PISA 2006: Science Competencies for Tomorrow's World

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OECD briefing note for Japan

What the OECD indicators have shown so far…

Over the past generations, Japan has shown that it is possible to achieve strong educational progress: In the 1960s, Japan still ranked 14th among OECD countries in the proportion of people with university-level or vocational tertiary qualifications, today it ranks 2nd just after Canada. However, in Japan, the number of science graduates remains below the OECD average. There are 1596 people with a tertiary science degree per 100,000 employed 25-to-34-year-olds in Japan, compared with an OECD average of 1675. This is mainly because of the low female participation. The number of female science graduates from tertiary education per 100,000 25-to-34-year-olds in employment in Japan is the lowest among OECD countries and much lower than that of males (573 against 2302) (*Education at a Glance,* 2007).

…and what PISA adds to this.

The OECD Programme for International Student Assessment (PISA) extends the picture that emerges from comparing national qualifications with the most comprehensive and rigorous international assessment of student knowledge and skills. PISA represents a commitment by the 57 participating countries to monitor the outcomes of education systems in terms of student achievement on a regular basis, within an internationally agreed common framework, and in innovative ways that reflect judgments about the skills that are relevant to adult life. PISA seeks to assess not merely whether students can reproduce what they have learned in science, mathematics and reading, but also how well they can extrapolate from what they have learned and apply their knowledge in new situations. PISA also collects extensive data on student, family and institutional factors that can help to explain differences in the performance of countries.

Decisions about the scope and nature of the assessments and the background information to be collected were made by leading experts in participating countries, and steered jointly by countries on the basis of shared, policy-driven interests. Substantial efforts and resources were devoted to achieving cultural and linguistic breadth and balance in the assessment materials. Stringent quality assurance mechanisms were applied in translation, sampling and data collection.

This briefing note summarises results from the latest PISA assessment, carried out in 2006 with an extensive two-hour test comprising both open-ended and multiple-choice questions. More than 400,000 15-year-old students from 57 countries, including the 30 OECD countries took part. These countries make up close to 90% of the world economy.

The full report *PISA 2006: Science Competencies for Tomorrow's World* as well as its executive summary, data tables, web-only tables and the PISA 2006 database can be downloaded free of charge at www.pisa.oecd.org. References to tables and figures in this note refer to the full report.

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PERFORMANCE IN SCIENCE

PISA defines *science competency* as the extent to which a student: *i)* possesses scientific knowledge and uses that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues; *ii)* understands the characteristic features of science as a form of human knowledge and enquiry; *iii)* shows awareness of how science and technology shape our material, intellectual and cultural environments; and *iv)* engages in science-related issues and with the ideas of science, as a reflective citizen.

PISA 2006 assessed students' ability to perform scientific tasks in a variety of situations, ranging from those that affect their personal lives to wider issues for the community or the world. These tasks measured students' performance in relation both to their science competencies and to their scientific knowledge.

Global trends

The best performing countries

- Finland, with an average of 563 score points, is the highest performing country on the PISA 2006 science assessment.
- Six other high-scoring countries have mean scores of 530 to 542 points: Canada, Japan and New Zealand and the non-OECD countries/economies Hong Kong-China, Chinese Taipei and Estonia.
- Australia, the Netherlands, Korea, Germany, the United Kingdom, the Czech Republic, Switzerland, Austria, Belgium, Ireland and the non-OECD countries/economies Liechtenstein, Slovenia and Macao-China also score above the OECD average of 500 score points *(Figure 2.11b).*
- One way to interpret differences in PISA science scores is in terms of the progress students typically make over a school year. For the 28 OECD countries in which a sizeable number of 15-year-olds are enrolled in at least two different grades, the difference between students in two grades, after adjusting for a range of school and socio-economic factors, implies that one school year corresponds to an average of 38 score points on the PISA science scale *(Table A1.2).*

Key results for Japan

15-year-olds in Japan achieve a mean score of 531 score points in science, on a scale that has an OECD average of 500 score points and for which two thirds of the OECD student population perform between 400 and 600 score points.

- Finland and the partner economy Hong Kong-China have higher mean scores than Japan. Canada, New Zealand, Australia, the Netherland and Korea as well as the partner countries/economies Chinese Taipei, Estonia, and Liechtenstein cannot be distinguished from Japanese performance with statistical significance *(Figure 2.11b).*
- When comparing three science competencies, Japanese students demonstrated relative strength on the PISA *using scientific evidence* scale, which requires students to interpret evidence to draw conclusions and to explain them, to identify the assumptions, evidence and reasoning that underpin them and to reflect on their implications. On the other hand, Japanese students demonstrated relative weakness on the PISA *identifying scientific issues* scale, which required students to recognize issues that can be explored scientifically, and to recognize the key features of a scientific investigation, and on the PISA *explaining phenomena scientifically* scale, in which students have to apply knowledge of science in a given situation to describe or interpret phenomena scientifically and predict changes.compared to other two areas of competencies: "identifying scientific issues" and "explaining phenomena scientifically". The similar tendency can be found in Finland, Canada and Luxembourg as well as partier countries Uruguay and Thailand.

In relative terms, Japan ranks 3rd among the 30 OECD countries, but the confidence interval extends from the 2nd to the 5th rank.

- In 2003, Japan had ranked 2nd (confidence interval 1st to 3rd rank) among 29 OECD countries with comparable data and in 2000 2nd among 27 OECD countries with comparable data. However, the 2006 science scale is not directly comparable with the science

	scale used in the 2003 and 2000 assessments.
While basic competencies are generally considered important for the absorption of new technology, high-level competencies are critical for the creation of new technology and innovation. The report also cites evidence that individuals with high-level skills generate relatively large externalities in knowledge creation and utilization. • On average across OECD countries, 1.3% of 15-year-olds reach Level 6 of the PISA 2006 science scale, the highest proficiency level. In New Zealand and Finland this figure is at least 3.9%, three times the OECD average. In the United Kingdom, Australia, Japan and Canada, as well as the non-OECD countries/economies Liechtenstein, Slovenia and Hong Kong-China, between 2% and 3% reach Level 6 *(Table 2.1a).* • Over one in five students in Finland (21%) and over one in six in New Zealand (18%) reach at least Level 5. In Japan, Australia and Canada, and the partner economies Hong Kong-China and Chinese Taipei, this figure is between 14% and 16% (OECD average 9%). By contrast, 15 of the countries in the survey have less than 1% of students reaching either Level 5 or Level 6, and in 25 countries 5% or fewer reaching the two highest levels *(Table 2.1a)*. • Even if different age cohorts are concerned and PISA cannot establish the causal nature of the relationship, the proportion of Level 5 and 6 performers at age 15 is a good predictor for a country's research intensity, explaining, across OECD countries, 70% of the cross-country variation in the number of researchers per thousand employed in full-time equivalents *(Box 2.3)*.	***Japan has a comparatively large proportion of top performers.*** • 2.6% of Japanese 15-year-olds reach Level 6 on the science scale, demonstrating that they can consistently identify, explain and apply scientific knowledge, and knowledge about science, in a variety of complex life situations (OECD average 1.3%). 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 demonstrate use of their scientific understanding in support of solutions to unfamiliar scientific and technological situations *(Table 2.1a).* • 15.1% of Japanese 15-year-olds reach at least Level 5 (OECD average 9%) *(Table 2.1a).* • The number of students at Level 6 cannot be reliably predicted from a country's average performance. The United Kingdom (515 score points) has a lower average score than Japan (531 score points). Nevertheless, the United Kingdom and Japan have similar percentages of students at Level 6 *(Table 2.1a).*
The report cites the number of students at very low proficiency as an important indicator too, not in relation to scientific personnel but in terms of citizens' ability to participate fully in society and in the labour market. • Across the OECD, on average 19.2% of students perform below the baseline Level 2, including 5.2% below Level 1 *(Table 2.1a).* • The majority of students did not reach Level 2 in ten countries. These included one OECD country, Mexico *(Table 2.1a).*	***Japan has a comparatively small proportion of poor performers.*** • 12.0% of Japanese 15-year-olds do not reach Level 2, the baseline level of achievement on the PISA scale at which students begin to demonstrate the science competencies that will enable them to participate actively in life situations related to science and technology *(Table 2.1a).* To reach Level 2 requires competencies such as identifying key features of a scientific investigation, recalling single scientific concepts and information relating to a situation, and using results of a scientific experiment represented in a data table as they support a personal decision. In contrast, students at Level 1 often confuse key features of an investigation, apply incorrect scientific information, and mix personal beliefs

• In contrast, there are five countries or economies where around 10% or fewer perform at Level 1 or below: Finland and Canada, and the non-OECD countries/economies Estonia, Hong Kong-China and Macao-China *(Table 2.1a)*.	with scientific facts in support of a decision.
Different from mathematics and reading, males and females show no difference in average science performance in the majority of countries, including 22 of the 30 OECD countries (Table 2.1c). • In 12 countries, females outperform males, on average, while males outperform females in 8 countries. Most of these differences are small. • In no OECD country is the gender difference larger than 12 points on the science scale. • Some non-OECD countries show larger differences. In Qatar and Jordan, females are 32 and 29 points ahead of males, respectively. ***These gender differences are smaller than those observed in mathematics and much smaller than those observed in reading. However, similarities in average performance mask certain differences:*** • Some countries show larger gender differences in particular science competencies. In most countries, females perform better in *identifying scientific issues*, while males are stronger at *explaining phenomena scientifically (Tables 2.2c, 2.3c).* • Males perform substantially better than females when answering "Physical systems" questions – 26 points better on average, rising to 45 points in Austria *(Table 2.10).* • In most countries more females attend higher performing, academically oriented tracks and schools than do males. As a result of this, in many countries gender differences in science are substantial within schools or programmes, even if they appeared small overall. From a policy perspective – and for teachers in classrooms – gender differences in science performance therefore warrant continued attention.	***Overall, 15-year-old males and females in Japan perform at equal levels. However, gender differences are apparent in some aspects, as is the case in many countries. There are gender differences on two of the three science competencies that were measured.*** • On the PISA *identifying scientific issues* scale, which required students to recognize issues that can be explored scientifically, and to recognize the key features of a scientific investigation, females in Japan are 18 score points ahead (OECD average difference 17 score points) *(Table 2.2c).* • On the PISA *explaining phenomena scientifically* scale, in which students have to apply knowledge of science in a given situation to describe or interpret phenomena scientifically and predict changes, males in Japan are 16 points ahead (OECD average difference 15 score points) *(Table 2.3c).* • On the PISA *using scientific evidence* scale, which requires students to interpret evidence to draw conclusions and to explain them, to identify the assumptions, evidence and reasoning that underpin them and to reflect on their implications, there are no significant gender differences (on average across OECD countries females are 3 score points ahead of males) *(Table 2.4c).* ***Males are ahead in content-related knowledge on the earth and space systems scale and on the physical systems scale.*** • On the PISA *knowledge about science*, which includes understanding the purposes and nature of scientific enquiry and understanding scientific explanations, which are the results of scientific enquiry, there are no significant gender differences in Japan (OECD average difference 10 score points favor to females) *(Table 2.7).* • On the *earth and space systems* scale, males score 26 points higher than females in Japan (OECD average difference 17 score points favor to males) *(Table 2.8).* • On the *living systems* scale, there are no significant gender differences in Japan (OECD average difference 4 points favor to males) *(Table 2.9).* • On the *physical systems* scale, males score 22 points higher than females in Japan (OECD average difference 26 score points favor to males) *(Table 2.10).*

	Both males and females are equally likely to attend higher performing, academically oriented tracks and schools in Japan. • Even after the program level and destinations are accounted for, there are no gender differences in Japan (OECD average difference 9 score points favor to males) *(Table 2.5).*

EQUITY IN LEARNING OPPORTUNITIES

Home background influences educational success and experiences at school often appear to reinforce its effects. Although PISA shows that poor performance in school does not automatically follow from a disadvantaged socio-economic background, socio-economic background does appear to be a powerful influence on performance.

This represents a significant challenge for public policy striving to provide learning opportunities for all students irrespective of their socio-economic backgrounds. National research evidence from various countries has often been discouraging. Often simply because of limited between-school variation, schools have appeared to make little difference. And most importantly, either because privileged families are better able to reinforce and enhance the effect of schools, or because schools are better able to nurture and develop young people from privileged backgrounds, it has often appeared that schools reproduce existing patterns of privilege, rather than bringing about a more equitable distribution of outcomes.

The internationally comparative perspective that emerges from PISA is more encouraging. While all countries show some relationship between home background and educational outcomes, some countries demonstrate that high average quality and a moderate impact of socio-economic background on learning outcomes can go together.

Global trends

Schools and societies face major challenges with the integration of immigrants.

- International migration has become a key issue in most OECD countries, sparking intense debate on how immigrants can be successfully integrated into societies and labour markets. PISA 2006 assesses the educational success of 15-year-old students from immigrant families and shows that serious challenges lie ahead for many education systems.
- Among 15-year-old students, the proportion of students who are foreign born or who have foreign-born parents now exceeds 10% in Germany, Belgium, Austria, France, the Netherlands and Sweden as well as the non-OECD countries Croatia, Estonia and Slovenia, and is 15% in the United States, 17% in Jordan, between 21 and 23% in Switzerland, Australia, New Zealand and Canada, and the non-OECD country Israel, 36% in Luxembourg, 37% in Liechtenstein, and over 40% in the non-OECD countries/economies Macao-China, Hong Kong-China and Qatar *(Table 4.2c)*. These migrant students constitute a very heterogeneous group with a diverse range of skills, backgrounds and motivations.
- Among the countries with significant shares of 15-year-olds with an immigrant background, first-generation students – that is, students who are born outside the country of assessment and who also have foreign-born parents – lag, on average, 58 score points behind their native counterparts, a sizeable difference considering that 38 score points are roughly equivalent to the OECD average of a school year's difference *(Table 4.2c)*. The performance

Key results for Japan

Only 0.4% of 15-year-old students in Japan have an immigrant background, so Japan was not included in analysis relating to immigrant background.

disadvantage of first-generation immigrant students ranges from 22 score points in Canada and the non-OECD country Croatia to between 77 and 95 score points in Germany, Sweden, Denmark, Austria, Belgium and Switzerland. In contrast, first-generation immigrant students perform at the same level as their native peers in Australia, New Zealand and Ireland as well as in the non-OECD countries/economies Serbia, Israel, Macao-China and the Russian Federation. Much of this difference remains even after accounting for other socio-economic factors *(Table 4.3c)*. • Second-generation immigrant students are born in the country of assessment and therefore have benefited from participation in the same formal education system as their native peers for the same number of years, unlike first-generation immigrant students who started their education in another country. Second-generation immigrant students perform relatively better than first-generation immigrant students in Sweden, Switzerland and Canada, as well as in the non-OECD economies Hong Kong-China and Macao-China, suggesting that participation in the education and social system from birth onwards can bring an advantage, although in the cases of Sweden and Switzerland these students still perform below the national average in PISA *(Figure 4.2a, Table 4.2c)*. • The science achievement of the highest performers among students with an immigrant background varies much less across countries than the achievement of the lowest performing students with an immigrant background. At the bottom end of the scale, 31% of second-generation immigrant students do not demonstrate basic science competencies in PISA (performing below the baseline PISA proficiency Level 2). Even in some countries with good science performance overall, there are high proportions of poorly performing immigrants. In Luxembourg, Denmark, the Netherlands, Switzerland, Austria and Germany, for example, the proportion of second-generation immigrant students who do not reach Level 2 is at least three times as high as the proportion of native students who do not reach Level 2 *(Figure 4.2b, Table 4.2b)*. • In general, immigrant students attend schools with a more disadvantaged socio-economic intake, which poses a double disadvantage for them. These differences are particularly pronounced in Denmark, the Netherlands, Luxembourg, Germany, Norway, Austria, the United States, Belgium, France, Switzerland and the non-OECD countries/economies Slovenia, Hong Kong-China and Macao-China.	

However, in several countries all students attend schools with similar socio-economic intake, regardless of their immigrant background (Australia, New Zealand, Portugal, Canada and Ireland and as well as the non-OECD countries the Russian Federation, Serbia, Estonia and Latvia) *(Figure 4.3).* ***PISA data show that immigrant students report no signs of a lack of engagement in learning science*** • Throughout the OECD immigrant students tend to report higher or comparable levels of future-oriented science motivation, enjoyment of science and personal value of science than do their native peers *(Figure 4.4).*	
Some countries succeed not only in securing high average performance standards, but also in minimizing between-school performance variation. • On average, around one-third of all variation in student performance (33%) is between schools, but this varies widely from one country to another *(Table 4.1a).* • In Germany and the non-OECD country Bulgaria performance variation between schools is about twice the OECD average. It is over one and a half times the average in the Czech Republic, Austria, Hungary, the Netherlands, Belgium, Japan and Italy, and the non-OECD countries Slovenia, Argentina and Chile. In most of these countries, the grouping and tracking of students by school affects this result *(Table 4.1a).* • In other countries, school differences play only a minor part in performance variation. In Finland less than 5% of the overall performance variation among OECD countries lies between schools and in Iceland and Norway it is still less than 10%. Other countries in which performance is not very closely related to the schools in which students are enrolled include Sweden, Poland, Spain, Denmark and Ireland as well as the non-OECD countries Latvia and Estonia. It is noteworthy that Finland shows also the highest overall performance in science, suggesting that parents can rely on high and consistent performance standards across schools in the entire education system *(Table 4.1a).* • Students' socio-economic differences account for a significant part of between-school differences in some countries. This factor contributes most to between-school variance in the United States, the Czech Republic, Luxembourg, Belgium, the Slovak	***While average performance of 15-year-olds in Japan is above the OECD average, there is more variation in performance levels among schools.*** • In Japan 49% of all variation in students performance is between schools, which is above the OECD average of 33% *(Table 4.1a).* However, in other education systems, notably in Finland, parents can rely on both high and consistent performance standards across schools (less than 5% of the variation in Finnish students' performance is between schools) *(Table 4.1a).*

Republic, Germany, Greece and New Zealand, and the non-OECD countries Bulgaria, Chile, Argentina and Uruguay *(Table 4.1a).*	
Some countries succeed in ensuring that students perform well irrespective of the socio-economic contexts from which they come, while in other countries there are large socio-economic disparities. • Less than 10% of the variation in student performance is explained by student background in five of the seven countries with the highest mean science scores of above 530 (Finland, Canada and Japan, and the non-OECD countries/economies Hong Kong-China and Estonia). These countries demonstrate that quality and equity can be jointly achieved. This compares to an OECD average of 14.4%. In the other two countries, New Zealand andthe non-OECD economy Chinese Taipei, 16 and 13% of variation can be explained by student background *(Table 4.4a)*. • The countries where student background explains the largest proportion of performance variation (strongest socio-economic gradients) are Luxembourg, Hungary and France, and the non-OECD countries Bulgaria and Chile *(Table 4.4a)*. • The countries where two students of different socio-economic background has the largest difference in expected science scores (steepest socio-economic gradients) are France, New Zealand, the Czech Republic, the United States, the United Kingdom, Belgium and Germany, and the non-OECD country Bulgaria *(Table 4.4a)*.	***Socio-economic disparities have a weak impact on student performance in Japan.*** • 7.4% of the variation in student performance in Japan is explained by students' background – this is significantly below the OECD average of 14.4% *(Table 4.4a).* • In Japan, two students of different socio-economic background had the OECD average level difference in expected science scores (average socio-economic gradients). *(Table 4.4a)*.
In some countries, the key issue to address is a relatively high number of students with low proficiency in science and other competencies. • Among the lowest performing countries in PISA, a very high proportion of students have low levels of proficiency, indicating a need to improve standards across the board, for example through improvements in the curriculum. In Mexico and Turkey, as well as the non-OECD countries Kyrgyzstan, Qatar, Azerbaijan, Tunisia, Indonesia, Brazil, Colombia, Argentina, Montenegro, Romania, Thailand, Jordan, Bulgaria and Uruguay, more than 40% of 15-year-old students perform at Level 1 or below *(Table 2.1a)*. ***In another group of countries, fewer students are poor performers, but their numbers are still high relative to***	

the overall performance of these countries.	

STUDENT ENGAGEMENT IN SCIENCE

In PISA, student attitudes, and an awareness of the life opportunities that possessing science competencies may open, are seen as key components of an individual's *scientific literacy*. PISA therefore collected data on students' support for scientific enquiry, their self-beliefs as science learners, their interest in science and their sense of responsibility towards resources and environments.

Issues of motivation and attitudes are particularly relevant in science, which plays a key part in today's societies and economies, but appears not always to be taken up enthusiastically by young people at school. Engagement in science is considered important because *i*) continued investment in scientific endeavor relies on broad public support, which can be influenced by citizens' responses to science and technology; *ii)* scientific and technological advances are important influences on nearly everyone's life; and *iii)* a continued supply of scientific personnel requires a proportion of the population to take a close interest in science. Attitudes at age 15 can also influence whether students continue to study science and take a career path in science.

Many of the PISA measures presented in this section summarise student responses to a series of related questions. The questions were selected from larger constructs on the basis of theoretical considerations and previous research and the theoretically expected behaviour of the scales and indices was validated both within and across countries. The report focuses on those measures for which the relationship with student performance is consistent at least within countries. The PISA measures on student attitudes need to be interpreted with caution: Many factors contribute to forming student attitudes about science. Attitudes can be influenced by students' peers in the classroom, the culture of their school, their home and family culture, and more generally their national culture. Furthermore, all of the attitudinal results are based on students' self-reports and cultural factors can influence the way in which responses are given.

Global trends

In general, students show strong support for scientific enquiry.

- 93% agree that science is important for understanding the natural world.
- 92% agree that advances in science and technology usually improve people's living conditions.
- Also when asked about scientific enquiry in the context of specific tasks in the PISA 2006 science assessment students tended to express high levels of support.
- However, general support for science needs to be distinguished from the personal value of science: 75% agree that science helps them to understand things around them, but only 57% agree that science is relevant to them personally *(Box 3.1)*.

Students tend to report a stronger belief in the technological potential of science than in its capacity to make social improvements.

- On average across OECD countries, 25% of students (and over 40% in Iceland and Denmark) did not

Key results for Japan

Japanese 15-year-olds report a fairly strong level of appreciation of science in general, but still it is a below-average level compared with other OECD countries.

- 81% agree that science is important for understanding the natural world (OECD average 93%) *(Figure 3.2)*.
- 87% agree that advances in science and technology usually improved people's living conditions (OECD average 92%) *(Figure 3.2).*

Japanese 15-year-olds also express a fairly high level of acknowledgement of the economic and social benefits of science, which is at the OECD average level.

- 81% agree that science is valuable to society (OECD average 87%) *(Figure 3.2).*
- 81% agree that advances in science usually help to improve the economy (OECD average 80%) *(Figure 3.2).*
- 76% agree that advances in science and technology usually bring social benefits (OECD average 75%) *(Figure 3.2).*

agree with the statement "advances in science and technology usually bring social benefits". That said, over 90% of students report that they agree with this statement in Korea and the non-OECD countries/economies Thailand, Hong Kong-China, Macao-China, Chinese Taipei, Chile and Azerbaijan *(Figure 3.2)*.

Most students express confidence in being able to do scientific tasks (self-efficacy), but more so for some tasks than others. For example, on average among students in OECD countries:

- 76% say they can explain why earthquakes occurred more frequently in some areas than in others *(Figure 3.5)*.
- 64% say they can predict how changes to an environment would affect the survival of certain species *(Figure 3.5)*.
- 51% say they can discuss how new evidence could lead to a change in understanding about the possibility of life on Mars *(Figure 3.5)*.
- Just under one-half of students (47%) say that they find school science topics easy *(Figure 3.7)*.
- Self-efficacy is closely related to performance, even if the causal nature of this relationship cannot be established. The quarter of students expressing the strongest belief in their ability to do science tasks are, on average across OECD countries, about one and a half proficiency levels ahead of the quarter whose express the weakest self-belief *(Table 3.3)*.
- The quarter of students with the lowest sense of self-efficacy in tackling science problems are over twice as likely to be in the lowest performing quarter of students in the country *(Table 3.3)*.

- As in most countries, the general value of science which students report is closely related to their performance in science. In Japan, the top quarter of students on an index constructed from the above five questions attain 562 score points on the science scale, while the bottom quarter attain only 486 score points *(Table 3.5)*.

Japanese 15-year-olds also express a below-average level of personal value of science.

- In Japan, on average, the following percentage of students agreed that: science helps them to understand things around them (67%); they will use science in many ways when they are an adult (44%); some concepts in science help them to see how they relate to other people (54%); when they leave school there will be many opportunities for them to use science (48%); and science is very relevant to them (61%) *(Figure 3.4)*.

Among OECD countries, students in Japan expressed the lowest confidence in their science abilities (Figure 3.5).

The majority of students report that they are motivated to learn science, but only a minority report interest in a career involving science:

- 72% say that it is important for them to do well in science; 67% say that they enjoy acquiring new knowledge in science; 56% say that what they learn in school science subjects is important because they need it for what they want to study later on; but only 37% say they would like to work in a career involving science and 21% say that they would like to spend their life doing advanced science *(Table 3.7 and Figures 3.10, 3.12 and 3.13)*.
- Within each country, students who reported that they

Japanese 15-year-olds report different levels of interest in different science topics, which are all relatively low, but showed high levels of interest in learning more about the specific science topics there were tested on in PISA (Figures 3.8 and Table 3.1).

- 65% of the students reported interest in human biology (OECD average 68%).
- 55% of the students reported interest in topics in astronomy (OECD average 53%).
- 48% of the students reported interest in topics in chemistry (OECD average 50%).

enjoyed learning science were more likely to have higher levels of science performance *(Table 3.9)*.

Students from families with a more advantaged socio-economic status are more likely to show a general interest in science.

- This relationship is strongest in Ireland, France, Belgium and Switzerland. Those with a more advantaged socio-economic status are also more likely to identify how science may be useful to them in the future *(Table 3.22)*.

One significant feature of a student's background is whether they have a parent in a science-related career.

- Among the 18% for whom this is so, one-third (6% of students) see their own futures in such careers. A further 19% of students without a parent in a science-related career report that they expect to be in a science-related career at age 30, making a total of 25% of students *(Tables 3.12, 3.13 and 3.14)*.

- 40% of the students reported interest in topics in physics (OECD average 49%).

- 58% of the students reported interest in the biology of plants (OECD average 47%).

- 34% of the students reported interest in ways scientists design experiments (OECD average 46%).

- 33% of the students reported interest in topics in geology (OECD average 41%).

- 25% of the students reported interest in what is required for scientific explanations (OECD average 36%).

- In general, Japanese students have a below-average index score on the PISA *general interest in learning science as a subject* scale (Figure 3.5), while they have above-average score on the PISA *interest in learning science topics* scale (Table 3.1).

Japanese 15-year-olds report a comparatively low level of motivation to learn science because it will help them with their future studies or career.

- 42% say that they study science because they know it is useful for them (OECD average 67%), 47% say that making an effort in school science subjects is worthwhile because it will help them in the work they want to do later on (OECD average 63%), 41% say that studying their school science subjects is worthwhile for them because what they learn will improve their career prospects (OECD average 61%), 39% say that they will learn many things in their school science subjects that will help them get a job (OECD average 56%), and 42% say that what they learn in their school science subjects is important for them because they need this for what they want to study later on (OECD average 56%) *(Figure 3.12)*.

- As in most other countries, Japanese 15-year-olds report more frequently that doing well in mathematics or reading is important or very important than doing well in science *(Table 3.7)*.

Japanese 15-year-olds report a comparatively low level of future-oriented motivation to learn science.

- 23% say that they would like to work in a career involving science (OECD average 37%); 20% say that they would like to study science after high school (OECD average 31%); 17% say that they would like to work on science projects as an adult (OECD average 27%); and 23% say that they would like to spend their life doing advanced science (OECD average 21%) *(Figure 3.13)*.

- Only 8% of Japanese students say that they expect a science-related career at age 30 (OECD average 25%). This is the lowest proportion in the OECD, with the next lowest in Hungary (17%) and the highest proportions are in Portugal, the Unites States and Canada (37-39%). Japanese students who say they expected a science related career at age 30 say so score, on average, 567 points while students not saying so score 529 points *(Table 3.12).*

Only minority of Japanese students report that they do science-related activities on a regular basis, which is the lowest among the participating countries.

- 8% say they regularly or very often watch television programs about science (OECD average 21%); 8% say they regularly or very often read science magazines or science articles in newspapers (OECD average 20%); 5% say they regularly or very often visit websites on science (OECD average 13%); 4% say that they regularly or very often borrow books on science (OECD average 8%), 1% say the regularly or very often listen to radio programmes about advances in science (OECD average 7%), and 2% say they regularly or very often attend a science club (OECD average 4%) *(Figure 3.16)*.

Students report great concern for environmental issues and a strong desire to address them, but report generally to be pessimistic about things improving in this sphere.

- Despite a general interest in these issues, students know most about certain high profile areas, and for example only about half as many students express awareness of issues related to genetically modified crops as with that of deforestation *(Figure 3.17)*.
- Awareness of environmental issues varies by country, but there is a strong association between students' level of awareness on environmental issues and science performance in all participating countries. This suggests not just that students with a strong understanding of science tend to report being aware of environmental issues, but also that relative ignorance in science may cause these issues to go unnoticed by many citizens *(Table 3.16)*.
- On average across countries, the quarter of students reporting the least awareness of environmental issues are almost three times as likely to be among the lowest performing quarter of students. In contrast, there is much less of an association between concern for the environment and performance: this is only significant in about half of the countries *(Tables 3.16 and 3.17)*.

Japanese 15-year-olds report a below-average level of awareness of most of the environmental issues, but report a above-average level of awareness of acid rain (Figure 3.17).

- 68% of the students say that they are aware of the consequences of clearing forest for other land use (OECD average 73%).
- 75% say that they are aware of acid rain (OECD average 60%).
- 54% say that they are aware of the increase of greenhouse gases in the atmosphere (OECD average 58%).
- 33% say that they are aware of nuclear waste (OECD average 53%).
- 33% say that they are aware of Japane of genetically modified organisms (GMOs) (OECD average 35%).
- Environmental awareness and science performance are closely linked, both within and across countries. Japanese 15-year-olds scoring in the top quarter of an index constructed from the above questions score 582 points, while students in the bottom quarter score 460 points *(Table 3.16).*

There is some degree of pessimism among the students about the future of the natural environment.

In some countries, there are significant gender differences in science attitudes.

- Gender differences in attitudes to science are most prominent in Germany, Iceland, Japan, Korea, the Netherlands and the United Kingdom, and in the non-OECD economies Chinese Taipei, Hong Kong-China and Macao-China, where males report more positive characteristics on at least five aspects of attitude *(Table 3.21)*.

- Of the attitudes measured in PISA, the largest gender difference is observed in students' self-concept regarding science, that is, students' views of their own academic capabilities in science. In 22 out of the 30 OECD countries in the survey, males report thinking significantly more highly of their own science abilities than do females *(Table 3.21)*.

Japanese 15-year-olds report an above-average level of concern for environmental issues (Figure 3.19)….

…but they report an average level of sense of responsibility for sustainable development (Figure 3.21).

- 88% of students agree that industries should be required to prove that they safely dispose of dangerous waste material (OECD average 92%).

- 92% of students agree with having laws that protect the habitats of endangered species (OECD average 92%).

- 89% agree that it is important to carry out regular checks on the emissions from cars as a condition for their use (OECD average 91%).

- 90% agree that to reduce waste, the use of plastic packaging should be kept to a minimum (OECD average 82%).

- 88% agree that electricity should be produced from renewable sources as much as possible, even if this increases the cost (OECD average 79%).

- 73% agree that it disturbs them when energy is wasted through the unnecessary use of electrical appliances (OECD average 69%).

- 71% agree with having laws to regulate factory emissions even if this would increase the price of products (OECD average 69%).

Japanese students report an above-average level of optimism regarding environmental issues, the less they know in science, the more optimistic they are.

- 22% of students report that the problems associated with energy shortages will improve over the next 20 years (OECD average 21%).

- 20% consider this to be the case for water shortages (OECD average 18%).

- 20% consider this to be the case for air pollution (OECD average 16%).

- 17% consider this to be the case for nuclear waste (OECD average 15%).

- 16% consider this to be the case for the extinction of plants and animals (OECD average 14%).

	• 16% consider this to be the case for the clearing of forests for other land use (OECD average 13%) *(Figure 3.20)*. • Students with higher performance in science, who report greater awareness of environmental issues, also report being more pessimistic about the future of the environment *(Table 3.18)*.

SCHOOL AND SYSTEM-LEVEL FACTORS

What can schools and school policies do to raise performance and to moderate the impact that socio-economic background has on student performance? PISA 2006 examined various school and system-level factors including the policies and practices in admitting, selecting and grouping students, school management and funding, parental pressure and choice, accountability policies, school autonomy, and school resources.

The association of these factors with student performance was also estimated, both before and after accounting for the demographic and socio-economic context of students, schools and countries. However, several limitations should be taken into account in the interpretation of the results: First of all, on average only 300 school principals were surveyed and in seven countries fewer than 170 school principals were surveyed. Second, although school principals are able to provide information about their schools, generalizing from a single source of information for each school (and then matching that information with students' reports) is not straightforward. Third, the learning environment in which 15-year-olds find themselves may only be partially indicative of the learning environment that shaped their educational experiences earlier in their schooling career, particularly in education systems where students progress through different types of educational institutions at the lower secondary and upper secondary levels. To the extent that the current learning environment of 15-year-olds differs from that of their earlier school years, the contextual data collected by PISA is an imperfect proxy for the cumulative learning environments of students, and their effect on learning outcomes is therefore likely to be underestimated.

Global trends

How do schools in different countries confront the formidable challenge of grouping students in order to provide effective instruction for a diverse student body? They vary considerably in the extent to which they group students, both across and within schools.

- While residence is the most important single factor determining the allocation of students to schools (OECD average 47% of students), about one-quarter (27%) of 15-year-old students in OECD countries are in schools that select by students' academic record *(Table 5.1)*.
- Not surprisingly, within countries, students in schools that select by academic criteria perform, on average, better. However, school systems where there are more schools selecting students by ability, perform neither better nor worse overall.
- The age of first selection in the education system varies from 10 to 16 across OECD countries. The first selection is at the age of 11 or below in Austria, Germany, the Czech Republic, Hungary, the Slovak Republic and Turkey and in the non-OECD countries Bulgaria and Liechtenstein, while it is at the age of 16 or above in Australia, Canada, Denmark, Finland, Iceland, New Zealand, Norway, Poland, Spain, Sweden, the United Kingdom, the United States and in the non-OECD countries Brazil, Jordan, Latvia, Thailand and Tunisia *(Table 5.2)*.

Key results for Japan

Concerning school admittance, school principals in Japan report that…

- 86% are in schools that select by the students' academic record (OECD average 27%) *(Table 5.1)*.
- 29% are in schools that select by the students' needs or desires for a special program (OECD average 19%).
- 26% are in schools that select by recommendations of feeder schools (OECD average 13%).
- 20% of Japanese 15-year-old students are in schools that select students according to their residence in a particular area (OECD average 47%).
- 9% are in schools that select by parents' endorsement of the instructional or religious philosophy of the school (OECD average 12%).
- 6% are in schools that select according to whether there are other family members at the school (OECD average 17%).
- In Japan, students in schools that report selecting students by academic criteria did perform better by 12 score points, even after accounting for socio-economic and other school factors *(Table 5.21b)*.

School principals in Japan report ability grouping for all

Institutional tracking is closely related to the impact which socio-economic background has on student performance. • The earlier students are stratified into separate institutions or programmes, the stronger is the impact which the school's average socio-economic background has on performance *(Table 5.20a)*. • 14% of students in OECD countries are in schools that divide children by ability for all subjects between or within classes and 54% are in schools that practice ability grouping for some subjects, but not for all subjects *(Table 5.3)*. • Schools that divide students by ability for all subjects tend to have lower average student performance, on average, even after accounting for socio-economic factors and other school factors *(Table 5.19a)*.	***subjects less frequently than on average across OECD countries.*** • 10% of Japanese 15-year-old students are in schools that group students by ability for all subjects between or within classes (OECD average 14%) • 46% are in schools that practice ability grouping for some subjects, but not for all subjects (OECD average 54%). • 44% of students are in schools that do not practice ability grouping (OECD average 33%) *(Table 5.3)*. • In Japan, students in schools that divide students by ability for all subjects tend to have lower student performance (by 6 score points), even after socio-economic and other school factors are accounted for *(Table 5.21b)*.
In most countries, private schools outperform public schools but the picture reverses when socio-economic factors are accounted for. • Students in private schools outperform students in public schools in 12 OECD countries, while public schools outperform private ones in one OECD country *(Table 5.4)*. • The picture changes, however, when the socio-economic background of students and schools is accounted for. Public schools then have an advantage of 12 score points over private schools, on average across OECD countries *(Table 5.4)*. • That said, given the large advantage in gross terms, private schools may still pose an attractive alternative for parents looking to maximise the benefits for their children, including those benefits that are conferred to students through the socio-economic level of schools' intake *(Figure 5.5)*.	***Japanese 15-year-old students are less commonly enrolled in predominantly government-funded private schools than is the case across OECD countries.*** • In Japan, 70% of students are in public schools (OECD average 86%), 1% in predominantly government-funded private schools (OECD average 11%) and 29% in privately funded private schools (OECD average 4%) *(Table 5.4)*. ***Once socio-economic factors are accounted for, public and private schools show no performance differences.*** • There is no performance difference between private and public schools in Japan, but once the socio-economic intake of students and schools is accounted for, public schools outperform private schools *(Table 5.4)*.
Across OECD countries, 60% of students are enrolled in schools whose principals report that they compete with two or more other schools in the local area. • School choice is most prevalent in 10 countries where 80% or more of school principals report that students have a choice of at least two alternatives to their own school: Australia, the Slovak Republic, the United Kingdom, New Zealand and Japan, and the non-OECD countries/economies Indonesia, Hong	***The majority of Japanese 15-year-old students are enrolled in schools that compete with two or more other schools in the same area.*** • 82% of Japanese 15-year-olds are enrolled in schools whose principals report that they compete with two or more other schools in the same area (OECD average 60%). • 8 of students are enrolled in schools whose principals report that they compete with one other school in the same area (OECD

Kong-China, Chinese Taipei, Macao-China and Latvia. On the other hand, in Iceland, Norway, and Switzerland, and in the non-OECD countries Qatar and Uruguay, the parents of at least one-half of the students have effectively no choice of schools, according to school principals *(Table 5.5)*.

- Across countries, having a larger number of schools that compete for students is associated with better results, but that effect is no longer visible once socio-economic factors are accounted for *(Table 5.19c)*.
- Parents surveyed in 16 countries report generally to be positive and well-informed about their children's schools, but this varies considerably across countries. For example, fewer than 50% of parents in Germany, but over 90% in Poland and the partner county Colombia report that the school provided regular and useful information on their child's progress *(Table 5.7)*.
- On average across OECD countries, the majority of students (54%) are enrolled in schools where school principals report giving feedback to parents on their child's performance relative to the performance of other students at the school. In many OECD countries, the reporting of student performance information to parents is more commonly done relative to national benchmarks than relative to other students in the school. For example, in Sweden only 12% of 15-year-olds are enrolled in schools that report performance data to parents relative to those of other students in the school, while 94% of 15-year-olds are enrolled in schools that report data relative to national or regional standards or benchmarks. The pattern is similar in Japan, Finland, Norway, the United Kingdom, New Zealand as well as the non-OECD country Estonia *(Table 5.9)*.
- In the United Kingdom and the United States, school principals of more than 90% of 15-year-olds enrolled in school report that school achievement data are posted publicly; in the Netherlands, as well as in the non-OECD countries Montenegro and Azerbaijan, this is still the case for more than 80%. In contrast, in Finland, Belgium, Switzerland and Austria, as well as in the non-OECD country Argentina, this is the case for less than 10% of the students and in Japan, Spain, Germany, Korea and Ireland, and in the non-OECD countries/economies Macao-China, Uruguay, Indonesia, Tunisia and Bulgaria, it holds for less than 20% *(Table 5.8)*.
- There are considerable differences in performance

average 14%)

- 10% of students are enrolled in schools whose principals report that there are no other schools in the same area (OECD average 26%) *(Table 5.5)*.

Like in most countries, Japanese school principals most commonly report giving feedback to parents on their child's performance relative to regional benchmarks. Feedback is given:

- Relative to the performance of other students at the school (40%); and relative to national or regional benchmarks (80%). Similar to many other OECD countries, the reporting of student performance information to parents is most commonly done relative to national/regional benchmarks *(Table 5.9)*.

Only minority of Japanese schools post school achievement data publicly.

- In Japan, 11% of 15-year-olds are enrolled in schools whose principals report that school achievement data are posted publicly (OECD average 38%). As in many other OECD countries, students in schools that post their results publicly outperform students in schools that do not post them by 5 score points *(Tables 5.8 and 5.21b)*.

Pressure from parents on schools is comparatively high, with school principals reporting that high academic standards are expected from…

- Many parents in schools attended by 39% of students (OECD average 21%).
- A minority of parents in schools attended by 49% of students (OECD average 47%).
- Very few parents in schools attended by 12% of students (OECD average 32%) *(Table 5.6%)*.

School principals report a comparatively low use of achievement data for accountability purposes.

- 10% of students are in schools where achievement data are used in evaluation of the principal's performance (OECD average 32%).
- 26% of students are in schools where achievement data are used in evaluation of teachers' performance (OECD average 43%).
- 6% of students are in schools where achievement data are used in decisions about instructional resource allocation to the school

between students in schools that post their results publicly and students in schools that do not post them. Some of these differences are associated with other features of schools and school systems that tend to go along with strong accountability arrangements and with the socio-economic background of students in schools that have such arrangements. However, once these factors are taken into account, there still remains a significant positive association between schools making their achievement data public and having stronger results *(Tables 5.8 and 5.21b)*. • On average across OECD countries, 21% of students are enrolled in schools where school principals report constant pressure from many parents who expected the school to set very high academic standards and to have the students achieve them. Parental pressure for high academic standards is reported most often in New Zealand, Sweden and Ireland *(Table 5.6)*.	(OECD average 30%). • 16% of students are in schools where achievement data are tracked over time by an administrative authority (OECD average 65%) *(Table 5.8)*.
Increased autonomy over many aspects of school management has become common over the past 20 years, with countries aiming to raise performance levels and responsiveness by devolving responsibilities. School principals in PISA were asked to what extent only schools, only the government, or both the school and the government decide on matters. They report that: • The appointment of teachers is solely a school responsibility for almost all schools in 12 countries, but for almost no schools in seven countries. At least 95% of students attend schools where principals report that the school took sole responsibility for this in the Slovak Republic, New Zealand, the Netherlands, the Czech Republic, Iceland, Sweden, the United States and Hungary, and in the non-OECD countries/economies Lithuania, Montenegro, Macao-China and Estonia. Fewer than 10% are enrolled in such schools in Turkey, Greece, Italy and Austria, and the non-OECD countries Romania, Tunisia and Jordan *(Table 5.10)*. • The setting of budgets is solely a school responsibility for schools enrolling at least 90% of students in the Netherlands and New Zealand and in the non-OECD countries/economies Jordan, Macao-China, Indonesia and Hong Kong-China, but fewer than 10% in Poland and the non-OECD country Azerbaijan *(Table 5.10)*. • The determination of course content is solely a	***Compared to other countries, school principals in Japan report comparatively high levels of autonomy for schools in deciding educational content.*** • 39% of Japanese 15-year-old students are in schools whose principals report that only the school has considerable responsibility for formulating the school budget (OECD average 57%). • 88% are in schools whose principals report that only the school has considerable responsibility for deciding on budget allocations within the school (OECD average 84%). • 32% are in schools whose principals report that only the school has considerable responsibility for determining teachers' salary increases (OECD average 21%). • 32% are in schools whose principals report that only the school has considerable responsibility for selecting teachers for hire (OECD average 59%). • 32% are in schools whose principals report that only the school has considerable responsibility for dismissing teachers (OECD average 50%). • 32% are in schools whose principals report that only the school has considerable responsibility for establishing teachers' starting salaries (OECD average 22%). • 98% are in schools whose principals report that only the school has considerable responsibility for establishing student's

school responsibility in schools with 90% of students in Japan, Poland and Korea, as well as in the non-OECD countries/economies Macao-China and Thailand. But in Luxembourg, Greece and Turkey and the non-OECD countries Tunisia, Serbia, Montenegro, Uruguay, Croatia, Jordan and Bulgaria fewer than 10% of schools report determining content solely on their own *(Table 5.10)*.

Within countries, students in schools that exercise greater autonomy do not on average achieve better results, once the socio-economic context is accounted for. However, students in countries where certain aspects of autonomy are more common tend to do better in the science assessment, regardless of whether or not they themselves are enrolled in relatively autonomous schools.

- This is true for the aspects of school autonomy in formulating the school budget and deciding on budget allocations within the school, even after accounting for socio-economic background factors as well as other school and system-level factors *(Box 5.8)*.

disciplinary policies (OECD average 82%).

- 98% are in schools whose principals report that only the school has considerable responsibility for establishing student assessment policies (OECD average 63%).
- 99% are in schools whose principals report that only the school has considerable responsibility for approving students for admission to the school (OECD average 74%).
- 89% are in schools whose principals report that only the school has considerable responsibility for choosing which textbooks are used (OECD average 80%).
- 93% are in schools whose principals report that only the school has considerable responsibility for determining course content (OECD average 43%).
- 93% are in schools whose principals report that only the school has considerable responsibility for deciding which courses are offered (OECD average 51%) *(Table 5.10)*.

Business and industry have a below-average influence on the school curriculum in Japan.

- 63% are in schools whose principals report that business and industry has no influence on the school curriculum (OECD average 36%); 36% were business and industry had a minor or indirect influence of the curriculum (OECD average 53%); and 1% where business and industry had a considerable influence on the curriculum (OECD average 11%) *(Table 5.11)*.

In order to gauge the extent to which schools are able to employ an adequate supply of science teachers, school principals were asked if their school had any science teacher vacancies in the academic year in which PISA 2006 was conducted, and, if yes, whether the vacancies had been filled.

- On average, across OECD countries, 3% of students are in schools which report that one or more science teaching positions remained vacant, 59% in schools which report that all vacant science teaching positions had been filled either with newly appointed staff or by reassigning existing staff and 38% are in schools with no vacancies in science teaching positions *(Table 5.13)*.
- However, the proportion of 15-year-olds in schools with vacant science teacher positions ranges from less than 1% in Portugal, Greece, Poland, Italy, Spain, Ireland, the Slovak Republic, Sweden and Switzerland as well as the non-OECD countries

In Japan, the majority of students attend schools where all science teaching positions are filled, and an below-average proportion of school principals report that instruction was hindered by a lack of qualified science teachers.

- 11% of students are in schools where there are no vacant science teaching positions to be filled (OECD average 38%).
- 86% of students are in schools where all vacant science teaching positions had been filled (OECD average 59%).
- 3% of students are in schools where one or more vacant science teaching positions are not filled (OECD average 3%).
- 3% of students are in schools where, even though there are no vacant science positions, principals report that instruction was hindered to some extent or a lot due to a lack of qualified science teachers (OECD average 16%) *(Table 5.13)*.

<table>
<tr>
<td>Bulgaria, Hong Kong-China, Tunisia, Lithuania and Romania, to between 5 and 10% in Turkey, the United Kingdom, as well as the non-OECD countries/economies Colombia, Jordan, Slovenia, Israel, Chinese Taipei and Brazil, and to over 10% in Luxembourg and Germany and in the non-OECD countries Indonesia, Kyrgyzstan and Azerbaijan (Figure 5.14).

• On average across OECD countries 65% of principals in schools where there were vacancies report that instruction is hindered by a lack of qualified science teachers, but only 16% of principals in schools where there were no vacancies report the same (Table 5.13).</td>
<td></td>
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<tr>
<td>In 43 out of 57 participating countries at least 80% of 15-year-old students are still following some form of science education at school, whether a compulsory course, an optional course or a combination of both (Figure 5.16 and Table 5.16).

• In 24 of the participating countries at least 90% of students are enrolled in a science class at age 15. At least 95% of 15-year-old students report following science courses in Finland, the Slovak Republic, Iceland and France, and in the non-OECD countries Latvia, Slovenia and Montenegro, and all students report following science courses in Norway and Poland and the non-OECD country Russian Federation.

• On average across OECD countries, 28.7% of students report that they had four hours or more regular science lessons at school. This percentage rises to 64.8% in New Zealand, 61.9% in United Kingdom, 56.8% in Canada, and 49.1% in the United States. Among the non-OECD countries/economies, the percentage is between 40% and 46% in Macao-China, the Russian Federation, Colombia and Hong Kong-China. In Norway, only 6.9% of students report that they studied science at school for four hours or more per week (Figure 5.17 and Table 5.17).

• There are a number of countries where the majority of students report that they took two hours or less of science at school each week. This is the case in Norway, the Netherlands, Luxembourg, Switzerland, Hungary and the Slovak Republic, and also in the non-OECD countries Croatia, Brazil, Kyrgyzstan, Argentina, Romania, Chile, Liechtenstein and Uruguay (Table 5.17).</td>
<td>In Japan, 92% of 15-year-olds are taking some kind of science course, whether compulsory or optional (OECD average 87%).

• In general science 88% of students are taking compulsory courses (OECD average 64%) and 13% optional courses (OECD average 21%).

• In Biology 46% of students are taking compulsory courses (OECD average 57%) and 9% optional courses (OECD average 15%).

• In Physics 43% of students are taking compulsory courses (OECD average 61%) and 7% optional courses (OECD average 15%).

• In Chemistry 66% of students are taking compulsory courses (OECD average 60%) and 10% optional courses (OECD average 15%) (Table 5.16).

Like in other OECD countries, students in Japan spend most of their time learning science in regular lessons at school.

• 12% of students spend four hours or more a week in school science lessons (OECD average 29%), but 27% of students spend less than two hours a week in school science lessons (OECD average 33%).

• 94% of students spend less than two hours a week on science self-study or homework (OECD average 75%), but 1% spend four or more hours on this (OECD average 7%).

• Only 0.4% of students spend four hours or more a week on out-of-school science lessons (OECD average 3%) (Table 5.17).</td>
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</table>

Learning time and school activities to promote students' learning of science relate positively to learning outcomes.

- Resources such as an adequate supply of teachers and quality of educational resources at school are, on average across countries, associated with positive student outcomes, but many of these effects are not significant after taking account of the fact that students with higher socio-economic status tend to get access to more educational resources. However, after accounting for this, there remains a significant association between several aspects of learning time as well as school activities to promote students' learning of science and performance *(Table 5.21b)*.

Even after accounting for socio-economic factors and other school factors, there remains a significant association between several aspects of Japanese 15-year-olds learning time and learning outcomes.

- There is a positive association between schools' average learning time for regular lessons in school and for self-study or homework and science performance.

- There is a negative association between schools' average learning time for out-of-school lessons and science performance.

- There is a positive association between science performance and school activities to promote students' learning of science, although this is positively associated with performance across countries *(Table 5.21b).*

Shortage or inadequacy of educational resources is less frequently reported as hindering instruction than is the case on average across OECD countries.

- 34% are enrolled in schools whose principals report that the shortage or inadequacy of audio-visual resources hinders instruction (OECD average 37%).

- 29% are enrolled in schools whose principals report that the shortage or inadequacy of computer software hinders instruction (OECD average 38%).

- 25 % are enrolled in schools whose principals report that the shortage or inadequacy of science laboratory equipment hinders instruction (OECD average 42%).

- 24% are enrolled in schools whose principals report that the shortage or inadequacy of library materials hinders instruction (OECD average 34%).

- 19% of Japanese 15-year-olds are enrolled in schools whose principals report that the shortage or inadequacy of computers for instruction hinders instruction (OECD average 37%).

- 16% are enrolled in schools whose principals report that a lack or inadequacy of internet connections hinders instruction (OECD average 20%).

- 0% is enrolled in schools whose principals report that the shortage or inadequacy of instructional materials hinders instruction (OECD average 25%) *(Figure 5.15)*.

<table>
<tr><th colspan="2">MATHEMATICS PERFORMANCE</th></tr>
<tr><td colspan="2">PISA 2003 looked in detail at mathematics performance. PISA 2006 provides a briefer update. PISA uses a concept of mathematical literacy that is concerned with the capacity of students to analyze, reason and communicate effectively as they pose, solve and interpret mathematical problems in a variety of situations involving quantitative, spatial, probabilistic or other mathematical concepts.</td></tr>
<tr><th>Global trends</th><th>Key results for Japan</th></tr>
<tr><td>On the PISA 2006 mathematics scale…
• Four countries/economies outperform all other countries: Finland and Korea and the non-OECD economies Chinese Taipei and Hong Kong-China (Table 6.2c).
• Other countries with mean mathematics performances significantly above the OECD average are the Netherlands, Switzerland, Canada, Japan, New Zealand, Belgium, Australia, Denmark, the Czech Republic, Iceland and Austria, and the non-OECD countries/economies Macao-China, Liechtenstein, Estonia, and Slovenia (Table 6.2c).</td><td>Japanese 15-year-olds achieve a mean score of 523 score points in mathematics, on a scale that had an OECD average of 498 score points (Table 6.2c).
In relative terms, Japan ranked 6th among the 30 OECD countries, but the confidence interval extends from the 4th to the 9th rank (Figure 6.20b).
• In 2003, Japan had a mean score of 534 points and ranked 4th (confidence interval 2nd to 7th rank) among 29 OECD countries with comparable data (PISA 2003 report)</td></tr>
<tr><td>In order to perform the hardest mathematics tasks in PISA, students must put together complex elements of a question, use reflection and creativity to solve unfamiliar problems and engage in some form of argument, often in the form of an explanation.
• 13% of students are rated at the top two proficiency levels, Levels 5 and 6 in PISA 2006 (Table 6.2a).
• The highest percentages of students at Levels 5 and 6 are found in Korea (27%) and the non-OECD economies Chinese Taipei (32%) and Hong Kong-China (28%). Finland, Switzerland, Belgium and the Netherlands all had more than 20% of students at these top levels (Table 6.2a).
• With the exception of Mexico and Turkey, at least 5% of students in each OECD country reached Level 5 or 6 (Table 6.2a).</td><td>In mathematics, Japan has an above-average proportion of top-performers.
• 18.3% of Japanese15-year-olds reached at least Level 5 on the mathematics scale (OECD average 13%). These students can develop and work with models for complex situations, identifying constraints and specifying assumptions; select, compare, and evaluate appropriate problem solving strategies for dealing with complex problems related to these models; work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations, and insight pertaining to these situations (Table 6.2a).</td></tr>
<tr><td>Level 2 is considered a baseline level of mathematics proficiency at which students begin to demonstrate the kind of skills that enable them to use mathematics actively.
• Over three-quarters (78.7%) of students on average across OECD countries are proficient at least at this level (Table 6.2a).</td><td>87% of Japanese 15-year-olds reach the baseline level 2 of mathematics performance, which requires students to recognize mathematical problems requiring only direct inferences, to extract information from a single source and to make literal interpretations of their results.
• 13% of Japanese 15-year-olds performed below Level 2 and 4% below Level 1 (Table 6.2a).</td></tr>
</table>

• In Finland and Korea, and the non-OECD economy Hong Kong-China, more than 90% of students perform at or above Level 2 *(Table 6.2a)*. • In every OECD country except Mexico, Turkey, Italy, Greece and Portugal at least 70% of students are at Level 2 or above *(Table 6.2a)*. • The proportion falling short of this level varied widely across countries, from 6% in Finland to 56% in Mexico and, among non-OECD countries/economies, from 10% in Hong Kong-China to 89% in Kyrgyzstan *(Table 6.2a)*.	
It is only possible so far to compare mean scores in mathematics over a three-year period, from PISA 2003 to PISA 2006. For most countries, performance in mathematics remained broadly unchanged between PISA 2003 and PISA 2006. However, for a few countries there are notable performance differences. • Two OECD countries, Mexico and Greece, and two non-OECD countries, Indonesia and Brazil show higher performance in PISA 2006 than in PISA 2003 *(Tables 6.3b and 6.3d)*. • In Mexico mathematics performance is 20 score points higher in PISA 2006 than in PISA 2003 but at 406 score points it is still well below the OECD average. In reading, Mexican females perform significantly higher in PISA 2006 than in PISA 2003 while the performance of males remained unchanged; in mathematics both males and females saw similar performance increases between the two surveys *(Tables 6.3a and 6.3b)*. • In Greece, mathematics performance is 14 score points higher in PISA 2006 than in PISA 2003. Most of the increase was driven in the lower and middle range of the performance distribution. It is also noteworthy that the performance difference is mainly due to the significantly higher performance of females in PISA 2006 *(Tables 6.3b and 6.3d)*. • In Indonesia, mathematics performance is 31 score points higher in PISA 2006 than in PISA 2003, which was, as in the case of reading, largely driven by the higher performance of males in PISA 2006 *(Table 6.3b)*. • In Brazil, mathematics performance is 13 score points higher in PISA 2006 than in PISA 2003, which was mainly driven by performance improvements at the lower end of the distribution	***In Japan, mean mathematics performance in 2006 was 11 score points lower than in 2003, and the decline is statistically significant only at the 95% confidence level (Figure 6.21).The decline is markedly…..*** • The decline is markedly: at the higher end of the performance distribution (75^{th}, 90^{th}, and 95^{th} percentiles) *(Table 6.3d)* and also for the female students, while no decline between 2000 and 2003 is observed for male students *(Table 6.3b)*.

(Tables 6.3b and 6.3d). • Mathematics performance in PISA 2006 is significantly lower in France (15 score points), and significantly lower performance is seen throughout the performance distribution. Among the non-OECD countries in Liechtenstein performance in PISA 2006 is 11 score points lower than in PISA 2003 *(Tables 6.3b and 6.3d)*.	
In 35 of the 57 countries participating in PISA 2006, males perform significantly ahead of females. In 21 countries there is no significant difference, and in the non-OECD country Qatar, females outperform males. In 2006: • Overall gender differences in mathematics are less than a third as large as for reading, 11 points on average across OECD countries. This has not changed since 2003 *(Tables 6.1c and 6.2c)*. • In 2006, males outperform females by above 20 points only in Austria (23 points) and the non-OECD countries Chile (28 points) and Colombia (22 points) *(Table 6.2c)*. • Males also had an above-average advantage of 13 to 20 points in Japan, Germany, the United Kingdom, Italy, Luxembourg, Portugal, Australia, the Slovak Republic, Canada, Switzerland and the Netherlands, and the non-OECD countries/economies Brazil, Indonesia, Hong Kong-China, Tunisia, Croatia, Chinese Taipei, Uruguay and Argentina *(Table 6.2c)*.	***Japanese 15-year-old males outperform females by 20 score points (OECD average 11 score points) (Table 6.2c).*** • This gender gap has not been widening since PISA 2003 and it stays the same between 2003 and 2006 *(Tables 6.3b)*.

READING PERFORMANCE

PISA 2000 looked in detail at reading performance, while PISA 2003 and PISA 2006 provided briefer updates. It is now possible to see changes in reading performance over six years. PISA measures *reading literacy* in terms of students' ability to use written information in situations that they encounter in their lives. This goes beyond the traditional notion of decoding information and literal interpretation. Students are shown different kinds of text, and required to retrieve information, to interpret the text and to reflect on and evaluate what they read.

Global trends	*Key results for Japan*
On the PISA 2006 reading scale: • Korea has significantly higher performance in *reading literacy* than any other country, including Finland, the top performer in previous PISA reading surveys. Korea's mean score, 556 score points, is nearly one proficiency level above the OECD average of 492 score points. Finland is a clear second with 547 points and the non-OECD economy Hong Kong-China a clear third with 536 points *(Table 6.1c)*. • Canada and New Zealand have mean reading scores between 520 and 530, and the following other countries score significantly above the OECD average: Ireland, Australia, Poland, Sweden, the Netherlands, Belgium and Switzerland as well as the non-OECD countries Liechtenstein, Estonia and Slovenia *(Table 6.1c)*.	***Japanese 15-year-olds achieved a means score of 498 score points in reading, on a scale that had an OECD average of 492 score points. (Table 6.1c).*** ***In relative terms, Japan ranked 12th among the 29 OECD countries, but the confidence interval extends from the 9th to the 16th rank (Figure 6.8b).*** • In 2000, Japan had a mean score of 522 points and ranked 8th among 27 OECD countries with comparable data *(PISA 2000 report)*. • In 2003, Japan had a mean score of 498 points and ranked 12th (confidence interval 10th and 18th rank) among 29 OECD countries with comparable data *(PISA 2003 report)*. •
A minority of students (8.6% on average across OECD countries) are proficient at the highest reading level, Level 5. These students are capable of sophisticated, critical thinking. In PISA 2006 : • Korea has the largest number of students at Level 5 (22%), followed by Finland and New Zealand (over 15%), Canada (14%) and Ireland, Poland and Belgium and the partner economy Hong Kong-China (over 11%) *(Table 6.1a)*. • At the other extreme, less than 1% are proficient at Level 5 in Mexico and in the non-OECD countries/economies Indonesia, Kyrgyzstan, Azerbaijan, Tunisia, Jordan, Thailand, Serbia, Romania and Montenegro it is less than one-half of a percent *(Table 6.1a)*. • Countries with large numbers at Level 5 vary considerably in terms of how many students are at low proficiency levels, and therefore their mean	***In reading, Japan has an average level proportion of top-performers. These students are capable of sophisticated, critical thinking.*** • 9.4% of Japanese 15-year-olds reached at the highest reading level, Level 5 (OECD average 8.6%) *(Table 6.1a)*.

performance. For example, Finland and New Zealand have 17% and 16% respectively at Level 5, but New Zealand has 15% at Level 1 or below compared to just 5% in Finland. Finland's average score of 547 is well above New Zealand's of 521 *(Tables 6.1a and 6.1c)*.	
Most students (80% across OECD countries) are capable of basic reading tasks at Level 2 - locating straightforward information, making low-level inferences of various types, working out what a well-defined part of a text means and using some outside knowledge to understand it. ***Longitudinal follow-up studies in Australia, Canada and Denmark suggest that the minority of students not capable of these tasks, those classified either at Level 1 or below, are likely to face difficulty using reading materials to fulfill their goals and to acquire knowledge. In PISA 2006:*** • In every OECD country except Mexico, Turkey, the Slovak Republic, Greece, Italy and Spain at least 75% of students are at Level 2 or above *(Table 6.1a)*. • Countries with the fewest students below Level 2 are: Finland (5%), Korea (6%) and the non-OECD economy Hong Kong-China (7%). Between 10% and 15% of students are below Level 2 in Canada, Ireland, Australia, New Zealand, the Netherlands and Sweden, and the non-OECD countries/economies Macao-China, Estonia, Liechtenstein and Chinese Taipei *(Table 6.1a)*. • On the other hand, the majority of students are at Level 1 or below in the non-OECD countries Kyrgyzstan, Qatar, Azerbaijan, Tunisia, Indonesia, Argentina, Montenegro, Colombia, Brazil, Romania, Serbia and Bulgaria *(Table 6.1a)*.	***82% of Japanese students are capable of basic reading tasks at Level 2 - locating straightforward information, making low-level inferences of various types, working out what a well-defined part of a text means and using some outside knowledge to understand it.*** • 18% of Japanese 15-year-odls performed below Level2 and 7% below Level 1 *(Table 6.1a)*.
It is now possible to track change in reading performance over a six-year period. • The results suggest that, across the OECD area, reading performance has generally remained flat between 2000 and 2006. This needs to be seen in the context of significant rises in expenditure levels. Between 1995 and 2004 expenditure per primary and secondary student increased by 39% in real terms, on average across OECD countries *(Table 2.6)*. • Two OECD countries (Korea and Poland) and five	***In Japan, mean reading performance in 2006 was 24 score points lower than in 2000, but there is no change since 2003 (Table 5.3a).*** • The decline between 2000 and 2003 are markedly at the lower end of the performance distribution (5^{th}, 10^{th} and 25^{th} percentiles) *(Table 6.3c)*. • Between 2003 and 2006, no changes are observed at any percentiles.

non-OECD countries/economies (Chile, Liechtenstein, Indonesia, Latvia and Hong Kong-China) have seen significant rises in reading performance since PISA 2000 *(Figure 6.9).*

- Korea increased its reading performance between PISA 2000 and PISA 2006 from an already high level by 31 score points, thus reaching the highest reading performance among all participating countries – even surpassing Finland, the performance of which remained stable at a high level. Korea achieves this increase mainly by significantly raising performance standards among the better performing students, while the performance at the lower end of the distribution remained essentially unchanged. Indeed, at the 95th percentile, the point above which the 5% best performing students score, reading performance rose by 59 score points, to 688 score points, at the 90th percentile still by 55 score points and at the 75th percentile by 44 score points. In contrast, there is no significant change at the 5th and 10th percentiles for Korea *(Tables 6.3a and 6.3c)*.
- Hong Kong-China has also seen a significant increase, by 11 score points since 2000, from an already high level of reading performance, reaching 536 score points in PISA 2006. Here the change was mainly driven by improvements among the lowest performing students, with the 5th percentile rising by 21 score points, but there were also significant performance improvements among the top performers at the 90th and 95th percentiles *(Tables 6.3a and 6.3c)*.
- Poland increased its reading performance by 17 score points between PISA 2000 and PISA 2003 and another 11 score points between PISA 2003 and PISA 2006 and now performs at 508 score points, for the first time clearly above the OECD average. Between the PISA 2000 and PISA 2003 assessments, Poland raised its average performance mainly through increases at the lower end of the performance distribution. As a result, in PISA 2003 fewer than 5% of students fell below performance standards that had not been reached by the bottom 10% of Polish students in PISA 2000. Since PISA 2003, performance in Poland has risen at the higher end of the performance distribution (75th, 90th and 95th percentiles) *(Tables 6.3a and 6.3c)*.
- The other countries that have seen significant performance increases in reading between PISA 2000 and PISA 2006 – Chile (33 score points), Liechtenstein (28 score points), Indonesia (22 score

points) and Latvia (21 score points) – perform, with the exception of Liechtenstein, significantly below the OECD average *(Tables 6.3a and 6.3c)*. • A number of countries saw a decline in their reading performance between PISA 2000 and PISA 2006, comprising nine OECD countries (in descending order) – Spain, Japan, Iceland, Norway, Italy, France, Australia, Greece, Mexico and the non-OECD countries, Argentina, Romania, Bulgaria, the Russian Federation and Thailand *(Table 6.3a)*.	
In all OECD countries in PISA 2006, females perform better in reading on average than males. In PISA 2006: • In twelve countries, the gap is at least 50 score points. In Greece and Finland, females are 57 and 51 points ahead respectively, and the gap is 50 to 66 points in the non-OECD countries Qatar, Bulgaria, Jordan, Thailand, Argentina, Slovenia, Lithuania, Kyrgyzstan, Latvia and Croatia *(Table 6.1c)*. • The smallest gender gaps among OECD countries are in the Netherlands and the United Kingdom (24 and 29 points, respectively) *(Table 6.1c)*. • In Korea, males increased their performance by 20 score points between 2000 and 2006, but females at twice that rate. In Finland and Korea, over 60% of females are at high levels of reading proficiency, Level 4 or 5, compared to just over a third (36%) of boys in Finland and below half (47%) of boys in Korea.	***Japanese 15-year-olds females outperform males by 31 score points (OECD average 38 score points favor to females) (Table 6.1c).*** • This gender gap has not been widening since 2000 *(Tables 6.3a)*.

References:
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OECD (2007), Education at a Glance 2007 – OECD Indicators