

# Executive Summary

The Programme for International Student Assessment (PISA) is an initiative of the Organisation for Economic Cooperation and Development (OECD) in Paris. PISA is part of an ongoing OECD program of reporting on indicators in education, which first appeared in the annual OECD publication *Education at a Glance* more than a decade ago. Over this period, the OECD has successfully developed indicators of human and monetary resources invested in education and how education systems operate. PISA arose because there was a need for regular and reliable information on educational outcomes across countries, particularly a measure of students' skills. Because it is part of an ongoing program of reporting, an aim of PISA is to monitor trends in performance over time.

## What does PISA assess?

The primary focus of PISA is on public policy issues related to education provision, with the aim of helping the governments of OECD member countries (and others) to have the best possible education systems. Questions guiding the development of PISA are the following:

- ▶ How well are young adults prepared to meet the challenges of the future? What skills do they possess that will facilitate their capacity to adapt to rapid societal change?
- ▶ Are some ways of organising schools and school learning more effective than others?
- ▶ What influence does the quality of school resources have on student outcomes?
- ▶ What educational structures and practices maximise the opportunities of students from disadvantaged backgrounds? How equitable is education provision for students from all backgrounds?

## Who is assessed?

The student population chosen for PISA is students aged 15 years, who are thus assessed as they approach the end of their secondary schooling. National random samples of at least 4,500 15-year-old students are chosen from 150 or more schools in each country to participate in the assessment.

The first assessment of 15-year-old students in 28 OECD member countries (including Australia) and four non-OECD (or partner) countries took place in 2000. The second assessment was undertaken in 2003, and involved more than one-quarter of a million students in 41 countries (all 30 OECD member countries and 11 non-OECD countries)<sup>1</sup>. In 2006, 57 countries participated; all OECD countries and 27 partner countries in regions spanning all inhabited continents. In total, almost 400,000 students worldwide participated in PISA 2006.

In Australia, 356 schools and 14,170 students participated in PISA. The larger sample was taken in Australia for a number of reasons:

- ▶ Smaller states and Indigenous students were oversampled so that reliable estimates could be inferred for those populations; and
- ▶ The PISA 2006 sample was designed to become a cohort of the Longitudinal Surveys of Australian Youth (LSAY). These students will be contacted in future years to trace their progress through school and entry into further education and the work force. A large sample is needed to allow for attrition: over time contact is lost with a proportion of the original sample.

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<sup>1</sup> Although the Netherlands participated in PISA 2000, and the United Kingdom in PISA 2003, neither countries' results are reported as they were unable to meet sampling requirements.

## What is assessed?

The goal of PISA is to measure competencies that will equip students to participate productively and adaptively in their life beyond school education. The PISA assessment focuses on young people's ability to apply their knowledge and skills to real-life problems and situations. The emphasis is on whether students, faced with problem situations that might occur in real life, are able to analyse, reason and communicate their ideas effectively. In addition, how well do they make use of technological advances? Do they have the capacity and are they equipped with strategies to continue learning throughout their lives? The term *literacy* is attached to each domain to reflect the focus on these broader skills. The way in which it is used is a great deal broader than in the traditional sense of being able to read and write. The OECD considers that mathematics, science and technology are so pervasive in modern life that it is important for students to be 'literate' in these areas as well.

The relevant skills are measured with assessment tasks that typically contain some text describing a real-life situation and a series of two or more questions for students to answer about the text. For the mathematical and scientific components of the assessment, the text typically presents situations in which mathematical or scientific problems are posed or mathematical or scientific concepts need to be understood. In all domains, the 'text' is not necessarily prose text, but can be a diagram, table, or chart, for example. Some of the PISA 2006 items were multiple choice, but for others, students had to construct and write their own answers.

There are many more skills in which PISA is interested than could be measured in each survey. As the surveys are planned every three years a different domain is chosen to be the focus for each assessment. Reading literacy was the major domain in PISA 2000, mathematical literacy in PISA 2003, and scientific literacy was the major focus of the PISA 2006 assessment.

With the focus on scientific literacy as a major domain for PISA 2006, the framework describing PISA science was developed in depth. The PISA 2006 assessment more clearly separates *knowledge about science* from *knowledge of science*. *Knowledge of science* refers to knowledge of the natural world across the major fields of physics, chemistry, biological science, Earth and space science, and science-based technology. *Knowledge about science* refers to knowledge of the means (scientific enquiry) and the goals (scientific explanations) of science. The PISA framework further elaborates on, and gives greater emphasis to, *knowledge about science* as an aspect of science performance, through the addition of elements that underscore students' knowledge about the characteristic features of science.

The PISA scientific competencies can be thought of as a sequence of strategies students use when solving a problem. First they identify the problem, then apply their *knowledge of science* to find a solution, and finally interpret and use the results. The three competencies defined in PISA 2006 for science are identifying scientific issues, explaining phenomena scientifically and using scientific evidence. The term 'scientific literacy' used in this report refers collectively to both *knowledge about science* and *knowledge of science*.

## What did participants need to do?

Students who participated in PISA completed an assessment booklet that contained questions from the major domain and one or more of the minor domains being tested – in PISA 2006 they were assessed on scientific literacy (the major domain), reading literacy, and mathematical literacy. Students also answered a short questionnaire, which included scales to measure their attitudes as well as questions to collect information on their backgrounds. School principals completed a short questionnaire which collected information about their schools.

## How are results reported?

Results are reported for scientific, reading and mathematical literacy, for the PISA scientific literacy knowledge domains and scientific competencies, and for attitudes towards science and science learning. For each of the major domains, a scale was defined that had a mean of 500 and a standard deviation of 100.

Results from countries are reported as average scores, as distributions of scores, and as percentages of students who attain each of a set of defined levels of proficiency. The science proficiency scales contain descriptions of the skills typically shown by students achieving at each level, and were defined especially for PISA 2006 by international science experts.

## How is PISA managed?

PISA 2006 was implemented internationally by a consortium led by the Australian Council for Educational Research (ACER). Other members of the consortium were the Netherlands National Institute for Educational Measurement (CITO), Westat Inc. in the United States, and the National Institute for Educational Policy Research (NIER) in Japan.

There is a high emphasis in PISA on collaboration between countries, and between countries and the consortium. Input is sought from countries by the consortium at all stages of the development of the PISA instruments and the frameworks that establish what is to be assessed.

## PISA 2006 in Australia

- ▶ Just over 14,000 students from 356 schools participated, from all States and Territories and all sectors of schooling.
- ▶ Data were gathered between late-July and early September 2006.
- ▶ Teachers who were not on the staff of any of the selected schools, and who were not currently teaching, travelled throughout Australia to administer the assessment sessions. These Test Administrators were all required to attend a training session about PISA procedures in order to ensure that testing occurred in a standard way.
- ▶ A group of teachers coded the students' answers to questions where the answers had to be written in. These teachers attended training sessions for several days to become familiar with the wide range of items in PISA and the criteria that were set up as the basis for decisions about the correctness of students' answers.
- ▶ Students' results were sent back to their own schools. Apart from that, all information in PISA at student and school levels is strictly confidential at all times.

## Australia's performance in PISA 2006

Overall, Australia's students acquitted themselves very well in PISA 2006. The following are some highlights. Differences are only mentioned if tests of statistical significance showed that the differences were highly likely to indicate real differences.

*In terms of country averages:*

- ▶ Australia's results were above the OECD average in each of scientific, reading and mathematical literacy.
- ▶ Australia was significantly outperformed in scientific literacy by three countries – Finland, Hong Kong-China and Canada. Australia's performance was not significantly different from that of Japan or Korea or to that of five other countries. In 2003, four countries also achieved better results than Australia in scientific literacy – Finland, Japan, Korea and Hong Kong-China. In PISA 2000, only Korea and Japan outperformed Australia.

- ▶ Eight countries outperformed Australia in mathematical literacy in PISA 2006, compared with seven countries in PISA 2003 and one in PISA 2000.
- ▶ In reading literacy in PISA 2006 Australia was outperformed by five countries: Korea, Finland, Hong Kong-China, Canada and New Zealand. In PISA 2003 Finland and Korea achieved significantly better results than Australia and in PISA 2000 only Finland achieved significantly better results than Australia in reading literacy. The change in Australia's position has occurred because of a combination of Australia's decline in score, improvements for Korea and Hong Kong-China, and the scores for Canada, Finland and New Zealand remaining the same.
- ▶ Australian students scored significantly higher than the OECD average in both science knowledge domains, scoring 533 points for *knowledge about science* and 528 points for *knowledge of science*, compared to the OECD averages of 500.
- ▶ Australia performed at a level higher than the OECD average in all three of the content areas within the PISA *knowledge of science* domain: Earth and space systems, living systems, and physical systems. Physical systems was a relative weakness nationally, with achievement in this domain a significant 12 points lower than the average overall science performance score for Australia. The score in living systems was also relatively lower than the overall average score for scientific literacy, while the score for Earth and space systems was slightly higher than the overall average score.
- ▶ Australian students performed well in the *identifying scientific issues* competency, scoring second only to Finland. This was also a strength nationally, with an average score eight points higher than the overall Australian science average. As was the case in almost all participating countries, Australian females scored significantly higher than males in this competency.
- ▶ Australian students demonstrated a relative weakness in the *explaining phenomena scientifically* competency. The average score was seven score points lower than the overall average for science, and Australian students were outperformed by five other countries. Gender differences internationally were almost all in favour of males, and Australian males outscored their female counterparts by a significant 14 score points.
- ▶ In *using scientific evidence*, Australian students performed moderately well. The average score was four points higher than the overall science average, and Australian students were outperformed by four other countries. There were fewer gender differences in this competency than in the other two, and most were in favour of females. In Australia the gender difference was not significant.

*In terms of distribution of scores:*

- ▶ In Australia, the ranges of scores between the 5<sup>th</sup> and 95<sup>th</sup> percentile are wider than the OECD average for scientific literacy, and narrower than the OECD average for reading literacy and mathematical literacy. A lower spread in scores means that there is a smaller gap in performance between the highest- and lowest-achieving students.

*In terms of proficiency levels in scientific literacy:*

- ▶ Three per cent of Australia's students achieved the highest scientific literacy proficiency level (Level 6), which was above the OECD average of one per cent. The country with the highest proportion of students achieving proficiency level 6 was Finland, with four per cent of its students at Level 6.
- ▶ In Australia, three per cent of students reached proficiency level 6 in *identifying scientific issues* (highest was New Zealand with 4%), three per cent in *explaining phenomena scientifically* (highest was Finland with 5%), and four per cent in *using scientific evidence* (highest were New Zealand and Finland with 7%).
- ▶ At Level 6, students can consistently identify, explain and apply scientific knowledge and *knowledge about science* in a variety of complex life situations. They can link different

information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they are willing to use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social, or global situations.

- ▶ Fifteen per cent of Australian students were placed at Level 5 or higher in scientific literacy, 40 per cent at Level 4 or higher, and two-thirds at Level 3 or higher. Corresponding figures for the OECD as a whole were nine per cent at Level 5 or higher, 29 per cent at Level 4 or higher, and 56 per cent at Level 3 or higher.
- ▶ Only 13 per cent of Australian students did not reach at least Level 2 in scientific literacy, compared with the OECD average of 19 per cent. Ten per cent of Australian students in *identifying scientific issues*, 14 per cent in *explaining phenomena scientifically*, and 14 per cent in *using scientific evidence* did not reach Level 2.
- ▶ Four per cent of Australia's students were not achieving at the basic PISA proficiency level, Level 1, in scientific literacy compared with eight per cent in the OECD as a whole. Students performing below the lower boundary of Level 1 were not necessarily incapable of performing any scientific tasks but were unable to utilise these skills in a given situation, as required by the easiest PISA tasks.

*In terms of proficiency levels in reading literacy and mathematical literacy:*

- ▶ Eleven per cent of Australian students were achieving at the highest level of reading literacy, Level 5, which was higher than the OECD average of nine per cent. The country with the highest proportion of students achieving at this level was Korea, with 22 per cent of students achieving at Level 5.
- ▶ About 14 per cent of Australian students were performing below proficiency level 2 in reading, lower than the OECD average (21%), but higher than that of the highest performing country, Korea (5%).
- ▶ Four per cent of Australian students were achieving at the highest level of mathematical literacy, Level 6, which was just higher than the OECD average of three per cent. Finland, one of the other highest scoring countries, achieved six per cent at Level 6, while Chinese Taipei, the other highest-scoring country achieved 12 per cent at level 6.
- ▶ Sixteen per cent of Australian students, compared with 13 per cent for the OECD on average and 32 per cent for Chinese Taipei, scored at Level 5 or 6 in mathematics.
- ▶ Thirteen per cent of Australian students, compared with 22 per cent of students on average in the OECD and 12 per cent in Chinese Taipei, failed to achieve Level 2 on the mathematical literacy scale. In Finland, just six per cent of students failed to achieve Level 2.

*Between 2000, 2003 and 2006:*

- ▶ Australia's performance significantly declined in reading literacy, and remained statistically the same in mathematical literacy. As the first major assessment of science, the PISA 2006 assessment establishes the basis for analysis of trends in science performance in the future and it is therefore not possible to compare science learning outcomes from PISA 2006 with those of earlier PISA assessments as is done for reading and mathematics.
- ▶ Data on reading literacy achievement by state and gender over the period from 2000 to 2006 show that there was a statistically significant decline in the reading literacy performance of females in the Northern Territory and Western Australia between PISA 2003 and PISA 2006 and for Tasmania between PISA 2000 and PISA 2006. There were also significant declines for males between 2003 and 2006 in South Australia and the Northern Territory and in the Northern Territory, New South Wales and South Australia between 2000 and 2006. Overall for

Australia, mean reading scores for both males and females declined significantly between 2003 and 2006.

- ▶ While the mean scores in mathematical literacy for Australia as a whole and for most of the states declined between PISA 2003 and PISA 2006, the decreases were not significant for Australia overall and were significant for only two states – Western Australia (by 17 score points) and South Australia (by 15 score points). However, there was a significant decline in the mean score of female students between 2003 and 2006 for Australia as a whole.

*In terms of results for the Australian states and territories:*

- ▶ In scientific literacy, the Australian states and territories all performed, on average, at a level in each domain that was either at or above the OECD average.
- ▶ In scientific literacy, the average performance of students in the Australian Capital Territory was significantly higher than that of all states other than Western Australia. The scores of students in Western Australia were statistically similar to those of students in New South Wales and South Australia but higher than those of the other states. These findings were similar to those reported for PISA 2000 and PISA 2003.
- ▶ In reading literacy, the Australian Capital Territory and Western Australia achieved the highest means (which were not statistically different from one another) while Western Australia also performed on a par with New South Wales and South Australia.
- ▶ In mathematical literacy the score for the Australian Capital Territory was not significantly different to that of Chinese Taipei, the highest scoring country. The score for Western Australia was not significantly different to that of the Australian Capital Territory, and was also significantly higher than the Australian average.
- ▶ In both the Australian Capital Territory and Western Australia, around 20 per cent of students were performing at the highest two proficiency levels in scientific literacy, 40 per cent of students were performing at the highest two proficiency levels in reading literacy, and more than 20 per cent were performing above Level 5 in mathematical literacy.

*In terms of the results for males and females:*

- ▶ Internationally there were gender differences in scientific literacy in 20 countries: 12 in favour of females and eight in favour of males. In Australia there was no significant gender difference on the overall scientific literacy scale.
- ▶ There were, however, some gender differences in scores at the level of content areas and competencies. Australian female students performed at a significantly lower level than Australian male students in both Earth and space systems and physical systems but at a similar level in living systems. In Earth and space systems and living systems the average scores for Australian females were significantly higher than the OECD average, but in physical systems the average score for females was not significantly different to the OECD average. In the science competencies, Australian males outscored females in *explaining phenomena scientifically*, and females outscored males in *identifying scientific issues*.
- ▶ As in PISA 2000 and PISA 2003, the gender difference in favour of females in reading literacy was large, about 0.4 of a standard deviation, and this was about the same as the OECD average.
- ▶ Males significantly outscored females in mathematical literacy in Australia in 2006, in contrast to the position in the previous cycle when there was no significant gender difference.
- ▶ There were no gender differences shown in overall scientific literacy within the states of Australia.
- ▶ In reading literacy the gender difference in each state was in favour of females, and was largest in New South Wales, where the difference was 46 score points or half a proficiency level. In

terms of proficiency levels, there were more than twice as many females as males achieving at Level 5 in the Northern Territory and South Australia, and almost twice as many females as males in New South Wales, Queensland, and Tasmania. The smallest gender differences at Level 5 were found in the Australian Capital Territory, where 4% more females than males achieved Level 5, Western Australia, with a 5% gap between the proportion of females and males, and Victoria, with a 3% gap between the proportion of females and males.

- ▶ In mathematical literacy the largest gender differences were found in Victoria (23 points) and Western Australia (19 points). In the Australian Capital Territory, 29 per cent of males but only 18 per cent of females were found to be achieving at or above Level 5, and in Victoria and Western Australia there was a gap of some eight percentage points between the percentage of males and females achieving at this high level. The smallest gender difference at high proficiency levels was found in the Northern Territory, where 10 per cent of females and 12 per cent of males achieved at Level 5 or higher.

*In terms of Indigenous students' results:*

- ▶ Altogether, 1,080 Indigenous students were assessed in PISA 2006. On average, the performance of Indigenous Australians in scientific literacy was 88 score points lower than that of non-Indigenous students. That is, Indigenous students scored around one proficiency level lower than non-Indigenous students.
- ▶ Similar results were evident for reading and mathematical literacy.
- ▶ Indigenous students were over-represented in the lowest categories of science proficiency and under-represented in the highest category. Only three per cent of Indigenous students demonstrated skills at proficiency level 5 or higher, and 40 per cent failed to achieve proficiency level 2.
- ▶ Similarly, Indigenous students were over-represented in the lowest categories of reading and mathematical literacy, and under represented in the highest categories. In reading, 12 per cent of Indigenous students were found in the highest two proficiency levels along with 36 per cent of non-Indigenous students. In mathematical literacy, two per cent of Indigenous students and 16 per cent of non-Indigenous students were found in the higher levels. In reading, 38 per cent of Indigenous and 12 per cent of non-Indigenous students did not achieve Level 2, and in mathematical literacy 39 per cent of Indigenous and 12 per cent of non-Indigenous students did not achieve Level 2.
- ▶ The scores for Indigenous students on the three scientific competencies were also significantly lower than the scores for non-Indigenous students and also than the OECD averages. Indigenous students performed relatively better in the *identifying scientific issues* competency, scoring an average of 12 points more than the Indigenous overall scientific literacy score. Their performance in *explaining phenomena scientifically* and *using scientific evidence* was close to the Indigenous overall average for scientific literacy.

*For other student groups:*

- ▶ The average scientific literacy score of students attending schools in remote areas was significantly lower than that of students attending schools in either provincial areas (by 47 score points) or metropolitan areas (by 57 score points). More than one-quarter of students in remote schools were not achieving at Level 2, compared with around 12 per cent of the cohort in metropolitan or provincial areas. At the higher end of the achievement scale, only seven per cent of students in remote areas achieved Level 5 or higher, compared with 13 and 15 per cent of students in provincial and metropolitan schools respectively.
- ▶ In reading literacy, the average score of students attending remote schools was about 30 score points lower than that of students attending schools in provincial areas, and about 50 score points lower than that of students attending schools in metropolitan areas. Twenty-four per cent

of the students in remote areas did not achieve the baseline proficiency level, compared to 17 per cent of students in provincial areas and 12 per cent in metropolitan areas. Around 12 per cent of students attending metropolitan schools were achieving at Level 5, compared to eight per cent of those in provincial schools and seven per cent of those in remote schools.

- ▶ In mathematical literacy the average score of students who attended schools in remote areas was 40 score points lower than that of students attending schools in provincial areas, and 58 score points lower than that of students attending schools in metropolitan areas. Twenty-eight per cent of the students in remote areas did not achieve proficiency level 2, compared to 20 per cent of students in provincial areas and 12 per cent in metropolitan areas. Around 18 per cent of students attending metropolitan schools were achieving at Level 5, compared to 12 per cent of those in provincial schools and seven per cent of those in remote schools.
- ▶ The average scientific literacy score of students in the lowest socioeconomic quartile was significantly lower than that of students in the highest socioeconomic quartile (by 87 score points). Twenty-three per cent of students in the lowest socioeconomic quartile were not achieving at Level 2, compared with five per cent of the cohort in the highest socioeconomic quartile. Only six per cent of students in the lowest socioeconomic quartile achieved Level 5 or higher, compared with 26 per cent of students in the highest socioeconomic quartile.
- ▶ In reading literacy the difference in average scores between students in the highest and lowest socioeconomic quartiles was 84 score points. Five per cent of students in the highest socioeconomic quartile were not achieving at Level 2, compared with 23 per cent of the cohort in the lowest socioeconomic quartile. Only four per cent of students in the lowest socioeconomic quartile achieved Level 5, compared with 21 per cent of students in the highest socioeconomic quartile.
- ▶ In mathematical literacy, students in the lowest socioeconomic quartile scored on average 78 score points lower than those of students in the highest socioeconomic quartile. Twenty-two per cent of students in the lowest socioeconomic quartile were not achieving at Level 2, compared with five per cent of the cohort in the highest socioeconomic quartile. Only six per cent of students in the lowest socioeconomic quartile achieved Level 5 or higher, compared with 29 per cent of students in the highest socioeconomic quartile.
- ▶ To examine the effects of immigrant status on scientific literacy two indicators were used: immigrant status (based on country of birth of students and their parents) and language background. Language background is of interest because unfamiliarity with the language of testing could possibly be a factor in student performance in scientific, reading or mathematical literacy. Students' immigrant status is categorised in the Australian context as either Australian-born, first-generation, or foreign-born. Language background is dichotomised as 'English-speaking' or 'language background other than English'.
- ▶ In scientific literacy there were no significant differences between the scores of the three immigrant groups, but students with a language background other than English scored significantly lower than those who spoke English. Slightly more foreign-born students than Australian-born students and substantially more students with a language background other than English (20% compared to 11% of English-speaking students) were not achieving proficiency level 2.
- ▶ In reading literacy, first-generation students achieved significantly higher scores than Australian-born students. In the proficiency levels, English-speaking students scored at a significantly higher level than those students with a language background other than English, and 20 per cent of students with a language background other than English failed to achieve Level 2, compared with 12 per cent of English-speaking students.
- ▶ In mathematical literacy, both first-generation and foreign-born students significantly outperformed Australian-born students. There was no significant difference in the average scores of English-speaking students and those with a language background other than English. Similar proportions of students in each of the immigrant and language categories achieved at the lower proficiency levels. However, a higher proportion of foreign-born (23%) than first-



generation (18%) and Australian-born (15%) students and a higher proportion of students with a language background other than English (22%) than English-speaking (16%) students were achieving at Level 5 or higher.

*In relation to socioeconomic background:*

- ▶ The primary measure of a student's family and home background in PISA is the index of economic, social and cultural status (ESCS). PISA collected detailed information from students including information on the occupations of the student's parents or guardians, the level of education of the parents or guardians, and an index of home possessions, which included access to educational and cultural resources at home. The composite socioeconomic background index, ESCS, was based on the occupations of the parents or guardians, the highest level of education of the parents converted into years of education, an index of the home educational resources, an index of cultural possessions in the home, and an index of family wealth.
- ▶ As for all the other indices used in PISA, the ESCS index was standardised to have a mean of zero and a standard deviation of 1 for all OECD countries combined. Australia's mean value on the ESCS was 0.21, which was higher than the OECD average. This is similar to the ESCS score for OECD countries Austria (0.20), Finland (0.26), the Netherlands (0.25), and Sweden (0.24), is lower than that of Canada (0.37) and Iceland (0.77), and higher than that of countries such as New Zealand (0.10) and the United States (0.14). Within Australia, the mean values for the ESCS were 0.58 in the Australian Capital Territory, 0.28 in New South Wales, 0.21 in Victoria and Western Australia, 0.16 in South Australia, 0.10 in Queensland, 0.07 in the Northern Territory, and -0.04 in Tasmania.
- ▶ The terms 'socioeconomic gradient' or 'social gradient' refer in PISA to the relationship between students' performance and ESCS, which is evident in all countries but the strength varies between countries. Four types of information are useful in a discussion of this relationship.
  - The *strength* of the relationship between science achievement and socioeconomic background – represented by the percentage of the variation in performance that can be explained by the ESCS index. If the percentage is large it indicates that performance is relatively highly determined by ESCS whereas if it is small it indicates that performance is not highly determined by ESCS.
  - The *slope* of the gradient line is an indication of the extent of inequality in the relationship between students' results and their socioeconomic background (as measured by ESCS). A steeper slope indicates a greater difference in performance between low socioeconomic background students and high socioeconomic background students. Greater equity would be indicated by a flatter gradient.
  - The average *level* of the line in the graph gives an indication of how well the overall population has achieved on the given assessment. Lines at higher levels indicate higher mean performance by the students.
  - The *length* of the line indicates the range of ESCS. The graphs in this report are plotted between the 5<sup>th</sup> percentile of ESCS and the 95<sup>th</sup> percentile of ESCS. A smaller range indicates less difference in socioeconomic background between students from the highest and lowest socioeconomic backgrounds in the country.
- ▶ The strength of the relationship between ESCS and performance in science in Australia is significantly lower than for the OECD overall, meaning that the relationship is not as deterministic.
- ▶ The slope of the socioeconomic gradient for Australia was 43, significantly higher than the slope of 40 for the OECD. This means that in Australia every additional unit increase on the index of socioeconomic background translates into an additional 43 score points on the scientific literacy scale, significantly more than the 40 score points on average over the OECD.

- On the basis of Australia's lower than (OECD) average strength of relationship between socioeconomic background and performance and higher than (OECD) average performance, Australia is categorised as a high quality and high equity country in relation to science literacy performance in PISA 2006. Other countries categorised as high quality/high equity in science in 2006 were Finland, Hong-Kong China, Japan and Canada. New South Wales, Western Australia, South Australia, Queensland and Victoria are similarly characterised. Countries such as New Zealand, the Netherlands and Germany, as well as the Australian Capital Territory and Tasmania, are classed as high quality/low equity. The United States and France, as well as the Northern Territory, are classed as low quality/low equity, and countries such as Italy and Norway are classed as low quality/high equity.
- Level of the lines: The Australian gradient line is higher than that of the OECD, reflecting the fact that Australian students performed at a higher level than on average in the OECD.
- Length of the lines: The range of ESCS scores between the 5<sup>th</sup> and 95<sup>th</sup> percentiles is smaller in Australia than over the OECD as a whole, as would be expected given the range of countries contributing to the OECD average score.
- There is less difference in performance, generally, between countries at high levels of ESCS than there is at low levels. This means that students with high levels of socioeconomic background tend to vary less in their scientific literacy performance, from country to country, than students with relatively low levels of socioeconomic background. That is, the impact of educational experiences on student performance is greatest for students from lower socioeconomic backgrounds.
- The slopes for each of the three domains are very similar in Australia. There is a slightly lower impact of socioeconomic background on mathematics achievement than either scientific or reading literacy achievement. The slope for reading scores has declined significantly from that measured in PISA 2000, meaning that Australia's reading literacy score, although significantly lower than in PISA 2000, is also more equitably distributed in terms of socioeconomic background. The strength of the relationship has also decreased over the time period.
- In scientific literacy, the gradient for the Northern Territory is the steepest, with the Australian Capital Territory almost as steep, and Victoria has the flattest slope. The graphs for Tasmania and the Australian Capital Territory have a negative curvilinearity (the curvature of the line), indicating that there is a decreasing return on achievement for socioeconomic background past a certain point. South Australia's slope on the other hand shows a positive curvilinearity, indicating a higher rate of increase in science scores for students in high socioeconomic backgrounds than for students with low socioeconomic backgrounds. The average socioeconomic background for the Australian Capital Territory is generally higher than that of other states. Performance is also generally higher than that of students in other states. Performance across the states at the lower levels of ESCS has a wider range than at the higher levels; as was found internationally, the range of the states' performance converges at higher levels of ESCS.
- In most OECD countries, including Australia, the effect of the average ESCS of students in a school outweighs the effects of the student's own socioeconomic background.

*In terms of students' attitudes and motivation:*

- A number of measures used in PISA reflect indices that summarise responses from students to a series of related questions. The questions were selected on the basis of theoretical considerations and previous research. Values on the index were standardised so that the mean value for the OECD student population was zero and the standard deviation was one. The highest correlations between constructs discussed in this report and Australian scientific literacy performance were for self-efficacy in science, awareness of environmental issues, self-concept in science and enjoyment of science.

- ▶ Australian students had higher levels of self-efficacy in science than the OECD average. There was a significant gender difference in Australia in relation to self-efficacy in science, with males scoring significantly higher than females; however, both were higher than the OECD average.
- ▶ Students from New South Wales had the highest levels of self-efficacy in science. Students in the Australian Capital Territory, Western Australia, South Australia and the Northern Territory had higher mean levels of self-efficacy in science than the OECD average, while students in Victoria, Tasmania and Queensland had means that were slightly lower than the OECD average. Males from all states showed higher levels on the self-efficacy in science index than females. The largest gender differences were found in Western Australia and Victoria, with differences of approximately 0.25 points. There was a large positive relationship between self-efficacy in science and scientific literacy performance for Australian students. Students in the highest quartile scored 130 points on average higher than students in the lowest quartile on the self-efficacy in science index, which is equivalent to almost four years of schooling or almost two proficiency levels on the scientific literacy scale.
- ▶ The average for Australia for self-concept in science was -0.03, which was not significantly different to the OECD average. There was a significant gender difference in Australia, with males generally more confident in science than the OECD mean for males, and females less confident than the OECD mean for females. Western Australia had a mean score for self-concept in science that was just higher than the OECD mean; all other states scored below the OECD average, indicating lower levels of self-concept in science than students on average in OECD countries. The largest gender differences in relation to self-concept in science were in the Northern Territory and Western Australia. Self-concept in science has a moderately strong positive relationship with scientific literacy performance in Australia. There were 113 points on average between students in the highest quartile of the self-concept in science index and students in the lowest quartile.
- ▶ In general there was a positive association in Australia between scientific literacy performance and most of the constructs. An exception to this was optimism regarding environmental issues, where students with high levels of optimism about future environmental issues scored lower than students with low levels of optimism.
- ▶ Significant gender differences were found for all indices in Australia except in the index of general interest in learning science and the index of instrumental motivation in science, where no significant gender differences were found. All but two of the significant gender differences were in favour of males, the exceptions being the indices related to responsibility for sustainable development and concern for environmental issues, where they were in favour of females.

## Policy Issues

Australia is well placed to continue its tradition of producing high quality scientists. The average score in scientific literacy is significantly higher than the OECD average, and either statistically similar to, or significantly higher than, most trading partners and other countries to which we would usually compare ourselves. Fifteen per cent of our young people scored in the top two proficiency levels, comparing favourably internationally.

The 'gap' in achievement between the best and the weakest students varies by subject domain. In science, there is a relatively wide gap, narrower than that of the United States and the United Kingdom, but wider than the OECD average and that of most other countries. In reading and mathematical literacy, however, it is narrower than the OECD average and also narrower than the spread for between 60 per cent of other countries (for reading) and 70 per cent of other countries (for mathematics).

Analysis of Australia's performance in terms of equity and achievement places us in the category of above-average level of student performance and below-average impact of socioeconomic background in scientific literacy; in other words, high quality and high equity. In terms of the slope and strength of the association between socioeconomic background and achievement in science, both have decreased significantly since PISA 2003. Australia's outcomes have become more equitable, as shown by a flatter gradient, and less deterministic, as shown by the smaller proportion of variance explained by socioeconomic background. In reading literacy the slope and strength have also significantly declined, while in mathematics only the strength of the relationship has decreased. However, the increase in equity in reading literacy may be an artefact of declining achievement in the higher levels rather than because achievement at the bottom end has improved.

Australia's results in scientific, reading and mathematical literacy are laudable. However average scores do not paint the complete picture of a country's performance, and that has been the primary aim of this report. There are a number of areas in which Australia's performance is not as good as would be hoped.

### Decline in reading achievement

The results from the first three cycles of PISA indicate that the performance levels of Australian students, while comparing reasonably well internationally, are generally not improving. TIMSS 2003 found that scores in science at Year 8 had improved significantly; however, this improvement in scores has not really translated to an improvement in scientific literacy in the manner in which it is presented in PISA. There had also been no evidence previously of any decline in performance, but the PISA 2006 results now point to a significant decrease in performance in reading literacy since PISA 2000. While some caution should be exercised in interpreting these results, as PISA 2006 is comparing the results from the assessment of a minor domain to the assessment of a major domain, there is evidence of a decline, and it seems to be occurring primarily at the upper end of the achievement scale without any compensatory improvement at the lower end. The decline was found for both male and female students. While there is no evidence of any decrease in the average achievement levels in mathematical or scientific literacy, there was a significant decline in the mathematics achievement of Australian females.

### Gender

In terms of gender, there was no difference overall in scientific literacy; however, males performed significantly better than females in both Earth and space systems and physical systems, and the performance of females in the latter was at the OECD average. In reading literacy, the gender gap continued to favour females, and it is of a similar size to the gap found in PISA 2000. In PISA 2006 mathematics there is evidence of a decline in the scores of 15-year-old females and no associated decline in the score for males, resulting in a significant gender difference and one that

is higher than the OECD average. The decline in scores for females appears to have come from the higher end of achievement.

The performance of males in reading relative to females has not improved, and there is now a gender difference in mathematics, in favour of males, that has not existed for many years. Perhaps gender needs to be reconsidered as an issue for Australian education.

### Indigenous students

The achievement of Australia's Indigenous students continues to be a concern. Average scores for Indigenous students place them on a par with students in a low-performing country such as Chile, and two and a half years behind the average for their non-Indigenous contemporaries. While some individual Indigenous students performed very well on the PISA assessment many more performed extremely poorly. There is no doubt that many Indigenous students will continue to need extra support.

### Students attending schools in remote locations

The relatively poor performance of students attending schools in remote areas is also evident from these analyses, and requires attention. Students attending schools in remote areas were found to be achieving at a level about a year and a half lower than their counterparts in metropolitan schools in all of the assessment areas. It is recognised that schools in remote areas face problems such as attracting and retaining qualified teachers, maintaining services and providing resources, and in their capacity to send staff to participate in professional development, which may impinge on the quality of student outcomes.

### Students and schools with low socioeconomic levels

This report has also examined differences in achievement by quartiles of socioeconomic background. Students in the lowest socioeconomic quartile, on average, were achieving at a level two and a half years lower than students in the highest socioeconomic quartile across all three domains. Of the students in the lowest socioeconomic quartile around one-quarter failed to achieve the baseline proficiency levels in scientific, reading or mathematical literacy. Few achieved the highest levels in any domain.

Achievement differences in Australia are much larger within schools than they are between schools. However, the discussion of the PISA findings in scientific literacy indicates that the average socioeconomic background of a school outweighs a student's own socioeconomic background, and that the impact of schooling is greatest for students from disadvantaged backgrounds or attending schools with a low average socioeconomic background.

However, students from low socioeconomic backgrounds are a diverse group encompassing the full range of learning abilities, evidenced by the relatively low strength of the relationship between socioeconomic background and performance. They can and do achieve high standards.

Students who are confident in their own abilities and well motivated tend to do better at school. Positive approaches not only help to explain student performance but also are themselves important outcomes of education. Students who have become effective learners by the time they leave school, and particularly those who have learned to regulate their own learning, are often considered more likely to learn throughout life.

Australia remains committed to the principle of equity and social justice in education and to the goal of allowing and encouraging all children to fulfil their full educational potential. To a large extent, these goals are realised; evidenced by the high average achievement levels in all three assessment domains in PISA. However, there is some evidence from this cycle that Australia appears to be standing still while other countries improve their levels of performance. This report has also shown that behind the higher than average scores, significant levels of

educational disadvantage exist in Australia, and that the gap between students of the same age can be equivalent to several years of schooling. This gap places an unacceptable proportion of 15-year-old students at serious risk of not achieving levels sufficient for them to participate fully in the 21<sup>st</sup> century work force and to contribute to Australia as productive citizens.

Educational inequality is not a given. Some schools, some school systems, and some countries do more to mitigate inequality than others. Using PISA to monitor national outcomes on a regular basis provides Australian educators at all levels with the opportunity to step back and see how we measure up in terms of educational outcomes.