Acknowledgements

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Table of Contents

Overview......................................................................................................................................................1
  What is PISA?...............................................................................................................................................1
  What does PISA tell us about science?........................................................................................................1
  How good are New Zealand students at science?........................................................................................1
  What are the differences in science performance between different groups in New Zealand?................1
  Are 15-year-old New Zealander’s science abilities getting better or worse?........................................1

Background: the PISA survey .................................................................................................................2
  Assessing scientific literacy in PISA 2003 ..................................................................................................2
  Science scores in PISA 2003 ......................................................................................................................3

A profile of student science performance in New Zealand ...............................................................4
  Mean scientific literacy ...............................................................................................................................4
  Box A: Illustration of PISA science tasks of about medium difficulty....................................................5
  Distribution of scientific literacy ................................................................................................................7
  Percentage with high and low scientific literacy.......................................................................................7
  Overall variation within New Zealand......................................................................................................8

Who are the stronger and weaker students in science in New Zealand?.........................................9
  Gender differences in science performance .............................................................................................9
  Differences in science performance by ethnic group .............................................................................10
  Differences in science performance by socio-economic status ............................................................12
  Box B: A difficult science question ...........................................................................................................14
  Difference in science performance by school attended ............................................................................15

First estimates of changes over time .........................................................................................................17

Conclusion..................................................................................................................................................18

Administration of PISA 2003 ..................................................................................................................19

Sources for this summary .........................................................................................................................19

For further information in New Zealand ................................................................................................19
Overview

What is PISA?
The Programme for International Student Assessment (PISA) is a three-yearly international survey of 15-year-olds that assesses their knowledge and skills for modern life. In 2003, the survey was carried out in the 30 Organisation for Economic Co-operation and Development (OECD) member countries, plus 11 other countries, and it tested over a quarter of a million students, including 4500 from New Zealand.

What does PISA tell us about science?
PISA tells us how well students can use scientific knowledge to identify questions and draw evidence-based conclusions that are useful in real life situations, both for public and private decision making and for problem solving. This requires them to use knowledge from the main areas of science, to think scientifically, and to apply this knowledge and these skills in a range of situations that they will encounter as adults.

How good are New Zealand students at science?
On average, New Zealand students are significantly better than other students across the OECD countries.

More precisely, New Zealand has more students with high science skills and fewer students with low science skills, on average, compared to other OECD countries. However, there is scope for improvement. New Zealand has more than twice as many low-skill students as Finland, which is one of the two best-performing countries, and a third fewer high-performing students than the other best-performing country, Japan.

The amount of variation in performance among New Zealand students is close to the international average.

What are the differences in science between different groups in New Zealand?
- Boys do significantly better overall in science than girls, but girls are no more likely than boys to score below 400 points on the science scale. The advantage boys have is in reaching high, rather than medium, levels of performance.

- There were significant differences between the mean science scores of all four main ethnic groups, with Pākehā/European students doing best on average, followed by Asian, Māori and Pasifika respectively.

- Students from families with high socio-economic status do much better than those from lower socio-economic status families. This advantage is accentuated by the differences in performance levels between high-decile and low-decile schools. Around 30% of students attending low-decile schools scored below 400 points compared with only 5% of high-decile schools.

Are 15-year-old New Zealander’s science abilities getting better or worse?
This is just the second PISA survey and comparisons with the first one in 2000 show no change overall in science. However, there was a significant drop in the performance of girls between the two surveys. In 2000, New Zealand was one of only four countries where girls outperformed boys in science, whereas in 2003 it was one of 12 OECD countries where boys outperformed girls. This result must be treated with caution since a single change of this kind cannot be considered to be a trend.

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1 Throughout this report, the term ‘significantly’ refers to statistical significance at the 0.05 level.

2 A school’s decile indicates the extent to which the school draws its students from low or high socio-economic communities. It does not indicate the overall socio-economic mix of the school.
Background: the PISA survey

PISA surveys the knowledge and skills of 15-year-olds in the principal industrialised countries. The product of collaboration between participating governments through the OECD, it draws on leading international expertise to develop valid comparisons across countries and cultures.

PISA 2003 is the second assessment in the series. In this survey:

- Well over a quarter of a million students in 41 countries took part. All 30 OECD member countries participated, as well as ‘partner countries’ in Asia, Africa, Eastern Europe, and Latin America.
- Each student took a two-hour written test in their school.
- Students were assessed in mathematics, reading, science, and problem-solving. Mathematics was the main focus in 2003, while reading was the main focus in the first survey in 2000. The next PISA assessment in 2006 will focus on student performance in science.

The key features of the PISA approach are:

- Its policy orientation, with design and reporting methods determined by the need of governments to draw policy lessons.
- The innovative ‘literacy’ concept, which is concerned with the capacity of students to apply their knowledge and skills in key subject areas and to analyse, reason, and communicate effectively as they pose, solve, and interpret problems in a variety of situations.
- Its inclusion of assessment that is not restricted to particular areas of the school curriculum. The assessment of ‘problem solving’ in 2003 was the first such ‘cross-curricular’ assessment.
- Its regularity, which will enable countries to monitor their progress in meeting the key learning objectives over time.
- Its consideration of student performance alongside the background characteristics of students’ at home and school in order to explore some of the main features associated with educational success. Each participating student and school completed a questionnaire that allowed a wide range of background information to be considered alongside student performance.
- Its breadth of geographical coverage, as the countries that have participated so far represent one-third of the world’s population and almost nine-tenths of the world’s gross domestic product (GDP).

The comparisons made below set New Zealand students’ performance alongside that of students in the OECD countries, which are the countries in the survey most comparable to New Zealand: it excludes countries such as Tunisia, Peru, and Russia from the analysis. A total of 29 OECD countries reported results in 2003. (The United Kingdom participated but did not meet the sampling requirements.)

Assessing scientific literacy in PISA 2003

Students in PISA are asked to apply science knowledge and skills to real-life situations. According to the agreed PISA definition, science literacy is:
...the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.


The concept of scientific literacy in PISA is defined by three dimensions:

- **Scientific knowledge or concepts**: as science was a minor domain in 2003, it was not possible to assess all areas of scientific knowledge. A sample of concepts was assessed from the major scientific fields of physics, chemistry, biological science, and earth and space science.

- **Scientific processes used in relation to the subject matter of science**: describing, explaining and predicting scientific phenomena; understanding scientific investigation; and interpreting scientific evidence and conclusions.

- **Situations or context in which the knowledge and processes are assessed**: For PISA 2003, these contexts were: science in life and health, science in earth and the environment, and science in technology.

Most of the assessment items from PISA 2000 were also used in PISA 2003, allowing direct comparison between the two cycles.

The questions set in PISA varied in format: some were multiple choice; others required written answers. Of the latter, some required one correct answer and others were more ‘open’ and could be answered correctly in a variety of ways. In some cases, partial credit could be given for responses that showed some, but not all, of the required degree of understanding.

**Science scores in PISA 2003**

Performance in science is marked on a single scale with an average score of 500 score points and a standard deviation of 100 score points. Approximately two-thirds of students across the OECD countries score between 400 and 600 points. This report uses mean scores to compare the science performance of New Zealand students with those in other OECD countries.

Because science has been a minor domain, with less testing time in both of the 2000 and 2003 cycles of PISA, the scale cannot be defined as yet in terms of proficiency levels, which help to describe what kinds of skills are needed to reach a particular score. In the third PISA cycle in 2006, science will be the major domain of testing and a full instrument for measuring and reporting science will enable proficiency levels to be defined. However, criteria for harder and easier tasks can still be described in relation to items associated with different points on the science scale. Examples of the kinds of tasks involved at different levels are provided in Boxes A and B later in this report.
A profile of student science performance in New Zealand

The performance of New Zealand 15-year-olds in science tasks can be described in relation to the overall distribution of science performance by 15-year-olds across the OECD countries. This can be done by looking at benchmarks in terms of how well New Zealanders do, relative to the OECD average, and also relative to the best-performing countries.

One commonly used benchmark that sums up the performance of all students is their mean (average) score. However, this is only one benchmark and it is also useful to examine the distribution of scores across the sample. For example, a country where almost all students are capable of straightforward science tasks, but relatively few have high scientific skills, will face very different issues from one where there are large numbers of students at each extreme of the scale – even though both these countries may have the same average score.

Mean scientific literacy
The overall average for the OECD countries is set at 500 points, with a standard deviation of 100, indicating that about two-thirds of students internationally score between 400 and 600. New Zealand students’ estimated average score in science is 521. This is a strong performance by international standards, significantly above the OECD average. Due to the fact that the averages of different countries are close and that testing a sample of students can provide only an estimate of the performance of the whole student population, it is not possible to give a precise rank order for New Zealand students’ average among the 29 OECD countries with valid results. However, we can say with confidence that New Zealand students’ average score in science is higher than the average scores in 19 other OECD countries, lower than those in just three countries, and similar to the average scores in six other countries, as shown in Table 1.

Table 1: Average science scores, OECD countries, PISA 2003

<table>
<thead>
<tr>
<th>Significantly higher than New Zealand</th>
<th>No significant difference from New Zealand</th>
<th>Significantly lower than New Zealand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland (548)</td>
<td>Australia (525)</td>
<td>Belgium (509)</td>
</tr>
<tr>
<td>Japan (548)</td>
<td>Netherlands (524)</td>
<td>Sweden (506)</td>
</tr>
<tr>
<td>Korea (538)</td>
<td>Czech Republic (523)</td>
<td>Ireland (505)</td>
</tr>
<tr>
<td></td>
<td>New Zealand (521)</td>
<td>Hungary (503)</td>
</tr>
<tr>
<td></td>
<td>Canada (519)</td>
<td>Germany (502)</td>
</tr>
<tr>
<td></td>
<td>Switzerland (513)</td>
<td>Poland (498)</td>
</tr>
<tr>
<td></td>
<td>France (511)</td>
<td>Slovak Republic (495)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Belgium (495)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Iceland (495)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Luxembourg (483)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greece (481)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denmark (475)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Portugal (468)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turkey (434)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mexico (405)</td>
</tr>
</tbody>
</table>

Note: The United Kingdom took part in the survey but did not meet the sampling requirements. Eleven non-OECD countries/territories also took part. Of these, only Hong Kong, performed better than New Zealand, and students in Liechtenstein and Macao-China had similar scores to New Zealand. The other non-OECD countries scored significantly below New Zealand.

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3 The United Kingdom participated in PISA 2003 but did not meet the sampling requirements.
**Box A: Illustration of PISA science tasks of about medium difficulty**

What is meant by a score of 500 in PISA, and what distinguishes students who can do comparatively more difficult tasks? The following PISA science ‘unit’ first shows two examples of tasks associated with scores around the OECD average of 500. A clear majority of students in New Zealand could be expected to answer such items correctly. A third item was somewhat more difficult, although, in practice, about half of the students in the New Zealand sample still managed to answer it correctly.

**CLONING**

*Read the newspaper article and answer the questions that follow.*

**A copying machine for living beings?**

Without any doubt, if there had been elections for the animal of the year 1997, Dolly would have been the winner! Dolly is a Scottish sheep that you see in the 5 photo. But Dolly is not just a simple sheep. She is a clone of another sheep. A clone means: a copy. Cloning means copying ‘from a single master copy’. Scientists succeeded in creating a sheep (Dolly) that is identical to a sheep that functioned as a ‘master copy’.

It was the Scottish scientist Ian Wilmut who designed the ‘copying machine’ for sheep. He took a very small piece from the 15 udder of an adult sheep (sheep 1).

From that small piece he removed the nucleus, then he transferred the nucleus into the egg-cell of another (female) sheep (sheep 2). But first he removed from that 20 egg-cell all the material that would have determined sheep 2 characteristics in a lamb produced from that egg-cell. Ian Wilmut implanted the manipulated egg-cell of sheep 2 into yet another (female) 25 sheep (sheep 3). Sheep 3 became pregnant and had a lamb: Dolly.

Some scientists think that within a few years it will be possible to clone people as well. But many governments have already 30 decided to forbid cloning of people by law.
The following is a question of medium difficulty (associated with score of 494) that requires students to extract information and show basic scientific knowledge:

**Question 1: CLONING**

Which sheep is Dolly identical to?

A. Sheep 1  
B. Sheep 2  
C. Sheep 3  
D. Dolly’s father

The correct answer is option A. Students are required to read the text carefully and also to know that the nucleus of the cell contains the material that will determine the characteristics of the offspring.

A second question of medium difficulty (associated with score of 507) is an illustration of how PISA requires not just scientific knowledge but also an understanding of scientific investigation and reasoning.

**Question 2: CLONING**

In the last sentence of the article it is stated that many governments have already decided to forbid cloning of people by law.

Two possible reasons for this decision are mentioned below.

Are these reasons scientific reasons?

Circle either “Yes” or “No” for each.

<table>
<thead>
<tr>
<th>Reason:</th>
<th>Scientific?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloned people could be more sensitive to certain diseases than normal people.</td>
<td>Yes / No</td>
</tr>
<tr>
<td>People should not take over the role of a Creator.</td>
<td>Yes / No</td>
</tr>
</tbody>
</table>

Students who correctly answer Yes and No, in that order, show that they can distinguish between statements that are scientifically based and those that are not.

The third item in this unit is associated with a score of 572, which shows that it is somewhat more difficult than the previous two.

**Question 3: CLONING**

In line 14 the part of the udder that was used is described as “a very small piece”. From the article text you can work out what is meant by “a very small piece”.

That “very small piece” is

A. a cell.  
B. a gene.  
C. a cell nucleus.  
D. a chromosome.

To answer correctly (Option A), students must demonstrate an understanding of the structure of cells.
**Distribution of scientific literacy**

Figure 1 shows a wider set of benchmarks. It shows the distribution of the average student scores for the 29 OECD countries, for New Zealand, and for the two highest performing countries, Finland and Japan. The average OECD country manages to get 75% of its students above a benchmark of 427 points (the bottom quartile), but New Zealand exceeds this benchmark by 21 points with an equivalent score of 448. Overall, the distribution of performance in New Zealand is similar to the distribution in the average OECD country in the sense that the gaps between the percentile scores shown in Figure 1 are similar. As a result, at each of these percentiles, the New Zealand score is about 20 points above the OECD benchmark, which is also true for the mean score.

**Figure 1: Distribution of New Zealand science scores against international benchmarks**

A comparison with the two best-performing countries, Finland and Japan, shows a somewhat different story. The average New Zealand score is 27 points below that of Finland and Japan (see Table 1 on page 6). However, at the fifth percentile, Japan is only ten points ahead whereas Finland is 46 points ahead of New Zealand (Figure 1). What this shows is that 95% of students in Finland can do science tasks that are significantly more difficult than the tasks that can be managed by 95% of students in New Zealand. On the other hand, the top 5% of Japanese students score above 715 points on average, compared with 691 in Finland and 687 in New Zealand. In short, Finland achieves a high-average score by having fewer low performers than New Zealand, whereas Japan achieves a high-average score by having a larger number of high-performing students.

**Percentage with high and low scientific literacy**

Another way of looking at the distribution is to consider how many students perform above and below different thresholds. At present this is harder for science than for other areas of PISA because proficiency levels in science have not yet been defined. However, a crude indicator of high and low performance is when students score below 400 points or above 600 points. Around one-sixth of students internationally are in each of these categories.

Figure 2 compares countries in these terms. It confirms the pattern shown in the previous section but gives a more precise idea of the comparative proportions of low-performing and high-performing students in each
country. Around 13% of New Zealand students scored below 400 points on the PISA 2003 science scale, compared with the OECD average of 18%. For Finland the corresponding figure was 6%. This suggests that there is still scope for reducing low achievement in science. Conversely, one in three Japanese students on average scored above 600 points on the science scale. This score is achieved by around one in six students in the average OECD country and by just under a one in four students in New Zealand.

**Figure 2: Percentage of students with high and low science performances**

![Bar chart showing percentage of students with high and low science performances for OECD average, New Zealand, Finland, and Japan.](image)

**Overall variation within New Zealand**

To what extent do students differ in science achievement within each country? As Figure 1 (on page 9) illustrates, Finland has a high overall performance with much less variation between students than New Zealand. Japan also achieves a high score with strong performance at the top end of the scale but a relatively high level of inequality between students.

New Zealand has an average level of variation in student performance in science, with the top 5% of students scoring 340 points on average more than the bottom 5% of students, compared to 354 for the OECD. This is also true in terms of the standard deviation: a statistical measure summarising variability across the whole distribution. Among the 29 OECD countries reporting results in science, Japan and Switzerland have the highest standard deviation (most unequal) and Finland and Mexico the lowest. It is interesting to note that the results from Finland and Mexico show very different forms of equality; the former based on generally high performance and the latter on generally low performance.
Who are the stronger and weaker students in science in New Zealand?

This section of the report examines science performance in more depth by comparing different groups of students within New Zealand. It compares boys with girls, members of different ethnic groups, members of different socio-economic groups, and students in different schools.

**Gender differences in science performance**

Internationally, the smallest gender differences among the four domains assessed in PISA 2003 were observed in science. The OECD results showed that girls scored 497 and boys scored 503, on average. Although small, the six-point difference in favour of boys was significant.

The gender differences in PISA 2003 were statistically significant in 16 OECD countries. In 13 of these countries, including New Zealand, boys outperformed girls, on average. In New Zealand, students of both sexes achieved relatively high mean scores compared with the OECD average. However, the mean score for boys (529 points) was significantly higher than the mean score for girls (513 points).

Behind this 16-point difference between the mean scores for boys and girls, was a somewhat different distribution of performance, as shown in Figure 3. In general low-performing girls were no weaker in science than their male counterparts. However, in the middle of the distribution (between the lower and upper quartiles, shown by the middle bars in Figure 3), there was a wider range of performance for boys than for girls. As a result, the top quarter of boys scored at least 607 points, 22 points higher than the top quarter of girls. In the case of the top 5%, there was an even bigger gap of 26 points.

**Figure 3: Distribution of New Zealand science scores by gender**

This pattern of difference is, in fact, typical in the OECD countries; girls perform similarly to boys at the lower end of the distribution but below boys at the higher end of the distribution. So, how do boys and girls in New Zealand each perform against the international benchmarks in terms of the proportion of strong and weak students in science? Figure 4 shows that the chance of being a weak student in science is more strongly influenced by country because there is no gender difference across the OECD countries for students scoring under 400 points. Relatively more New Zealand girls score below 400 points than boys, but the difference is not significant.
When it comes to high performance, however, the likelihood that New Zealand boys will score above 600 points is significantly higher than for New Zealand girls; 27% of boys scored above 600 points in PISA 2003 science compared with only 20% of girls. Among the best-performing countries, patterns differ. In Japan boys are more likely than girls to score above 600 points, but in Finland the same proportion of males and females score above 600.

In summary, the biggest gap in performance between the sexes is at the top end of the scale, and an increase in the number of girls with a higher level of skills in science should raise the overall science performance of New Zealand girls.

The last section of this report (on page 19) also draws attention to a substantial decline in girls’ science scores between PISA 2000 and PISA 2003, which resulted in a reversal of the gender gap that favoured girls in 2000.

**Figure 4: Gender differences and international benchmarks**

**Differences in science performance by ethnic group**

The science performance of students differs considerably between the four main ethnic groupings in New Zealand. Looking at mean scores, the overall performance of boys and girls by ethnic group can be summed up as follows:

**Table 2: Mean science score by ethnic group and gender**

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>All</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pākehā/European</td>
<td>547</td>
<td>554</td>
<td>540</td>
</tr>
<tr>
<td>Asian</td>
<td>520</td>
<td>528</td>
<td>513</td>
</tr>
<tr>
<td>Māori</td>
<td>473</td>
<td>480</td>
<td>467</td>
</tr>
<tr>
<td>Pasifika</td>
<td>441</td>
<td>448</td>
<td>436</td>
</tr>
</tbody>
</table>

This comparison shows that the overall performance in science for Māori and Pasifika students is below the OECD average of 500 points for all students, whereas for Pākehā/European and Asian students it is above the international average. The differences in mean scores between the four main ethnic groups were statistically significant. The differences between boys and girls within each ethnic group are smaller than the differences across ethnic groups and the gender gaps within each ethnic group are similar in size.

However, average scores mask the fact that within each of the groups shown there is a wide variation in performance. In each ethnic group, at least 5% of students show high performance above 600 points and at least
5% show low performance below 400 points. But the differences in the distribution of scores are also clear. For example, the bottom 25% of Pasifika students scored below 373 points, whereas only 5% of Pākehā/European students scored below 384 points, as shown in Figure 5. Conversely, only 5% of Pasifika students scored above 603 points, compared with more than 25% of Pākehā/European students.

Looking at the distribution of science performance among boys and girls in different ethnic groups, the pattern is, in most cases, similar to the overall gender pattern described earlier in this report. That is to say, the performance of girls and boys is similar at the lower end of the distribution, but at the upper end of the scale boys do somewhat better than their female counterparts.

**Figure 5: Distribution of New Zealand science scores by ethnic group**

There are two cases, however, where there are particularly distinctive gender patterns within ethnic groups, as shown in Figure 6. Pasifika girls and boys have a similar pattern of performance at the lower end of the science scale, but performance at the upper end is much lower for girls. Pasifika girls’ performance is limited to within a relatively narrow range of scores and only 5% of Pasifika girls score above 565 points on average. In contrast, there is a very wide variation in the performance of Asian boys, as shown in Figure 6. At the 95th percentile, Asian boys score 692 points, a high score only 18 points behind the equivalent Pākehā boys. But at the 5th percentile, they score only 341 points, 45 points behind Pākehā boys. This wide variation may partly reflect the diverse backgrounds of students in this group; Asian students are over-represented in both the highest and lowest socio-economic groups (see the following section for a definition of socio-economic categories).
Differences in science performance by socio-economic status

Socio-economic background is a key factor associated with higher and lower student performance across countries, subject areas, and different assessments. The results show that there is a ‘social gradient’, where students from more advantaged socio-economic backgrounds perform better on average in both curriculum-based assessments and problem-solving.

In PISA this is measured using a single index, based on the highest international socio-Economic index of occupational status of the parents (ISEI): the highest level of parental education, an index of the educational resources in the home, and the number of books at home4.

In the following analysis, New Zealand students have been divided into four roughly equal groups, according to socio-economic status, by using the ISEI as a proxy measure. Table 3 shows that there are substantial differences in the average science score achieved by students from different socio-economic groups. Mean science scores for students in the high ISEI group are 87 score points above those in the low ISEI group. Differences between the mean scores of all four groups are statistically significant.

Table 3: Mean science score by socio-economic status

<table>
<thead>
<tr>
<th>Socio-economic status (ISEI measure)</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>566</td>
</tr>
<tr>
<td>Medium – high</td>
<td>533</td>
</tr>
<tr>
<td>Medium – low</td>
<td>513</td>
</tr>
<tr>
<td>Low</td>
<td>479</td>
</tr>
</tbody>
</table>

Once again, however, the average score masks a wide range of scores within each group. At each part of the distribution, the kinds of tasks that students can do varies greatly by socio-economic status. For example, only 5% of students with low socio-economic status can reliably do tasks with a score of about 640 points, whereas 25% of students with high socio-economic status can do tasks at this level.

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4 PISA index of economic, social and cultural status
However, the differences are not only at the top level of difficulty. In fact, the gap between the top and bottom socio-economic groups is greatest at the lower quartile, with a gap of nearly 100 points. In PISA 2003, only one in four students with a high socio-economic status performed below the OECD average of 500 points in science, but for those in the lowest socio-economic group, 25% score around 400 points and below.
**Box B: A difficult science question**

The following item illustrates a task requiring a high level of scientific conceptualisation. Students could gain credit at two levels, with full credit associated with a score of 720 points, which is achieved only by a small minority of New Zealand students.

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**DAYLIGHT**

Read the following information and answer the questions that follow.

**Daylight on 22 June 2002**

Today, as the Northern Hemisphere celebrates its longest day, Australians will experience their shortest.

In Melbourne*, Australia, the Sun will rise at 7:36 am and set at 5:08 pm, giving nine hours and 32 minutes of daylight.

Compare today to the year’s longest day in the Southern Hemisphere, expected on 22 December, when the Sun will rise at 5:55 am and set at 8:42 pm, giving 14 hours and 47 minutes of daylight.

The President of the Astronomical Society, Mr Perry Vlahos, said the existence of changing seasons in the Northern and Southern Hemispheres was linked to the Earth’s 23-degree tilt.

*Melbourne is a city in Australia at a latitude of about 38 degrees South of the equator.
Question 2: DAYLIGHT

In the Figure light rays from the Sun are shown shining on the Earth.

![Light rays from Sun](image)

**Figure: light rays from Sun**

Suppose it is the shortest day in Melbourne
Show the Earth’s axis, the Northern Hemisphere, the Southern Hemisphere and the Equator on the Figure.

Label all parts of your answer

For full credit, associated with a score of 720 points, students had to include a diagram of the earth with the equator tilted towards the sun at an angle of between 10° and 45° and the earth’s axis tilted towards the sun within the range 10° and 45° from vertical and the northern and southern hemispheres correctly labelled (or one only labelled and the other implied).

For partial credit, associated with a score of 667 points, students had to include a diagram with two of the three items correctly placed and labelled, that is,

- the angle of tilt of earth’s axis between 10° and 45°, the northern and/or southern hemispheres correctly labelled (or one only labelled and the other implied) but the angle of tilt of the equator not between 10° and 45° or the equator missing. OR

- the angle of tilt of the equator between 10° and 45°, the northern and/or southern hemispheres correctly labelled (or one only labelled and the other implied), but the angle of tilt of the earth’s axis not between 10° and 45° or the axis missing. OR

- the angle of tilt of the equator between 10° and 45° and the angle of tilt of the earth’s axis between 10° and 45° but the northern and southern hemispheres not correctly labelled (or one only labelled and the other implied or both missing.

**Difference in science performance by school attended**

The science performance of students varies across schools, and this can be partly attributed to the different socio-economic mix of students at different schools.

One way of looking at science performance by schools is to use decile ranking. New Zealand schools are ranked into 10 percent groups, roughly equal in number, which are called deciles. The Ministry of Education allocates
funding to state and state-integrated schools based on their decile ranking. Decile 1 schools are the 10 percent of schools with the highest proportion of students from socio-economically disadvantaged communities, while Decile 10 schools are the 10 percent of schools with students from the lowest level of socio-economically disadvantaged communities. A school’s decile does not necessarily reflect the overall socio-economic mix of students attending the school.

Table 4 presents average science scores for the three decile groupings; Low (Deciles 1 to 3), Medium (Deciles 4 to 6) and High (Deciles 7 to 10). These groupings are not equal in size; the low-decile group contains 30% of all schools but has only 17% of the total student population. Students in high-decile schools score 100 points more on average in science than those in low-decile schools, placing them well above the OECD average in science.

<table>
<thead>
<tr>
<th>Decile Grouping</th>
<th>Mean science score</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>558</td>
</tr>
<tr>
<td>Medium</td>
<td>513</td>
</tr>
<tr>
<td>Low</td>
<td>458</td>
</tr>
</tbody>
</table>

In Figure 8 the pattern of distribution of science scores varies according to the decile grouping of the schools. Only around one in four students in low-decile schools reach scores above the New Zealand average of 521 points. In high-decile schools, on the other hand, one in four students score above 625 points; a high level of performance only reached by the top 5% of students in low-decile schools. Figure 8 also illustrates the wide variation of scores within the decile groupings; the top 5% of students in each grouping score over 300 points more on average than the bottom 5% of students.

Figure 8: Distribution of New Zealand science scores by school decile

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5 Ethnicity was also a factor in the calculation of deciles in 2003.
First estimates of changes over time

The PISA survey takes place every three years and is designed to monitor student performance over time. The 2003 survey was only the second assessment, so it is too early to identify clear trends. However, some preliminary comparisons are possible between the science performance in PISA 2003 and that in the first survey, PISA 2000.

Overall, the mean science score for New Zealand students fell from 528 in 2000 to 521 in 2003, but this change was not statistically significant. Nor was there any significant change in the distribution of student scores overall.

However, there was a significant change in the results when analysed by gender. Girls’ performance dropped significantly from an average of 535 points in 2000 to 513 points in 2003 - a fall of 22 points. Boys’ scores rose from 523 to 529 points, although this was not statistically significant. The result is that New Zealand went from being one of just three countries where girls performed significantly better in science in 2000 to being the country with the fourth biggest advantage for boys over girls in science performance.

This turnaround in mean scores was not a common pattern across the 41 countries that took part in both cycles of PISA. Apart from New Zealand, only the Russian Federation experienced a significant change in mean scores in favour of boys. For New Zealand students, the change between 2000 and 2003 can be mainly attributed to the drop in girls’ mean scores, whereas the mean scores for both girls and boys in the Russian Federation increased significantly, but boys made much bigger gains than girls.

There is no clear explanation for this shift in scores by gender. Most of the science assessment items used in PISA 2003 had also been used in the previous assessment in 2000, allowing linking to occur between the two studies. Also, girls’ performance on most of the common science items was poorer in 2003, whereas boys’ performance by item was fairly consistent across the two assessments. It is interesting to note that a 12-point differential, favouring Year 5 girls over boys in science in the 1994 Trends in Mathematics and Science study (TIMSS), had reversed to a seven-point differential in the direction of boys in the next TIMSS study four years later. The 1994 cohort of Year 5 students would have been the same cohort eligible to take part in PISA in 2000. The results from the third cycle of PISA in 2006 may shed further light on cohort patterns of achievement by gender.

Differences by ethnic group, socio-economic status and school decile grouping remained more or less unchanged between 2000 and 2003. Within each ethnic group, girls’ means scores declined significantly, except for Asian girls whose fall of 12 points was not statistically significant.

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Conclusion

Scientific knowledge and understanding, plus the ability to apply that to everyday problems and public issues, are becoming increasingly important in a complex world. This survey shows that most New Zealand students nearing the end of their compulsory education are well equipped to use science in their adult lives when judged against international benchmarks. Overall, science performance is significantly higher in only three other OECD countries.

However, there is still room for improvement. The PISA assessment is useful in highlighting particular groups of students who do less well in science. Pasifika girls in particular do poorly on average, as do students from low socio-economic backgrounds. Gender differences are smaller, although girls’ performance in science in 2003 was considerably lower than in 2000.

The first two PISA surveys have been able to give only a limited profile in science, but the 2006 survey, which will focus on the science domain, should provide a much richer picture of students’ performance at different levels of proficiency in this subject.
Administration of PISA 2003

The Australian Council for Educational Research (ACER) led the PISA Consortium which managed the international coordination of the project. Other partners in this consortium include:

- The Netherlands National Institute for Educational Measurement (Citogroep);
- The National Institute for Educational Research in Japan (NIER);
- The Educational Testing Service in the United States (ETS); and
- WESTAT in the United States.

The Comparative Education Research Unit was responsible for carrying out the PISA activities in New Zealand. This Unit is located within the Research Division of the Ministry of Education.

Sources for this summary


For further information in New Zealand

Enquiries about this project may be directed to the:

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