people to understand the world, improves living conditions and the economy and is of value to society. However, this appears to be contradicted to some extent by the relatively low agreement that advances lead to social benefits. It is also clear that while students generally agree that science is of value to society, they are less convinced of its personal value to them.

6.3 Science self-belief

The student questionnaire contained questions intended to measure students' belief in their own abilities. These questions were in two sections, the first asking students how confident they were about their ability to perform specific tasks (self-efficacy), and the second asking more general questions about science learning (self-concept).

6.3.1 Students' self-efficacy

Students in England reported that they could do the following tasks on their own easily or with a bit of effort:

- 80% could recognise the science question that underlies a newspaper report on a health issue. *The OECD average is 73%.*
- 78% could predict how changes to an environment will affect the survival of certain species. *The OECD average is 64%*.
- 77% could explain why earthquakes occur more frequently in some areas than in others.
- 70% could interpret the scientific information provided on the labelling of food items. *The OECD average is 64%.*

- 67% could identify the science question associated with the disposal of rubbish. *The OECD average is 62%.*
- 62% could identify the better of two explanations for the formation of acid rain.
- 61% could describe the role of antibiotics in the treatment of disease.
- 53% could discuss how new evidence can lead you to change your understanding about the possibility of life on Mars.

In general the majority of students were confident that they could do a variety of tasks related to science learning either easily or with a bit of effort. This confidence was either similar to or more than that of students in other OECD countries.

6.3.2 Students' self-concept

Scientific self-concept of students in England

- 72% agreed that they can usually give good answers to test questions on science topics. *The OECD average is 65%.*
- 64% agreed that when they are being taught science, they can understand the concepts very well. *The OECD average is 59%.*
- 64% agreed that they can easily understand new ideas in science. *The OECD average is 55%.*
- 54% agreed that they learn science topics quickly.
- 45% agreed that learning advanced science topics would be easy for them.
- 44% agreed that science topics are easy for them.

Students showed less confidence in their general learning abilities than they did in their ability to tackle specific tasks. They reported more confidence in their ability to answer test questions and in their understanding of science than students in other OECD countries. However, less than half reported that learning science is easy, and this was similar to the OECD average. The contrast between self-efficacy as measured by the questions reported in Section 6.3.1 above and self-concept in this group of questions appears to be the case in many other OECD countries.

6.4 Motivation and engagement

There were various groups of questions which can be categorised as measuring students' motivation to learn science and their engagement in learning. These ranged from questions dealing with interest and enjoyment to those which explored more instrumental motivation.

6.4.1 Enjoyment of science

Students' enjoyment of science

- 69% of students said that they enjoy acquiring new knowledge in science.
- 67% of students said that they are interested in learning about science.
- 55% of students said that they generally have fun when they are learning science topics. *The OECD average is 63%*.
- 54% of students said that they are happy doing science problems. *The OECD average is 43%.*
- 38% of students said that they like reading about science. *The OECD average is 50%.*

Responses to these questions reveal a different pattern in England to the OECD average. While students were in general similar in their attitude to learning science, and more positive in their enjoyment of doing science problems, they appear to be more negative about enjoyment of science for its own sake. They find science less fun and report less enjoyment of reading about it, compared with the average response in other OECD countries.

6.4.2 Interest in science

Students' interest in science topics

- 77% of students expressed medium or high interest in learning about human biology. *The OECD average is 68%.*
- 56% of students expressed medium or high interest in learning about chemistry. *The OECD average is 50%.*
- 52% of students expressed medium or high interest in learning about physics.
- 50% of students expressed medium or high interest in learning about astronomy.
- 47% of students expressed medium or high interest in learning about the biology of plants.
- 40% of students expressed medium or high interest in learning about the way scientists design experiments. *The OECD average is 46%.*
- 35% of students expressed medium or high interest in learning about geology. *The OECD average is 41%.*
- 35% of students expressed medium or high interest in learning about what is required for scientific explanations.

Human biology was the subject in which students in England expressed most interest, more than the average proportion of students across OECD countries. The proportion of students expressing *high* interest in learning about human biology was 34 per cent; no other subject had more than 18 per cent of students expressing high interest in it.

The level of interest shown by students in England for other subjects was lower, and more similar to the OECD average.

6.4.3 Participation in science-related activities

Science-related activities that students in England do very often, regularly or sometimes

- 57% watch TV programmes about science.
- 56% visit websites about science topics.
- 36% borrow or buy books on science topics.
- 33% read science magazines or science articles in newspapers.
- 18% listen to radio programmes about advances in science.
- 10% attend a science club.

The OECD average is not available for these combined categories.

The question about science activities on the student questionnaire did not specify whether students should respond about activities at school or outside school, so their responses can be assumed to cover both settings.

The science-related activities that students in England were most likely to do at least sometimes were watching TV programmes or visiting websites about science, with just over half doing this. Apart from this, they did not appear to spend a lot of time involved in science activities. Of the activities presented, students were least likely to report attending science clubs.

6.4.4 Importance of school subjects and students' instrumental motivation to learn science

The student questionnaire asked students how important they thought it was to do well in science, English and mathematics. For science, as well as its importance, students were asked what they would gain from studying science.

How important students in England think it is to do well in science, mathematics and English

- 96% of students said it was important or very important to do well in mathematics. *The OECD average is 91%.*
- 95% of students said it was important or very important to do well in English. *The OECD average (for the language of education) is 89%.*
- 84% of students said it was important or very important to do well in science. *The OECD average is 73%.*

Students' levels of instrumental motivation

- 75% agreed that they study science because they know it is useful for them. *The OECD average is 67%.*
- 71% agreed that making an effort in science subject(s) is worth it because this will help them in the work they want to do later on. *The OECD average is 63%.*
- 71% agreed that studying science subject(s) is worthwhile for them because what they learn will improve their career prospects. *The OECD average is 62%*.
- 65% agreed that they will learn many things in their science subject(s) that will help them get a job. *The OECD average is 56%.*
- 54% agreed that what they learn in their science subject(s) is important for them because they need this for what they want to study later on.

Students were on average more likely to be positive about the importance of learning maths and English than they were about science. Nevertheless, a large percentage did report that learning science was important – 84 per cent compared with an OECD average of 73 per cent. They were in fact generally inclined to be more positive in their ratings of the importance of doing well than students in other OECD countries. They were also more positive in their ratings of the importance of studying science for their future lives.

6.4.5 Interest in science-related careers

The first of a series of questions about science-related careers examined students' future motivation to pursue science-related careers.

Intentions of students in England to pursue scientific careers

- 34% agreed that they would like to work in a career involving science.
- 33% agreed that they would like to study science after secondary school.
- 19% agreed that they would like to work on science projects as an adult. *The OECD average is 27%.*
- 13% agreed that they would like to spend their life doing advanced science. *The OECD average is 21%.*

While many students in England acknowledge that studying science is useful for their futures, fewer report a desire to work in science-related careers or to study science. It seems that although students agree that science is useful and beneficial, the majority to not wish to be involved with it in their future lives. This contrast is similar to that discussed earlier – i.e. that students may be more convinced of the general value of science than they are of its value for them personally.

6.5 Science in schools

Questions on both the school and the student questionnaire covered various aspects of science learning, science facilities and science activities in schools.

6.5.1 Science-related activities provided by schools

In the school questionnaire, headteachers were asked about the activities that their schools provided for fifteen-year-old students to engage with science, and in particular, environmental issues.

Schools in England promote engagement with science for 15-year-olds with the following activities

- 85% have excursions and field trips.
- 75% have science clubs. *The OECD average is 39%.*
- 67% have science competitions. *The OECD average is 53%.*
- 59% have extracurricular science projects (including research). *The OECD average is 45%.*
- 32% have science fairs.

Schools provide opportunities for 15-year-olds to learn about environmental topics with the following activities

- 87% have field trips. *The OECD average is 77%*.
- 68% have trips to science and/or technology centres.
- 67% have trips to museums. *The OECD average is 75%*.
- 56% have lectures and/or seminars (e.g. guest speakers).
- 52% have extracurricular environmental projects (including research). *The OECD average is 45%.*

As reported earlier in Section 6.4.3, few students reported attending science clubs. However, this would appear not to be because of a lack of provision since three-quarters of schools reported that they have them. In fact, for some science activities a greater proportion of schools reported provision of opportunities for 15-year-olds to engage with science and environmental topics than the OECD average. This was the case for science clubs, science competitions, extracurricular projects and field trips.

6.5.2 School preparation for science-related careers

Students were asked how well they felt their schools equipped them with basic science-related skills and knowledge.

Preparation of schools in England for students to pursue science-related careers

- 92% of students agreed that the subjects available at their school provide students with the basic skills and knowledge for a science-related career. *The OECD average is 83%*.
- 87% of students agreed that the science subjects at their school provide students with the basic skills and knowledge for many different careers. *The OECD average is 80%*.
- 84% of students agreed that their teachers equip them with the basic skills and knowledge they need for a science-related career. *The OECD average is 73%*.
- 77% of students agreed that the subjects they study provide them with the basic skills and knowledge for a science-related career. *The OECD average is 71%*.

Again, as with science activities, these responses indicate a contrast between what is available and the extent to which students see this availability as personally relevant. Students were very positive about the extent to which their schools prepare them for science-related careers. This contrasts with the low numbers of students stating that they wish to follow such careers or to continue to study science which were reported in Section 6.4.5.

6.5.3 Student information about science-related careers

Students were also asked about their knowledge of the routes available into science-based careers.

Information in England about the routes into science-related careers

- 53% of students felt very or fairly well informed about where to find information about science-related careers.
- 49% of students felt very or fairly well informed about the steps students need to take if they want a science-related career.
- 47% of students felt very or fairly well informed about science-related careers that are available in the job market.
- 36% of students felt very or fairly well informed about employers or companies that recruit people to work in science-related careers.

In contrast to the responses reported in Section 6.5.2 above, which showed that students felt their schools equip them with the skills needed for careers in science, students did not feel they were very well informed about such careers.

6.5.4 Hindrances to learning

In the school questionnaire, headteachers were asked about shortages of teachers of mathematics, science and English. They were also asked more specifically about recruitment of science teachers. Finally, they were asked if instruction was hindered by shortages of resources.

Headteachers in England reporting that instruction is hindered to some extent or a lot by a lack of qualified teachers

- 27% identified a lack of qualified mathematics teachers as a hindrance.
- 18% identified a lack of qualified science teachers as a hindrance.
- 12% identified a lack of qualified English teachers as a hindrance.
- 22% identified a lack of qualified teachers of other subjects as a hindrance.

Headteachers' experience of science teacher vacancies in England in the last academic year

- 17% had no vacant science teaching positions to be filled. *The OECD average is 38%.*
- 74% filled all vacant science teaching positions, either with newly appointed staff or by reassigning existing staff. *The OECD average is 59%.*
- 9% could not fill one or more vacant science teaching positions. *The OECD average is 3%.*

Headteachers in England reporting that instruction is hindered to some extent or a lot by a shortage of educational resources

- 37% identified a shortage or inadequacy of computers for instruction.
- 28% identified a shortage or inadequacy of science laboratory equipment. *The OECD average is 42%.*
- 25% identified a shortage or inadequacy of computer software. *The OECD average is 38%.*
- 23% identified a shortage or inadequacy of library materials. *The OECD average is 34%.*
- 23% identified a shortage or inadequacy of audio-visual resources. *The OECD average is 37%.*
- 20% identified a shortage or inadequacy of instructional materials. *The OECD average is 25%.*
- 19% identified a lack or inadequacy of internet connectivity.

The subject that was most commonly reported as affected by staff shortages was mathematics. As far as science teaching is concerned, 18 per cent reported that a shortage of teachers was a hindrance to learning, and this was similar to the OECD average. However, both the number of science vacancies and the number left unfilled were higher than the OECD average.

Schools in England reported fewer shortages or inadequacies of educational resources than the OECD average, with the exception of computers for instruction and internet connectivity which were similar to the average.

6.6 Students' attitudes towards and understanding of environmental issues

6.6.1 Knowledge of environmental issues

The student questionnaire contained a number of questions aimed at investigating their awareness, attitudes and understanding of environmental issues.

Students in England reporting that their knowledge of a subject was great enough that they could explain the general issue or explain it well

- 75% said that they could give an explanation of the consequences of clearing forests for other land use.
- 72% said that they could give an explanation of the increase of greenhouse gases in the atmosphere. *The OECD average is 58%.*
- 72% said that they could give an explanation of acid rain. *The OECD average is 60%.*
- 59% said that they could give an explanation of nuclear waste. *The OECD average is 53%.*
- 37% said that they could give an explanation of the use of genetically modified organisms (GMOs).

While approximately three-quarters of students said they could explain the first three issues, they were much less confident in their knowledge of nuclear waste and GMOs. They were more confident than the OECD average on three of these five issues.

6.6.2 Concern for environmental issues

Students were asked if a number of issues were a serious concern for them.

Students in England reporting that environmental issues were a serious concern for them personally

- 56% said air pollution was a serious concern for them.
- 52% said water shortages were a serious concern for them.
- 51% said energy shortages were a serious concern for them.
- 39% said extinction of plants and animals was a serious concern for them.
- 36% said clearing of forests for other land use was a serious concern for them.
- 34% said nuclear waste was a serious concern for them.

The OECD average is not available.

More than half of the students reported that air pollution, water shortages or energy shortages were a serious concern for them personally. Students reported less concern about the extinction of plants and animals, clearing of forests and nuclear waste.

6.6.3 Optimism about the future of the environment

Students were asked whether they thought the problems associated with a number of environmental issues would improve, stay the same or worsen over the next 20 years.

Students' optimism in England that problems associated with environmental issues will improve over the next 20 years

- 21% thought problems with water shortages will improve.
- 18% thought problems with energy shortages will improve.
- 17% thought problems with air pollution will improve.
- 13% thought problems with clearing of forests for other land use will improve.
- 12% thought problems with extinction of plants and animals will improve.
- 12% thought problems with nuclear waste will improve.

English students, similar to students in other OECD countries, were not optimistic that problems associated with environmental issues would improve over the next 20 years. In fact, they appear very pessimistic about this. However, this does contrast to some extent with their responses about issues which personally concern them which were reported in Section 6.6.2 above. For example, although 88 per cent did not think that problems with nuclear waste will improve, only 34 per cent said that nuclear waste was an important issue for them. So, it may be that students do not necessarily think that it is a problem if these things do not improve.

6.6.4 Students' concern for sustainable development

Students were asked about practical changes that could be implemented with the aim of addressing some of the problems associated with environmental issues.

Students in England indicating a concern for sustainable development

- 92% agreed that it is important to carry out regular checks on the emissions from cars as a condition of their use.
- 90% agreed that industries should be required to prove that they safely dispose of dangerous waste materials.
- 89% agreed that they were in favour of having laws that protect the habitats of endangered species.
- 83% agreed that to reduce waste, the use of plastic packaging should be kept to a minimum.

- 82% agreed that electricity should be produced from renewable sources as much as possible, even if this increases the cost.
- 58% agreed that it disturbs them when energy is wasted through the unnecessary use of electrical appliances.
- 56% agreed that they were in favour of having laws that regulate factory emissions even if this would increase the price of products. *The OECD average is 69%*.

Students in England showed strong support for measures to promote sustainable development. However, there are again signs that their personal involvement may on average be less developed than their knowledge and awareness of what would be good for the environment. So, for example, only 58 per cent reported feeling disturbed when they saw electricity being wasted, in contrast to the 82 per cent who thought electricity should be produced from renewable resources. A high proportion agreed that emissions from cars should be controlled, but only 56 per cent would be in favour of controlling emissions from factories if this resulted in an increase in prices.

6.7 Summary

Students in England see science as valuable to society for understanding the world and improving living conditions. However, they see science as less valuable personally than it is to society, but acknowledge that it is important for them to do well in science.

Students are confident that they can do a variety of tasks related to science learning easily or with a bit of effort. They enjoy learning about science and think they do it relatively well, but feel learning and understanding science is not easy. On the whole, they do not think it is fun and outside of activities directly connected with their learning at school, generally do not participate in science-related activities.

On environmental issues, students in England report that they feel well informed, they are generally concerned (and pessimistic) about problems associated with environmental issues and they agree with measures to encourage sustainable development. However, there are some doubts about the extent to which they feel personally involved in these problems and willing to make sacrifices to help conquer them.

Schools in England report slightly higher science teacher shortages than the average in OECD countries, but fewer shortages or inadequacies of educational resources.

This chapter gives a summary of only some of the responses to the student and school questionnaires. There is an extensive amount of data available from these two instruments which has the potential to provide a rich picture of students in England, their schools and their science learning. The general account given in this chapter could be usefully extended by further exploration of the data, particularly if this explored relationships between responses, matching of student and school questionnaire data, and connections with attainment.

7 PISA in the United Kingdom

7.1 Introduction

This chapter describes some of the main outcomes of the PISA survey in England, Wales, Northern Ireland and Scotland. In particular, it outlines some aspects where there were differences in attainment, in the range of attainment, in the pattern of gender differences or in students' attitudes to science.

7.2 Student achievement in science

This section compares the findings outlined in Chapter 3 with the comparable findings for the other parts of the UK.

7.2.1 Mean scores in science

Table 7.2.1 summarises the mean scores for each of England, Wales, Northern Ireland and Scotland on the science achievement scale. Performance was relatively consistent across the UK, with few significant differences in terms of overall achievement. The one exception was that England's mean score was significantly higher than that of Wales.

Table 7.2.1 Mean scores for science overall

	Mean	England	Northern Ireland	Scotland	Wales
England	516	–	NS	NS	▲
Northern Ireland	508	NS	–	NS	NS
Scotland	515	NS	NS	–	NS
Wales	505	▼	NS	NS	–

▲ = *significantly higher* ▼ = *significantly lower* *NS = no significant difference*

On the three competency sub-scales also, few differences emerged. There were no significant differences between the countries in terms of scores on the *Explaining phenomena scientifically* scale, indicating that students across the UK are fairly well matched in terms of skills such as applying their knowledge of science in given situations, describing or interpreting phenomena scientifically and predicting changes. The same was true in most cases for *Identifying scientific issues* and *Using scientific evidence*. Exceptions were that both England and Scotland scored significantly higher than Wales on *Identifying scientific issues* (which includes skills such as recognising issues that can be investigated scientifically, and recognising the key features of a scientific investigation), while Scotland also scored significantly higher than Wales on *Using scientific evidence* (skills such as interpreting scientific evidence, making and communicating conclusions, identifying assumptions, evidence and reasoning behind conclusions, and reflecting on the societal implications of science and technological developments). Tables 7.2.2 to 7.2.4 summarise these findings.

Table 7.2.2 Mean scores on the *Explaining phenomena scientifically* scale

	Mean	England	Northern Ireland	Scotland	Wales
England	518	–	NS	NS	NS
Northern Ireland	510	NS	–	NS	NS
Scotland	508	NS	NS	–	NS
Wales	508	NS	NS	NS	–

▲ = *significantly higher* ▼ = *significantly lower* *NS = no significant difference*

Table 7.2.3 Mean scores on the *Identifying scientific issues* scale

	Mean	England	Northern Ireland	Scotland	Wales
England	515	–	NS	NS	▲
Northern Ireland	504	NS	–	NS	NS
Scotland	516	NS	NS	–	▲
Wales	500	▼	NS	▼	–

▲ = *significantly higher* ▼ = *significantly lower* *NS = no significant difference*

Table 7.2.4 Mean scores on the *Using scientific evidence* scale

	Mean	England	Northern Ireland	Scotland	Wales
England	514	–	NS	NS	NS
Northern Ireland	508	NS	–	NS	NS
Scotland	521	NS	NS	–	▲
Wales	504	NS	NS	▼	–

▲ = *significantly higher* ▼ = *significantly lower* *NS = no significant difference*

7.2.2 Distribution of performance in science

Chapter 3 showed that there was some degree of variation around the mean score for science in all countries, as would be expected. In the case of the UK countries, this variation was pronounced.

The difference between the OECD mean score at the 5th percentile and the OECD mean score at the 95th percentile was 311 scale points, with the comparable differences for all participating countries ranging from 257 to 367 scale points. The highest difference of 367 was found in Northern Ireland, although all four parts of the UK had a wide distribution compared with other PISA countries. The mean scores at the 5th and the 95th percentile and the differences between them are shown in Table 7.2.5 below.

Table 7.2.5 Scores of highest- and lowest-achieving students in science

	Lowest (5th percentile)	Highest (95th percentile)	Difference
England	336	686	350
Northern Ireland	320	686	367
Scotland	350	679	330
Wales	339	673	334
OECD average	*340*	*652*	*311*

Note: differences may appear not to correspond to mean scores because of rounding.

Table 7.2.5 shows that the lowest-achieving students in Scotland performed a little better than the lowest-achieving students elsewhere in the UK (a mean score of 350 at the 5th percentile), while it was the students in England and Northern Ireland who did best at the top end of the achievement scale (mean scores of 686 each at the 95th percentile). The score differences at these percentile points were small, however, and may not be significant.

Full information on the distribution of performance is in Appendices A2 and A10.

7.2.3 Percentages at each level in science

The range of achievement in each country is further emphasised by the percentages of students at each of the six PISA proficiency levels set out in Chapter 3. These percentages are summarised in Tables 7.2.6 and 7.2.7. They show that all parts of the UK have some students at the top and bottom of the achievement range, but that the percentages vary in each case. Northern Ireland has the most students below level 1, and more than the OECD average, while the other countries have fewer than, or the same as, the OECD average at this level. At the other end of the scale, England and Northern Ireland have the most students at PISA level 6 and Wales and Scotland have the fewest, but all have more than the OECD average. At the top two levels, all parts of the UK are above the OECD average. Wales has the fewest students at these two levels, with 11 per cent compared with 14 per cent in England and Northern Ireland and 13 per cent in Scotland.

Full information on the percentages at each level are in Appendices A11 and A12.

Table 7.2.6 Percentages at PISA science levels

	below level 1 %	levels 1–6 %	levels 2–6 %	levels 3–6 %	levels 4–6 %	levels 5–6 %	level 6 %
England	5	95	83	62	36	14	3
Northern Ireland	7	93	80	59	35	14	3
Scotland	4	96	85	61	33	13	2
Wales	5	95	82	58	31	11	2
OECD average	*5*	*95*	*81*	*57*	*29*	*9*	*1*

Table 7.2.7 Percentages at or below each PISA science level

	below level 1 %	level 1 and below %	level 2 and below %	level 3 and below %	level 4 and below %	level 5 and below %	level 6 and below %
England	5	17	38	64	86	97	100
Northern Ireland	7	20	41	65	86	97	100
Scotland	4	15	39	67	87	98	100
Wales	5	18	42	69	89	98	100
OECD average	*5*	*19*	*43*	*71*	*91*	*99*	*100*

7.2.4 Gender differences in science

There were differences between the regions, in terms of the achievement of males and females. Table 7.2.8 shows the mean scores for each country and highlights differences which were statistically significant.

Table 7.2.8 Mean scores of males and females in science

	Overall mean score	Mean score of males	Mean score of females	Difference
England	516	521	510	11*
Northern Ireland	508	509	507	2
Scotland	515	517	512	4
Wales	505	510	500	10*
OECD average	*500*	*501*	*499*	*2**

** statistically significant difference*

In just over a third of the 57 countries participating in PISA, one gender performed better than the other. The direction of those differences was split, with nine countries where males did better and 12 where females did so. The OECD average showed a slight advantage for males and this was mirrored in England and Wales, where males significantly outperformed females. There were no statistically significant gender differences on the overall science scale in Northern Ireland or Scotland.

In both Wales and England, the largest gender difference was due to differential performance on the *Explaining phenomena scientifically* scale. This was also true for most participating countries: typically, males outperformed females on this scale. In both Wales and England, there were no significant gender differences on the other competency scales.

Northern Ireland had no significant gender differences on any of the three competencies, while Scotland had differences on two competencies, despite having no overall difference. This was probably because the two differences cancelled each other out overall in Scotland: males did better at *Explaining phenomena scientifically* while females did better at *Identifying scientific issues*. Table 7.2.9 summarises differences on these scales for each country.

Table 7.2.9 Mean scores of males and females in the science competencies

	Identifying scientific issues				Explaining phenomena scientifically				Using scientific evidence			
	all	males	females	diff.	*all*	males	females	diff.	*all*	males	females	diff.
England	*515*	512	518	6	*518*	529	507	22*	*514*	517	510	7
Northern Ireland	*504*	496	512	16	*510*	517	502	15	*508*	507	509	2
Scotland	*516*	509	523	15*	*508*	516	501	15*	*521*	523	520	3
Wales	*500*	497	504	7	*508*	519	498	21*	*504*	507	501	6
OECD average	*499*	490	508	17*	*500*	508	493	15*	*499*	498	501	3*

** statistically significant difference*

7.2.5 Summary

This section has reviewed performance across the UK in science. It shows that overall performance is similar in each country, with only one significant difference: that England scored higher than Wales. Students in all countries were comparable in their ability in *Explaining phenomena scientifically*, but the mean score of students in Wales was lower for *Identifying scientific issues* and *Using scientific evidence*.

There was a large difference in the achievement of the highest-attaining and the lowest-attaining students in all parts of the UK, with the largest difference found in Northern Ireland. It was in Northern Ireland also that the highest proportion of lower-attaining students was found. Wales had a similar number of low-attaining students to England, but fewer high-attaining students.

Gender differences varied. Northern Ireland had no significant gender differences at all, while Scotland had differences on two competency scales but no overall difference. England and Wales had overall differences, mostly explained by the better performance of males in *Explaining phenomena scientifically*.

7.3 Student achievement in mathematics

Mathematics was a minor domain in the PISA 2006 survey. This means that not all students were assessed in this subject, and that the mathematics questions did not cover the subject as fully as in science which was the major domain. The results reported for mathematics are estimates for the whole population, based on the performance of students who were presented with mathematics test items. These estimates take into account information about how students with specific characteristics performed. The scores reported in this section therefore give a ‘snapshot’ of performance in mathematics rather than the fuller more rigorous assessment which is available for science (see OECD (2005a) for full details of the analysis of the minor domains in PISA).

7.3.1 Mean scores in mathematics

Table 7.3.1 below shows the mean scores of England, Wales, Northern Ireland and Scotland for mathematics, along with the significance of differences between the countries. Full data can be found in Appendix B2.

Table 7.3.1 Mean scores for mathematics

	Mean	England	Northern Ireland	Scotland	Wales
England	495	-	NS	NS	▲
Northern Ireland	494	NS	-	▼	NS
Scotland	506	NS	▲	-	▲
Wales	484	▼	NS	▼	-

▲ = *significantly higher* ▼ = *significantly lower* *NS = no significant difference*

The highest attainment for mathematics was in Scotland, followed by England and Northern Ireland. The mean score for Northern Ireland was significantly lower than that for Scotland. The lowest attainment was in Wales, and the mean score for Wales was significantly lower than that for Scotland and England.

7.3.2 Distribution of performance in mathematics

Table 7.3.2 shows the scores of students in each country in the 5th and the 95th percentiles of achievement, along with the OECD average score in each of those percentiles. This shows the range of scores in each country. The table also shows the number of score points difference between the two figures. Full data can be found in Appendices B2 and B3.

Table 7.3.2 Scores of highest- and lowest-achieving students in mathematics

	Lowest (5th percentile)	Highest (95th percentile)	Difference*
England	350	643	293
Northern Ireland	341	647	306
Scotland	367	647	279
Wales	351	621	270
OECD average	*346*	*645*	*300*

** may be affected by rounding up or down*

Table 7.3.2 shows that the lowest-achieving students were in Northern Ireland where the scores at the 5th percentile were slightly lower than the OECD average. England and Wales had similar scores and they were slightly higher than the OECD average. Scotland had the highest scores at the 5th percentile in the UK.

The greatest proportions of the highest-achieving students were in Northern Ireland and Scotland where the scores at the 95th percentile were the same. This was followed by England. The lowest were in Wales, where the score of students in the 95th percentile was

26 points lower than that in Northern Ireland and Scotland, and 22 points lower than England.

Looking at the range of performance, as shown by the number of score points difference between the highest and lowest achievers, the largest gap was in Northern Ireland and the smallest in Wales.

This range can perhaps be appreciated more clearly by examination of the distribution graph in Appendix B3.

7.3.3 Percentages at each mathematics level

Tables 7.3.3 and 7.3.4 show the percentages of students at each of the six levels of mathematics attainment, along with the percentages below level 1.

Scotland has the lowest percentage at the lower levels of attainment but the proportions at the highest levels are similar in England, Northern Ireland and Scotland, with all three close to the OECD mean. Wales has the lowest proportion at the higher levels, with only 23 percent at the highest three levels compared with 32 per cent in Scotland.

Full data can be found in Appendices B5 and B6.

Table 7.3.3 Percentages at PISA mathematics levels

	below level 1 %	levels 1-6 %	levels 2-6 %	levels 3-6 %	levels 4-6 %	levels 5-6 %	level 6 %
England	6	94	80	55	29	11	2
Northern Ireland	7	93	77	54	31	12	3
Scotland	4	96	84	60	32	12	3
Wales	6	94	78	51	23	7	1
OECD average	*8*	*92*	*79*	*57*	*32*	*13*	*3*

Table 7.3.4 Percentages at and below each PISA mathematics level

	below level 1 %	level 1 and below %	level 2 and below %	level 3 and below %	level 4 and below %	level 5 and below %	level 6 and below %
England	6	20	45	71	89	98	100
Northern Ireland	7	23	46	69	88	97	100
Scotland	4	16	40	68	88	97	100
Wales	6	22	49	76	93	99	100
OECD average	*8*	*21*	*43*	*68*	*87*	*97*	*100*

7.3.4 Gender differences in mathematics

Table 7.3.5 shows the mean scores of males and females, and the differences in their mean scores. Full data can be found in Appendix B2.

Table 7.3.5 Mean scores of males and females for mathematics

	Overall mean score	Mean score of males	Mean score of females	Difference
England	495	504	487	17*
Northern Ireland	494	497	491	7
Scotland	506	514	498	16*
Wales	484	492	476	16*
OECD average	*498*	*503*	*492*	*11**

** statistically significant difference*

The differences between males and females were statistically significant in England, Scotland and Wales but not in Northern Ireland. The difference in score points between males and females was similar in England, Scotland and Wales and this was above the OECD average.

In the UK, Northern Ireland stood out as having a relatively small difference between males and females. It was the sixteenth lowest in gender difference out of the 44 comparison countries. The gender gap in England, Wales and Scotland was high in the international comparison. Within the 44 comparison countries, England had one of the largest gender differences, just after Austria, Japan and Germany. There were only five countries with a larger gender difference than Wales and Scotland.

7.4 Student achievement in reading

Reading was a minor domain in the PISA 2006 survey. This means that not all students were assessed in this subject, and that the reading questions did not cover the subject as fully as in science which was the major domain. The results reported for reading are estimates for the whole population, based on the performance of students who were presented with reading test items. These estimates take into account information about how students with specific characteristics performed. The scores reported in this chapter therefore give a 'snapshot' of performance in reading rather than the fuller more rigorous assessment which is available for science (see OECD (2005a) for full details of the analysis of minor domains in PISA).

7.4.1 Mean scores for reading

Table 7.4.1 below shows the mean scores of England, Wales, Northern Ireland and Scotland for reading, along with the significances of differences between the countries. Full data can be found in Appendix C2.

Table 7.4.1 Mean scores for reading

	Mean	England	Northern Ireland	Scotland	Wales
England	496	-	NS	NS	▲
Northern Ireland	495	NS	-	NS	▲
Scotland	499	NS	NS	-	▲
Wales	481	▼	▼	▼	-

▲ = *significantly higher* ▼ = *significantly lower* *NS = no significant difference*

The highest attainment for reading was in Scotland, followed by England and Northern Ireland. However, the differences between these three countries were not significant. The lowest attainment was in Wales, and the mean score for Wales was significantly lower than the other three parts of the UK.

7.4.2 Distribution of performance in reading

Table 7.4.2 shows the scores of students in each country in the 5th and the 95th percentiles of achievement, along with the OECD average score in each of those percentiles. This shows the range of scores in each country. The table also shows the number of score points difference between the two figures. Full data can be found in Appendix C2.

Table 7.4.2 Scores of highest- and lowest-achieving students in reading

	Lowest (5th percentile)	Highest (95th percentile)	Difference
England	317	654	337
Northern Ireland	311	659	348
Scotland	334	650	316
Wales	312	635	323
OECD average	*317*	*642*	*324*

Table 7.4.2 shows that there were more low-achieving students in Wales and Northern Ireland, where the scores at the 5th percentile were similar. In England, the score was slightly higher and was the same as the OECD average. Scotland has less of a tail of achievement than the other parts of the UK, with the least highly attaining students nevertheless achieving higher scores than those in England, Wales and Northern Ireland.

The largest proportion of high-achieving students was in Northern Ireland, followed by England and Scotland. The lowest proportion was in Wales, where the score of students in the 95th percentile was 15 points lower than that in Scotland, 19 points lower than England and 24 points lower than Northern Ireland.

Looking at the range of performance, as shown by the number of score points difference between the highest and lowest achievers, the largest gap was in Northern Ireland and the smallest in Scotland.

This range can perhaps be appreciated more clearly by examination of the distribution graph in Appendix C3.

7.4.3 Percentages at each reading level

Tables 7.4.3 and 7.4.4 show the percentages of students at each of the five PISA levels of reading attainment, along with the percentages below level 1.

The information in Tables 7.4.3 and 7.4.4 adds to that discussed in the preceding section, and again shows that the widest spread of achievement was in Northern Ireland which had a slightly higher proportion than England and Scotland at the top two levels, but also a higher proportion below level 1. Scotland has the lowest percentage at level 1 or below, while Wales has the lowest at the highest two levels.

Full data can be found in Appendix C6.

Table 7.4.3 Percentages at reading levels

	below level 1 %	levels 1-5 %	levels 2-5 %	levels 3-5 %	levels 4-5 %	level 5 %
England	7	93	81	59	30	9
Northern Ireland	8	92	79	57	32	10
Scotland	5	95	83	60	29	8
Wales	8	92	78	51	24	6
OECD average	*7*	*93*	*80*	*57*	*29*	*9*

Table 7.4.4 Percentages at and below each reading level

	below level 1 %	level 1 and below %	level 2 and below %	level 3 and below %	level 4 and below %	level 5 and below %
England	7	19	41	70	91	100
Northern Ireland	8	21	43	68	90	100
Scotland	5	17	40	71	92	100
Wales	8	22	49	76	94	100
OECD average	*7*	*20*	*43*	*71*	*91*	*100*

7.4.4 Gender differences in reading

Table 7.4.5 shows the mean scores of males and females, and the difference in their mean scores. Full data can be found in Appendix C2.

Table 7.4.5 Mean scores of males and females for reading

	Overall mean score	Mean score of males	Mean score of females	Difference
England	496	481	510	29*
Northern Ireland	495	479	512	33*
Scotland	499	486	512	26*
Wales	481	465	496	31*
OECD average	*492*	*473*	*511*	*38**

** statistically significant difference*

In all cases, females had higher mean scores and the differences were statistically significant. This was in fact the case in every country in the PISA survey. The differences in each part of the UK were of a similar size.

7.5 Attitudes to science

Students in England, Northern Ireland, Scotland and Wales gave similar responses to many of the attitudinal questions on the student questionnaire which are discussed in more detail in Chapter 6 of this report. In particular, there was little variance across their evaluations of: the value of science for society and for them personally; how well they thought they learnt and understood science; how important they thought it was to do well in science, mathematics and English or Welsh; the extent to which studying science is worthwhile; and their intentions to pursue scientific careers. On environmental topics students across the UK were similar in their personal concern for environmental issues, their optimism or otherwise about improvements in environmental problems and their support for steps towards sustainable development.

There were, however, some aspects where there were differences in responses. Table 7.5.1 shows the variables where there was a marked difference in the percentage of students agreeing or strongly agreeing. These are organised in three categories: students' confidence in their abilities, variables relating to interest in or enjoyment of science, and aspects relating to science careers.

As can be seen from table 7.5.1, where there are differences they are most often seen in Scotland, where there are lower levels of agreement on several variables. Exceptions to this pattern are that students in Northern Ireland were the least confident in explaining the use of genetically modified organisms (GMOs) and discussing life on Mars, although students in Scotland were also less confident on the latter than those in Wales and England. Students in Northern Ireland also expressed the lowest happiness about doing science problems. On aspects relating to careers, students in Scotland expressed the highest level of agreement that science at school prepared them for careers, while those in England appeared to be the least well informed about careers in science.

Table 7.5.1 Attitudinal variables – UK differences

% agreeing or strongly agreeing				
England	Northern Ireland	Scotland	Wales	
Confidence				
77	74	**67**	73	said they could explain why earthquakes occur more frequently in some areas than in others
67	72	**58**	68	said they could identify the science question associated with the disposal of rubbish
53	**43**	**45**	52	said they could discuss how new evidence can lead you to change your understanding about the possibility of life on Mars
72	72	**62**	74	could give an explanation of the increase of greenhouse gases in the atmosphere
72	75	**65**	69	could give an explanation of acid rain
37	**27**	37	36	could give an explanation of the use of genetically modified organisms (GMO)
Interest or enjoyment				
54	**46**	56	56	said that they are happy doing science problems
77	75	**64**	79	expressed medium or high interest in learning about human biology
56	54	**44**	62	expressed medium or high interest in learning about chemistry
52	53	**41**	54	expressed medium or high interest in learning about physics
50	**45**	**40**	52	expressed medium or high interest in learning about astronomy
47	47	**41**	52	expressed medium or high interest in learning about biology of plants
35	35	**28**	39	expressed medium or high interest in learning about geology
Science careers				
87	89	95	90	agreed that the science subjects at their school provide students with the basic skills and knowledge for many different careers
47	53	56	55	felt very or fairly well informed about science-related careers that are available in the job market

7.6 Summary

In science, the average performance in all four parts of the UK was similar. The only significant difference was that the mean score of students in Wales was significantly lower than that in England. Males outperformed females in England and Wales but not in Northern Ireland and Scotland. The widest spread of attainment between the highest- and lowest-scoring students was in Northern Ireland.

Performance in mathematics showed more variation across the UK countries than performance in science. The mean score of students in England and Scotland was significantly higher than that in Wales, and the mean score in Scotland was also significantly higher than the score in Northern Ireland. Males outperformed females in England, Wales and Scotland with a significant difference in the mean scores. In Northern Ireland the mean score of males was higher than that of females but the difference was not statistically significant. The widest spread of attainment was again in Northern Ireland.

The average performance in reading in England, Scotland and Northern Ireland was similar. In Wales, the mean score was lower and this difference was statistically significant compared with all three other countries. Females outperformed males in reading in all parts of the UK, as they did in every other country in the PISA survey. As with science and mathematics, the widest spread of performance was in Northern Ireland.

Students' reported attitudes towards aspects of science and science learning were remarkably similar across the UK. Where there were differences, the most common direction of difference was for students in Scotland to be less positive than those in the other parts of the UK. However, none of these differences was very large.

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Appendix A Chapter 3 tables and figures

A.1 Significant differences in mean scores on the science scale

	Mean score		significance
	Mean	S.E.	
Finland*	563	2.0	▲
Hong Kong-China	542	2.5	▲
Canada	534	2.0	▲
Chinese Taipei	532	3.6	▲
*Estonia**	531	2.5	▲
Japan	531	3.4	▲
New Zealand	530	2.7	▲
Australia	527	2.3	*NS*
Netherlands*	525	2.7	*NS*
Liechtenstein	522	4.1	*NS*
Korea	522	3.4	*NS*
*Slovenia**	519	1.1	*NS*
Germany*	516	3.8	*NS*
England	516	2.7	
United Kingdom*	515	2.3	
Czech Republic*	513	3.5	*NS*
Switzerland	512	3.2	*NS*
Macao-China	511	1.1	*NS*
Austria*	511	3.9	*NS*
Belgium*	510	2.5	*NS*
Republic of Ireland*	508	3.2	*NS*
Hungary*	504	2.7	*NS*
Sweden*	503	2.4	▼
OECD average[1]	**500**	**0.5**	▼
Poland*	498	2.3	▼
Denmark*	496	3.1	▼
France*	495	3.4	▼
Croatia	493	2.4	▼
Iceland	491	1.6	▼
*Latvia**	490	3.0	▼
United States	489	4.2	▼
Slovak Republic*	488	2.6	▼
Spain*	488	2.6	▼
*Lithuania**	488	2.8	▼
Norway	487	3.1	▼
Luxembourg*	486	1.1	▼
Russian Federation	479	3.7	▼
Italy*	475	2.0	▼
Portugal*	474	3.0	▼
Greece*	473	3.2	▼
Israel	454	3.7	▼
Chile	438	4.3	▼
Serbia	436	3.0	▼
*Bulgaria**	434	6.1	▼
Turkey	424	3.8	▼
*Romania**	418	4.2	▼
Mexico	410	2.7	▼

key

▲	significantly higher
NS	no significant difference
▼	significantly lower

OECD countries (not italicised)
Countries not in OECD (italicised)
*EU countries

12 countries with scores below 430 omitted

Multiple comparison P-value = 0.045%

[1] Simple comparison P-value = 5%

A.2 Mean score, variation and gender differences in student performance on the science scale

	All students				Gender differences						Percentiles												
	Mean score		Standard deviation		Males		Females		Difference (M - F)		5th		10th		25th		75th		90th		95th		Difference between 5th & 95th percentile
	Mean	S.E.	S.D.	S.E.	Mean	S.E.	Mean	S.E.	Score diff.	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	
Australia	527	(2.3)	100	(1.0)	527	(3.2)	527	(2.7)	0	(3.8)	358	(3.5)	395	(3.4)	459	(2.6)	598	(2.5)	653	(2.9)	685	(3.4)	328
Austria*	511	(3.9)	98	(2.4)	515	(4.2)	507	(4.9)	8	(4.9)	341	(9.3)	378	(6.2)	443	(5.4)	582	(4.1)	633	(3.6)	663	(4.1)	321
Belgium*	510	(2.5)	100	(2.0)	511	(3.3)	510	(3.2)	1	(4.1)	336	(7.3)	374	(5.4)	442	(3.8)	584	(2.4)	634	(2.3)	660	(2.7)	323
*Bulgaria**	434	(6.1)	107	(3.2)	426	(6.6)	443	(6.9)	**-17**	(5.8)	266	(8.1)	300	(7.1)	358	(6.4)	509	(7.8)	577	(8.2)	612	(8.3)	346
Canada	534	(2.0)	94	(1.1)	536	(2.5)	532	(2.1)	4	(2.2)	372	(4.7)	410	(3.7)	472	(2.5)	601	(2.2)	651	(2.4)	681	(2.8)	309
Chile	438	(4.3)	92	(1.8)	448	(5.4)	426	(4.4)	**22**	(4.8)	295	(4.8)	323	(4.1)	374	(4.0)	501	(5.9)	560	(6.5)	595	(6.1)	300
Chinese Taipei	532	(3.6)	94	(1.6)	536	(4.3)	529	(5.1)	7	(6.0)	369	(4.5)	402	(5.0)	466	(5.3)	602	(3.4)	651	(2.7)	676	(3.4)	307
Croatia	493	(2.4)	86	(1.4)	492	(3.3)	494	(3.1)	-2	(4.1)	354	(4.5)	383	(3.8)	433	(3.1)	553	(2.7)	604	(3.2)	634	(3.5)	280
Czech Republic*	513	(3.5)	98	(2.0)	515	(4.2)	510	(4.8)	5	(5.6)	350	(6.0)	385	(5.2)	443	(4.6)	583	(3.9)	641	(4.3)	672	(4.7)	322
Denmark*	496	(3.1)	93	(1.4)	500	(3.6)	491	(3.4)	**9**	(3.2)	341	(5.9)	373	(4.8)	432	(4.3)	562	(2.9)	615	(3.7)	646	(4.3)	305
England	516	(2.7)	107	(1.8)	521	(3.5)	510	(3.2)	**11**	(4.1)	336	(6.8)	375	(5.1)	442	(3.6)	592	(3.3)	653	(3.5)	686	(3.8)	350
*Estonia**	531	(2.5)	84	(1.1)	530	(3.1)	533	(2.9)	-4	(3.1)	392	(4.7)	422	(3.8)	474	(3.2)	589	(3.1)	640	(3.3)	668	(3.7)	276
Finland*	563	(2.0)	86	(1.0)	562	(2.6)	565	(2.4)	-3	(2.9)	419	(4.4)	453	(3.3)	506	(2.9)	622	(2.5)	673	(2.9)	700	(3.1)	281
France*	495	(3.4)	102	(2.1)	497	(4.3)	494	(3.6)	3	(4.0)	320	(6.3)	359	(5.5)	424	(5.3)	570	(4.0)	623	(4.0)	653	(3.8)	333
Germany*	516	(3.8)	100	(2.0)	519	(4.6)	512	(3.8)	7	(3.7)	345	(8.1)	381	(7.0)	447	(5.3)	587	(3.6)	642	(3.2)	672	(3.6)	328
Greece*	473	(3.2)	92	(2.0)	468	(4.5)	479	(3.4)	**-11**	(4.7)	317	(7.3)	353	(5.4)	413	(4.4)	537	(3.3)	589	(4.1)	619	(3.8)	303
Hong Kong-China	542	(2.5)	92	(1.9)	546	(3.5)	539	(3.5)	7	(4.9)	380	(6.2)	418	(6.1)	482	(3.6)	609	(2.8)	655	(3.5)	682	(3.1)	301
Hungary*	504	(2.7)	88	(1.6)	507	(3.3)	501	(3.5)	6	(4.2)	358	(4.4)	388	(4.2)	442	(3.5)	566	(3.3)	617	(3.1)	646	(4.2)	288
Iceland	491	(1.6)	97	(1.2)	488	(2.6)	494	(2.1)	-6	(3.4)	328	(4.9)	364	(3.1)	424	(2.6)	560	(2.3)	614	(2.9)	644	(3.4)	316
Israel	454	(3.7)	111	(2.0)	456	(5.6)	452	(4.2)	3	(6.5)	275	(5.7)	310	(5.2)	374	(4.8)	535	(4.6)	601	(4.5)	636	(5.5)	361
Italy*	475	(2.0)	96	(1.3)	477	(2.8)	474	(2.5)	3	(3.5)	318	(3.1)	351	(2.8)	409	(3.0)	543	(2.4)	598	(2.6)	630	(2.8)	312
Japan	531	(3.4)	100	(2.0)	533	(4.9)	530	(5.1)	3	(7.4)	356	(6.1)	396	(6.2)	465	(5.1)	603	(3.1)	654	(3.1)	685	(3.6)	328
Korea	522	(3.4)	90	(2.4)	521	(4.8)	523	(3.9)	-2	(5.5)	367	(8.4)	403	(5.7)	462	(4.1)	586	(3.8)	635	(4.7)	662	(5.9)	296
*Latvia**	490	(3.0)	84	(1.3)	486	(3.5)	493	(3.2)	-7	(3.1)	348	(5.2)	380	(4.2)	432	(3.7)	547	(3.5)	597	(3.5)	627	(3.1)	279
Liechtenstein	522	(4.1)	97	(3.1)	516	(7.6)	527	(6.3)	-11	(11.1)	358	(11.2)	393	(12.8)	457	(7.3)	591	(7.1)	643	(9.4)	675	(13.4)	317
*Lithuania**	488	(2.8)	90	(1.6)	483	(3.1)	493	(3.1)	**-9**	(2.8)	340	(3.8)	370	(3.2)	425	(3.3)	551	(3.5)	604	(4.2)	633	(5.5)	293
Luxembourg*	486	(1.1)	97	(0.9)	491	(1.8)	482	(1.8)	**9**	(2.9)	322	(3.9)	358	(2.8)	419	(2.0)	556	(2.4)	609	(2.8)	640	(2.6)	318
Macao-China	511	(1.1)	78	(0.8)	513	(1.8)	509	(1.6)	4	(2.7)	378	(3.6)	409	(2.5)	458	(1.9)	566	(1.8)	611	(1.8)	635	(2.6)	257
Mexico	410	(2.7)	81	(1.5)	413	(3.2)	406	(2.6)	**7**	(2.2)	281	(4.4)	306	(4.2)	354	(3.6)	465	(2.9)	516	(3.0)	544	(3.5)	263
Netherlands*	525	(2.7)	96	(1.6)	528	(3.2)	521	(3.1)	**7**	(3.0)	362	(5.9)	395	(5.4)	456	(4.7)	596	(2.6)	646	(3.4)	675	(3.6)	313
New Zealand	530	(2.7)	107	(1.4)	528	(3.9)	532	(3.6)	-4	(5.2)	347	(5.2)	389	(4.5)	455	(3.6)	608	(2.9)	667	(3.3)	699	(3.1)	352
Northern Ireland	508	(3.3)	113	(2.3)	509	(6.0)	507	(5.8)	2	(9.7)	320	(6.4)	359	(4.9)	428	(4.8)	590	(4.9)	652	(3.3)	686	(4.5)	367
Norway	487	(3.1)	96	(2.0)	484	(3.8)	489	(3.2)	-4	(3.4)	328	(7.8)	365	(5.6)	422	(3.9)	553	(3.0)	610	(3.5)	641	(3.4)	313
Poland*	498	(2.3)	90	(1.1)	500	(2.7)	496	(2.6)	3	(2.5)	352	(3.8)	381	(2.9)	434	(2.7)	562	(3.1)	615	(3.3)	645	(3.3)	293
Portugal*	474	(3.0)	89	(1.7)	477	(3.7)	472	(3.2)	5	(3.3)	329	(5.4)	357	(4.8)	411	(4.2)	539	(3.0)	588	(2.9)	617	(3.2)	288
Republic of Ireland*	508	(3.2)	94	(1.5)	508	(4.3)	509	(3.3)	0	(4.3)	351	(5.8)	385	(4.4)	444	(4.6)	575	(3.4)	630	(3.7)	660	(4.9)	309
*Romania**	418	(4.2)	81	(2.4)	417	(4.1)	419	(4.8)	-2	(3.3)	291	(4.5)	314	(5.0)	361	(5.2)	473	(5.7)	526	(5.7)	557	(8.2)	266
Russian Federation	479	(3.7)	90	(1.4)	481	(4.1)	478	(3.7)	3	(2.7)	333	(5.6)	364	(5.4)	418	(4.4)	541	(4.2)	596	(3.9)	627	(4.2)	295
Scotland	515	(4.0)	100	(2.0)	517	(5.0)	512	(4.0)	4	(4.4)	350	(7.5)	387	(6.4)	446	(4.7)	585	(5.2)	646	(5.8)	679	(6.7)	330
Serbia	436	(3.0)	85	(1.6)	433	(3.3)	438	(3.8)	-5	(3.8)	297	(4.9)	327	(4.0)	377	(3.8)	495	(3.9)	545	(3.8)	576	(4.0)	279
Slovak Republic*	488	(2.6)	93	(1.8)	491	(3.9)	485	(3.0)	6	(4.7)	334	(5.6)	368	(3.7)	426	(3.2)	555	(4.0)	609	(4.1)	638	(3.9)	305
*Slovenia**	519	(1.1)	98	(1.0)	515	(2.0)	523	(1.9)	**-8**	(3.2)	358	(3.8)	391	(2.8)	449	(2.7)	589	(2.1)	647	(3.3)	680	(3.0)	322
Spain*	488	(2.6)	91	(1.0)	491	(2.9)	486	(2.7)	4	(2.4)	338	(4.1)	370	(3.7)	427	(3.0)	552	(3.1)	604	(3.0)	633	(3.1)	295
Sweden*	503	(2.4)	94	(1.4)	504	(2.7)	503	(2.9)	1	(3.0)	347	(3.8)	381	(4.0)	439	(3.3)	569	(2.8)	622	(2.6)	654	(3.4)	308
Switzerland	512	(3.2)	99	(1.7)	514	(3.3)	509	(3.6)	**6**	(2.7)	340	(5.0)	378	(4.9)	445	(3.9)	584	(3.5)	636	(3.8)	665	(4.6)	325
Turkey	424	(3.8)	83	(3.2)	418	(4.6)	430	(4.1)	**-12**	(4.1)	301	(2.8)	325	(3.2)	366	(2.6)	475	(5.8)	540	(9.7)	575	(9.8)	274
United Kingdom*	515	(2.3)	107	(1.5)	520	(3.0)	510	(2.8)	**10**	(3.4)	337	(5.4)	376	(4.3)	441	(3.2)	590	(3.1)	652	(2.9)	685	(3.5)	348
United States	489	(4.2)	106	(1.7)	489	(5.1)	489	(4.0)	1	(3.5)	318	(4.5)	349	(5.9)	412	(5.4)	567	(4.6)	628	(4.3)	662	(4.8)	344
Wales	505	(3.5)	102	(1.9)	510	(4.0)	500	(4.2)	**10**	(4.3)	339	(5.9)	373	(5.6)	433	(4.2)	577	(4.3)	638	(5.2)	673	(5.7)	334
OECD average	500	(0.5)	95	(0.3)	501	(0.7)	499	(0.6)	**2**	(0.7)	340	(1.0)	375	(0.9)	434	(0.7)	568	(0.6)	622	(0.7)	652	(0.8)	(311.4)

12 countries with scores below 430 omitted

Note: Values that are statistically significant are indicated in bold

OECD countries (not italicised)

Countries not in OECD (italicised)

*EU countries

A.3 Mean performance on each subscale

	Mean scores				Difference from overall mean		
	Overall science scale	Identifying scientific issues	Explaining phenomena scientifically	Using scientific evidence	Identifying scientific issues	Explaining phenomena scientifically	Using scientific evidence
Australia	527	535	520	531	8	-7	4
Austria*	511	505	516	505	-6	6	-6
Belgium*	510	515	503	516	5	-8	6
*Bulgaria**	434	427	444	417	-7	10	-17
Canada	534	532	531	542	-3	-4	7
Chile	438	444	432	440	6	-6	1
Chinese Taipei	532	509	545	532	-24	13	-1
Croatia	493	494	492	490	0	-1	-3
Czech Republic*	513	500	527	501	-12	15	-12
Denmark*	496	493	501	489	-3	5	-7
England	516	515	518	514	-1	3	-2
*Estonia**	531	516	541	531	-16	9	0
Finland*	563	555	566	567	-8	3	4
France*	495	499	481	511	4	-14	16
Germany*	516	510	519	515	-6	3	0
Greece*	473	469	476	465	-5	3	-8
Hong Kong-China	542	528	549	542	-14	7	0
Hungary*	504	483	518	497	-21	14	-7
Iceland	491	494	488	491	3	-3	0
Israel	454	457	443	460	3	-10	6
Italy*	475	474	480	467	-1	4	-8
Japan	531	522	527	544	-9	-4	13
Korea	522	519	512	538	-3	-11	16
*Latvia**	490	489	486	491	-1	-3	1
Liechtenstein	522	522	516	535	0	-6	13
*Lithuania**	488	476	494	487	-12	7	-1
Luxembourg*	486	483	483	492	-3	-3	5
Macao-China	511	490	520	512	-21	9	1
Mexico	410	421	406	402	12	-3	-7
Netherlands*	525	533	522	526	8	-3	1
New Zealand	530	536	522	537	6	-8	6
Northern Ireland	508	504	510	508	-4	2	0
Norway	487	489	495	473	3	9	-14
Poland*	498	483	506	494	-15	8	-4
Portugal*	474	486	469	472	12	-5	-2
Republic of Ireland*	508	516	505	506	8	-3	-2
*Romania**	418	409	426	407	-9	7	-11
Russian Federation	479	463	483	481	-17	4	1
Scotland	515	516	508	521	1	-6	7
Serbia	436	431	441	425	-5	5	-11
Slovak Republic*	488	475	501	478	-13	13	-11
*Slovenia**	519	517	523	516	-2	4	-3
Spain*	488	489	490	485	0	2	-4
Sweden*	503	499	510	496	-5	6	-7
Switzerland	512	515	508	519	3	-4	7
Turkey	424	427	423	417	4	-1	-7
United Kingdom*	515	514	517	514	-1	2	-1
United States	489	492	486	489	3	-3	0
Wales	505	500	508	504	-4	4	0

12 countries with scores below 430 omitted

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

Differences are based on unrounded figures and are rounded to the nearest whole number.

A.4 Mean score, variation and gender differences in student performance on the *Identifying scientific* issues scale

	All students				Gender differences						Percentiles												
	Mean score		Standard deviation		Males		Females		Difference (M - F)		5th		10th		25th		75th		90th		95th		Difference between 5th & 95th percentile
	Mean	S.E.	S.D.	S.E.	Mean score	S.E.	Mean score	S.E.	Score diff.	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	
Australia	535	(2.3)	98	(1.2)	525	(3.2)	546	(2.6)	**-21**	(3.6)	368	(4.3)	406	(3.1)	471	(2.7)	604	(2.8)	658	(3.2)	689	(3.6)	320
Austria*	505	(3.7)	90	(2.2)	495	(4.2)	516	(4.7)	**-22**	(4.6)	351	(6.8)	383	(6.7)	443	(4.8)	571	(3.8)	618	(4.1)	644	(4.0)	292
Belgium*	515	(2.7)	100	(2.3)	508	(3.8)	523	(3.1)	**-14**	(4.3)	340	(8.6)	382	(6.6)	449	(3.7)	587	(2.9)	639	(2.9)	668	(3.5)	328
*Bulgaria**	427	(6.3)	109	(3.3)	411	(6.6)	445	(7.1)	**-34**	(5.6)	251	(8.2)	289	(8.7)	350	(7.3)	504	(7.6)	571	(7.4)	607	(8.4)	356
Canada	532	(2.3)	97	(1.3)	525	(2.7)	539	(2.4)	**-14**	(2.4)	363	(4.9)	404	(4.1)	469	(2.9)	599	(2.3)	652	(2.5)	683	(2.9)	320
Chile	444	(4.1)	89	(1.7)	445	(5.0)	443	(4.1)	3	(4.5)	300	(6.1)	330	(3.9)	383	(4.1)	505	(5.0)	561	(5.4)	594	(6.8)	294
Chinese Taipei	509	(3.7)	95	(1.9)	506	(4.4)	512	(5.0)	-6	(5.8)	344	(5.7)	379	(5.9)	444	(5.5)	578	(3.2)	628	(3.7)	655	(3.8)	312
Croatia	494	(2.6)	86	(1.6)	480	(3.5)	507	(3.1)	**-27**	(4.1)	354	(5.2)	384	(4.1)	435	(3.2)	552	(2.8)	604	(3.5)	634	(4.9)	280
Czech Republic*	500	(4.2)	99	(3.4)	492	(4.8)	511	(5.3)	**-19**	(5.7)	341	(8.2)	376	(5.9)	434	(4.7)	570	(4.5)	625	(5.2)	656	(5.2)	315
Denmark*	493	(3.0)	90	(1.4)	488	(3.5)	499	(3.2)	**-11**	(3.2)	341	(5.5)	375	(4.5)	432	(4.0)	556	(3.2)	607	(3.2)	637	(4.4)	296
England	515	(2.8)	106	(1.8)	512	(3.4)	518	(3.3)	-6	(3.9)	337	(7.3)	377	(5.3)	444	(3.5)	588	(3.1)	649	(3.4)	683	(3.7)	346
*Estonia**	516	(2.6)	77	(1.3)	504	(3.1)	528	(2.6)	**-25**	(2.8)	387	(5.3)	415	(4.0)	464	(3.7)	570	(2.9)	613	(2.9)	639	(3.5)	252
Finland*	555	(2.3)	84	(1.1)	542	(2.7)	568	(2.6)	**-26**	(2.8)	411	(4.0)	446	(3.5)	501	(3.1)	612	(2.9)	659	(2.8)	686	(3.2)	275
France*	499	(3.5)	104	(2.4)	491	(4.6)	507	(3.7)	**-16**	(4.7)	319	(7.0)	358	(5.9)	427	(5.5)	576	(3.5)	629	(3.7)	659	(4.5)	341
Germany*	510	(3.8)	98	(2.4)	502	(4.5)	518	(3.9)	**-16**	(3.4)	341	(8.3)	381	(6.6)	444	(5.0)	579	(3.4)	630	(3.5)	660	(4.0)	320
Greece*	469	(3.0)	92	(2.1)	453	(4.1)	485	(3.1)	**-31**	(4.3)	309	(6.1)	347	(5.3)	411	(4.4)	533	(2.9)	581	(3.4)	608	(3.2)	299
Hong Kong-China	528	(3.2)	101	(2.2)	520	(4.1)	535	(4.5)	**-15**	(5.9)	352	(6.6)	393	(5.4)	461	(4.4)	599	(3.8)	652	(4.5)	683	(4.4)	332
Hungary*	483	(2.6)	81	(1.8)	477	(3.4)	489	(3.3)	**-13**	(4.1)	347	(5.7)	378	(4.4)	430	(3.6)	539	(3.3)	583	(3.6)	610	(4.4)	263
Iceland	494	(1.7)	103	(1.4)	479	(2.9)	509	(2.4)	**-30**	(4.1)	318	(5.0)	358	(4.8)	426	(2.5)	566	(2.2)	625	(3.1)	656	(3.7)	338
Israel	457	(3.9)	114	(2.0)	451	(5.9)	463	(4.0)	-12	(6.6)	272	(6.4)	311	(5.5)	378	(4.2)	538	(4.7)	604	(5.4)	641	(5.6)	369
Italy*	474	(2.2)	99	(1.5)	466	(2.9)	483	(2.5)	**-17**	(3.4)	310	(4.7)	347	(3.5)	409	(3.0)	543	(2.8)	600	(2.7)	632	(3.4)	321
Japan	522	(4.0)	106	(2.5)	513	(5.1)	531	(6.6)	**-18**	(8.5)	337	(8.2)	381	(6.9)	453	(5.6)	597	(3.9)	652	(4.0)	682	(4.0)	345
Korea	519	(3.7)	91	(2.4)	508	(4.9)	530	(4.2)	**-22**	(5.7)	361	(7.6)	400	(6.0)	461	(4.4)	583	(4.1)	630	(4.1)	657	(5.0)	296
*Latvia**	489	(3.3)	83	(1.5)	473	(3.7)	504	(3.5)	**-31**	(3.1)	346	(6.1)	377	(5.2)	434	(4.2)	547	(3.4)	594	(3.5)	621	(4.1)	275
Liechtenstein	522	(3.7)	91	(3.1)	508	(7.0)	534	(5.7)	**-26**	(10.3)	366	(11.2)	405	(11.7)	461	(6.6)	589	(7.1)	634	(12.1)	667	(9.1)	301
*Lithuania**	476	(2.7)	84	(1.4)	463	(2.9)	489	(3.0)	**-26**	(2.7)	336	(4.5)	366	(3.2)	419	(3.4)	535	(3.4)	583	(3.5)	609	(4.5)	273
Luxembourg*	483	(1.1)	92	(0.9)	477	(1.7)	489	(1.8)	**-11**	(2.8)	329	(2.9)	362	(2.3)	421	(2.0)	548	(2.3)	600	(2.4)	628	(2.5)	299
Macao-China	490	(1.2)	79	(1.0)	483	(1.9)	498	(1.6)	**-15**	(2.6)	358	(3.5)	388	(2.5)	437	(2.4)	545	(2.0)	591	(2.5)	615	(3.1)	258
Mexico	421	(2.6)	85	(1.6)	418	(2.9)	425	(2.8)	-7	(2.2)	280	(6.1)	312	(4.7)	365	(3.4)	479	(2.8)	529	(3.0)	559	(3.9)	279
Netherlands*	533	(3.3)	103	(2.9)	527	(3.8)	539	(3.5)	**-12**	(3.2)	360	(7.3)	397	(5.7)	462	(4.5)	606	(3.5)	662	(4.0)	694	(4.5)	334
New Zealand	536	(2.9)	106	(1.6)	525	(3.7)	547	(3.7)	**-22**	(4.9)	356	(4.8)	396	(4.8)	465	(4.3)	612	(3.0)	668	(3.0)	701	(3.5)	345
Northern Ireland	504	(3.8)	109	(2.7)	496	(6.0)	512	(5.6)	-16	(8.8)	320	(7.1)	361	(6.9)	430	(5.1)	583	(4.5)	641	(4.3)	674	(6.4)	353
Norway	489	(3.1)	94	(2.0)	478	(3.9)	501	(3.3)	**-24**	(3.7)	333	(7.6)	368	(5.7)	426	(3.6)	555	(3.1)	608	(4.0)	640	(4.1)	307
Poland*	483	(2.5)	84	(1.1)	476	(2.8)	490	(2.7)	**-13**	(2.5)	344	(3.9)	374	(3.2)	425	(3.0)	542	(3.2)	591	(2.7)	619	(3.7)	276
Portugal*	486	(3.1)	91	(1.9)	480	(3.6)	493	(3.4)	**-13**	(3.1)	336	(5.4)	367	(4.3)	423	(4.1)	551	(3.4)	603	(3.7)	632	(4.9)	295
Republic of Ireland*	516	(3.3)	95	(1.7)	508	(4.4)	524	(3.5)	**-16**	(4.6)	357	(5.7)	391	(4.9)	450	(4.0)	584	(3.3)	638	(3.4)	668	(4.4)	311
*Romania**	409	(3.6)	77	(2.7)	401	(3.6)	418	(4.4)	**-17**	(3.5)	284	(6.2)	311	(5.1)	357	(4.2)	461	(4.9)	510	(6.4)	539	(6.4)	254
Russian Federation	463	(4.2)	89	(1.3)	453	(4.6)	472	(4.1)	**-20**	(2.6)	315	(5.8)	348	(5.7)	402	(4.6)	524	(4.7)	576	(4.9)	607	(4.5)	291
Scotland	516	(4.1)	101	(2.2)	509	(4.8)	523	(4.4)	**-15**	(4.0)	351	(6.2)	388	(6.5)	448	(5.0)	583	(4.5)	648	(5.8)	682	(7.5)	331
Serbia	431	(3.0)	83	(1.8)	420	(3.3)	441	(3.6)	**-21**	(3.7)	289	(6.9)	323	(4.9)	377	(3.6)	487	(3.0)	533	(3.4)	560	(3.4)	271
Slovak Republic*	475	(3.2)	96	(3.6)	465	(4.5)	485	(3.6)	**-20**	(5.1)	315	(8.5)	356	(4.9)	416	(3.6)	541	(3.6)	592	(3.6)	622	(3.7)	307
*Slovenia**	517	(1.4)	87	(0.8)	504	(2.0)	530	(2.0)	**-27**	(2.8)	372	(3.1)	402	(4.0)	457	(2.3)	579	(1.9)	627	(2.6)	655	(3.3)	283
Spain*	489	(2.4)	89	(1.1)	482	(2.7)	496	(2.6)	**-15**	(2.1)	341	(4.1)	374	(3.2)	431	(2.7)	550	(2.4)	599	(2.7)	627	(3.1)	287
Sweden*	499	(2.6)	96	(1.4)	491	(2.9)	507	(3.1)	**-16**	(3.0)	338	(4.5)	374	(4.2)	435	(3.2)	566	(3.2)	619	(3.1)	653	(3.3)	315
Switzerland	515	(3.0)	95	(1.4)	510	(3.1)	520	(3.3)	**-10**	(2.4)	350	(4.9)	387	(4.4)	452	(3.9)	583	(3.1)	633	(3.7)	661	(4.6)	312
Turkey	427	(3.4)	79	(2.7)	414	(4.1)	443	(3.6)	**-29**	(3.8)	304	(5.1)	330	(3.8)	374	(3.2)	480	(4.7)	531	(6.7)	561	(8.5)	257
United Kingdom*	514	(2.3)	106	(1.5)	510	(2.9)	517	(2.8)	-7	(3.2)	337	(6.1)	377	(4.3)	443	(2.9)	587	(2.8)	648	(2.8)	682	(3.2)	344
United States	492	(3.8)	100	(1.7)	484	(4.6)	500	(3.8)	**-16**	(3.6)	330	(5.8)	362	(5.3)	420	(4.7)	563	(4.2)	621	(4.9)	654	(5.2)	325
Wales	500	(3.3)	101	(1.7)	497	(3.4)	504	(4.3)	-7	(4.3)	336	(6.2)	370	(4.8)	430	(4.0)	572	(4.0)	631	(4.1)	665	(5.4)	329
OECD average	499	(0.5)	95	(0.4)	490	(0.7)	508	(0.6)	**-17**	(0.7)	339	(1.1)	375	(0.9)	436	(0.7)	565	(0.6)	618	(0.7)	648	(0.8)	(308.8)

12 countries with scores below 430 omitted

Note: Values that are statistically significant are indicated in bold

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

A.5 Mean score, variation and gender differences in student performance on the *Explaining phenomena scientifically* scale

	All students				Gender differences						Percentiles												
	Mean score		Standard deviation		Males		Females		Difference (M - F)		5th		10th		25th		75th		90th		95th		Difference between 5th & 95th percentile
	Mean	S.E.	S.D.	S.E.	Mean score	S.E.	Mean score	S.E.	Score diff	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	
Australia	520	(2.3)	102	(1.0)	527	(3.1)	513	(2.7)	**13**	(3.6)	351	(3.2)	388	(3.0)	450	(2.7)	592	(2.8)	650	(3.1)	683	(3.1)	332
Austria*	516	(4.0)	100	(2.1)	526	(4.4)	507	(4.7)	**19**	(4.8)	343	(7.5)	382	(7.3)	447	(4.9)	590	(4.0)	642	(3.5)	672	(3.9)	329
Belgium*	503	(2.5)	102	(1.9)	510	(3.4)	494	(3.1)	**16**	(4.1)	328	(6.5)	365	(5.8)	432	(4.0)	578	(2.3)	632	(2.4)	661	(2.5)	333
*Bulgaria**	444	(5.8)	105	(3.4)	442	(6.5)	447	(6.5)	**-5**	(5.8)	276	(9.4)	312	(6.1)	370	(5.6)	516	(6.9)	583	(6.0)	616	(8.8)	342
Canada	531	(2.1)	100	(1.2)	539	(2.6)	522	(2.3)	**17**	(2.5)	362	(4.4)	400	(3.4)	464	(2.8)	601	(2.5)	657	(2.4)	689	(2.6)	327
Chile	432	(4.1)	94	(1.8)	448	(5.1)	414	(4.1)	**34**	(4.6)	284	(4.3)	314	(4.0)	366	(4.0)	495	(5.7)	560	(6.1)	597	(6.7)	313
Chinese Taipei	545	(3.7)	101	(1.7)	554	(4.3)	535	(5.3)	**19**	(6.1)	373	(4.5)	407	(5.0)	474	(5.7)	619	(3.9)	673	(3.4)	702	(3.4)	328
Croatia	492	(2.5)	87	(1.4)	498	(3.2)	487	(3.3)	**11**	(4.1)	351	(4.1)	380	(3.8)	432	(3.5)	552	(3.3)	606	(3.8)	638	(4.1)	287
Czech Republic*	527	(3.5)	102	(1.8)	537	(4.3)	516	(4.6)	**21**	(5.7)	360	(6.3)	395	(5.1)	456	(4.5)	598	(3.8)	659	(4.6)	694	(4.7)	334
Denmark*	501	(3.3)	96	(1.4)	512	(3.8)	491	(3.7)	**21**	(3.4)	342	(5.1)	376	(5.0)	435	(4.0)	568	(3.6)	627	(3.8)	658	(4.2)	315
England	518	(2.7)	110	(1.6)	529	(3.5)	507	(3.3)	**22**	(4.2)	340	(5.4)	376	(4.0)	441	(3.6)	596	(3.5)	662	(4.1)	698	(4.2)	358
*Estonia**	541	(2.6)	91	(1.3)	544	(3.2)	537	(3.0)	6	(3.3)	393	(5.1)	422	(3.1)	477	(3.2)	604	(3.2)	658	(3.5)	688	(3.7)	295
Finland*	566	(2.0)	88	(1.1)	571	(2.5)	562	(2.5)	**9**	(3.0)	420	(4.8)	452	(3.3)	506	(2.6)	626	(2.5)	679	(2.8)	709	(4.0)	288
France*	481	(3.2)	100	(1.8)	489	(4.2)	474	(3.4)	**15**	(4.1)	313	(5.6)	349	(5.5)	412	(4.7)	552	(3.3)	609	(3.9)	640	(3.6)	326
Germany*	519	(3.7)	103	(2.0)	529	(4.5)	508	(3.7)	**21**	(3.7)	345	(6.8)	381	(6.2)	448	(5.5)	592	(3.8)	651	(3.6)	684	(4.6)	338
Greece*	476	(3.0)	93	(1.9)	478	(4.3)	475	(3.0)	3	(4.2)	321	(6.5)	356	(5.4)	413	(4.1)	541	(3.6)	596	(3.5)	626	(4.2)	305
Hong Kong-China	549	(2.5)	94	(2.1)	560	(3.5)	539	(3.3)	**21**	(4.6)	387	(7.0)	423	(5.0)	488	(3.4)	615	(2.7)	667	(3.3)	695	(3.9)	308
Hungary*	518	(2.6)	94	(1.5)	529	(3.2)	507	(3.6)	**22**	(4.4)	365	(3.8)	398	(4.0)	453	(3.2)	583	(3.4)	639	(4.3)	674	(5.5)	308
Iceland	488	(1.5)	92	(1.2)	491	(2.6)	485	(2.1)	6	(3.7)	335	(4.3)	369	(3.3)	425	(2.3)	553	(2.4)	606	(2.9)	636	(4.3)	301
Israel	443	(3.6)	109	(2.0)	451	(5.4)	436	(4.0)	**16**	(6.4)	269	(6.0)	304	(5.6)	366	(4.2)	520	(4.7)	587	(4.2)	625	(4.2)	356
Italy*	480	(2.0)	100	(1.3)	487	(2.8)	472	(2.5)	**15**	(3.4)	315	(3.7)	350	(3.2)	411	(2.8)	548	(2.6)	608	(2.6)	642	(2.6)	326
Japan	527	(3.1)	97	(1.8)	535	(4.6)	519	(4.4)	**16**	(6.6)	362	(6.5)	399	(5.3)	462	(4.2)	595	(2.9)	649	(3.6)	680	(3.9)	318
Korea	512	(3.3)	91	(2.3)	517	(4.8)	506	(4.0)	11	(5.7)	359	(6.3)	392	(5.0)	450	(3.9)	576	(4.1)	627	(5.1)	656	(5.9)	297
*Latvia**	486	(2.9)	88	(1.3)	491	(3.6)	481	(3.2)	**10**	(3.3)	340	(4.8)	373	(3.8)	427	(3.6)	546	(4.0)	599	(3.7)	631	(4.1)	290
Liechtenstein	516	(4.1)	97	(3.0)	519	(7.5)	513	(6.4)	6	(11.1)	357	(10.1)	390	(10.5)	450	(7.3)	586	(7.2)	640	(8.7)	670	(12.2)	313
*Lithuania**	494	(3.0)	96	(1.8)	499	(3.3)	490	(3.4)	**9**	(3.1)	338	(4.3)	370	(4.1)	428	(3.5)	561	(3.8)	617	(5.1)	651	(6.3)	313
Luxembourg*	483	(1.1)	97	(0.9)	495	(1.8)	471	(2.0)	**25**	(3.0)	321	(2.9)	357	(2.5)	416	(2.2)	552	(1.8)	608	(2.4)	639	(4.2)	318
Macao-China	520	(1.2)	83	(1.2)	527	(2.0)	513	(1.6)	**14**	(2.7)	381	(4.3)	413	(3.1)	464	(2.0)	578	(2.3)	626	(2.5)	652	(2.8)	271
Mexico	406	(2.7)	83	(1.6)	415	(3.3)	398	(2.6)	**18**	(2.3)	274	(4.8)	301	(3.7)	349	(3.2)	462	(2.9)	514	(3.5)	545	(4.1)	271
Netherlands*	522	(2.7)	95	(1.7)	531	(3.1)	512	(3.1)	**18**	(3.0)	360	(5.3)	394	(5.6)	455	(4.7)	589	(2.7)	643	(3.3)	673	(3.5)	313
New Zealand	522	(2.8)	111	(1.5)	528	(4.0)	517	(3.6)	**11**	(5.2)	339	(5.9)	378	(4.3)	445	(3.6)	601	(3.2)	664	(3.1)	700	(4.1)	362
Northern Ireland	510	(3.2)	113	(2.3)	517	(6.0)	502	(5.8)	15	(9.9)	324	(6.7)	361	(5.6)	430	(4.6)	590	(4.3)	654	(4.6)	691	(6.6)	367
Norway	495	(3.0)	101	(1.7)	498	(3.9)	492	(3.2)	6	(3.9)	327	(8.2)	366	(5.1)	427	(3.6)	565	(3.2)	624	(3.3)	656	(4.0)	329
Poland*	506	(2.5)	95	(1.2)	514	(2.9)	498	(2.8)	**17**	(2.7)	353	(4.4)	384	(3.8)	438	(2.8)	572	(3.3)	630	(3.2)	664	(3.8)	310
Portugal*	469	(2.9)	87	(1.7)	477	(3.6)	462	(3.0)	**16**	(3.2)	329	(4.7)	357	(4.5)	409	(3.8)	530	(2.7)	581	(2.9)	610	(3.7)	281
Republic of Ireland*	505	(3.2)	100	(1.6)	510	(4.4)	501	(3.5)	**9**	(4.6)	340	(6.1)	377	(5.0)	436	(4.1)	575	(3.9)	635	(3.9)	668	(4.4)	328
*Romania**	426	(4.0)	83	(2.4)	431	(4.3)	421	(4.5)	**10**	(3.6)	297	(5.7)	321	(5.3)	367	(6.0)	481	(4.8)	535	(7.2)	567	(7.2)	271
Russian Federation	483	(3.4)	90	(1.3)	493	(4.0)	474	(3.4)	**19**	(2.6)	335	(5.1)	367	(4.3)	422	(4.5)	544	(3.8)	600	(4.2)	634	(4.3)	299
Scotland	508	(4.3)	103	(2.1)	516	(5.2)	501	(4.2)	**15**	(4.4)	345	(6.4)	378	(6.2)	435	(5.0)	579	(5.6)	645	(5.7)	683	(6.0)	338
Serbia	441	(3.1)	90	(1.6)	444	(3.7)	438	(3.8)	**6**	(4.1)	295	(5.6)	326	(4.7)	380	(3.6)	502	(3.9)	557	(3.8)	589	(4.2)	293
Slovak Republic*	501	(2.7)	97	(1.9)	512	(4.0)	490	(3.0)	**22**	(4.7)	342	(4.5)	377	(5.5)	435	(3.0)	568	(3.6)	626	(3.8)	660	(5.1)	318
*Slovenia**	523	(1.5)	105	(1.1)	528	(2.3)	518	(2.2)	**10**	(3.3)	353	(4.7)	388	(3.9)	449	(2.0)	595	(2.6)	661	(3.3)	698	(5.4)	345
Spain*	490	(2.4)	98	(1.0)	499	(2.8)	481	(2.7)	**18**	(2.6)	329	(4.0)	364	(3.2)	423	(2.7)	558	(3.1)	616	(2.6)	649	(2.9)	319
Sweden*	510	(2.9)	99	(1.8)	516	(3.0)	504	(3.5)	12	(3.1)	346	(7.2)	382	(5.6)	443	(3.6)	578	(3.3)	636	(3.6)	669	(3.4)	324
Switzerland	508	(3.3)	102	(1.8)	517	(3.4)	498	(3.9)	**18**	(2.8)	333	(5.3)	373	(4.6)	438	(4.1)	580	(3.4)	635	(4.8)	667	(4.7)	334
Turkey	423	(4.1)	86	(3.5)	423	(4.7)	423	(4.5)	1	(4.1)	297	(3.8)	321	(2.9)	363	(2.7)	475	(6.5)	542	(11.2)	584	(12.5)	287
United Kingdom*	517	(2.3)	110	(1.4)	527	(3.0)	506	(2.7)	**21**	(3.5)	340	(4.5)	375	(3.4)	439	(3.0)	594	(2.9)	660	(3.4)	696	(3.9)	356
United States	486	(4.3)	110	(1.5)	492	(5.3)	480	(4.0)	**13**	(3.6)	311	(5.5)	345	(5.2)	404	(5.5)	565	(4.8)	632	(4.6)	670	(6.0)	359
Wales	508	(3.7)	106	(1.9)	519	(4.1)	498	(4.3)	**21**	(4.1)	339	(6.1)	373	(5.1)	433	(4.2)	582	(4.5)	648	(5.4)	684	(6.7)	345
OECD average	500	(0.5)	98	(0.3)	508	(0.7)	493	(0.6)	**15**	(0.7)	339	(1.0)	373	(0.9)	433	(0.7)	569	(0.6)	626	(0.7)	658	(0.9)	320

12 countries with scores below 430 omitted

Note: Values that are statistically significant are indicated in bold

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

A.6 Mean score, variation and gender differences in student performance on the *Using scientific evidence* scale

	All students				Gender differences						Percentiles												Difference between 5th & 95th percentile
	Mean score		Standard deviation		Males		Females		Difference (M - F)		5th		10th		25th		75th		90th		95th		
	Mean	S.E.	S.D.	S.E.	Mean score	S.E.	Mean score	S.E.	Score diff.	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	
Australia	531	(2.4)	107	(1.1)	530	(3.4)	533	(3.0)	-3	(4.2)	348	(3.8)	390	(3.3)	459	(2.8)	607	(2.7)	665	(2.7)	698	(3.5)	350
Austria*	505	(4.7)	116	(3.4)	509	(4.9)	500	(6.2)	9	(6.1)	305	(11.2)	350	(9.0)	428	(6.2)	589	(4.6)	649	(4.7)	680	(4.7)	375
Belgium*	516	(3.0)	113	(2.4)	512	(3.8)	521	(3.8)	-9	(4.7)	312	(9.8)	360	(7.2)	442	(4.5)	599	(2.4)	652	(2.6)	680	(3.3)	367
*Bulgaria**	417	(7.5)	127	(3.7)	404	(8.0)	430	(8.2)	**-26**	(6.7)	216	(10.2)	256	(8.8)	325	(8.1)	506	(8.7)	585	(9.3)	624	(8.7)	409
Canada	542	(2.2)	99	(1.3)	541	(2.7)	542	(2.3)	-1	(2.3)	370	(4.3)	408	(4.3)	477	(2.9)	612	(2.2)	664	(2.5)	695	(3.1)	325
Chile	440	(5.1)	103	(1.9)	447	(6.2)	431	(5.2)	**16**	(5.3)	275	(5.2)	309	(5.3)	367	(5.4)	511	(6.7)	576	(5.9)	613	(6.5)	338
Chinese Taipei	532	(3.7)	100	(1.8)	532	(4.5)	532	(5.1)	0	(6.0)	356	(5.8)	393	(5.9)	464	(6.0)	605	(3.3)	656	(3.5)	683	(3.2)	326
Croatia	490	(3.0)	96	(1.9)	488	(4.1)	493	(3.5)	-5	(4.8)	333	(5.8)	367	(4.3)	424	(3.8)	557	(3.5)	614	(3.8)	645	(3.4)	313
Czech Republic*	501	(4.1)	113	(2.4)	501	(5.0)	500	(5.4)	1	(6.5)	312	(8.6)	353	(6.6)	423	(5.1)	581	(4.7)	644	(5.4)	681	(5.9)	369
Denmark*	489	(3.6)	107	(1.7)	490	(4.1)	487	(4.0)	3	(3.8)	310	(6.6)	349	(4.8)	416	(4.3)	564	(3.9)	624	(4.6)	658	(5.3)	348
England	514	(2.9)	117	(2.1)	517	(3.7)	510	(3.7)	7	(4.6)	315	(7.3)	360	(5.0)	434	(4.2)	598	(3.6)	662	(3.7)	699	(4.1)	383
*Estonia**	531	(2.7)	93	(1.3)	529	(3.2)	533	(3.0)	-5	(3.3)	374	(5.3)	409	(3.9)	468	(3.3)	595	(3.2)	650	(3.4)	681	(3.8)	306
Finland*	567	(2.3)	96	(1.2)	564	(3.0)	571	(2.7)	**-7**	(3.3)	406	(5.4)	442	(4.0)	504	(2.9)	633	(2.7)	690	(2.9)	722	(3.9)	316
France*	511	(3.9)	114	(2.6)	509	(5.0)	513	(4.2)	-4	(4.7)	311	(7.9)	359	(6.7)	432	(5.9)	595	(4.2)	654	(4.1)	685	(4.3)	374
Germany*	515	(4.6)	115	(3.3)	517	(5.6)	513	(4.5)	4	(4.3)	317	(11.2)	361	(8.1)	440	(6.8)	597	(3.9)	658	(4.2)	691	(4.4)	375
Greece*	465	(4.0)	107	(3.2)	456	(5.6)	475	(3.7)	**-20**	(5.4)	279	(9.9)	325	(7.9)	399	(5.8)	539	(3.8)	596	(4.3)	630	(4.3)	350
Hong Kong-China	542	(2.7)	99	(1.8)	544	(3.8)	541	(4.0)	2	(5.5)	367	(6.0)	408	(4.7)	479	(4.4)	613	(3.1)	663	(3.2)	691	(3.3)	325
Hungary*	497	(3.4)	102	(2.1)	497	(4.1)	498	(4.5)	-1	(5.2)	325	(7.6)	362	(6.3)	429	(4.2)	568	(4.4)	628	(4.8)	661	(4.4)	336
Iceland	491	(1.7)	111	(1.4)	487	(3.1)	495	(2.5)	-7	(4.4)	303	(5.3)	345	(4.1)	414	(3.1)	570	(2.4)	632	(3.3)	666	(3.3)	362
Israel	460	(4.7)	133	(2.3)	456	(6.7)	464	(5.4)	-8	(7.6)	241	(7.4)	286	(6.5)	366	(6.0)	558	(5.5)	635	(4.6)	676	(5.2)	435
Italy*	467	(2.3)	111	(1.6)	466	(3.2)	468	(3.1)	-2	(4.2)	279	(5.0)	323	(3.5)	393	(3.0)	545	(2.8)	606	(2.8)	642	(2.9)	362
Japan	544	(4.2)	116	(2.5)	543	(5.8)	545	(6.4)	-2	(8.9)	340	(8.6)	388	(7.9)	468	(5.9)	627	(3.6)	685	(3.4)	719	(4.8)	380
Korea	538	(3.7)	102	(2.9)	535	(5.2)	542	(4.5)	-8	(6.4)	359	(9.1)	402	(7.6)	473	(5.4)	611	(4.1)	664	(4.3)	694	(5.0)	335
*Latvia**	491	(3.4)	92	(1.8)	484	(4.1)	497	(3.6)	**-13**	(3.6)	332	(6.7)	370	(5.5)	429	(4.5)	555	(3.5)	606	(3.4)	636	(3.2)	303
Liechtenstein	535	(4.3)	111	(3.6)	524	(8.2)	544	(6.8)	-20	(12.2)	354	(19.1)	388	(11.3)	458	(10.1)	619	(7.6)	681	(12.4)	710	(12.4)	356
*Lithuania**	487	(3.1)	99	(1.8)	478	(3.7)	495	(3.3)	**-17**	(3.0)	321	(5.2)	357	(3.8)	418	(4.0)	557	(3.9)	612	(4.3)	643	(4.9)	322
Luxembourg*	492	(1.1)	113	(1.1)	493	(2.0)	490	(2.2)	3	(3.5)	296	(4.3)	341	(3.1)	415	(2.5)	572	(1.9)	635	(2.8)	668	(3.0)	372
Macao-China	512	(1.2)	84	(1.0)	512	(2.0)	511	(1.6)	0	(2.7)	367	(3.8)	401	(2.9)	456	(1.7)	571	(2.0)	618	(2.4)	645	(3.4)	278
Mexico	402	(3.1)	94	(1.8)	404	(3.7)	401	(3.0)	3	(2.7)	248	(6.0)	280	(5.4)	339	(3.8)	467	(3.3)	523	(3.0)	554	(3.6)	306
Netherlands*	526	(3.3)	106	(2.0)	527	(3.8)	524	(3.7)	3	(3.5)	346	(6.5)	382	(6.5)	446	(5.3)	606	(3.4)	662	(2.9)	691	(3.0)	345
New Zealand	537	(3.3)	121	(1.7)	532	(4.4)	541	(4.3)	-10	(5.8)	331	(7.1)	377	(5.2)	453	(4.4)	624	(3.4)	687	(4.5)	725	(4.9)	394
Northern Ireland	508	(3.7)	125	(2.5)	507	(6.7)	509	(6.4)	-2	(10.7)	297	(9.1)	342	(6.7)	420	(5.3)	599	(4.7)	665	(6.0)	702	(6.4)	405
Norway	473	(3.6)	109	(1.9)	469	(4.2)	476	(3.9)	-7	(3.8)	294	(7.9)	334	(5.8)	398	(4.5)	549	(3.8)	613	(3.4)	649	(4.7)	355
Poland*	494	(2.7)	98	(1.4)	492	(3.0)	495	(3.0)	-3	(2.8)	330	(4.7)	365	(3.7)	425	(3.4)	563	(3.5)	621	(3.5)	652	(4.0)	322
Portugal*	472	(3.6)	103	(1.9)	473	(4.2)	471	(4.0)	2	(3.8)	297	(6.9)	337	(6.0)	401	(5.2)	547	(3.4)	602	(3.5)	634	(4.3)	336
Republic of Ireland*	506	(3.4)	102	(1.6)	503	(4.8)	509	(3.5)	-7	(4.8)	331	(5.4)	370	(5.0)	437	(4.5)	579	(3.1)	635	(3.8)	666	(4.5)	335
*Romania**	407	(6.0)	104	(3.1)	403	(6.0)	412	(6.7)	-9	(4.6)	239	(7.5)	273	(6.8)	335	(7.9)	480	(6.8)	541	(7.0)	576	(8.2)	337
Russian Federation	481	(4.2)	102	(1.6)	478	(4.5)	483	(4.4)	-5	(3.1)	311	(6.5)	350	(5.6)	413	(4.9)	551	(4.7)	611	(5.1)	647	(4.7)	337
Scotland	521	(4.1)	113	(2.2)	523	(5.3)	520	(4.1)	3	(4.8)	335	(10.1)	375	(5.6)	443	(5.0)	601	(4.4)	666	(5.3)	705	(5.2)	371
Serbia	425	(3.7)	100	(1.9)	419	(4.0)	431	(4.8)	**-11**	(4.9)	260	(5.4)	295	(4.5)	357	(4.8)	495	(4.6)	554	(4.4)	589	(4.8)	328
Slovak Republic*	478	(3.3)	108	(2.5)	478	(4.8)	478	(3.6)	0	(5.6)	294	(8.1)	336	(5.8)	407	(4.6)	554	(4.2)	615	(4.1)	647	(4.1)	353
*Slovenia**	516	(1.3)	100	(1.0)	510	(2.3)	522	(2.0)	**-12**	(3.4)	351	(4.3)	386	(3.1)	447	(2.0)	586	(2.6)	647	(3.2)	679	(3.1)	328
Spain*	485	(3.0)	101	(1.2)	484	(3.4)	485	(3.1)	-1	(2.5)	315	(5.5)	355	(3.6)	418	(3.6)	556	(3.2)	610	(3.2)	641	(3.8)	326
Sweden*	496	(2.6)	106	(1.5)	494	(3.1)	499	(3.2)	-5	(3.4)	318	(6.4)	359	(4.9)	425	(3.5)	570	(3.0)	630	(3.3)	664	(3.2)	346
Switzerland	519	(3.4)	111	(1.9)	520	(3.6)	517	(3.9)	2	(2.9)	325	(6.4)	368	(5.0)	445	(4.4)	597	(3.5)	656	(4.5)	691	(5.5)	366
Turkey	417	(4.3)	97	(3.2)	410	(5.2)	426	(4.6)	**-16**	(4.7)	271	(4.6)	302	(3.7)	352	(3.3)	479	(6.9)	548	(9.2)	589	(10.5)	318
United Kingdom*	514	(2.5)	117	(1.7)	517	(3.1)	510	(3.1)	6	(3.8)	316	(6.2)	361	(4.3)	434	(3.6)	597	(2.9)	661	(3.2)	699	(3.8)	382
United States	489	(5.0)	116	(2.5)	486	(6.1)	491	(4.6)	-5	(4.1)	296	(10.1)	335	(8.8)	405	(7.0)	573	(5.1)	640	(5.2)	677	(5.9)	381
Wales	504	(4.1)	112	(2.1)	507	(4.6)	501	(4.8)	6	(4.6)	321	(7.1)	360	(7.0)	426	(5.4)	565	(4.4)	647	(4.7)	684	(5.6)	364
OECD average	499	(0.6)	108	(0.4)	498	(0.8)	501	(0.7)	**-3**	(0.8)	316	(1.3)	357	(1.1)	427	(0.8)	576	(0.7)	635	(0.7)	668	(0.8)	352

12 countries with scores below 430 omitted

Note: Values that are statistically significant are indicated in bold

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

A.7 Significant differences in mean scores on the *Identifying scientific issues* scale

	Mean score		significance
	Mean	S.E.	
Finland*	555	2.3	▲
New Zealand	536	2.9	▲
Australia	535	2.3	▲
Netherlands*	533	3.3	▲
Canada	532	2.3	▲
Hong Kong-China	528	3.2	NS
Liechtenstein	522	3.7	NS
Japan	522	4.0	NS
Korea	519	3.7	NS
*Slovenia**	517	1.4	NS
Republic of Ireland*	516	3.3	NS
*Estonia**	516	2.6	NS
Belgium*	515	2.7	NS
Switzerland	515	3.0	NS
England	515	2.8	
United Kingdom*	514	2.3	
Germany*	510	3.8	NS
Chinese Taipei	509	3.7	NS
Austria*	505	3.7	NS
Czech Republic*	500	4.2	NS
France*	499	3.5	▼
Sweden*	499	2.6	▼
OECD average[1]	**499**	**0.5**	▼
Iceland	494	1.7	▼
Croatia	494	2.6	▼
Denmark*	493	3.0	▼
United States	492	3.8	▼
Macao-China	490	1.2	▼
Norway	489	3.1	▼
Spain*	489	2.4	▼
*Latvia**	489	3.3	▼
Portugal*	486	3.1	▼
Poland*	483	2.5	▼
Luxembourg*	483	1.1	▼
Hungary*	483	2.6	▼
*Lithuania**	476	2.7	▼
Slovak Republic*	475	3.2	▼
Italy*	474	2.2	▼
Greece*	469	3.0	▼
Russian Federation	463	4.2	▼
Israel	457	3.9	▼
Chile	444	4.1	▼
Serbia	431	3.0	▼
Turkey	427	3.4	▼
*Bulgaria**	427	6.3	▼
Mexico	421	2.6	▼
*Romania**	409	3.6	▼

key

▲	significantly higher
NS	no significant difference
▼	significantly lower

OECD countries (not italicised)
Countries not in OECD (italicised)
*EU countries

12 countries with scores below 430 omitted

Multiple comparison P-value = 0.045%

[1] Simple comparison P-value = 5%

A.8 Significant differences in mean scores on the *Explaining phenomena scientifically* scale

	Mean score		significance
	Mean	S.E.	
Finland*	566	2.0	▲
Hong Kong-China	549	2.5	▲
Chinese Taipei	545	3.7	▲
*Estonia**	541	2.6	▲
Canada	531	2.1	▲
Czech Republic*	527	3.5	*NS*
Japan	527	3.1	*NS*
*Slovenia**	523	1.5	*NS*
New Zealand	522	2.8	*NS*
Netherlands*	522	2.7	*NS*
Australia	520	2.3	*NS*
Macao-China	520	1.2	*NS*
Germany*	519	3.7	*NS*
England	518	2.7	
Hungary*	518	2.6	*NS*
United Kingdom*	517	2.3	
Austria*	516	4.0	*NS*
Liechtenstein	516	4.1	*NS*
Korea	512	3.3	*NS*
Sweden*	510	2.9	*NS*
Switzerland	508	3.3	*NS*
Poland*	506	2.5	▼
Republic of Ireland*	505	3.2	*NS*
Belgium*	503	2.5	▼
Denmark*	501	3.3	▼
Slovak Republic*	501	2.7	▼
OECD average[1]	**500**	**0.5**	▼
Norway	495	3.0	▼
*Lithuania**	494	3.0	▼
Croatia	492	2.5	▼
Spain*	490	2.4	▼
Iceland	488	1.5	▼
*Latvia**	486	2.9	▼
United States	486	4.3	▼
Russian Federation	483	3.4	▼
Luxembourg*	483	1.1	▼
France*	481	3.2	▼
Italy*	480	2.0	▼
Greece*	476	3.0	▼
Portugal*	469	2.9	▼
*Bulgaria**	444	5.8	▼
Israel	443	3.6	▼
Serbia	441	3.1	▼
Chile	432	4.1	▼
*Romania**	426	4.0	▼
Turkey	423	4.1	▼
Mexico	406	2.7	▼

key

▲	significantly higher
NS	no significant difference
▼	significantly lower

OECD countries (not italicised)
Countries not in OECD (italicised)
*EU countries

12 countries with scores below 430 omitted

Multiple comparison P-value = 0.045%

[1] Simple comparison P-value = 5%

A.9 Significant differences in mean scores on the *Using scientific evidence* scale

	Mean score		significance
	Mean	S.E.	
Finland*	567	2.3	▲
Japan	544	4.2	▲
Hong Kong-China	542	2.7	▲
Canada	542	2.2	▲
Korea	538	3.7	▲
New Zealand	537	3.3	▲
Liechtenstein	535	4.3	▲
Chinese Taipei	532	3.7	▲
Australia	531	2.4	▲
*Estonia**	531	2.7	▲
Netherlands*	526	3.3	*NS*
Switzerland	519	3.4	*NS*
*Slovenia**	516	1.3	*NS*
Belgium*	516	3.0	*NS*
Germany*	515	4.6	*NS*
England	514	2.9	
United Kingdom*	514	2.5	
Macao-China	512	1.2	*NS*
France*	511	3.9	*NS*
Republic of Ireland*	506	3.4	*NS*
Austria*	505	4.7	*NS*
Czech Republic*	501	4.1	*NS*
OECD average[1]	**499**	**0.6**	▼
Hungary*	497	3.4	*NS*
Sweden*	496	2.6	▼
Poland*	494	2.7	▼
Luxembourg*	492	1.1	▼
Iceland	491	1.7	▼
*Latvia**	491	3.4	▼
Croatia	490	3.0	▼
Denmark*	489	3.6	▼
United States	489	5.0	▼
*Lithuania**	487	3.1	▼
Spain*	485	3.0	▼
Russian Federation	481	4.2	▼
Slovak Republic*	478	3.3	▼
Norway	473	3.6	▼
Portugal*	472	3.6	▼
Italy*	467	2.3	▼
Greece*	465	4.0	▼
Israel	460	4.7	▼
Chile	440	5.1	▼
Serbia	425	3.7	▼
Turkey	417	4.3	▼
*Bulgaria**	417	7.5	▼
*Romania**	407	6.0	▼
Mexico	402	3.1	▼

key

▲	significantly higher
NS	no significant difference
▼	significantly lower

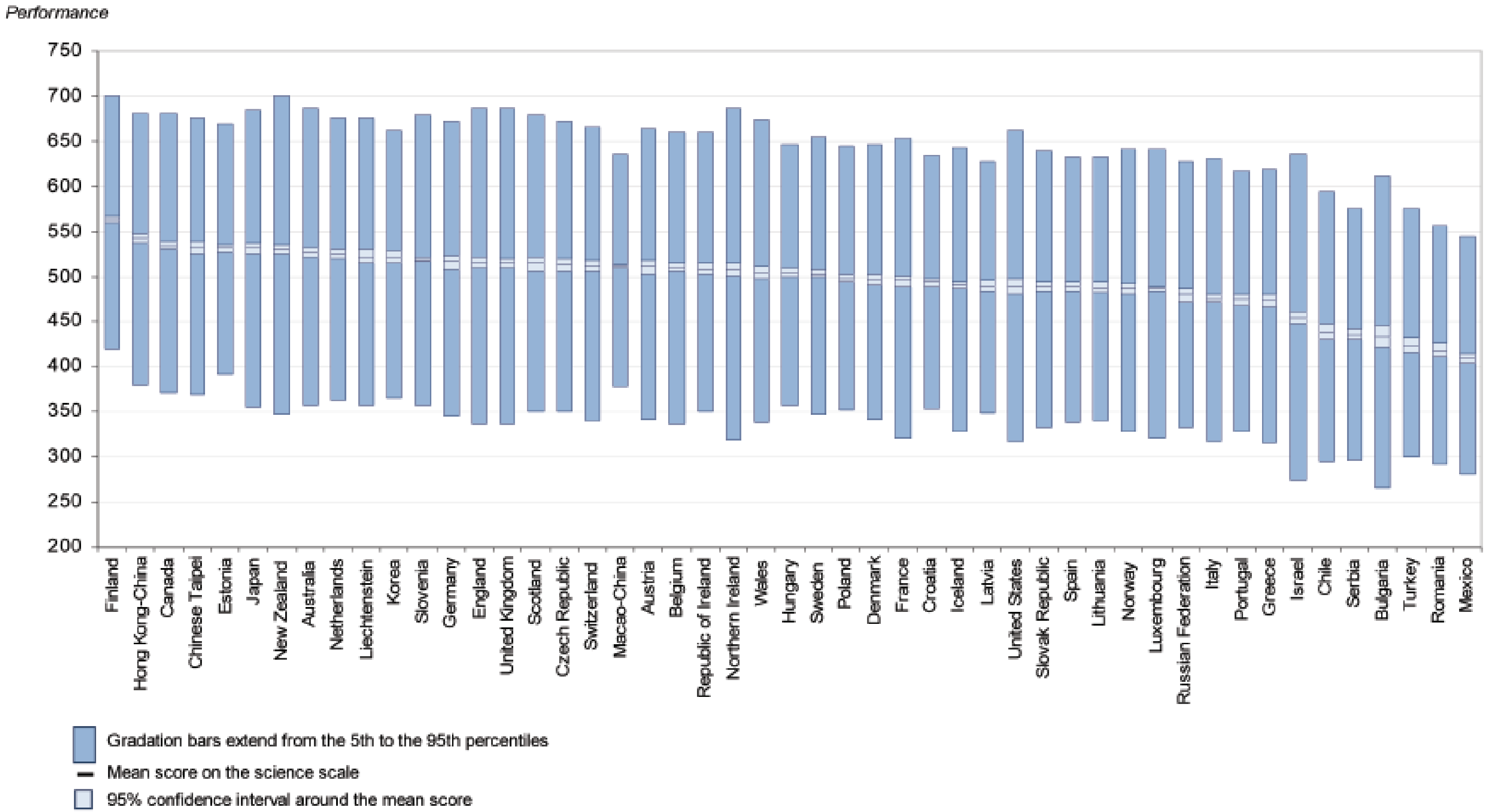
OECD countries (not italicised)
Countries not in OECD (italicised)
*EU countries

12 countries with scores below 430 omitted

Multiple comparison P-value = 0.045%

[1] Simple comparison P-value = 5%

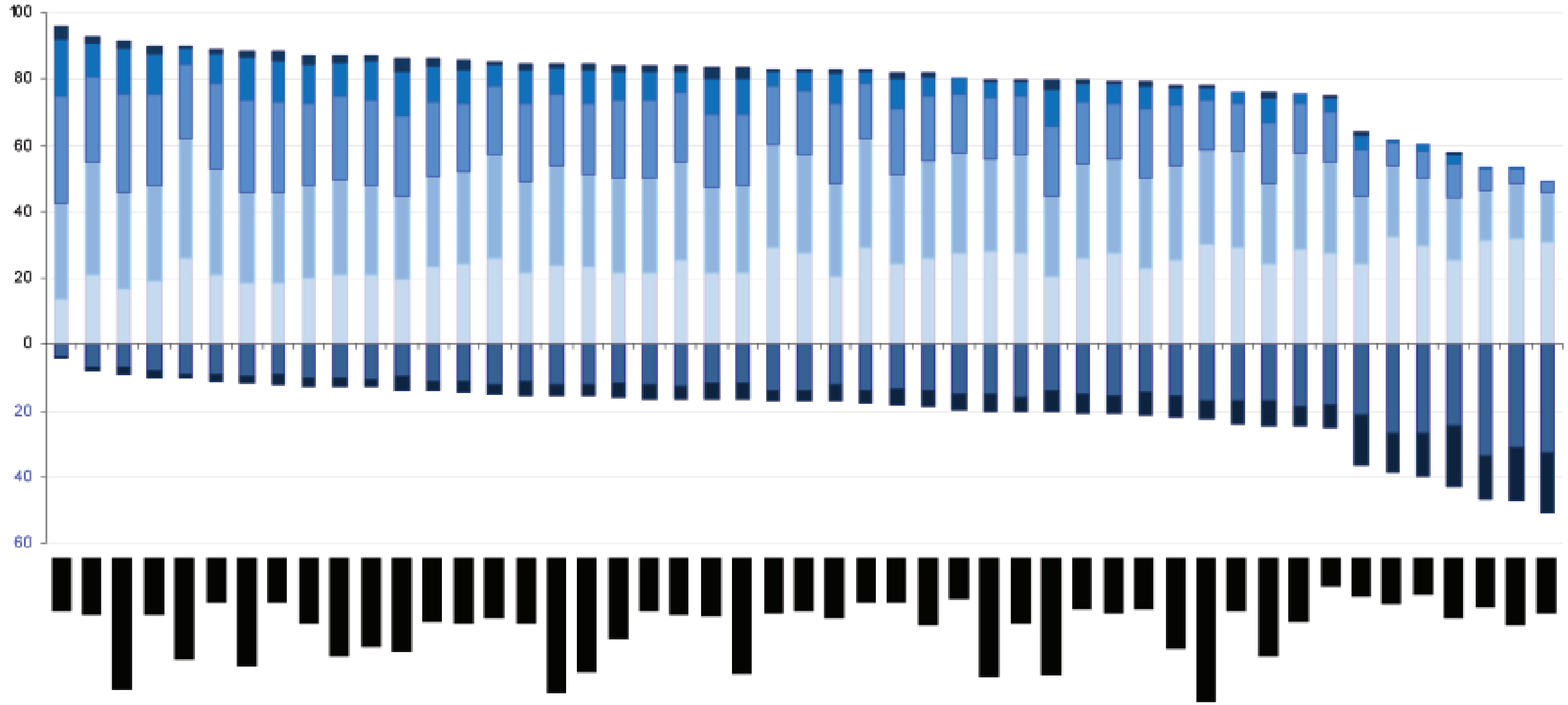
A.10 Distribution of student performance on the science scale



Countries are ranked in descending order of mean score.

12 countries with scores below 430 omitted

A.11 Summary of percentage of students at each level of proficiency on the science scale



Countries are ranked in descending order of percentage of 15-year-olds in Levels 2, 3, 4, 5 and 6.

12 countries with scores below 430 omitted

A.12 Percentage of students at each level of proficiency on the science scale

	Proficiency levels													
	Below level 1		Level 1		Level 2		Level 3		Level 4		Level 5		Level 6	
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
Australia	3.0	(0.3)	9.8	(0.5)	20.2	(0.6)	27.7	(0.5)	24.6	(0.5)	11.8	(0.5)	2.8	(0.3)
Austria*	4.3	(0.9)	12.0	(1.0)	21.8	(1.0)	28.3	(1.0)	23.6	(1.1)	8.8	(0.7)	1.2	(0.2)
Belgium*	4.8	(0.7)	12.2	(0.6)	20.8	(0.8)	27.6	(0.8)	24.5	(0.8)	9.1	(0.5)	1.0	(0.2)
Bulgaria*	18.3	(1.7)	24.3	(1.3)	25.2	(1.2)	18.8	(1.1)	10.3	(1.1)	2.6	(0.5)	0.4	(0.2)
Canada	2.2	(0.3)	7.8	(0.5)	19.1	(0.6)	28.8	(0.6)	27.7	(0.6)	12.0	(0.5)	2.4	(0.2)
Chile	13.1	(1.1)	26.7	(1.5)	29.9	(1.2)	20.1	(1.4)	8.4	(1.0)	1.8	(0.3)	0.1	(0.1)
Chinese Taipei	1.9	(0.3)	9.7	(0.8)	18.6	(0.9)	27.3	(0.8)	27.9	(1.0)	12.9	(0.8)	1.7	(0.2)
Croatia	3.0	(0.4)	14.0	(0.7)	29.3	(0.9)	31.0	(1.0)	17.7	(0.9)	4.6	(0.4)	0.5	(0.1)
Czech Republic*	3.5	(0.6)	12.1	(0.8)	23.4	(1.2)	27.8	(1.1)	21.7	(0.9)	9.8	(0.9)	1.8	(0.3)
Denmark*	4.3	(0.6)	14.1	(0.8)	26.0	(1.1)	29.3	(1.0)	19.5	(0.9)	6.1	(0.7)	0.7	(0.2)
England	4.9	(0.6)	11.8	(0.7)	21.5	(0.9)	25.7	(0.8)	22.1	(0.7)	11.0	(0.6)	3.0	(0.4)
Estonia*	1.0	(0.2)	6.7	(0.6)	21.0	(0.9)	33.7	(1.0)	26.2	(0.9)	10.1	(0.7)	1.4	(0.3)
Finland*	0.5	(0.1)	3.6	(0.4)	13.6	(0.7)	29.1	(1.1)	32.2	(0.9)	17.0	(0.7)	3.9	(0.3)
France*	6.6	(0.7)	14.5	(1.0)	22.8	(1.1)	27.2	(1.1)	20.9	(1.0)	7.2	(0.6)	0.8	(0.2)
Germany*	4.1	(0.7)	11.3	(1.0)	21.4	(1.1)	27.9	(1.1)	23.6	(0.9)	10.0	(0.6)	1.8	(0.2)
Greece*	7.2	(0.9)	16.9	(0.9)	28.9	(1.2)	29.4	(1.0)	14.2	(0.8)	3.2	(0.3)	0.2	(0.1)
Hong Kong-China	1.7	(0.4)	7.0	(0.7)	16.9	(0.8)	28.7	(0.9)	29.7	(1.0)	13.9	(0.8)	2.1	(0.3)
Hungary*	2.7	(0.3)	12.3	(0.8)	26.0	(1.2)	31.1	(1.1)	21.0	(0.9)	6.2	(0.6)	0.6	(0.2)
Iceland	5.8	(0.5)	14.7	(0.8)	25.9	(0.7)	28.3	(0.9)	19.0	(0.7)	5.6	(0.5)	0.7	(0.2)
Israel	14.9	(1.2)	21.2	(1.0)	24.0	(0.9)	20.8	(1.0)	13.8	(0.8)	4.4	(0.5)	0.8	(0.2)
Italy*	7.3	(0.5)	18.0	(0.6)	27.6	(0.8)	27.4	(0.6)	15.1	(0.6)	4.2	(0.3)	0.4	(0.1)
Japan	3.2	(0.4)	8.9	(0.7)	18.5	(0.9)	27.5	(0.9)	27.0	(1.1)	12.4	(0.6)	2.6	(0.3)
Korea	2.5	(0.5)	8.7	(0.8)	21.2	(1.0)	31.8	(1.2)	25.5	(0.9)	9.2	(0.8)	1.1	(0.3)
Latvia*	3.6	(0.5)	13.8	(1.0)	29.0	(1.2)	32.9	(0.9)	16.6	(1.0)	3.8	(0.4)	0.3	(0.1)
Liechtenstein	2.6	(1.0)	10.3	(2.1)	21.0	(2.8)	28.7	(2.6)	25.2	(2.5)	10.0	(1.8)	2.2	(0.8)
Lithuania*	4.3	(0.4)	16.0	(0.8)	27.4	(0.9)	29.8	(0.9)	17.5	(0.8)	4.5	(0.6)	0.4	(0.2)
Luxembourg*	6.5	(0.4)	15.6	(0.7)	25.4	(0.7)	28.6	(0.9)	18.1	(0.7)	5.4	(0.3)	0.5	(0.1)
Macao-China	1.4	(0.2)	8.9	(0.5)	26.0	(1.0)	35.7	(1.1)	22.8	(0.7)	5.0	(0.3)	0.3	(0.1)
Mexico	18.2	(1.2)	32.8	(0.9)	30.8	(1.0)	14.8	(0.7)	3.2	(0.3)	0.3	(0.1)	0.0	-
Netherlands*	2.3	(0.4)	10.7	(0.9)	21.1	(1.0)	26.9	(0.9)	25.8	(1.0)	11.5	(0.8)	1.7	(0.2)
New Zealand	4.0	(0.4)	9.7	(0.6)	19.7	(0.8)	25.1	(0.7)	23.9	(0.8)	13.6	(0.7)	4.0	(0.4)
Northern Ireland	6.6	(0.7)	13.7	(0.7)	20.6	(1.1)	24.3	(1.5)	20.9	(1.4)	11.2	(1.1)	2.7	(0.4)
Norway	5.9	(0.8)	15.2	(0.8)	27.3	(0.8)	28.5	(1.0)	17.1	(0.7)	5.5	(0.4)	0.6	(0.1)
Poland*	3.2	(0.4)	13.8	(0.6)	27.5	(0.9)	29.4	(1.0)	19.3	(0.8)	6.1	(0.4)	0.7	(0.1)
Portugal*	5.8	(0.8)	18.7	(1.0)	28.8	(0.9)	28.8	(1.2)	14.7	(0.9)	3.0	(0.4)	0.1	(0.1)
Republic of Ireland*	3.5	(0.5)	12.0	(0.8)	24.0	(0.9)	29.7	(1.0)	21.4	(0.9)	8.3	(0.6)	1.1	(0.2)
Romania*	16.0	(1.5)	30.9	(1.6)	31.8	(1.6)	16.6	(1.2)	4.2	(0.8)	0.5	(0.1)	0.0	-
Russian Federation	5.2	(0.7)	17.0	(1.1)	30.2	(0.9)	28.3	(1.3)	15.1	(1.1)	3.7	(0.5)	0.5	(0.1)
Scotland	3.6	(0.6)	11.0	(1.0)	24.1	(1.2)	27.9	(1.1)	20.7	(1.1)	10.1	(0.9)	2.4	(0.5)
Serbia	11.9	(0.9)	26.6	(1.2)	32.3	(1.3)	21.8	(1.2)	6.6	(0.6)	0.8	(0.2)	0.0	-
Slovak Republic*	5.2	(0.6)	15.0	(0.9)	28.0	(1.0)	28.1	(1.0)	17.9	(1.0)	5.2	(0.5)	0.6	(0.1)
Slovenia*	2.8	(0.3)	11.1	(0.7)	23.1	(0.7)	27.6	(1.1)	22.5	(1.1)	10.7	(0.6)	2.2	(0.3)
Spain*	4.7	(0.4)	14.9	(0.7)	27.4	(0.8)	30.2	(0.7)	17.9	(0.8)	4.5	(0.4)	0.3	(0.1)
Sweden*	3.8	(0.4)	12.6	(0.6)	25.2	(0.9)	29.5	(0.9)	21.1	(0.9)	6.8	(0.5)	1.1	(0.2)
Switzerland	4.5	(0.5)	11.6	(0.6)	21.8	(0.9)	28.2	(0.8)	23.5	(1.1)	9.1	(0.8)	1.4	(0.3)
Turkey	12.9	(0.8)	33.7	(1.3)	31.3	(1.4)	15.1	(1.1)	6.2	(1.2)	0.9	(0.3)	0.0	-
United Kingdom*	4.8	(0.5)	11.9	(0.6)	21.8	(0.7)	25.9	(0.7)	21.8	(0.6)	10.9	(0.5)	2.9	(0.3)
United States	7.6	(0.9)	16.8	(0.9)	24.2	(0.9)	24.0	(0.8)	18.3	(1.0)	7.5	(0.6)	1.5	(0.2)
Wales	4.5	(0.7)	13.6	(0.8)	24.3	(1.0)	26.9	(1.0)	19.8	(1.0)	9.0	(0.8)	1.9	(0.4)
OECD average	5.2	(0.1)	14.1	(0.1)	24.0	(0.2)	27.4	(0.2)	20.3	(0.2)	7.7	(0.1)	1.3	(0.0)

12 countries with scores below 430 omitted

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

Appendix B Chapter 4 tables and figures

B.1 Significant differences in mean scores on the mathematics scale

	Mean score		significance
	Mean	S.E.	
Chinese Taipei	549	4.1	▲
Finland*	548	2.3	▲
Hong Kong-China	547	2.7	▲
Korea	547	3.8	▲
Netherlands*	531	2.6	▲
Switzerland	530	3.2	▲
Canada	527	2.0	▲
Macao-China	525	1.3	▲
Liechtenstein	525	4.2	▲
Japan	523	3.3	▲
New Zealand	522	2.4	▲
Belgium*	520	3.0	▲
Australia	520	2.2	▲
*Estonia**	515	2.7	▲
Denmark*	513	2.6	▲
Czech Republic*	510	3.6	▲
Iceland	506	1.8	▲
Austria*	505	3.7	*NS*
*Slovenia**	504	1.0	▲
Germany*	504	3.9	*NS*
Sweden*	502	2.4	*NS*
Republic of Ireland*	501	2.8	*NS*
OECD average[1]	**498**	**0.5**	*NS*
France*	496	3.2	*NS*
United Kingdom*	495	2.1	
Poland*	495	2.4	*NS*
England	495	2.5	
Slovak Republic*	492	2.8	*NS*
Hungary*	491	2.9	*NS*
Luxembourg*	490	1.1	*NS*
Norway	490	2.6	*NS*
*Lithuania**	486	2.9	*NS*
*Latvia**	486	3.0	*NS*
Spain*	480	2.3	▼
Azerbaijan	476	2.3	▼
Russian Federation	476	3.9	▼
United States	474	4.0	▼
Croatia	467	2.4	▼
Portugal*	466	3.1	▼
Italy*	462	2.3	▼
Greece*	459	3.0	▼
Israel	442	4.3	▼
Serbia	435	3.5	▼
Turkey	424	4.9	▼
*Romania**	415	4.2	▼
*Bulgaria**	413	6.1	▼
Mexico	406	2.9	▼

key
▲ significantly higher
NS no significant difference
▼ significantly lower

OECD countries (not italicised)
Countries not in OECD (italicised)
*EU countries

12 countries with scores below 430 omitted

Multiple comparison P-value = 0.045%

[1] Simple comparison P-value = 5%

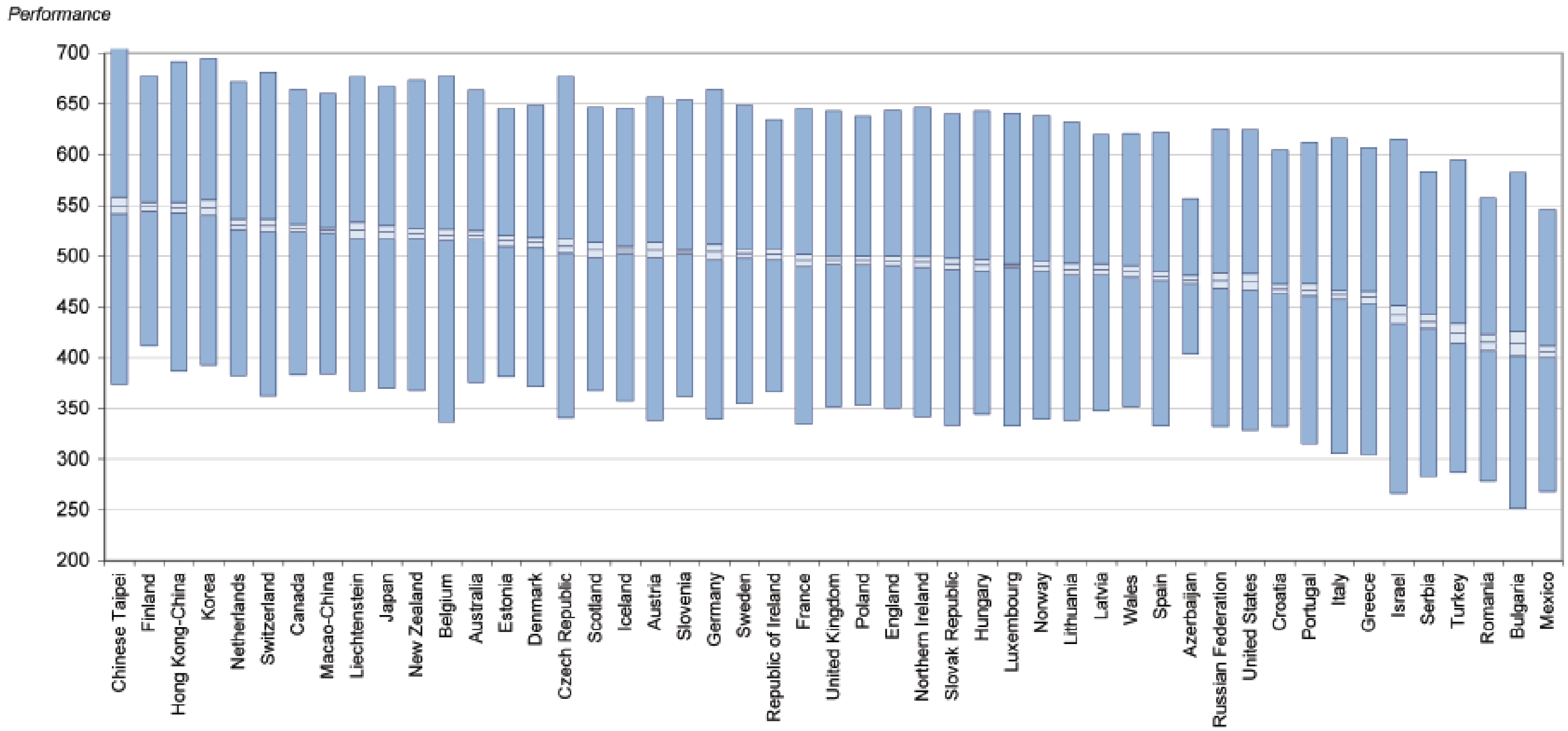
B.2 Mean score, variation and gender differences in student performance on the mathematics scale

	All students				Gender differences						Percentiles												
	Mean score		Standard deviation		Males		Females		Difference (M - F)		5th		10th		25th		75th		90th		95th		difference between 5th & 95th percentile
	Mean	S.E.	S.D.	S.E.	Mean score	S.E.	Mean score	S.E.	Score diff.	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	
Australia	520	(2.2)	88	(1.1)	527	(3.2)	513	(2.4)	**14**	(3.4)	375	(3.2)	406	(2.7)	460	(2.3)	581	(2.5)	633	(3.3)	663	(4.0)	289
Austria*	505	(3.7)	98	(2.3)	517	(4.4)	494	(4.1)	**23**	(4.7)	338	(6.8)	373	(6.3)	438	(5.5)	577	(4.0)	630	(3.8)	657	(4.0)	319
Azerbaijan	476	(2.3)	48	(1.7)	475	(2.4)	477	(2.6)	-1	(2.0)	403	(2.4)	419	(2.2)	443	(2.5)	505	(3.0)	536	(3.6)	556	(5.2)	153
Belgium*	520	(3.0)	106	(3.3)	524	(4.1)	517	(3.4)	7	(4.8)	337	(8.9)	381	(6.6)	451	(4.0)	598	(2.5)	650	(2.4)	678	(2.7)	341
*Bulgaria**	413	(6.1)	101	(3.6)	412	(6.7)	415	(6.5)	-4	(4.9)	251	(8.3)	287	(7.2)	345	(6.1)	481	(6.8)	543	(8.4)	583	(11.0)	332
Canada	527	(2.0)	86	(1.1)	534	(2.4)	520	(2.0)	**14**	(1.9)	383	(4.0)	416	(3.3)	470	(2.4)	587	(2.3)	635	(2.3)	664	(3.3)	281
Chinese Taipei	549	(4.1)	103	(2.2)	556	(4.7)	543	(5.9)	**13**	(6.7)	373	(7.2)	409	(6.2)	477	(6.1)	625	(3.3)	677	(3.4)	707	(3.9)	333
Croatia	467	(2.4)	83	(1.5)	474	(3.2)	461	(2.8)	**13**	(3.8)	332	(4.3)	361	(3.3)	410	(3.0)	524	(3.3)	576	(3.6)	605	(3.8)	273
Czech Republic*	510	(3.6)	103	(2.1)	514	(4.2)	504	(4.8)	11	(5.6)	340	(5.2)	376	(4.7)	441	(4.3)	582	(4.7)	644	(4.8)	677	(6.0)	337
Denmark*	513	(2.6)	85	(1.5)	518	(2.9)	508	(3.0)	**10**	(2.8)	371	(5.0)	404	(4.3)	456	(3.4)	572	(2.8)	621	(3.4)	649	(4.3)	278
England	495	(2.5)	89	(1.6)	504	(3.0)	487	(3.1)	**17**	(3.5)	350	(6.1)	380	(3.7)	434	(3.1)	557	(3.0)	613	(3.6)	643	(4.3)	293
*Estonia**	515	(2.7)	80	(1.5)	515	(3.3)	514	(3.0)	1	(3.2)	381	(5.9)	411	(4.3)	461	(3.5)	570	(3.3)	618	(3.2)	646	(4.1)	264
Finland*	548	(2.3)	81	(1.0)	554	(2.7)	543	(2.6)	**12**	(2.6)	411	(5.0)	444	(3.4)	494	(2.6)	605	(2.6)	652	(2.8)	678	(3.0)	266
France*	496	(3.2)	96	(2.0)	499	(4.0)	492	(3.3)	6	(3.7)	334	(5.5)	369	(5.4)	429	(4.7)	565	(3.8)	617	(3.8)	646	(4.0)	312
Germany*	504	(3.9)	99	(2.6)	513	(4.6)	494	(3.9)	**20**	(3.7)	339	(8.5)	375	(6.8)	437	(4.9)	574	(3.9)	632	(3.8)	664	(4.6)	325
Greece*	459	(3.0)	92	(2.4)	462	(4.3)	457	(3.0)	5	(4.5)	304	(7.3)	341	(5.6)	399	(3.9)	522	(4.0)	575	(4.1)	607	(4.5)	303
Hong Kong-China	547	(2.7)	93	(2.4)	555	(3.9)	540	(3.7)	**16**	(5.5)	386	(6.1)	423	(6.4)	486	(4.5)	614	(3.1)	665	(3.5)	692	(4.8)	306
Hungary*	491	(2.9)	91	(2.0)	496	(3.5)	486	(3.7)	**10**	(4.3)	343	(5.6)	377	(3.9)	431	(2.9)	551	(4.1)	609	(5.0)	643	(5.8)	299
Iceland	506	(1.8)	88	(1.1)	503	(2.6)	508	(2.2)	-4	(3.2)	357	(3.5)	391	(3.6)	446	(2.4)	567	(2.4)	618	(3.2)	646	(4.4)	289
Israel	442	(4.3)	107	(3.3)	448	(6.6)	436	(4.3)	12	(6.9)	266	(11.2)	304	(6.9)	368	(5.4)	518	(4.7)	581	(5.0)	615	(4.7)	350
Italy*	462	(2.3)	96	(1.7)	470	(2.9)	453	(2.7)	**17**	(3.4)	305	(4.4)	341	(3.3)	398	(2.7)	527	(2.8)	584	(4.2)	616	(3.8)	311
Japan	523	(3.3)	91	(2.1)	533	(4.8)	513	(4.9)	**20**	(7.2)	370	(6.4)	404	(5.5)	463	(4.6)	587	(3.0)	638	(3.6)	668	(4.2)	298
Korea	547	(3.8)	93	(3.1)	552	(5.3)	543	(4.5)	9	(6.3)	392	(7.1)	426	(6.1)	485	(4.3)	612	(4.4)	664	(6.9)	694	(8.2)	302
*Latvia**	486	(3.0)	83	(1.6)	489	(3.5)	484	(3.2)	5	(3.0)	347	(5.6)	378	(5.2)	432	(3.6)	542	(3.2)	590	(3.4)	619	(4.2)	272
Liechtenstein	525	(4.2)	93	(3.2)	525	(7.4)	525	(7.0)	0	(11.7)	367	(9.7)	402	(11.1)	464	(10.0)	588	(5.2)	643	(9.5)	677	(10.6)	310
*Lithuania**	486	(2.9)	90	(1.8)	487	(3.3)	485	(3.3)	2	(3.0)	338	(4.9)	369	(4.3)	426	(3.3)	549	(3.6)	602	(4.9)	632	(4.6)	294
Luxembourg*	490	(1.1)	93	(1.0)	498	(1.7)	482	(1.8)	**17**	(2.8)	332	(4.4)	368	(3.5)	426	(1.9)	555	(1.9)	610	(2.7)	641	(3.6)	309
Macao-China	525	(1.3)	84	(0.9)	530	(2.1)	520	(1.7)	**11**	(2.9)	384	(3.6)	416	(3.1)	467	(2.1)	585	(2.0)	632	(2.4)	660	(3.3)	276
Mexico	406	(2.9)	85	(2.2)	410	(3.4)	401	(3.1)	**9**	(2.6)	268	(6.6)	299	(4.9)	349	(3.7)	463	(2.8)	514	(3.3)	546	(4.2)	278
Netherlands*	531	(2.6)	89	(2.2)	537	(3.1)	524	(2.8)	**13**	(2.8)	382	(6.0)	412	(5.0)	467	(4.6)	596	(2.7)	645	(3.3)	672	(4.3)	290
New Zealand	522	(2.4)	93	(1.2)	527	(3.1)	517	(3.6)	**11**	(4.7)	368	(3.6)	401	(4.1)	458	(3.2)	587	(3.0)	643	(4.0)	674	(3.6)	306
Northern Ireland	494	(2.8)	93	(1.9)	497	(5.3)	491	(4.4)	7	(8.1)	341	(6.8)	373	(4.9)	427	(4.3)	561	(3.5)	616	(3.4)	647	(4.8)	306
Norway	490	(2.6)	92	(1.4)	493	(3.3)	487	(2.8)	**6**	(3.1)	339	(6.0)	373	(3.8)	428	(3.9)	552	(2.8)	609	(3.3)	638	(2.8)	299
Poland*	495	(2.4)	87	(1.2)	500	(2.8)	491	(2.7)	**9**	(2.6)	353	(3.3)	384	(3.4)	435	(2.8)	557	(3.3)	610	(3.7)	638	(3.5)	285
Portugal*	466	(3.1)	91	(2.0)	474	(3.7)	459	(3.2)	**15**	(3.3)	315	(6.5)	348	(5.2)	404	(4.2)	530	(3.0)	583	(2.8)	612	(3.8)	297
Republic of Ireland*	501	(2.8)	82	(1.5)	507	(3.7)	496	(3.2)	**11**	(4.1)	366	(4.6)	396	(4.4)	445	(4.1)	559	(3.1)	608	(3.2)	634	(2.9)	268
*Romania**	415	(4.2)	84	(2.9)	418	(4.2)	412	(4.9)	**7**	(3.3)	278	(6.5)	307	(7.4)	358	(5.5)	470	(4.9)	523	(7.1)	557	(7.7)	279
Russian Federation	476	(3.9)	90	(1.7)	479	(4.6)	473	(3.9)	6	(3.3)	331	(5.4)	363	(4.8)	416	(4.2)	535	(5.1)	592	(5.3)	625	(5.5)	294
Scotland	506	(3.6)	85	(1.9)	514	(4.2)	498	(4.0)	**16**	(4.0)	367	(6.2)	398	(4.6)	447	(4.2)	564	(4.7)	616	(5.1)	647	(6.5)	279
Serbia	435	(3.5)	92	(1.8)	438	(4.0)	433	(4.4)	5	(4.5)	282	(6.2)	318	(5.0)	375	(4.4)	498	(3.8)	553	(3.9)	584	(4.4)	302
Slovak Republic*	492	(2.8)	95	(2.5)	499	(3.7)	485	(3.5)	**14**	(4.6)	333	(7.0)	370	(5.1)	433	(3.6)	558	(3.5)	611	(4.4)	640	(4.8)	308
*Slovenia**	504	(1.0)	89	(0.9)	507	(1.8)	502	(1.8)	5	(2.9)	361	(2.7)	390	(2.1)	441	(2.4)	566	(2.1)	623	(2.7)	654	(3.8)	292
Spain*	480	(2.3)	89	(1.1)	484	(2.6)	476	(2.6)	**9**	(2.2)	332	(4.4)	366	(2.8)	421	(3.2)	542	(2.5)	593	(2.9)	622	(3.3)	290
Sweden*	502	(2.4)	90	(1.4)	505	(2.7)	500	(3.0)	5	(2.9)	354	(5.6)	387	(4.2)	442	(3.5)	565	(3.2)	617	(2.8)	649	(4.2)	295
Switzerland	530	(3.2)	97	(1.6)	536	(3.3)	523	(3.6)	**13**	(2.7)	362	(5.5)	401	(4.7)	464	(4.1)	600	(3.7)	652	(3.7)	682	(4.2)	320
Turkey	424	(4.9)	93	(4.3)	427	(5.6)	421	(5.1)	6	(4.6)	287	(6.1)	316	(4.0)	360	(3.3)	477	(7.2)	550	(12.4)	595	(15.8)	308
United Kingdom*	495	(2.1)	89	(1.3)	504	(2.6)	487	(2.6)	**17**	(2.9)	351	(5.0)	381	(3.3)	434	(2.7)	557	(2.5)	612	(3.2)	643	(3.8)	292
United States	474	(4.0)	90	(1.9)	479	(4.6)	470	(3.9)	**9**	(2.9)	328	(7.6)	358	(5.8)	411	(4.8)	537	(5.0)	593	(4.8)	625	(4.8)	297
Wales	484	(2.9)	83	(1.2)	492	(3.1)	476	(3.5)	**16**	(3.3)	351	(4.0)	378	(3.7)	428	(3.0)	541	(3.4)	592	(4.4)	621	(4.9)	270
OECD average	498	(0.5)	92	(0.4)	503	(0.7)	492	(0.6)	**11**	(0.7)	346	(1.1)	379	(0.9)	436	(0.7)	561	(0.6)	615	(0.8)	645	(0.9)	300

12 countries with scores below 430 omitted

Note: Values that are statistically significant are indicated in bold — OECD countries (not italicised) — *Countries not in OECD (italicised)* — *EU countries

B.3 Distribution of student performance on the mathematics scale



Countries are ranked in descending order of mean score.

12 countries with scores below 430 omitted

Gradation bars extend from the 5th to the 95th percentiles

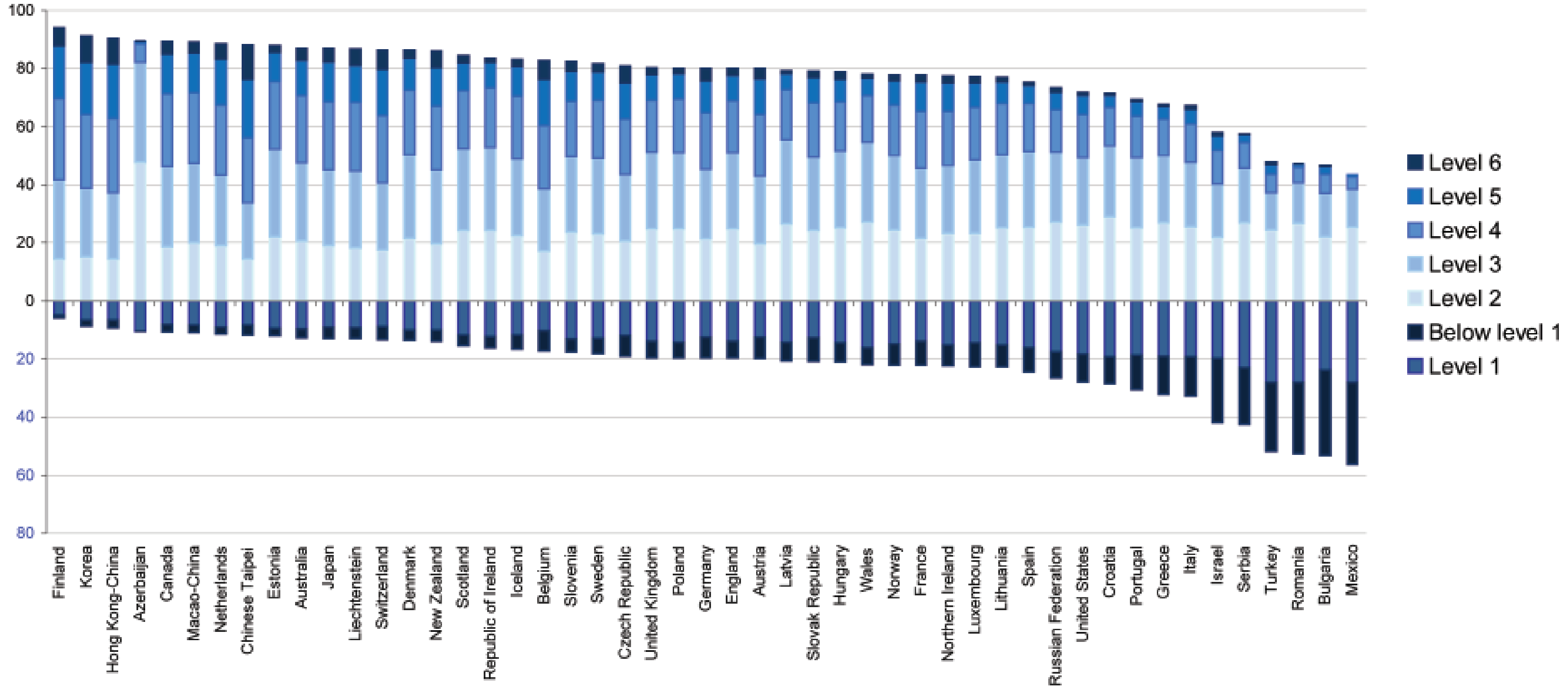
Mean score on the mathematics scale

95% confidence interval around the mean score

B.4 Summary descriptions for the six levels of proficiency in mathematics

LEVEL	*What students can typically do*
6	At Level 6 students can conceptualise, generalise, and utilise information based on their investigations and modelling 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.
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 characterisations, and insight pertaining to these situations. They can reflect on their actions and formulate and communicate their interpretations and reasoning.
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 utilise 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.
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.
2	At Level 2 students can interpret and recognise 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, formulae, procedures, or conventions. They are capable of direct reasoning and making literal interpretations of the results.
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.

B.5 Summary of percentage of students at each level of proficiency on the mathematics scale



Countries are ranked in descending order of percentage of 15-year-olds in Levels 2, 3, 4, 5 and 6.

12 countries with scores below 430 omitted

B.6 Percentage of students at each level of proficiency on the mathematics scale

	Proficiency levels													
	Below level 1		Level 1		Level 2		Level 3		Level 4		Level 5		Level 6	
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
Australia	3.3	(0.3)	9.7	(0.4)	20.5	(0.6)	26.9	(0.6)	23.2	(0.5)	12.1	(0.5)	4.3	(0.5)
Austria*	7.5	(0.9)	12.5	(1.1)	19.5	(1.1)	23.3	(0.9)	21.3	(1.1)	12.3	(0.8)	3.5	(0.5)
Azerbaijan	0.2	(0.1)	10.4	(1.0)	47.6	(1.6)	34.4	(1.6)	6.6	(0.9)	0.6	(0.3)	0.2	(0.1)
Belgium*	7.1	(0.9)	10.2	(0.7)	17.0	(0.7)	21.4	(0.7)	21.9	(0.8)	16.0	(0.7)	6.4	(0.4)
*Bulgaria**	29.4	(2.2)	23.9	(1.1)	22.0	(1.0)	14.9	(1.1)	6.7	(0.8)	2.5	(0.6)	0.6	(0.3)
Canada	2.8	(0.3)	8.0	(0.5)	18.6	(0.6)	27.5	(0.7)	25.1	(0.7)	13.6	(0.6)	4.4	(0.4)
Chinese Taipei	3.6	(0.6)	8.3	(0.7)	14.3	(0.9)	19.4	(0.7)	22.4	(0.8)	20.1	(0.9)	11.8	(0.8)
Croatia	9.3	(0.7)	19.3	(0.9)	28.9	(1.1)	24.3	(0.9)	13.6	(0.7)	4.0	(0.5)	0.8	(0.2)
Czech Republic*	7.2	(0.7)	11.9	(0.8)	20.5	(1.0)	23.0	(0.9)	19.1	(1.1)	12.3	(0.8)	6.0	(0.7)
Denmark*	3.6	(0.5)	10.0	(0.7)	21.4	(0.8)	28.8	(0.9)	22.5	(0.8)	10.9	(0.6)	2.8	(0.4)
England	6.0	(0.7)	13.9	(0.8)	24.7	(1.0)	26.2	(0.8)	18.0	(0.7)	8.7	(0.6)	2.5	(0.3)
*Estonia**	2.7	(0.5)	9.4	(0.8)	21.9	(0.9)	30.2	(1.0)	23.3	(1.1)	10.0	(0.6)	2.6	(0.4)
Finland*	1.1	(0.2)	4.8	(0.5)	14.4	(0.7)	27.2	(0.7)	28.1	(0.8)	18.1	(0.8)	6.3	(0.5)
France*	8.4	(0.8)	13.9	(1.0)	21.4	(1.2)	24.2	(1.0)	19.6	(1.0)	9.9	(0.7)	2.6	(0.5)
Germany*	7.3	(1.0)	12.5	(0.8)	21.2	(1.1)	24.0	(1.1)	19.4	(0.9)	11.0	(0.8)	4.5	(0.5)
Greece*	13.3	(1.1)	19.0	(1.2)	26.8	(0.9)	23.2	(1.1)	12.6	(1.0)	4.2	(0.5)	0.9	(0.2)
Hong Kong-China	2.9	(0.5)	6.6	(0.6)	14.4	(0.8)	22.7	(1.1)	25.6	(0.9)	18.7	(0.8)	9.0	(0.8)
Hungary*	6.7	(0.6)	14.5	(0.8)	25.1	(1.0)	26.5	(0.9)	16.9	(1.1)	7.7	(0.7)	2.6	(0.5)
Iceland	5.1	(0.4)	11.7	(0.7)	22.3	(0.9)	26.6	(1.0)	21.7	(0.9)	10.1	(0.7)	2.5	(0.3)
Israel	22.2	(1.5)	19.8	(1.0)	21.8	(1.0)	18.4	(0.9)	11.8	(0.8)	4.8	(0.5)	1.3	(0.2)
Italy*	13.5	(0.7)	19.3	(0.7)	25.5	(0.7)	22.1	(0.7)	13.3	(0.6)	5.0	(0.4)	1.3	(0.3)
Japan	3.9	(0.6)	9.1	(0.7)	18.9	(0.9)	26.1	(1.0)	23.7	(1.0)	13.5	(0.8)	4.8	(0.5)
Korea	2.3	(0.5)	6.5	(0.7)	15.2	(0.7)	23.5	(1.1)	25.5	(1.0)	18.0	(0.8)	9.1	(1.3)
*Latvia**	6.4	(0.6)	14.3	(0.9)	26.3	(0.9)	29.0	(1.0)	17.4	(1.1)	5.5	(0.5)	1.1	(0.3)
Liechtenstein	4.0	(1.1)	9.2	(2.0)	18.2	(3.0)	26.4	(3.8)	23.7	(2.9)	12.6	(2.1)	5.8	(1.2)
*Lithuania**	7.8	(0.6)	15.2	(0.8)	25.1	(1.0)	25.1	(1.1)	17.8	(0.8)	7.3	(0.8)	1.8	(0.4)
Luxembourg*	8.3	(0.5)	14.5	(0.7)	23.2	(0.7)	25.2	(0.8)	18.2	(1.0)	8.2	(0.5)	2.3	(0.3)
Macao-China	2.6	(0.3)	8.3	(0.6)	20.0	(0.9)	27.3	(0.9)	24.4	(0.8)	13.6	(0.6)	3.8	(0.4)
Mexico	28.4	(1.4)	28.1	(0.9)	25.2	(0.8)	13.1	(0.6)	4.3	(0.4)	0.8	(0.2)	0.1	(0.0)
Netherlands*	2.4	(0.6)	9.1	(0.8)	18.9	(0.9)	24.3	(0.9)	24.1	(1.1)	15.8	(0.8)	5.4	(0.6)
New Zealand	4.0	(0.3)	10.0	(0.8)	19.5	(1.0)	25.5	(1.1)	22.1	(1.0)	13.2	(0.7)	5.7	(0.5)
Northern Ireland	7.3	(0.9)	15.3	(1.0)	23.2	(1.1)	23.3	(1.3)	18.8	(1.0)	9.6	(0.8)	2.6	(0.3)
Norway	7.3	(0.7)	14.9	(1.0)	24.3	(0.8)	25.6	(1.0)	17.4	(0.8)	8.3	(0.7)	2.1	(0.3)
Poland*	5.7	(0.4)	14.2	(0.7)	24.7	(0.8)	26.2	(0.7)	18.6	(0.8)	8.6	(0.7)	2.0	(0.3)
Portugal*	12.0	(1.0)	18.7	(0.9)	25.1	(0.9)	24.0	(0.9)	14.4	(0.8)	4.9	(0.4)	0.8	(0.2)
Republic of Ireland*	4.1	(0.5)	12.3	(0.9)	24.1	(1.0)	28.6	(0.9)	20.6	(0.9)	8.6	(0.7)	1.6	(0.2)
*Romania**	24.7	(2.2)	28.0	(1.9)	26.5	(1.8)	14.1	(1.1)	5.4	(0.8)	1.1	(0.3)	0.1	(0.1)
Russian Federation	9.1	(0.9)	17.6	(1.1)	27.0	(1.4)	24.2	(0.9)	14.7	(1.0)	5.7	(0.6)	1.7	(0.3)
Scotland	3.8	(0.7)	11.7	(0.9)	24.1	(1.1)	28.2	(1.2)	20.0	(1.2)	9.4	(0.9)	2.7	(0.5)
Serbia	19.6	(1.3)	23.0	(1.1)	26.8	(0.9)	18.7	(1.0)	9.1	(0.7)	2.4	(0.4)	0.4	(0.1)
Slovak Republic*	8.1	(0.7)	12.8	(0.9)	24.1	(1.0)	25.3	(1.0)	18.8	(0.9)	8.6	(0.7)	2.4	(0.4)
*Slovenia**	4.6	(0.3)	13.1	(0.8)	23.5	(0.8)	26.0	(0.8)	19.2	(0.8)	10.3	(0.8)	3.4	(0.4)
Spain*	8.6	(0.5)	16.1	(0.8)	25.2	(0.9)	26.2	(0.6)	16.8	(0.5)	6.1	(0.4)	1.2	(0.2)
Sweden*	5.4	(0.6)	12.9	(0.8)	23.0	(0.8)	26.0	(1.0)	20.1	(0.9)	9.7	(0.6)	2.9	(0.4)
Switzerland	4.6	(0.5)	9.0	(0.6)	17.4	(1.0)	23.2	(0.8)	23.2	(0.9)	15.9	(0.7)	6.8	(0.6)
Turkey	24.0	(1.4)	28.1	(1.4)	24.3	(1.3)	12.8	(0.8)	6.7	(0.9)	3.0	(0.8)	1.2	(0.5)
United Kingdom*	5.9	(0.6)	13.8	(0.7)	24.7	(0.8)	26.3	(0.7)	18.1	(0.6)	8.7	(0.5)	2.5	(0.3)
United States	9.9	(1.2)	18.2	(0.9)	26.1	(1.2)	23.1	(1.1)	15.1	(1.0)	6.4	(0.7)	1.3	(0.2)
Wales	6.0	(0.5)	16.1	(0.9)	27.0	(1.1)	27.5	(1.1)	16.1	(1.1)	6.0	(0.6)	1.2	(0.3)
OECD average	7.7	(0.1)	13.6	(0.2)	21.9	(0.2)	24.3	(0.2)	19.1	(0.2)	10.0	(0.1)	3.3	(0.1)

12 countries with scores below 430 omitted

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

Appendix C Chapter 5 tables and figures

C.1 Significant differences in mean scores on the reading scale

	Mean score		significance
	Mean	S.E.	
Korea	556	3.8	▲
Finland*	547	2.1	▲
Hong Kong-China	536	2.4	▲
Canada	527	2.4	▲
New Zealand	521	3.0	▲
Republic of Ireland*	517	3.5	▲
Australia	513	2.1	▲
Liechtenstein	510	3.9	NS
Poland*	508	2.8	NS
Sweden*	507	3.4	NS
Netherlands*	507	2.9	NS
Belgium*	501	3.0	NS
*Estonia**	501	2.9	NS
Switzerland	499	3.1	NS
Japan	498	3.6	NS
Chinese Taipei	496	3.4	NS
England	496	2.7	
United Kingdom*	495	2.3	
Germany*	495	4.4	NS
Denmark*	494	3.2	NS
*Slovenia**	494	1.0	NS
Macao-China	492	1.1	NS
OECD average[1]	**492**	**0.6**	NS
Austria*	490	4.1	NS
France*	488	4.1	NS
Iceland	484	1.9	▼
Norway	484	3.2	NS
Czech Republic*	483	4.2	NS
Hungary*	482	3.3	NS
*Latvia**	479	3.7	▼
Luxembourg*	479	1.3	▼
Croatia	477	2.8	▼
Portugal*	472	3.6	▼
*Lithuania**	470	3.0	▼
Italy*	469	2.4	▼
Slovak Republic*	466	3.1	▼
Spain*	461	2.2	▼
Greece*	460	4.0	▼
Turkey	447	4.2	▼
Chile	442	5.0	▼
Russian Federation	440	4.3	▼
Israel	439	4.6	▼
Mexico	410	3.1	▼
*Bulgaria**	402	6.9	▼
*Romania**	396	4.7	▼

key

▲ significantly higher
NS no significant difference
▼ significantly lower

OECD countries (not italicised)
Countries not in OECD (italicised)
*EU countries

13 countries with scores below 430 omitted

Multiple comparison P-value = 0.045%

[1] Simple comparison P-value = 5%

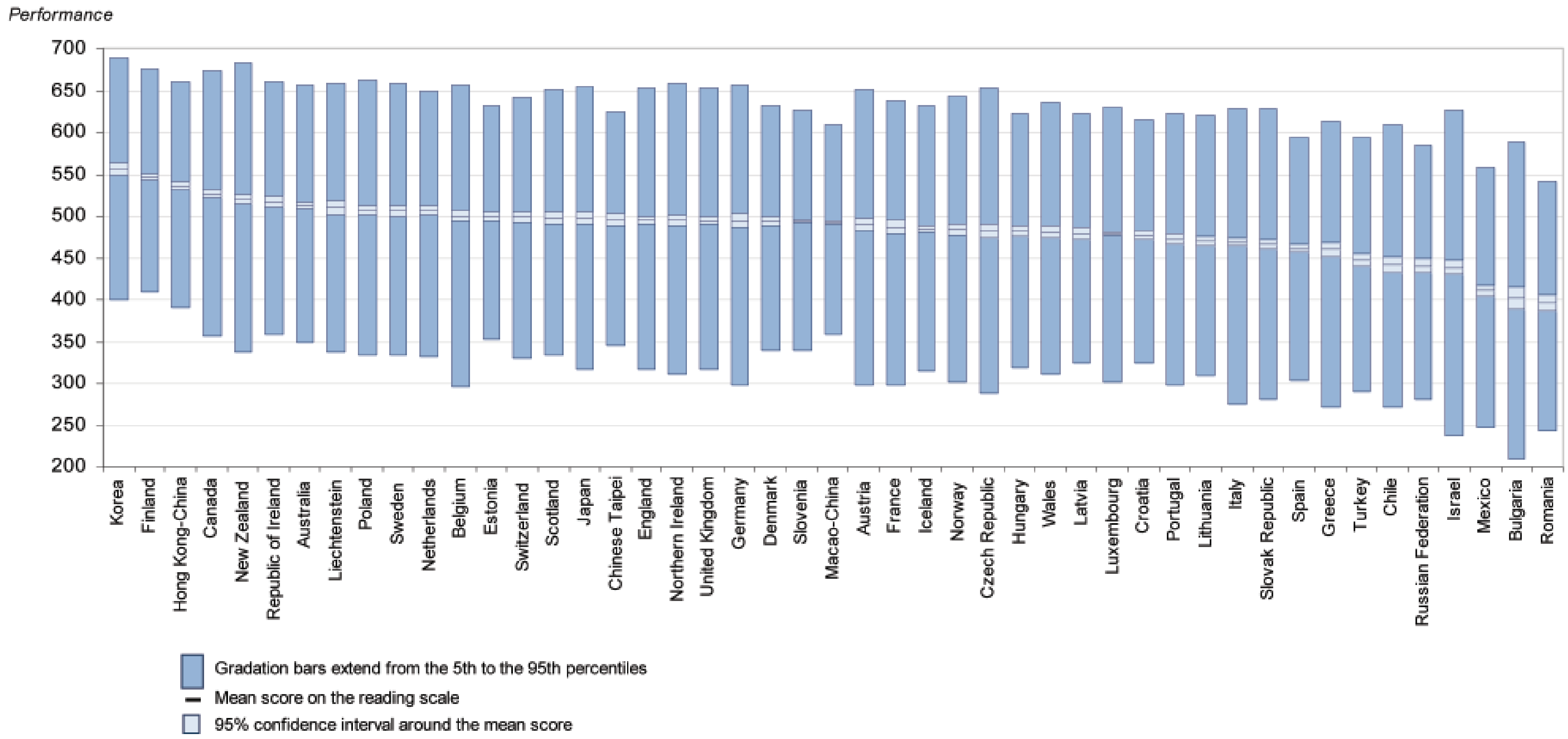
C.2 Mean score, variation and gender differences in student performance on the reading scale

	All students				Gender differences						Percentiles												
	Mean score		Standard deviation		Males		Females		Difference (M - F)		5th		10th		25th		75th		90th		95th		difference between 5th & 95th percentile
	Mean	S.E.	S.D.	S.E.	Mean score	S.E.	Mean score	S.E.	Score diff.	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	Score	S.E.	
Australia	513	(2.1)	94	(1.0)	495	(3.0)	532	(2.2)	**-37**	(3.6)	349	(3.4)	388	(3.4)	453	(2.4)	579	(2.3)	628	(2.9)	656	(2.6)	307
Austria*	490	(4.1)	108	(3.2)	468	(4.9)	513	(5.5)	**-45**	(6.0)	298	(11.9)	348	(9.4)	421	(5.5)	568	(3.7)	621	(3.1)	651	(3.7)	353
Belgium*	501	(3.0)	110	(2.8)	482	(4.1)	522	(3.5)	**-40**	(4.8)	297	(10.1)	347	(8.3)	433	(4.7)	581	(2.3)	631	(2.2)	657	(2.8)	360
*Bulgaria**	402	(6.9)	118	(4.0)	374	(7.7)	432	(6.9)	**-58**	(6.3)	210	(11.4)	251	(9.0)	321	(8.5)	486	(7.6)	554	(7.8)	589	(8.5)	380
Canada	527	(2.4)	96	(1.4)	511	(2.8)	543	(2.5)	**-32**	(2.3)	357	(4.8)	402	(3.9)	468	(3.0)	593	(2.6)	644	(2.7)	674	(3.9)	316
Chile	442	(5.0)	103	(2.5)	434	(6.0)	451	(5.4)	**-17**	(5.7)	271	(7.5)	310	(5.8)	373	(5.4)	513	(6.4)	575	(6.7)	609	(6.6)	338
Chinese Taipei	496	(3.4)	84	(1.8)	486	(4.4)	507	(4.2)	**-21**	(5.4)	346	(5.8)	381	(5.9)	442	(4.9)	556	(3.0)	598	(3.0)	624	(4.0)	278
Croatia	477	(2.8)	89	(2.1)	452	(3.8)	502	(3.3)	**-50**	(4.7)	324	(6.6)	359	(5.4)	418	(4.1)	540	(3.0)	589	(3.4)	615	(3.3)	291
Czech Republic*	483	(4.2)	111	(2.9)	463	(5.0)	509	(5.4)	**-46**	(6.2)	290	(10.5)	335	(7.0)	408	(6.2)	564	(3.8)	621	(4.2)	653	(4.3)	363
Denmark*	494	(3.2)	89	(1.6)	480	(3.6)	509	(3.5)	**-30**	(3.2)	339	(6.4)	378	(5.0)	437	(3.9)	557	(2.9)	604	(3.7)	633	(5.1)	293
England	496	(2.7)	102	(2.0)	481	(3.6)	510	(3.0)	**-29**	(4.1)	317	(6.5)	358	(4.8)	431	(3.3)	567	(3.0)	622	(3.6)	654	(4.0)	337
*Estonia**	501	(2.9)	85	(2.0)	478	(3.2)	524	(3.1)	**-46**	(2.7)	353	(7.2)	389	(5.4)	448	(3.8)	560	(2.8)	606	(3.2)	632	(3.8)	279
Finland*	547	(2.1)	81	(1.1)	521	(2.7)	572	(2.3)	**-51**	(2.8)	410	(4.8)	441	(3.8)	494	(2.9)	603	(2.2)	649	(2.5)	675	(2.8)	265
France*	488	(4.1)	104	(2.8)	470	(5.2)	505	(3.9)	**-35**	(4.4)	298	(9.7)	346	(7.5)	421	(6.1)	564	(3.8)	614	(4.0)	639	(4.1)	341
Germany*	495	(4.4)	112	(2.7)	475	(5.3)	517	(4.4)	**-42**	(3.9)	299	(9.7)	350	(8.0)	429	(5.9)	573	(3.4)	625	(3.7)	657	(3.7)	359
Greece*	460	(4.0)	103	(2.9)	432	(5.7)	488	(3.5)	**-57**	(5.6)	272	(11.6)	321	(8.5)	398	(5.2)	531	(3.8)	583	(4.2)	613	(4.5)	341
Hong Kong-China	536	(2.4)	82	(1.9)	520	(3.5)	551	(3.0)	**-31**	(4.5)	390	(6.2)	426	(5.8)	484	(3.7)	594	(2.4)	636	(2.9)	660	(2.7)	270
Hungary*	482	(3.3)	94	(2.4)	463	(3.7)	503	(3.9)	**-40**	(4.1)	318	(9.1)	359	(5.0)	422	(4.8)	549	(3.6)	595	(4.4)	623	(4.6)	305
Iceland	484	(1.9)	97	(1.4)	460	(2.8)	509	(2.3)	**-48**	(3.3)	314	(4.7)	356	(4.1)	423	(3.0)	552	(2.8)	603	(3.2)	633	(3.9)	318
Israel	439	(4.6)	119	(2.8)	417	(6.5)	460	(4.6)	**-42**	(6.8)	237	(10.1)	280	(8.0)	356	(6.2)	526	(4.8)	588	(4.9)	626	(5.0)	389
Italy*	469	(2.4)	109	(1.8)	448	(3.4)	489	(2.8)	**-41**	(4.0)	276	(5.9)	325	(4.8)	402	(3.6)	546	(2.3)	599	(2.9)	627	(2.8)	351
Japan	498	(3.6)	102	(2.4)	483	(5.4)	513	(5.2)	**-31**	(7.7)	317	(6.8)	361	(6.6)	433	(6.1)	569	(3.4)	623	(3.5)	654	(3.8)	337
Korea	556	(3.8)	88	(2.7)	539	(4.6)	574	(4.5)	**-35**	(5.9)	399	(9.7)	440	(7.9)	503	(4.8)	617	(3.4)	663	(4.3)	688	(5.0)	289
*Latvia**	479	(3.7)	91	(1.8)	454	(4.3)	504	(3.5)	**-50**	(3.2)	325	(6.7)	361	(5.4)	419	(4.9)	543	(4.2)	593	(4.0)	622	(4.8)	297
Liechtenstein	510	(3.9)	95	(4.0)	486	(7.7)	531	(6.3)	**-45**	(11.7)	337	(14.0)	379	(10.6)	452	(9.9)	578	(6.5)	623	(10.5)	658	(11.5)	321
*Lithuania**	470	(3.0)	96	(1.5)	445	(3.5)	496	(3.2)	**-51**	(3.0)	309	(4.4)	343	(3.9)	405	(4.0)	538	(3.9)	591	(3.9)	621	(4.0)	312
Luxembourg*	479	(1.3)	100	(1.1)	464	(2.0)	495	(2.1)	**-32**	(3.2)	302	(5.1)	344	(3.3)	415	(2.3)	552	(1.8)	602	(2.5)	630	(2.8)	329
Macao-China	492	(1.1)	77	(0.9)	479	(1.8)	505	(1.5)	**-26**	(2.4)	359	(4.3)	394	(2.5)	445	(1.9)	545	(1.6)	587	(1.8)	610	(2.4)	250
Mexico	410	(3.1)	96	(2.3)	393	(3.5)	427	(3.0)	**-34**	(2.5)	247	(7.5)	285	(6.2)	348	(4.2)	478	(2.8)	530	(3.1)	559	(3.0)	312
Netherlands*	507	(2.9)	97	(2.5)	495	(3.7)	519	(3.0)	**-24**	(3.4)	332	(10.0)	379	(6.4)	446	(4.3)	578	(2.5)	622	(2.4)	649	(3.5)	317
New Zealand	521	(3.0)	105	(1.6)	502	(3.6)	539	(3.6)	**-37**	(4.6)	339	(5.8)	381	(4.6)	453	(4.5)	595	(2.9)	651	(2.8)	683	(4.5)	344
Northern Ireland	495	(3.5)	106	(2.8)	479	(5.5)	512	(5.1)	**-33**	(8.0)	311	(8.3)	352	(8.7)	424	(5.5)	572	(3.2)	627	(4.8)	659	(6.0)	348
Norway	484	(3.2)	105	(1.9)	462	(3.8)	508	(3.3)	**-46**	(3.3)	301	(7.3)	346	(5.5)	416	(4.6)	558	(3.0)	613	(4.1)	643	(3.6)	342
Poland*	508	(2.8)	100	(1.5)	487	(3.4)	528	(2.8)	**-40**	(2.9)	335	(4.8)	374	(4.6)	441	(3.5)	579	(3.2)	633	(3.4)	663	(4.0)	328
Portugal*	472	(3.6)	99	(2.3)	455	(4.4)	488	(3.5)	**-33**	(3.7)	299	(7.6)	339	(6.3)	408	(5.3)	543	(3.6)	594	(3.7)	622	(4.5)	323
Republic of Ireland*	517	(3.5)	92	(1.9)	500	(4.5)	534	(3.8)	**-34**	(4.9)	358	(6.3)	395	(5.5)	457	(4.7)	582	(3.9)	633	(3.5)	661	(4.3)	303
*Romania**	396	(4.7)	92	(2.9)	374	(4.5)	418	(5.2)	**-44**	(3.4)	243	(6.6)	274	(7.2)	333	(7.3)	461	(5.2)	512	(5.6)	541	(6.1)	298
Russian Federation	440	(4.3)	93	(1.9)	420	(4.8)	458	(4.3)	**-38**	(3.2)	281	(7.3)	316	(6.0)	377	(5.7)	505	(4.2)	556	(3.6)	586	(4.9)	305
Scotland	499	(4.0)	96	(1.8)	486	(5.0)	512	(4.1)	**-26**	(4.4)	334	(7.8)	371	(6.2)	439	(4.3)	564	(4.1)	617	(4.7)	650	(7.3)	316
Slovak Republic*	466	(3.1)	105	(2.5)	446	(4.2)	488	(3.8)	**-42**	(5.4)	281	(7.1)	326	(6.6)	398	(4.3)	542	(3.4)	597	(3.8)	628	(3.3)	347
*Slovenia**	494	(1.0)	88	(0.9)	467	(1.9)	521	(1.4)	**-54**	(2.7)	340	(4.2)	377	(2.6)	437	(1.8)	558	(2.2)	603	(2.1)	627	(2.7)	287
Spain*	461	(2.2)	89	(1.2)	443	(2.6)	479	(2.3)	**-35**	(2.1)	304	(4.6)	343	(4.1)	405	(2.9)	523	(2.3)	569	(2.7)	594	(2.8)	291
Sweden*	507	(3.4)	98	(1.8)	488	(4.0)	528	(3.5)	**-40**	(3.2)	335	(7.7)	378	(5.6)	445	(3.8)	575	(3.3)	629	(4.0)	658	(4.9)	324
Switzerland	499	(3.1)	94	(1.8)	484	(3.2)	515	(3.3)	**-31**	(2.6)	331	(6.5)	373	(5.1)	440	(3.5)	566	(3.1)	615	(3.6)	642	(4.3)	311
Turkey	447	(4.2)	93	(2.8)	427	(5.1)	471	(4.3)	**-44**	(4.3)	291	(5.9)	330	(6.4)	388	(4.4)	510	(5.2)	564	(6.5)	594	(7.8)	303
United Kingdom*	495	(2.3)	102	(1.7)	480	(3.0)	510	(2.6)	**-29**	(3.5)	318	(5.2)	359	(4.0)	431	(2.8)	566	(2.5)	621	(3.1)	653	(3.6)	335
Wales	481	(3.7)	98	(2.3)	465	(4.2)	496	(4.2)	**-31**	(4.0)	312	(8.1)	352	(7.7)	417	(4.7)	550	(3.7)	603	(5.2)	635	(6.4)	323
OECD average	492	(0.6)	99	(0.4)	473	(0.7)	511	(0.7)	**-38**	(0.8)	317	(1.4)	360	(1.1)	429	(0.8)	562	(0.6)	613	(0.7)	642	(0.8)	324

13 countries with scores below 430 omitted

Note: Values that are statistically significant are indicated in bold   OECD countries (not italicised)   *Countries not in OECD (italicised)*   *EU countries

C3 Distribution of student performance on the reading scale

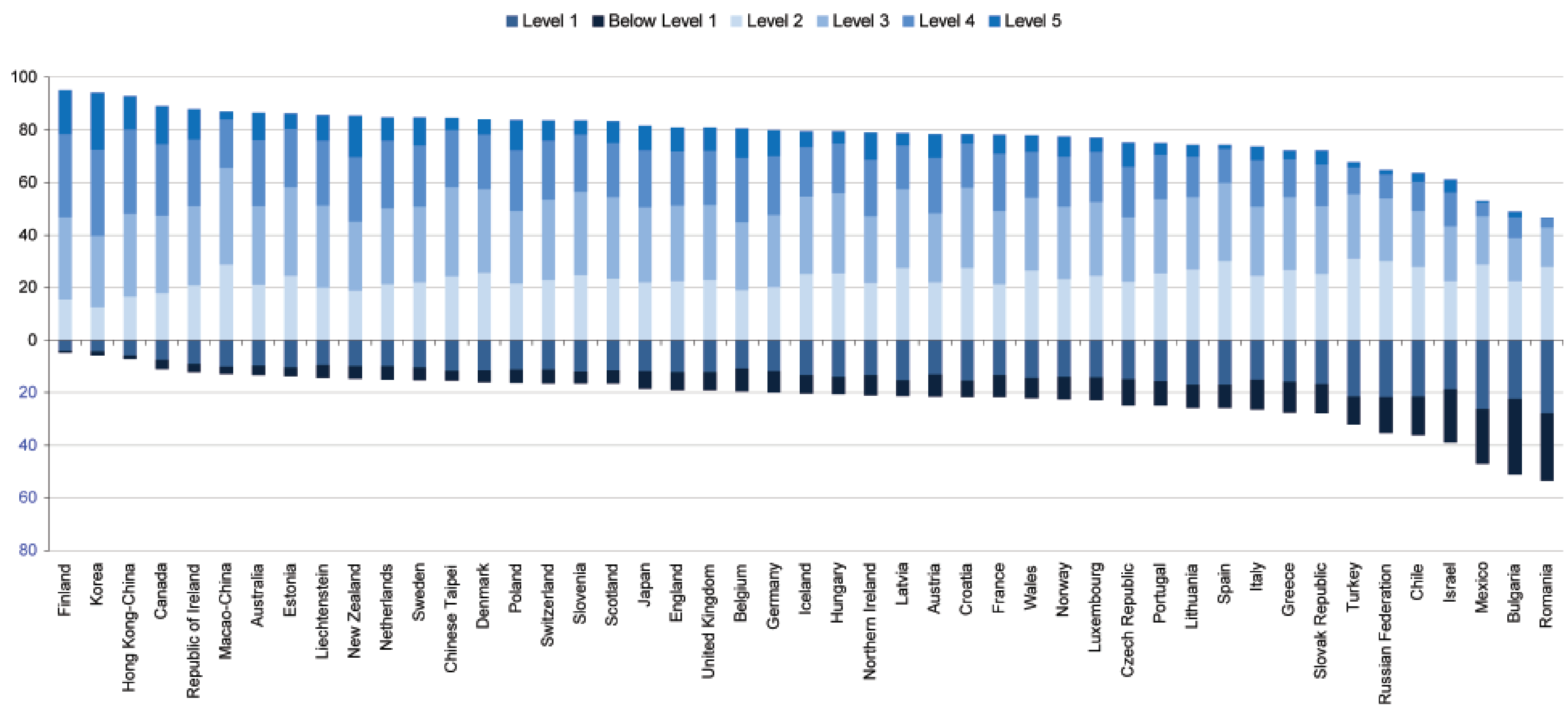


Countries are ranked in descending order of mean score. *13 countries with scores below 430 omitted*

C4 Summary descriptions for the five levels of proficiency in reading

LEVEL	*What students can typically do*
5	Locate and possibly sequence or combine multiple pieces of deeply embedded information, some of which may be outside the main body of the text. Infer which information in the text is relevant to the task. Deal with highly plausible and/or extensive competing information. Either construe the meaning of nuanced language or demonstrate a full and detailed understanding of a text. Critically evaluate or hypothesise, drawing on specialised knowledge. Deal with concepts that are contrary to expectations and draw on a deep understanding of long or complex texts. In continuous texts students can analyse texts whose discourse structure is not obvious or clearly marked, in order to discern the relationship of specific parts of the text to its implicit theme or intention. In non-continuous texts, students can identify patterns among many pieces of information presented in a display which may be long and detailed, sometimes by referring to information external to the display. The reader may need to realise independently that a full understanding of the section of text requires reference to a separate part of the same document, such as a footnote.
4	Locate and possibly sequence or combine multiple pieces of embedded information, each of which may need to meet multiple criteria, in a text with familiar context or form. Infer which information in the text is relevant to the task. Use a high level of text-based inference to understand and apply categories in an unfamiliar context, and to construe the meaning of a section of text by taking into account the text as a whole. Deal with ambiguities, ideas that are contrary to expectation and ideas that are negatively worded. Use formal or public knowledge to hypothesise about or critically evaluate a text. Show accurate understanding of long or complex texts. In continuous texts students can follow linguistic or thematic links over several paragraphs, often in the absence of clear discourse markers, in order to locate, interpret or evaluate embedded information or to infer psychological or metaphysical meaning. In non-continuous texts students can scan a long, detailed text in order to find relevant information, often with little or no assistance from organisers such as labels or special formatting, to locate several pieces of information to be compared or combined.
3	Locate, and in some cases recognise the relationship between pieces of information, each of which may need to meet multiple criteria. Deal with prominent competing information. Integrate several parts of a text in order to identify a main idea, understand a relationship or construe the meaning of a word or phrase. Compare, contrast or categorise taking many criteria into account. Deal with competing information. Make connections or comparisons, give explanations, or evaluate a feature of text. Demonstrate a detailed understanding of the text in relation to familiar, everyday knowledge, or draw on less common knowledge. In continuous texts students can use conventions of text organisation, where present, and follow implicit or explicit logical links such as cause and effect relationships across sentences or paragraphs in order to locate, interpret or evaluate information. In non-continuous texts students can consider one display in the light of a second, separate document or display, possibly in a different format, or combine several pieces of spatial, verbal and numeric information in a graph or map to draw conclusions about the information represented.
2	Locate one or more pieces of information, each of which may be required to meet multiple criteria. Deal with competing information. Identify the main idea in a text, understand relationships, form or apply simple categories, or construe meaning within a limited part of the text when the information is not prominent and low-level inferences are required. Make a comparison or connections between the text and outside knowledge, or explain a feature of the text by drawing on personal experience and attitudes. In continuous texts students can follow logical and linguistic connections within a paragraph in order to locate or interpret information; or synthesise information across texts or parts of a text in order to infer the author's purpose. In non-continuous texts students demonstrate a grasp of the underlying structure of a visual display such as a simple tree diagram or table, or combine two pieces of information from a graph or table.
1	Locate one or more independent pieces of explicitly stated information, typically meeting a single criterion, with little or no competing information in the text. Recognise the main theme or author's purpose in a text about a familiar topic, when the required information in the text is prominent. Make a simple connection between information in the text and common, everyday knowledge. In continuous texts students can use redundancy, paragraph headings or common print conventions to form an impression of the main idea of the text, or to locate information stated explicitly within a short section of text. In non-continuous texts students can focus on discrete pieces of information, usually within a single display such as a simple map, a line graph or a bar graph that presents only a small amount of information in a straightforward way, and in which most of the verbal text is limited to a small number of words or phrases.

C.5 Summary of percentage of students at each level of proficiency on the reading scale



Countries are ranked in descending order of percentage of 15-year-olds in Levels 2, 3, 4 and 5.

13 countries with scores below 430 omitted

C.6 Percentage of students at each level of proficiency on the reading scale

	Proficiency levels											
	Below level 1		Level 1		Level 2		Level 3		Level 4		Level 5	
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
Australia	3.8	(0.3)	9.6	(0.5)	21.0	(0.7)	30.1	(0.6)	24.9	(0.7)	10.6	(0.6)
Austria*	8.4	(1.1)	13.1	(0.8)	22.0	(1.2)	26.2	(1.0)	21.3	(1.0)	9.0	(0.7)
Belgium*	8.6	(0.9)	10.8	(0.6)	18.9	(0.7)	26.0	(0.8)	24.4	(0.9)	11.3	(0.6)
*Bulgaria**	28.8	(2.2)	22.3	(1.3)	22.4	(1.3)	16.4	(1.3)	8.1	(1.1)	2.1	(0.5)
Canada	3.4	(0.4)	7.6	(0.4)	18.0	(0.8)	29.4	(1.0)	27.2	(0.8)	14.5	(0.7)
Chile	14.8	(1.2)	21.5	(1.3)	28.0	(1.1)	21.1	(1.1)	11.0	(0.9)	3.5	(0.6)
Chinese Taipei	3.8	(0.6)	11.5	(0.9)	24.4	(0.9)	34.0	(1.1)	21.6	(1.0)	4.7	(0.6)
Croatia	6.2	(0.8)	15.3	(0.9)	27.6	(1.0)	30.6	(1.1)	16.5	(0.9)	3.7	(0.4)
Czech Republic*	9.9	(1.1)	14.9	(0.9)	22.3	(1.0)	24.5	(0.9)	19.3	(1.0)	9.2	(0.8)
Denmark*	4.5	(0.6)	11.5	(0.7)	25.7	(0.9)	31.8	(1.0)	20.7	(0.9)	5.9	(0.6)
England	6.8	(0.6)	12.1	(0.7)	22.5	(0.8)	28.7	(0.8)	20.6	(0.9)	9.2	(0.7)
*Estonia**	3.4	(0.6)	10.3	(0.7)	24.5	(0.8)	33.9	(1.0)	21.9	(1.0)	6.0	(0.6)
Finland*	0.8	(0.2)	4.0	(0.4)	15.5	(0.8)	31.2	(0.8)	31.8	(0.9)	16.7	(0.8)
France*	8.5	(1.0)	13.3	(1.0)	21.3	(1.0)	27.9	(1.3)	21.8	(1.2)	7.3	(0.7)
Germany*	8.3	(0.9)	11.8	(0.8)	20.3	(1.0)	27.3	(0.9)	22.5	(1.1)	9.9	(0.7)
Greece*	11.9	(1.2)	15.8	(0.8)	26.6	(1.2)	27.9	(1.1)	14.3	(0.9)	3.5	(0.4)
Hong Kong-China	1.3	(0.3)	5.9	(0.6)	16.5	(0.8)	31.5	(1.1)	32.0	(0.9)	12.8	(0.8)
Hungary*	6.6	(0.8)	14.0	(0.9)	25.3	(1.1)	30.6	(1.1)	18.8	(1.0)	4.7	(0.6)
Iceland	7.1	(0.5)	13.4	(0.7)	25.1	(1.0)	29.6	(0.8)	18.9	(1.0)	6.0	(0.5)
Israel	20.3	(1.4)	18.6	(0.8)	22.5	(1.0)	21.0	(0.8)	12.7	(0.8)	5.0	(0.5)
Italy*	11.4	(0.7)	15.0	(0.6)	24.5	(0.8)	26.4	(0.7)	17.5	(0.6)	5.2	(0.4)
Japan	6.7	(0.7)	11.7	(1.0)	22.0	(0.9)	28.7	(1.0)	21.5	(0.9)	9.4	(0.7)
Korea	1.4	(0.3)	4.3	(0.7)	12.5	(0.8)	27.2	(1.1)	32.7	(1.3)	21.7	(1.4)
*Latvia**	6.0	(0.7)	15.2	(1.1)	27.6	(1.2)	29.9	(1.4)	16.7	(1.2)	4.5	(0.5)
Liechtenstein	4.9	(1.2)	9.4	(2.0)	20.0	(2.4)	31.3	(2.6)	24.6	(2.8)	9.8	(1.8)
*Lithuania**	8.7	(0.6)	17.0	(0.9)	26.9	(1.1)	27.4	(1.0)	15.6	(1.0)	4.4	(0.5)
Luxembourg*	8.6	(0.4)	14.2	(0.6)	24.6	(0.7)	27.9	(0.7)	19.0	(0.7)	5.6	(0.4)
Macao-China	2.9	(0.3)	10.1	(0.6)	28.9	(0.9)	36.6	(1.2)	18.5	(0.8)	3.0	(0.3)
Mexico	21.0	(1.3)	26.0	(1.0)	28.9	(1.0)	18.2	(0.8)	5.3	(0.4)	0.6	(0.1)
Netherlands*	5.2	(0.7)	9.9	(0.9)	21.3	(0.9)	28.9	(1.0)	25.6	(1.0)	9.1	(0.6)
New Zealand	4.7	(0.5)	9.9	(0.7)	18.7	(0.8)	26.4	(0.8)	24.5	(0.8)	15.9	(0.8)
Northern Ireland	7.7	(1.0)	13.2	(1.0)	21.8	(1.3)	25.5	(1.1)	21.4	(1.2)	10.4	(1.0)
Norway	8.4	(0.7)	14.0	(0.7)	23.3	(0.8)	27.6	(0.9)	19.0	(0.8)	7.7	(0.6)
Poland*	5.0	(0.5)	11.2	(0.7)	21.5	(0.9)	27.5	(0.9)	23.1	(0.8)	11.6	(0.8)
Portugal*	9.3	(1.0)	15.6	(1.0)	25.5	(1.0)	28.2	(1.1)	16.8	(0.9)	4.6	(0.5)
Republic of Ireland*	3.2	(0.6)	9.0	(0.8)	20.9	(0.9)	30.2	(0.8)	25.1	(1.0)	11.7	(0.8)
*Romania**	25.6	(2.2)	27.9	(1.3)	27.9	(1.5)	15.1	(1.4)	3.2	(0.6)	0.3	(0.1)
Russian Federation	13.6	(1.4)	21.7	(1.0)	30.0	(0.9)	24.0	(1.3)	9.0	(0.7)	1.7	(0.3)
Scotland	5.2	(0.7)	11.5	(1.0)	23.5	(1.1)	30.9	(1.3)	20.6	(1.1)	8.5	(0.9)
Slovak Republic*	11.2	(0.9)	16.6	(0.9)	25.1	(1.0)	25.9	(1.2)	15.8	(0.8)	5.4	(0.5)
*Slovenia**	4.4	(0.4)	12.1	(0.6)	24.7	(0.8)	31.6	(1.0)	21.9	(0.8)	5.3	(0.5)
Spain*	8.7	(0.6)	17.0	(0.6)	30.2	(0.7)	29.7	(0.7)	12.6	(0.6)	1.8	(0.2)
Sweden*	5.0	(0.7)	10.3	(0.9)	21.9	(0.9)	28.9	(1.1)	23.3	(1.3)	10.6	(0.8)
Switzerland	5.3	(0.6)	11.1	(0.6)	22.9	(1.0)	30.4	(0.9)	22.6	(0.9)	7.7	(0.7)
Turkey	10.8	(1.0)	21.4	(1.4)	31.0	(1.3)	24.5	(1.2)	10.3	(1.1)	2.1	(0.6)
United Kingdom*	6.8	(0.5)	12.2	(0.6)	22.7	(0.7)	28.7	(0.7)	20.5	(0.7)	9.0	(0.6)
Wales	7.6	(0.9)	14.4	(0.8)	26.5	(1.1)	27.7	(1.1)	17.4	(1.2)	6.4	(0.9)
OECD average	7.4	(0.1)	12.7	(0.1)	22.7	(0.2)	27.8	(0.2)	20.7	(0.2)	8.6	(0.1)

13 countries with scores below 430 omitted

OECD countries (not italicised) *Countries not in OECD (italicised)* *EU countries

Appendix D Technical appendix

D.1 Critical P-values for PISA Between-Country Multiple Comparisons

In general when testing whether the means of two populations (e.g. countries) are significantly different a critical p-value of 5% is used. This means that if the probability of observing the given difference or larger between country means **assuming there was no actual difference in the underlying population means** is less than 5%, then the opposite assumption that there is an actual difference in the population means is embraced. Another way of saying this is that a 5% probability of a Type 1 error is accepted – assuming there is a real difference when really there is not.

However, if multiple comparisons are being made this 5% risk of making the error is present every time we do a comparison, and these error chances mount up so that eventually such an error is almost certain to have been made at least once. For example, with 56 other countries to compare with the given one, the probability of **not** making such an error is 0.95^{56}, which is equal to 0.057 or 5.7%. To avoid compounding errors to this level an adjustment is needed so that the final error probability is equal to the required value (e.g. 5%).

The PISA data analysis manual (OECD, 2005) addresses this issue on page 140. They recommend dividing the final required error probability by the number of other countries to be compared in order to get a critical p-value for each comparison. This gives us the following values:

Objective	No. of other countries	Critical p-value for single comparison*
Compare 1 UK country with all other non-UK countries	56	0.05/56 = 0.000893 = 0.089%
Compare 1 UK country with other 3 UK countries	3	0.05/3 = 0.016667 = 1.67%

** Half this value may be used in testing, due to the symmetry of the distribution.*

Reference

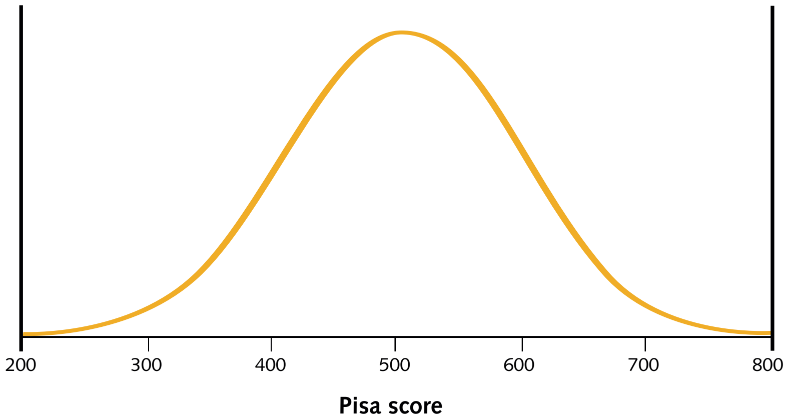
OECD (2005) PISA 2003 *Data Analysis Manual: SPSS Users*. Paris: OECD.

D.2 Notes on PISA International Scale Scores

PISA defines an international scale for each subject in such a way that, for each subject when it is first run as a major focus, the 'OECD population' has a Normal distribution with a mean of 500 and standard deviation of 100. This is illustrated in the 'bell-shaped' curve below.

How the OECD population is defined is rather complex:

- The sample of pupils within each OECD country is selected;
- Their results are weighted in such a way that each country in the study (i.e. UK as a whole, not Northern Ireland) has an equal weight;
- Pupils' scores are adjusted to have the above distribution within this hypothetical population.



Thus the important unit is the country, not the student – Russia and Hong Kong have the same weights in the scale, despite differences in size.

PISA scores are thus defined on a scale which does not relate directly to any other test measure. In particular, there is no easy or valid way to relate them to 'months of progress' or any measure of individual development.

Achievement of 15-year-olds in England:

PISA 2006 National Report

- How do 15-year-olds in England fare in science when compared to other countries?
- And what are their feelings about science?

The OECD Programme for International Student Assessment (PISA) is the world's biggest international education survey. PISA assesses the knowledge and skills of young people as they approach the end of compulsory education. Conducted every three years, the PISA survey involved schools and students in over 50 countries in 2006.

In the 2006 PISA survey, the main focus was on science, although there are also results for achievement in reading and maths. Nearly 500 schools across England, Wales, Northern Ireland and Scotland took part.

This report covers the results of PISA 2006 for England, including:

- achievement of 15-year-olds in England in science (and reading and maths) compared to similar groups in other countries
- gender differences in achievement
- the value students feel science has to society and to themselves
- students' belief in their own abilities in science
- students' motivation and engagement
- science activities in schools
- students' attitudes towards and understanding of environmental issues
- achievement and attitudes in England compared with Wales, Scotland and Northern Ireland.

This is important reading for policy makers, teachers, local authority staff and all those interested in improving young people's attainment in and attitudes towards science in England.

http://www.nfer.ac.uk/pisa
www.pisa.oecd.org

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