Spain. In these countries it may be that efforts to improve student performance need to be targeted at both males and females, whereas in countries with a larger number of gender differences – for example the Netherlands, Iceland and Norway – it may be more useful to focus on one of the sexes.

Overview

This report begins with a short summary of gender differences from early childhood through to labour market participation. A discussion of how PISA can inform the consideration of gender differences follows. A brief section reviews gender differences in reading from PISA 2000 and in mathematics and problem solving from PISA 2003. A discussion of science in PISA 2006 follows, including information derived from the computer based assessment of science in PISA 2006. This section also includes discussion of parents' perceptions, and of the relationships between performance and socio-economic background, single-sex and mixed-sex schooling, students' attitudes to school and the amount of time that they spend on homework. The report also looks at trends in some of these relationships over time.

In summary, the report concludes that there are significant gender differences in educational outcomes, and these appear as students grow older and gain education and labour market experience. Despite differences in the structure of the brains of females and males, there is no conclusive evidence that these differences lead to later differences in educational outcomes. There is some evidence of gender difference in early educational experiences but they are confined to reading. As students progress in their education, however, gender differences become more pronounced. In addition, labour market outcomes show significant earning gaps in favour of males.

WHAT DOES THE LITERATURE SAY ABOUT GENDER DIFFERENCES FROM EARLY CHILDHOOD TO THE LABOUR MARKET?

The structure of the brain

In recent years there has been much interest in investigating potential links between the structure of the brain and differing educational outcomes for males and females. The OECD report, *Understanding the Brain: The Birth of a Learning Science* (OECD, 2007b), synthesised progress on the brain informed approach to learning (that is a detailed consideration of the relationship between the structure of the brain and a child's capacity and approach to learning) and addressed a number of key educational issues. There are, indeed, functional and morphological differences between the male and female brain. The male brain is larger, for instance, but when it comes to language, the relevant areas of the brain are more strongly activated in females. Determining the importance of these differences in structure is extremely difficult. No study to date has shown gender-specific processes involved in building up the networks in the brain during learning.

Primary education

Small gender differences appear at early stages of education. Universal primary education is widespread in most countries and few gender differences appear in attainment, that is, in terms of the proportions of males and females completing primary education. In terms of performance, on the other hand, international assessments of primary school students show significant gender differences in reading in favour of females. On the other hand, there are few gender differences apparent in mathematics and science.

Reading at grade 4 (PIRLS)

The latest cycle of the Progress in International Reading Literacy Study (PIRLS) conducted by the International Association for the Evaluation of Educational Achievement (IEA) took place in 40 countries in 2006 (including 19 OECD countries and 10 non-OECD countries and economies which also participated in PISA 2006). The target population was fourth-grade students.

PIRLS found that females had significantly higher reading achievement than males in all except two countries, Luxembourg and Spain, where average achievement for males and females was equal. On average across the participating countries females scored 17 score points more than males in a test where the mean score was 500 and the standard deviation 100. In the OECD countries that participated the difference in favour of females was highest in New Zealand (24 score points). In terms of behaviour, PIRLS found that females reported more time than males reading books or magazines (1.5 hours vs. 1.3 hours), a difference being found in almost all participating countries. In comparison, on average, males reported more time than females reading on the Internet (1.0 hours vs. 0.9 hours) (Mullis, Martin, Kennedy and Foy, 2007).

Mathematics and science at grade 4 (TIMSS)

The IEA also conducts an assessment of student capacity in mathematics and science at grade 4 – the Trends in International Mathematics and Science Study (TIMSS). There were 36 countries and economies participating in TIMSS 2007. At grade 4 level, the TIMSS 2007 data show that on average in the participating countries there was not a gender difference in overall mathematics performance. Females had significantly higher scores in eight countries, while males had significantly higher scores in twelve countries (Mullis, Martin & Foy, 2008).

In science, at the fourth grade, performance for females was slightly higher than for males across the participating countries (3 points), although the situation varied from country to country. In more than half the countries (22), the difference in average achievement in science between females and males was negligible at the fourth grade. Males had higher average science achievement than females in 8 countries (Martin, Mullis & Foy, 2008).

Secondary education

Mathematics and science at grade 8 (TIMSS)

The second component of TIMSS is a study of the mathematics and science achievement of students at grade 8. At the eighth grade, on average across the TIMSS 2007 countries, females had higher average achievement than males in mathematics. Females had higher achievement than males in 16 of the participating countries, while males had higher achievement than females in 8 countries (Mullis, Martin & Foy, 2008).

In science, at the eighth grade, on average across the TIMSS 2007 countries, females had higher average achievement than males by 6 points. Females had higher achievement than males in 14 of the participating countries. Males had higher achievement than females in 11 countries (Martin, Mullis & Foy, 2008).

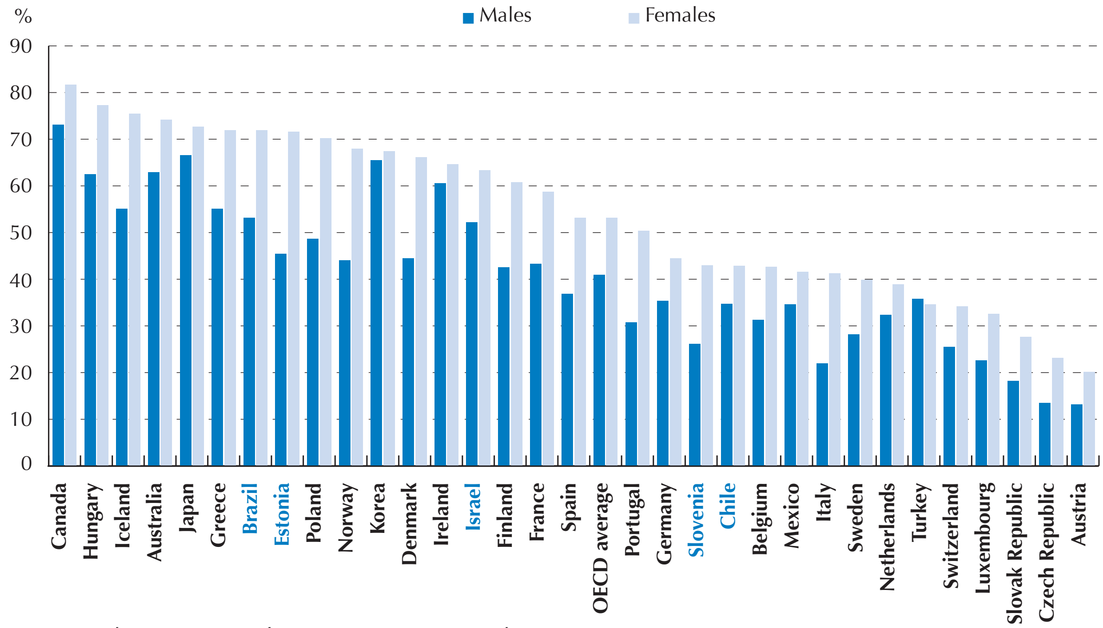
Secondary level attainment

Graduation rates for female students are generally higher than for males. The 2008 edition of the OECD report *Education at a Glance 2008 – OECD Indicators (OECD, 2008)* gives a detailed description of education systems in all OECD member countries and some partner countries (Brazil, Chile, Estonia, Israel, the Russian Federation and Slovenia). Data on gender differences in secondary education cover a number of important areas including overall attainment and graduation rates in different programmes. In general, the data show a gap in favour of females in terms of graduation rates, especially in general programmes.

In Table 1 it can be seen that across the OECD in 2006 there was an average of 79% of males and 87% of females who were upper secondary graduates. However, within some countries the differences between males and females were marked. The largest differences in favour of females were observed in New Zealand (23%), Norway (23%) and Iceland (19%). The country with the biggest difference in favour of males was Turkey (7%). Comparing the 2006 data with the figures for 2000 shows that there has been a slight overall

Figure 1

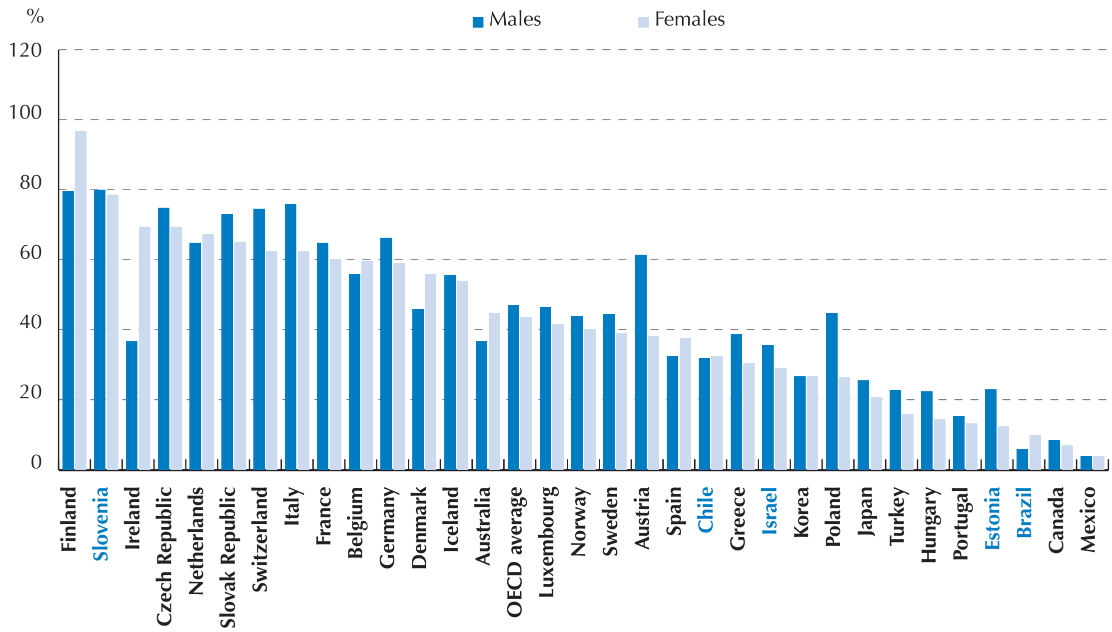
Graduation rate at upper secondary level for general programmes, by gender (2006)



Source: *Education at a Glance 2008 - OECD Indicators* (OECD, 2008).

Figure 2

Graduation rate at upper secondary level for vocational and pre-vocational programmes, by gender (2006)



Source: *Education at a Glance 2008 - OECD Indicators* (OECD, 2008).

increase in the percentage of upper secondary school graduates, but the overall difference between percentages of males and females is little changed, the figures for 2000 having been 74% of males and 80% of females (OECD, 2000).

It is possible to further analyse upper secondary graduation rates into graduation rates for general programmes and for pre-vocational and vocational programmes. Figure 1 shows that graduation rates for general programmes are higher for females in all countries. The largest difference in the OECD countries is in Norway where 44% of males compared to 68% of females graduate. Across the OECD the average is 41% for males and 53% for females. In the partner countries the largest difference is in Estonia (45% for males and 72% for females).

Looking at graduation rates for pre-vocational and vocational programmes, Figure 2 shows a different pattern, with around two-thirds of the countries having a greater percentage of males graduating. In Austria there are 23% more males than females graduating in pre-vocational and vocational programmes. In Poland this figure is 18% and in Italy 14%. Among the countries where females predominate in pre-vocational and vocational programmes, Ireland has the largest difference with 33% more females, followed by Finland (17%) and Denmark (10%).

Tertiary education

In tertiary education, females have been narrowing traditional gaps with male students. In mathematics and computer science however, graduation rates for females are still lower than the graduation rates for males. In today's global economy, where education and human capital accumulation drive innovation and competitive advantage, increasing graduation rates among female students is for many countries the most immediately available opportunity for increasing the output of graduates in these critical areas.

As the more detailed analysis below indicates, while the number of female students in tertiary education has increased more rapidly than that of males, the proportion of women choosing science and technology studies is still lower than that of men. Furthermore, even though the share has often increased in countries which had the lowest proportions of female science and technology students, trend analysis suggests that the overall proportion of female science and technology graduates tends to level out at around 40%.

Entrance into tertiary education

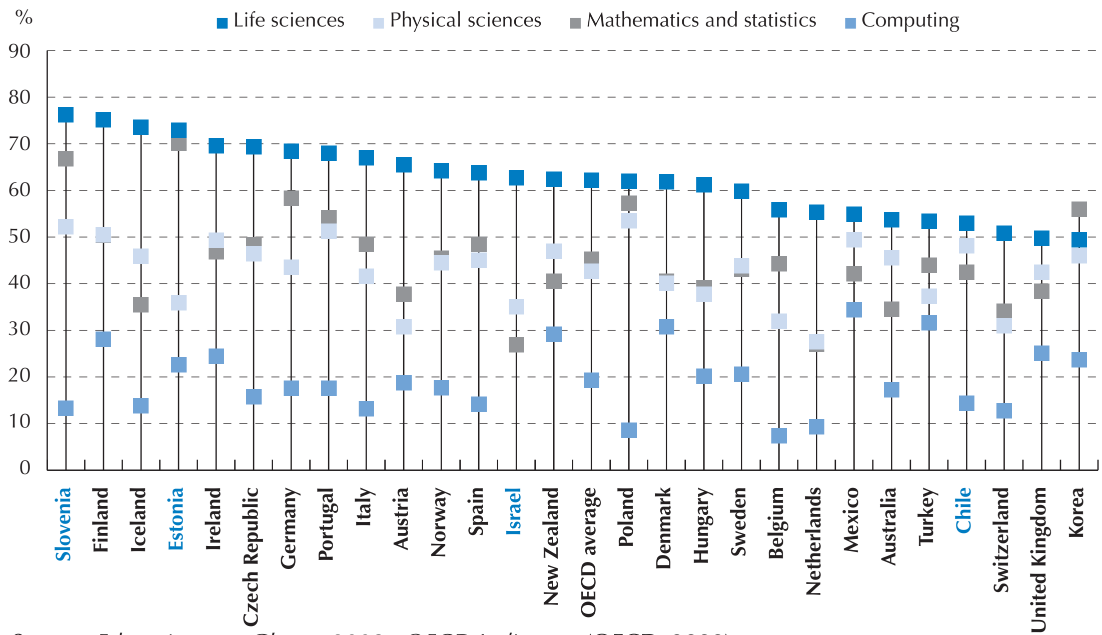
Since PISA focused on science in 2006, it is relevant to look at the entry of students into tertiary education and, in particular, to examine the taking up of various science based courses (life sciences, physical sciences, computing, and mathematics and statistics). It can be seen (Figure 3) that females dominate in the life sciences in all countries. The highest percentage is in Slovenia where 76% of students in life science courses are female. At the other extreme the numbers of females taking up computing courses remain much lower than males. In Belgium only 7% of entrants to computing courses are female, with the highest proportion of female entrants being 34% in Mexico.

The OECD's Global Science Forum in its policy report, *Evolution of Student Interest in Science and Technology Studies* (OECD, 2006b), found that women were strongly under-represented in science and technology studies. This was considered to be important because, with the number of males at a level where a large increase is not likely, female students are the most obvious resource for increasing science and technology enrolments.

The choice of discipline appears to be highly gender-dependent. In most countries, women constitute less than 25% of computing and engineering students. In contrast, women are consistently more numerous than men in life sciences.

Figure 3

Proportion of females in new entrants at tertiary level, by field of education



Source: *Education at a Glance 2008 - OECD Indicators* (OECD, 2008).

The report also concluded that there were significant differences between males and females in their attitudes to science. The Global Science Forum reported that it appeared young female students may suffer from stereotypes in relation to external expectations (those of parents, teachers and society in general) because despite having marks at least as good as males, females are usually not encouraged to pursue science and technology career paths by their families, teachers and career advisors. Females tended to undervalue their own performance, and hence their ability to pursue science and technology. There also may be a lack of role models for females (famous scientists, family members, etc.). Students' attitudes to careers are formed at secondary school and PISA provides a great deal of information on this which is discussed later in the report.

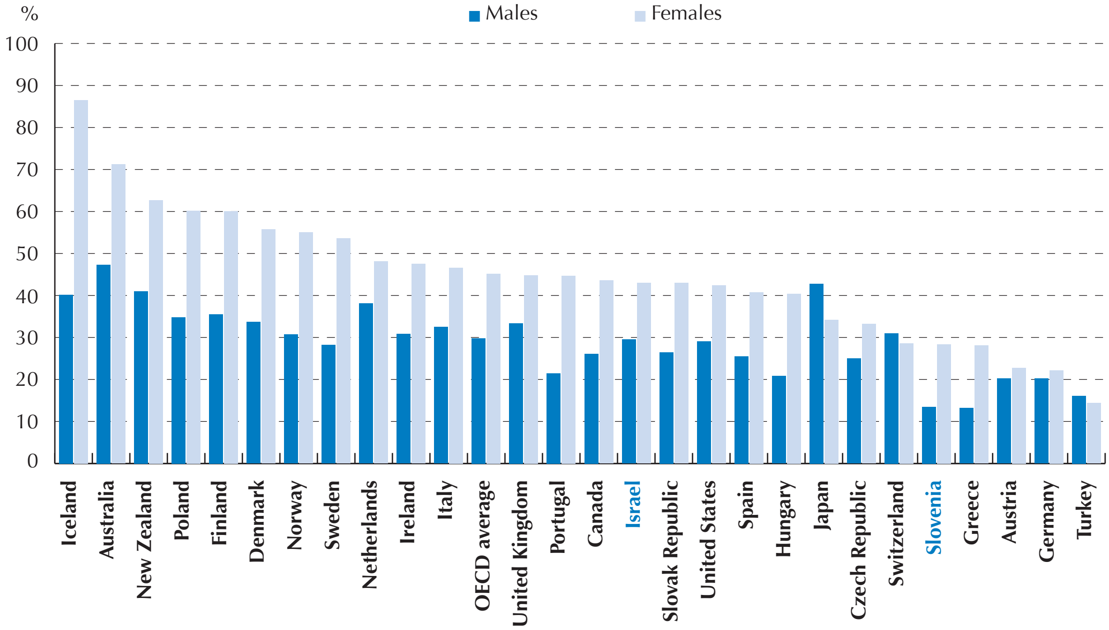
Graduation from tertiary education

As Figure 4 shows, in nearly all OECD countries the percentage of females graduating for the first time is larger than the percentage of males (OECD, 2008). Furthermore, as Figure 5 shows, on average in OECD countries, more than 70% of the tertiary graduates in the humanities, arts, education, and health and welfare are females, whereas only around 25% of those graduating in mathematics and computer science or engineering are females.

Figure 5 also shows that the percentage of graduates who are female declines as the level of education increases (OECD, 2008). The proportions of first or second tertiary–type A degree graduates in 2006 who were female were 58% and 56% respectively, and only 43% of advanced research qualifications, the highest level of education, were awarded to females. In OECD countries, the gap between males and females at this highest level of education has decreased between 2000 and 2006 – in 2000 39% of the graduates were female.

Figure 4

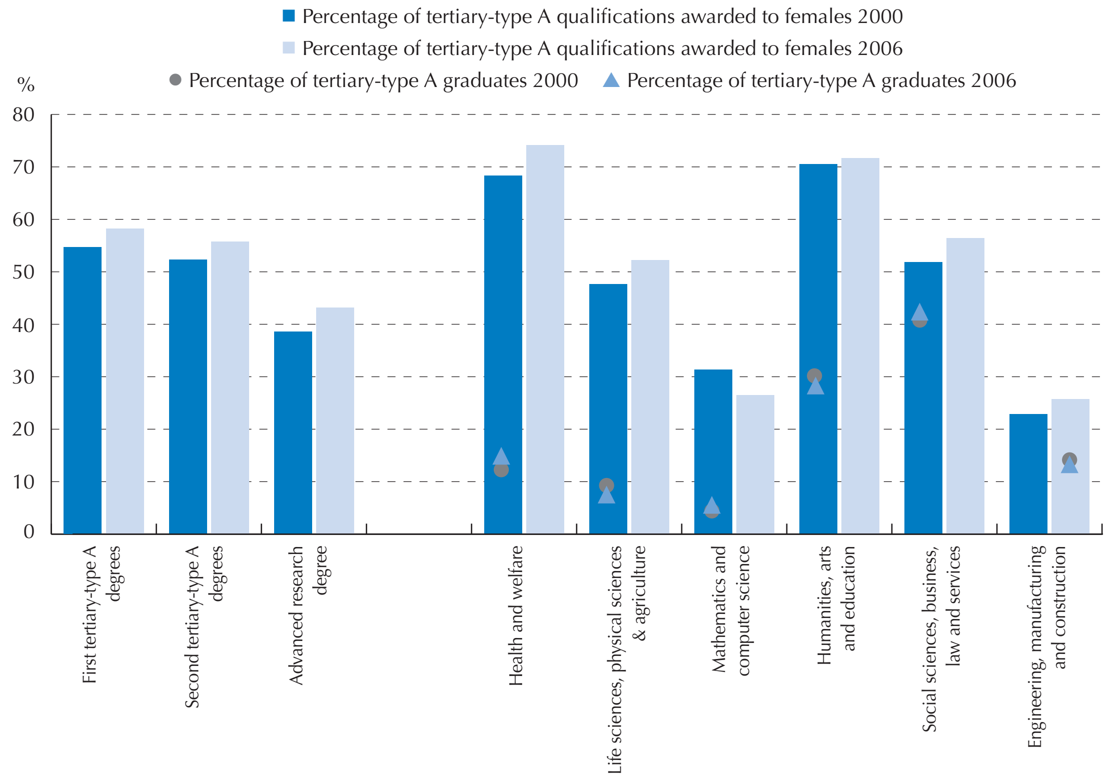
Tertiary-type A graduation rates, by gender (2006)



Source: *Education at a Glance 2008 - OECD Indicators* (OECD, 2008).

Figure 5

Percentage of tertiary-type A qualifications awarded to females and breakdown of tertiary graduates by field of education, OECD average (2000, 2006)



Source: *Education at a Glance 2008 - OECD Indicators* (OECD, 2008).

The United States may provide an example of what is happening in a number of OECD countries. In examining the physical sciences in the US, Taasoobshirazi and Carr (2008) wrote that the underrepresentation of women in the sciences is a significant and well documented societal concern and they cite Miller (2006) and Stake (2006). Using figures from the National Science Foundation, they found that in recent years, women had received 34% of the master's degrees in computer science, 21% of the master's degrees in physics, 41% of the master's degrees in chemistry, and 21% of the master's degrees in engineering. Results for doctoral degrees were similar: women received 19% of the doctoral degrees in computer science, 13% in physics, 32% in chemistry, and 17% in engineering. Thus, they concluded that women were greatly underrepresented in more advanced science degrees and degrees involving physics and engineering.

In relation to attitudes to science, the Global Science Forum report (OECD, 2006b) noted that "many surveys have shown clear differences between males and females in their experience with, interest in, and attitudes to science and engineering, so it is not surprising to see these attitudes transposed into differences in their choice of studies. Furthermore, females tend to show a stronger interest in people rather than facts or things, and these differences may be amplified in the way science and technology are taught, and in the perception of science and technology careers. These differences do not appear to be related to ability, since females tend to succeed well in science and technology, especially in the early stages. Some experts are working on the re-engineering of the education process to offer equal opportunity to both genders, but no consensus has yet emerged concerning the assumptions, methods, or results that can be achieved."

Labour market

Gender differences are apparent in labour market outcomes. In many countries the earnings of males and females are different for all levels of educational attainment. With few exceptions, females earn less than males with similar levels of educational attainment. For all levels of education, average earnings of females between the ages of 30 and 44 range from 51% of those of males in Korea to 89% in Slovenia (OECD, 2008, p.163).

Although the gap in earnings between males and females is explained in part by factors other than education (that is by different choices of career and occupation, by differences in the amount of time that males and females spend in the labour force, and by the relatively high incidence of part-time work among females), it is appropriate to examine these differences further, including using data from PISA 2006 to look at the attitudes of students to science before they enter the workforce.

WHAT CAN PISA SAY ABOUT GENDER DIFFERENCES?

PISA is well placed to further our understanding of the emerging patterns of gender differences developing through childhood and adolescence suggested by the evidence presented above. Because of its widespread implementation and the nature of the assessment, PISA can provide a great deal of information about gender differences in student performance and attitudes at the secondary level. These measurements are made at an important and formative time of an adolescent's life and can provide some insight into the patterns of behaviour that may develop.[1]

PISA seeks to provide information about the key competencies of 15-year-old students and is administered every three years in OECD member countries and a group of partner countries and economies. It assesses the extent to which students near the end of compulsory education have acquired the knowledge and skills that are needed for participation in society, focusing on student competencies in the key areas of reading, mathematics and science. PISA seeks to assess how well students can extrapolate from what they have learned at school and apply their knowledge in novel settings.

PISA can be used to give information about the performance of education systems, the equity in distribution of learning opportunities, consistency of school performance within a country and student dispositions to learning and to issues in the community. Performance in PISA is reported both in terms of a score (with mean of 500 and a standard deviation of 100 across OECD countries) and also as a proficiency level, which describes the tasks that a student can do. In science there are six proficiency levels, with Level 6 representing the highest capacity.

This report focuses on the gender differences observed in the first three PISA surveys. In PISA 2000 reading was the major area of assessment, in 2003 it was mathematics and in 2006 it was science. There are sections below devoted to each of these areas of assessment, with a more detailed description of the most recent survey in 2006 which focused on students' competency in science, offering a comprehensive international measurement in this area. In today's technology-based societies, understanding fundamental scientific concepts and theories and the ability to structure and solve scientific problems are more important than ever. PISA 2006 assessed not only science knowledge and skills, but also the attitudes which students had towards science.

WHAT DID PISA 2000 TELL US ABOUT GENDER DIFFERENCES IN READING?

PISA 2000 focused on reading and studied gender differences in great detail. One of the main findings of the initial PISA 2000 report was that females outperform males in reading and in all of its subcomponents. It was also the case that females showed a lot more interest than males in reading and in part this explains the performance gap.

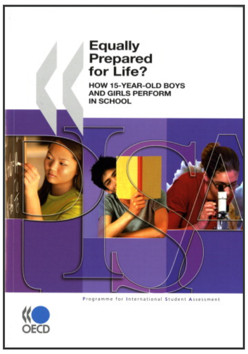
Student performance

The study of gender differences has always been one of the main areas of interest to countries participating in PISA. In the first cycle of PISA in 2000 the main focus of assessment was reading and a chapter of the initial report, *Knowledge and Skills for Life: First results from PISA 2000* (OECD, 2001), was devoted to gender differences. There were some large gender differences observed in both student performance and student attitudes.

In all participating countries females significantly outperformed males. The advantage to females, on average across the OECD, was 32 score points. This is nearly one half of a proficiency level (there are five proficiency levels in reading). There was, however, significant variation between countries in the size of gender differences. The largest difference between males and females was in Finland (the top-scoring country overall) with a difference of 51 score points. It must be pointed out, however, that males in Finland did not score poorly in PISA – there is no other country where males scored more highly – it is just that the females obtained exceptionally high results.

The distribution of performance showed strong contrasts between females and males. In the PISA 2000 assessment 11.9% of females performed at the highest level of proficiency (Level 5) compared with 7.2% of males. In all OECD countries males were more likely than females to be among the lowest-performing students. At Level 1 and below on the combined reading literacy scale, the ratio of males to females ranged from 1.3 to 3.5.

In PISA 2000 three areas of reading competency were measured on the *retrieving information scale,* the *interpretation scale* and the *reflection and evaluation scale*. With few exceptions, females outperformed males on every scale, with gender differences strongest in *reflection and evaluation*. On average, gender differences were 45 score points in favour of females on the *reflection and evaluation* scale, compared with 29 score points on the *interpretation* scale and 24 score points on the *retrieving information* scale.



Equally prepared for life?

How 15-year-old boys and girls perform in school