PISA 2006

Student attitudes to and engagement with science

How ready are our 15-year-olds for tomorrow's world?

Robyn Caygill

MINISTRY OF EDUCATION NEW ZEALAND
Te Tāhuhu o te Mātauranga Aotearoa

OECD PISA
Programme for International Student Achievement

An Overview of PISA

What is PISA?

The Programme for International Student Assessment (PISA) is an international standardised study that assesses and compares how well countries are preparing their 15-year-old[1] students to meet real-life opportunities and challenges.

What does PISA assess?

PISA assesses three key areas of knowledge and skills – reading literacy, mathematical literacy and scientific literacy – and has a focus on one of these literacy areas each time PISA is administered. The focus of PISA 2006 is science. The term 'literacy' is used to emphasise that the assessment is not restricted to assessing how well students have mastered the content of a specific school curriculum. Instead, PISA focuses on assessing students' ability to apply their knowledge and skills, and their ability to make decisions in real-life situations. PISA defines this approach as assessing "[t]he knowledge, skills, competencies and other attributes embodied in individuals that are relevant to personal, social and economic well-being" (OECD 2006, p.11).

What additional information is gathered?

Background information is also gained in each PISA cycle from questionnaires completed by students and school principals. In addition, in PISA 2006 parents completed a questionnaire. These questionnaires allow for the relationship between contextual information and achievement to be examined.

How often is PISA administered?

PISA is administered every three years, beginning in 2000. Reading was the main focus in the first cycle. In 2003 the focus was mathematical literacy, and in 2009 it will be reading literacy again. Rotating the major focus for each administration of PISA provides in-depth and detailed information on the subject of major focus, along with an ongoing source of achievement data on the two minor subjects.

Who participates in PISA?

Around 400,000 15-year-old students from 57[2] countries, including the 30 Organisation for Economic Co-operation and Development (OECD) member countries, participated in PISA 2006. In New Zealand 4,824 students from 170 schools took part. Students and schools were randomly selected. A two-tiered stratified sampling method was used to ensure the sample was representative. Students were sampled from schools of different sizes and decile groupings, and from urban and rural schools. As a result, every 15-year-old had roughly the same chance of selection.

Why participate in PISA?

PISA assesses students who have completed around 10 years of compulsory schooling, which means the PISA results are an important source of information in New Zealand. PISA measures progress towards the Government's goals of:

- building an education system that equips New Zealanders with 21st century skills; and
- reducing systemic underachievement in education.

PISA not only allows measurement of New Zealand's progress on these goals over time, but also allows measurement of New Zealand's performance relative to other countries in equipping students with skills and reducing disparities in achievement. The PISA data provide evidence to inform policy and practice in literacy, numeracy and curriculum development.

Who organises PISA?

PISA is an initiative of the OECD and a collaborative effort of the participating countries. A consortium is responsible for developing and overseeing PISA 2006 at the international level. This consortium is led by the Australian Council for Educational Research (ACER), and consists of the Netherlands National Institute for Educational Measurement (Citogroup), Westat (USA), the Educational Testing Service (ETS, USA), and the Japanese National Institute for Educational Policy Research (NIER, Japan). In New Zealand, the Comparative Education Research Unit within the Ministry of Education's Research Division is responsible for PISA.

How did countries ensure the PISA data were of high quality?

A number of quality assurance procedures were put in place, both nationally and internationally, to ensure the data were of as high a quality as possible. These included: rigorous training of staff; high-quality documentation; monitoring of sampling procedures; quality checks and monitoring at a number of stages, including during administration of the tests; multiple coding and data entry procedures; and data cleaning and checking procedures. Further details of international procedures can be found in the PISA 2006 technical report (OECD, in press), or in the technical notes (OECD, n.d.).

[1] Students are aged between 15 years 3 months and 16 years 2 months. As most students are aged 15, they are referred to as 15-year-olds for brevity.

[2] The countries participating in PISA 2006 are listed in Appendix 1.

PISA2006

Student attitudes to and engagement with science

How ready are our 15-year-olds for tomorrow's world?

Table of Contents

Acknowledgements

I am very grateful to the 45 schools that participated in the field trial and the 170 schools that participated in the main study. Without the support of schools (principals and staff), students and parents, this study would not be possible. The efforts of these participants have provided New Zealand with a valuable resource.

The fieldwork for the main study, which lies behind this and other reports using PISA data, was undertaken during June and July 2006. Data collection and management went smoothly thanks to Abby Nurse (PISA 2006 Research Administrator) and Jeremy Praat (PISA 2006 Data Manager).

I would like to thank my fellow members of the PISA 2006 Steering Group for providing valuable advice to PISA, particularly during the development phase: Adrienne Alton-Lee, Martin Connelly, Avril Gaastra, Claire Harkess, Janet Hay, Rosemary Hipkins, Richard Harker, Earl Irving, John Laurenson, Robert Lynn, Debra Masters, Stephanie Nichols, Lisa Rodgers, and Leilani Unasa.

The author of this report, Robyn Caygill, deserves recognition for her efforts in working with a very complex dataset and delivering a quality report. On behalf of the author I would also like to acknowledge Steve May for his analytical and technical contribution to this report and Sarah Kirkham for her work on the graphs; Chris Arcus, Chris Harwood, and Fred Bishop for their helpful comments in reviewing this report; and the Research Division's publication team, Christabel Dillon and Raelene Butters, for their assistance in the publication process.

Finally, I would like to extend my sincere gratitude to Maree Telford, National Project Manager of PISA 2006 and Steve May, Principal Research Analyst. Their dedication to the project helped to lay a solid foundation for this and future research endeavours using PISA data.

Lynne Whitney

Senior Manager
Research Division

Key findings

Interest, enjoyment and motivation with respect to science

- Around two-thirds of New Zealand 15-year-old students agreed that they had an interest in learning about science, and a similar proportion thought it would be useful for them in the future.
- At least half of 15-year-old students reported high or medium interest in human biology, chemistry and astronomy. Fewer students reported this level of interest in other topics in science.
- Approximately four in every ten students wanted a career involving science, and just under a quarter expected to be working in a science-related career at age 30.
- Compared with mathematics and English, fewer New Zealand 15-year-old students thought it was important to do well in science (18 percentage points less than English; 19 points less than mathematics).
- Students with higher engagement with science – as measured by statements on enjoyment, interest and motivation – generally had higher achievement in science than those with lower engagement.

Beliefs in own abilities in science

- At least half of New Zealand students were positive about statements on how good they believe they are at science (self-concept), although fewer (40%) agreed that *learning advanced science topics would be easy for me*.
- The majority of students agreed that they could perform a selection of scientific literacy tasks involving activities such as providing explanations, interpretations or descriptions, or discussing scientific evidence (self-efficacy).
- Students with higher self-belief, as measured by statements about how good they are at science (high self-concept) and statements about the ease of performing a selection of science tasks (high self-efficacy), were likely to show a stronger performance in scientific literacy than their counterparts with lower self-belief.

Value beliefs regarding science

- In general, the vast majority of New Zealand 15-year-old students felt that science was of value to society and that advances in science were important.
- Students were less likely to agree that science is important to them personally in their current and future life than to agree it is important for society in general.
- Students who placed a higher value on science (both for society and for themselves) were more likely to have a higher achievement than their peers who placed a lower value on science.

Scientific literacy and the environment

- The average New Zealand student was concerned about – and not very optimistic about – the possibility of improvement in environmental issues. However, they were generally less likely than their OECD counterparts to be concerned about these issues, either for themselves or for their country.
- Environmental awareness and responsibility for sustainable development were positively associated with achievement, whereas concern for environmental issues was not.

Attitudes to and engagement with science by gender

- A higher proportion of boys reported they enjoyed science compared with girls, and were more likely to engage in science-related activities than girls, whereas a higher proportion of girls expected to be in a science-related career at age 30.
- Boys were more likely to have higher self-belief in science than girls, more likely to express a high general value of science, and equally likely to express a high personal value of science.
- Girls were more likely to report high levels of concern and responsibility for the environment than boys.

Attitudes to and engagement with science by ethnic grouping

- Asian students were more positive in their views on engagement with science, were the most likely to have higher self-belief in science, reported the highest level of engagement in science-related activities, and were the most likely to express a high value of science, both generally and personally.
- Māori students were the least positive in their views on engagement with science, were least likely to have high self-belief in science, and were least likely to express a high value of science, both generally and personally.
- Students' level of concern for environmental issues did not differ markedly across ethnic groupings.

Comparisons with other countries

- In general, compared with other OECD countries, New Zealand students were more likely to agree that science will be useful for them in their future, and equally likely to report an intention to pursue science in the future. New Zealand students were equally likely as students in other OECD countries to enjoy science, but less likely to be interested in science.
- On average, New Zealand students were less likely to believe they are good at science (have a high self-concept) but just as likely to have a high self-efficacy (agree they could perform a selection of science tasks) as their counterparts in the OECD.
- The average New Zealand student was less likely to engage in science-related activities than their peers internationally, but just as likely as their peers in Australia.
- The average New Zealand student was less likely than their OECD counterparts to be concerned about environmental issues, either for themselves or for their country.

Introduction

Introduction

This report examines the attitudes of 15-year-old students to science, along with a measure of their engagement with science. The relationship between students' achievement in science and their attitudes to and engagement with science is also examined, and comparisons are made by gender, main ethnic groupings, and socio-economic background. The international findings from PISA 2006 were published by the OECD in two volumes in 2007 (OECD 2007a & 2007b). A summary of key New Zealand results from this study was published in December 2007 (Telford & Caygill 2007). Other New Zealand reports in the series include a report on 15-year-old students' science achievement, the school context within which science education takes place, and reports on the mathematics and reading achievement of students in PISA 2006.[3]

[3] Caygill et al. 2008; Marshall et al. 2008; others in press.

The late Professor Alan MacDiarmid[4] is quoted as saying, "Science education is the most important investment the country could make for the future" (Crean 2007). However, he also criticised the low regard he felt New Zealanders had for science, and pointed to the likely impact on the education of our students. How students feel about a subject, their interest, and the value they place on it for their future life seem intuitively to be linked to both the effort they put into trying to succeed and the outcomes of their education in that subject. Indeed, a number of studies (for example, Chiu & McBride-Chang 2006, Chamberlain 2007, Cullen 2006) have demonstrated a relationship between achievement in school subjects and enjoyment.

Future practitioners in science-oriented jobs are likely to come from those who enjoy learning science and are interested in becoming life-long learners. In a recent annual *Survey of Employers who have Recently Advertised* (SERA, Department of Labour 2007), skills shortages in science-related occupations were among the highest when compared with other occupations. Given these skill shortages, an examination of attitudes at the point of life where students are beginning to make important decisions affecting their futures seems pertinent.

PISA attitudinal framework

In PISA, attitudes are seen as a key component of an individual's scientific literacy, and include an individual's beliefs, motivational orientations and sense of self-efficacy (belief that they can perform scientific literacy tasks). As part of assessing scientific literacy among 15-year-old students in PISA 2006, students were given a questionnaire which included questions on engagement and motivation, as well as questions on personal background, learning habits, and perceptions of the learning environment. In addition, during the science assessment students were questioned about their attitudes to the issues being tested for a small selection of test questions.

The OECD framework for scientific attitudes included three areas: *interest in science*, *support for scientific enquiry,* and *responsibility towards resources and environments* (OECD 2006). This evaluation of attitudes was not intended to examine attitudes to science programmes or teachers, but rather to gain an understanding of students' general appreciation of science, their specific scientific attitudes and values, and their responsibility towards selected science-related issues that have national and international ramifications. According to the OECD (2006), *interest in science* was selected because of its established relationships with achievement, course selection, career choice, and lifelong learning. *Support for scientific enquiry* is widely regarded as a fundamental objective of science education and *responsibility towards resources and environments* is of international concern as well as being of economic relevance.

Report structure

This report is divided into seven chapters. After this brief introduction, Chapter 2 looks at students' interests in and enjoyment of science, along with their motivation to learn about and engage in science. Chapter 3 examines students' beliefs in their own abilities in science, including how good they believe they are at science (self-concept) and how easy they think scientific literacy tasks are (self-efficacy). Chapter 4 presents the science activities that students reported engaging in. Chapter 5 looks at students' value beliefs regarding science, including their general appreciation of science and scientific enquiry as well as their perceptions of the importance of science to them personally. Chapter 6 looks at students' attitudes toward the environment, and Chapter 7 concludes the report with a brief summary.

[4] New Zealand-born Alan MacDiarmid was a world-renowned chemist who won a Nobel Prize in Chemistry in 2000.

Chapter 2: Interest, enjoyment, and motivation with respect to science

This chapter examines several aspects of 15-year-old students' engagement with science: their general interest in science topics; their enjoyment of science in general, both in and out of school; the usefulness of school science for them and their future careers and study; and the likelihood they will engage in science beyond secondary school. It also includes a comparison of the importance to students of the three subject areas PISA covers: English, mathematics, and science.

General interest in learning science

Students in PISA were asked a series of questions designed to gauge their interest in learning about science topics. The list of topics is shown in Table 1. Two-thirds of students reported they were interested in learning about *human biology* and 55 percent of students were interested in learning about *topics in chemistry*, these two being the most popular topics among New Zealand 15-year-old students.

As shown in Table 1, the proportion of New Zealand students reporting high or medium interest in each of the topics is similar to the average across OECD countries. Australia had similar proportions of students reporting interest in *human biology* (62%), *astronomy* (46%), *physics* (44%), and the *biology of plants* (40%), but fewer interested in *chemistry* (48%).

Interestingly, Korea, Finland, and the Netherlands, although having a large proportion of high-performing students, were among the countries with the smallest proportions of students reporting high or medium levels of interest across topics in science. This may imply that in these countries high achievement may come at the price of interest in these topics.

Table 1: Proportion of students reporting high or medium interest in topics in science

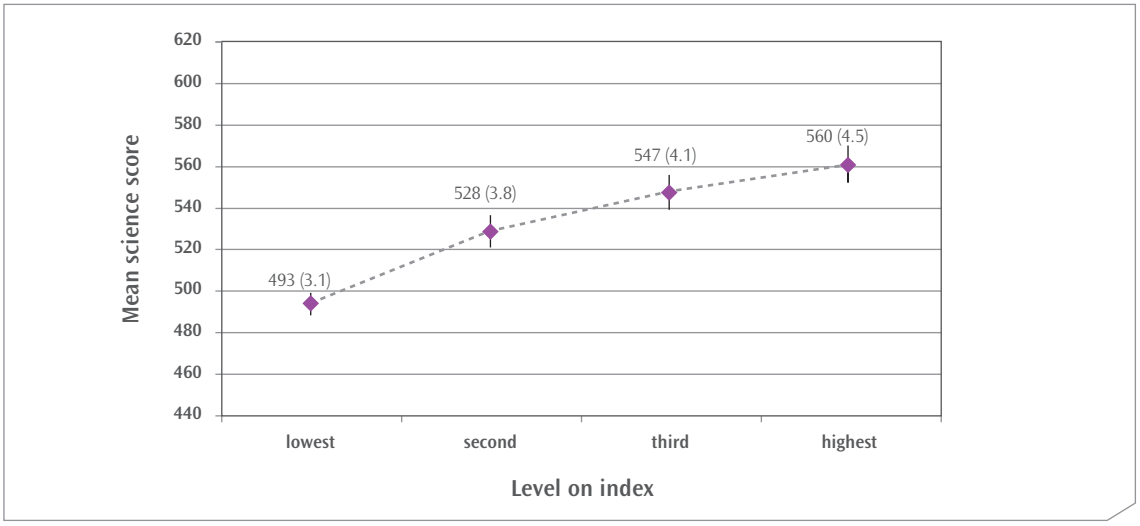
Topic of general interest in science	Proportion of students reporting high or medium interest (%)	
	New Zealand	OECD average
Human biology	66	68
Topics in chemistry	55	50
Topics in astronomy	50	53
Topics in physics	49	49
The biology of plants	44	47
The ways scientists design experiments	38	46
Topics in geology	36	41
What is required for scientific explanations	30	36

Note: Response options for each statement were: high interest, medium interest, low interest, and no interest. The proportions shown combine high and medium interest. For individual values, see Appendix 2.

Students' responses for these eight statements were combined in order to derive an index of general interest in science. The index was constructed so that, in general, students who reported higher interest were higher on the index, and students who were less interested in the science topics were lower on the index. The New Zealand average on the scale was lower than the OECD average, but higher than the averages for Finland, Korea, and Australia.

New Zealand students who were higher on the index – that is, students who had a greater general interest in science – had higher achievement than their peers who were lower on the index, as shown in Figure 1. The relationship between science achievement and general interest for New Zealand students was similar to that found on average across OECD countries.

Figure 1: Mean scientific literacy of New Zealand students in each quarter of the index of general interest in science



Notes: The index of general interest in science combines the responses to the aspects of science presented in Table 1. Students in the lowest ¼ of the index did not necessarily have no interest in all topics; rather, they were less interested in the topics in general than their counterparts in the other groupings.

Standard errors appear in parentheses.

Enjoyment of science

Students were asked how much they agreed with five statements designed to gauge their enjoyment of science (see Table 2 for statements). In the preamble to these statements, science was defined as follows: *Science refers to any topics that you might encounter in school, or outside of school (for example on television) that relate to space science, biology, chemistry, earth science or physics.* This wording was meant to indicate to students that they should answer this question more broadly than just how much they enjoyed science at school. A variety of words were used to capture aspects of enjoyment, including 'like', 'have fun', 'interest', 'happy', and 'enjoy', as shown in Table 2.

In general, the majority of students answered these questions positively, which implies that students are more likely than not to enjoy science. It is worth noting that while nearly three-quarters of students (71%) agreed that they enjoyed acquiring new knowledge in science, less than half (43%) liked to acquire it by reading. Just under two-thirds of students reported that they were interested in learning about science; a slightly smaller proportion (62%) agreed that they generally have fun when learning about science topics.

The proportions of New Zealand students enjoying science were similar to the proportions found on average across OECD countries, as shown in Table 2. However, fewer New Zealand students liked reading about science compared with the OECD average. In contrast, a greater proportion of New Zealand students reported being happy doing science problems compared with the average across OECD countries.

Table 2: Proportion of students agreeing with statements on enjoyment of science

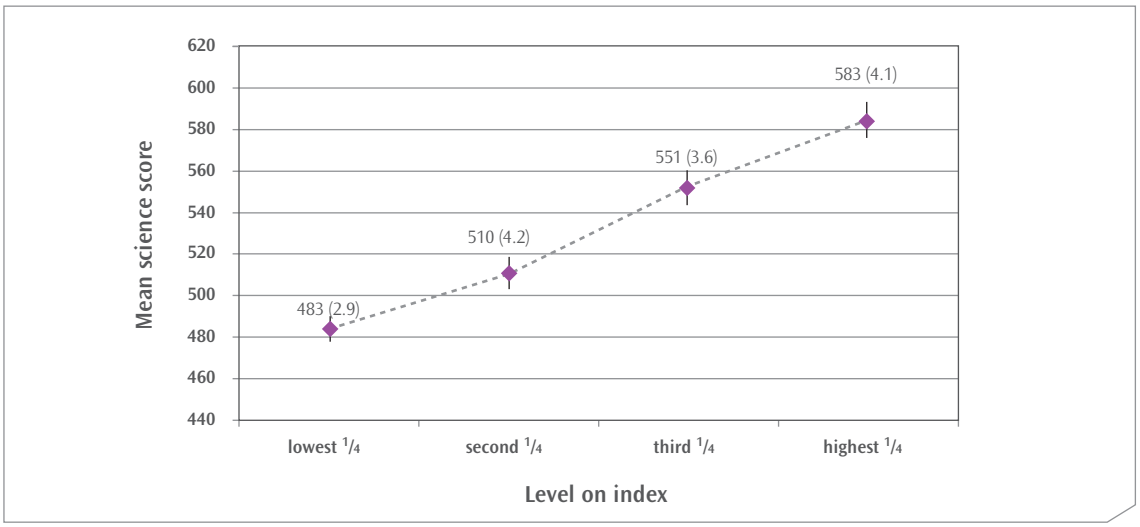
Statement on enjoyment of science	Proportion of students agreeing (%)	
	New Zealand	OECD average
I enjoy acquiring new knowledge in science	71	67
I generally have fun when I am learning science topics	62	63
I am interested in learning about science	65	63
I like reading about science	43	50
I am happy doing science problems	55	43

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. The proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

Students' responses for these five statements were combined in order to derive an index of enjoyment of science. The index was constructed so that, in general, students who agreed with these statements were higher on the index, and students who reacted more negatively to the statements were lower on the index. The New Zealand average on the scale was about the same as the OECD average, but higher than the averages for Australia, Korea, Japan, and the Netherlands.

New Zealand students who were more positive on the index, implying a greater enjoyment of science, had higher achievement than their peers who were less positive in their enjoyment of science, as shown in Figure 2. Internationally, New Zealand, along with Australia and the United Kingdom, showed a particularly strong relationship between enjoyment of science and science achievement. It is interesting to note that the OECD (2007) states that of all the motivational indices calculated for PISA, the index of enjoyment of science on average explains more of the performance variation than any other index.

Figure 2: Mean scientific literacy of students in each quarter of the index of enjoyment of science



Notes: The index of enjoyment of science combines the responses to the five statements in Table 2. Students in the lowest ¼ of the index did not necessarily have no enjoyment of science; rather, they were less likely to report enjoyment in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Importance of learning science for future careers (instrumental motivation)

While enjoyment of science has been shown in the previous section to be strongly related to achievement, students may be inclined to work harder at their study if they think it will be useful in their future working lives. In New Zealand currently, the Government is advocating a move towards a more knowledge-based economy (Ministry of Education 2007, Department of Labour 2000). Koslow (2005) argues that an increase in the number of university science graduates is one solution that would help make the New Zealand knowledge economy sustainable. Secondary school students' engagement in science should help in this changing environment.

Students were asked if they agreed with the statements (listed in Table 3) on the usefulness of school science for them, their future careers, and their future study. The majority of students agreed with each of these statements, implying that students were more likely than not to agree that science was important for their future study and careers. In particular, nearly three-quarters (71%) of students agreed that they study science because it is useful for them, with around two-thirds agreeing on each of the statements on the importance of science to their future careers and just over half of students agreeing that current science learning will help in future study.

With the exception of the statement about the value of current science learning for their future study, the proportions of New Zealand students agreeing with the statements were a little higher than the OECD average, as shown in Table 3. The proportions of New Zealand students agreeing with the statements were similar to those found in Australia (range of proportions 55% to 69%) and the United Kingdom (54% to 75%), but lower than in the United States (68% to 78%). See Appendix 3 for details.

Table 3: Proportion of students agreeing with statements on instrumental motivation to learn science

Statement on instrumental motivation to learn science	Proportion of students agreeing (%)	
	New Zealand	OECD average
I study science because I know it is useful for me	71	67
Making an effort in my science subject(s) is worth it because this will help me in the work I want to do later on	69	63
Studying my science subject(s) is worthwhile for me because what I learn will improve my career prospects	68	61
I will learn many things in my science subject(s) that will help me get a job	66	56
What I learn in my science subject(s) is worthwhile for me because I need this for what I want to study later on	56	56

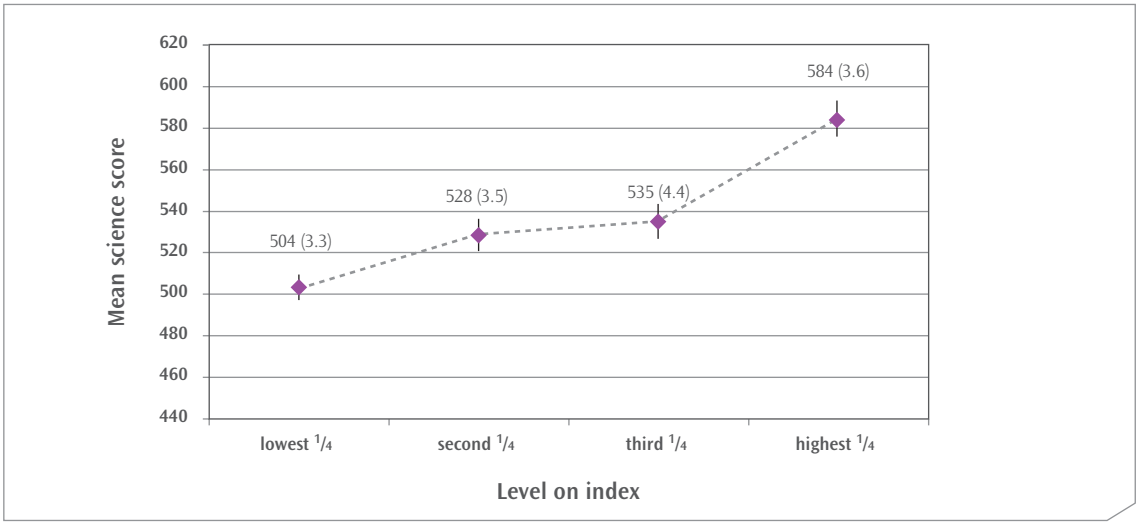
Notes: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. The proportions shown in this table combine those who agreed and those who strongly agreed.

See Appendix 3 for proportions of students agreeing in Australia, the United Kingdom, and the United States.

An index of instrumental motivation was created by combining students' responses to these five statements. The index was constructed so that, in general, students who agreed with these statements were higher on the index, and students who reacted more negatively to the statements were lower on the index. The New Zealand average on the scale was higher than the OECD average, and higher than the averages for Finland, Korea, Japan, and the Netherlands.

As observed for the enjoyment index, students who agreed science was useful in their future (i.e. were higher on the index) had higher achievement when compared with those who did not agree, as shown in Figure 3. Internationally, although the relationship was not as clear-cut as for enjoyment, students high on the instrumental motivation index generally had higher achievement than those lower on the index.

Figure 3: Mean scientific literacy of students in each quarter of the index of instrumental motivation to learn science



Notes: The student index of instrumental motivation to learn science combines the responses to the five statements presented in Table 3. Students in the lowest ¼ of the index did not necessarily disagree with all statements on the usefulness of science; rather, they were less likely to report agreement in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

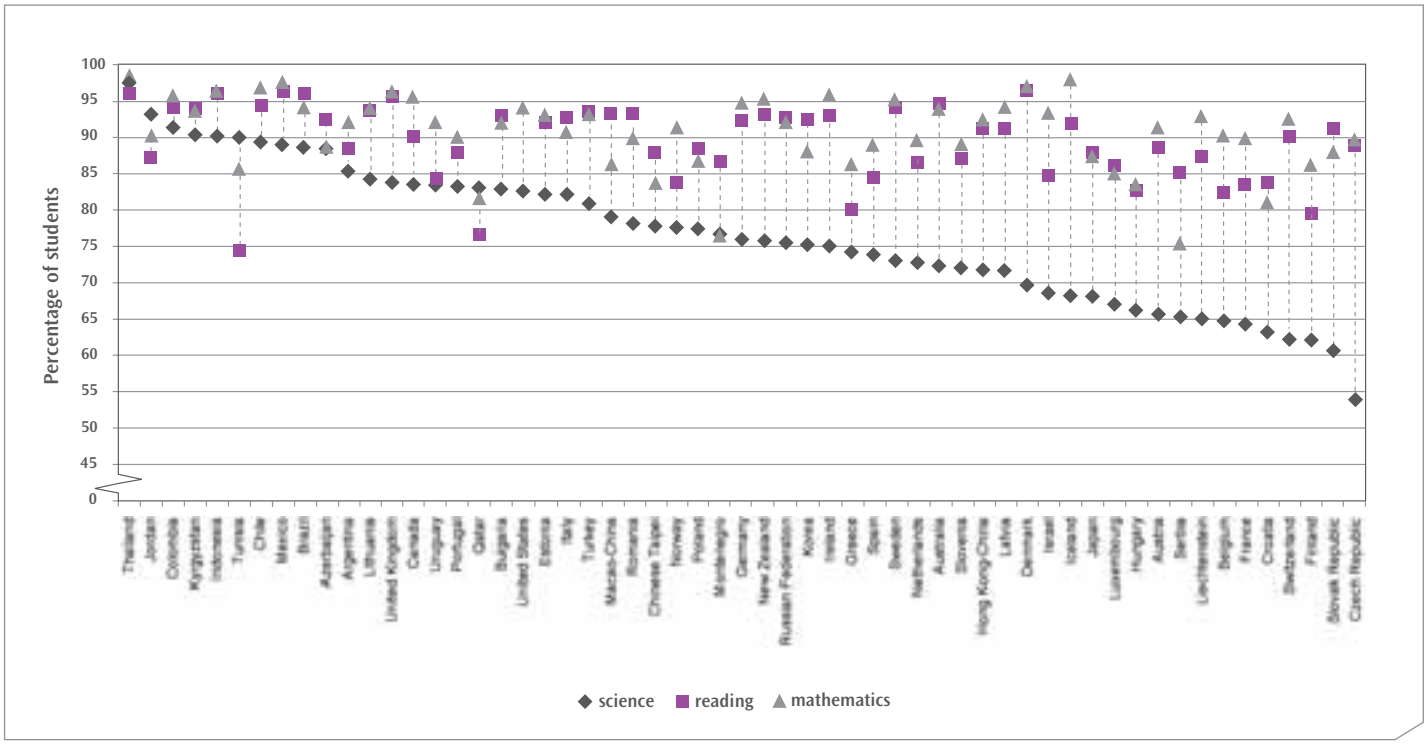
Importance of doing well in science compared with mathematics and English

While the previous sections indicate that science is important to many New Zealand students, PISA also included questions that allow comparisons to be made between the importance of science and what are often described as the core learning areas. Specifically, the New Zealand version of the question asked students how important they thought it was for them to do well in *science subjects, mathematics subjects*, and *English subjects*. Note that in other countries the wording differed to take account of language and naming conventions, but it had a similar intention.

Compared to mathematics and English subjects, fewer students thought it was important to do well in science. Nearly all New Zealand students thought it was *important* or *very important* for them to do well in mathematics (95%) and English (93%) subjects, compared with a much smaller proportion, around three-quarters, for science subjects (76%).

Comparison of the proportions of New Zealand students indicating they thought it was important or very important to do well in science with their counterparts in other countries (see Figure 4) showed that similar proportions of students on average across OECD countries (73%) indicated this level of importance of science. Fewer students in Australia (72%) thought that doing well in science was important or very important, while larger proportions of students in the United Kingdom (84%) and the United States (82%) indicated this.

Figure 4: Proportion of students who thought it important to do well in science compared with mathematics and reading, by country



Note: Response options for each statement were: very important, important, of little importance, and not important at all. The proportions shown in this graph combine very important and important.

Desire for future science study and a scientific career (future-oriented motivation)

Although similar to the statements in the instrumental motivation index, the future-oriented motivation statements were more specifically asking about students' desire to study science or pursue a scientific career in the future. These statements, listed in Table 4, gained much less agreement than the instrumental motivation statements, with students more likely to disagree with the statements than agree with them.

As shown in Table 4, the proportion of students agreeing in New Zealand was similar, on average, to that in OECD countries. However, it is interesting to note that some non-OECD countries (Thailand, 71%; Indonesia, 73%; Jordan, 78%; Kyrgyzstan, 78%; and Tunisia, 83%) had more than two-thirds of students who would like to work in a career involving science, and that these were among the lowest-performing countries internationally.

Table 4: Proportion of students agreeing with statements on future-oriented motivation to learn science

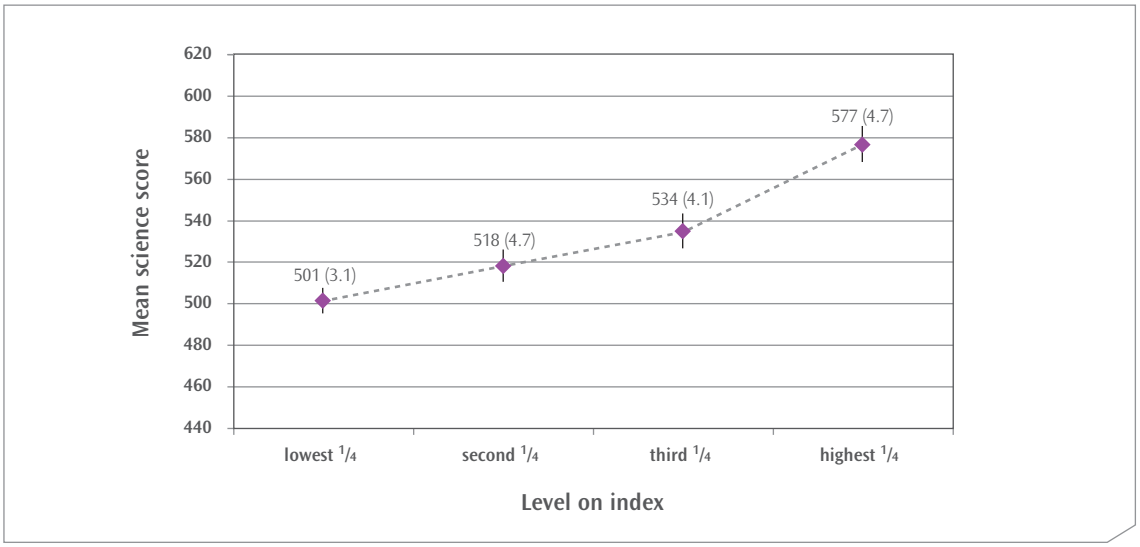
Statement on future-oriented motivation to learn science	Proportion of students agreeing (%)	
	New Zealand	OECD average
I would like to work on science projects as an adult	23	27
I would like to spend my life doing advanced science	17	21
I would like to study science after secondary school	35	31
I would like to work in a career involving science	42	37

Note: Response options for each statement were: strongly agree, agree, disagree and strongly disagree. Proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

An index of future-oriented motivation to learn science was created using students' responses to these four statements. The index was constructed so that, in general, students who agreed with these statements were higher on the index, and students who reacted more negatively to the statements were lower on the index. The New Zealand average on the scale was the same as the OECD average, and higher than the averages for Australia, Finland, Korea, Japan, and the Netherlands.

As with the indices mentioned previously, New Zealand students who reported higher future-oriented motivation were more likely to perform well in the science assessment questions than those who were not as highly motivated, as shown in Figure 5. New Zealand, along with Finland, Australia, Iceland, the United Kingdom, Japan, Ireland, and France, showed a strong positive relationship between performance on the science items and future-oriented motivation to learn science.

Figure 5: Mean scientific literacy of students in each quarter of the index of future-oriented motivation to learn science



Notes: The student index of future-oriented motivation to learn science combines the responses to the four statements presented in Table 4. Students in the lowest ¼ of the index did not necessarily disagree with all statements on science in their futures; rather, they were less likely to report agreement in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Intention to pursue a science-related career

Students were asked specifically what type of job they expected to have when they were about 30 years old. Twenty-four percent of New Zealand 15-year-olds were expecting to have a science-related career at age 30. This was similar to the OECD average of 25 percent of students. Interestingly, in the high-performing countries, Finland and Hong Kong-China, smaller proportions of students were intending to pursue science-related careers (18% and 21% respectively).

In general, students expecting to pursue a science-related career had higher scientific literacy achievement than those who were not (56 score points difference). This pattern was also evident across OECD countries (the OECD average score point difference was 48).

Gender differences in interest, enjoyment and motivation

New Zealand girls were just as interested in science as New Zealand boys, with no significant[5] difference observed on the index of general interest in science. No gender differences were observed when students' beliefs on the usefulness of science in their futures (instrumental motivation index) or students' intention to do more science in the future (future-oriented motivation to learn science index) were compared for boys and girls. There was also no significant difference in the proportions of boys and girls who agreed that it was important to do well in science or mathematics subjects.

A gender difference was observable, however, on the enjoyment index. A significantly greater proportion of boys enjoyed science compared to girls. In contrast, a higher proportion of girls (28%) expected to be in a science-related career at age 30 than boys (21%).

[5] Throughout this report, the term 'significant' refers to statistical significance at the 0.05 level. See the 'Definitions and technical notes' section at the back of this report for further details.

Ethnic differences in interest, enjoyment and motivation

Asian students in New Zealand were consistently more positive in their views on engagement with science in comparison to their Pākehā/European, Māori, and Pasifika peers. Specifically, the Asian students were more likely to have a higher general interest in science, higher enjoyment of science, and higher motivation to learn science.

Māori students were among the least likely to be positive in their views on engagement with science, with the lowest level on the enjoyment of science and the instrumental motivation to learn science indices. For the other two indices, general interest in science and future-oriented motivation to learn science, Māori students were just as likely to be positive as their Pākehā/European counterparts but less likely than their Pasifika and Asian peers; the Māori and Pākehā/European ethnic groupings had similar means on these indices.

Socio-economic differences in interest, enjoyment and motivation

Students from higher socio-economic backgrounds[6] tended to have higher engagement with science on average than those from lower socio-economic backgrounds.

[6] The measure used in PISA 2006 for socio-economic background was the PISA index of economic, social and cultural status (ESCS), which was derived from information from students on parental occupations, parental education, and home possessions. Students from higher socio-economic backgrounds are defined as those in the top quarter of the index, while students from lower socio-economic backgrounds are those in the bottom quarter of the index.

Chapter 3: Beliefs in own abilities in science

How students feel about themselves and their ability in science may influence how hard they work, their interest in learning more science and their orientation towards future science careers. For example, students who think they are not good at science and would not be able to use science in their career, may be less motivated to do science or to do well in science than those who think they are quite good at science and are interested and want to continue with science in their lives. Students were asked a number of questions in PISA about how good they felt they were at science and how easy they thought it would be for them to perform a selection of scientific literacy tasks.

How good students believe they are at science (self-concept)

PISA 2006 included six questions designed to measure students' general level of belief in their academic abilities in science (see Table 5). Just over two-thirds of New Zealand students (68%) agreed that they can usually give good answers to test questions on science topics, but they were less confident about their abilities to learn advanced science topics (40%). Less than half the students thought that science topics were easy (44%). Apart from their confidence in learning advanced science (significantly lower than the OECD average), New Zealand 15-year-old students were similar to the average for OECD countries (as shown in Table 5). It is worth noting that students in Australia had similar proportions of students agreeing with self-concept statements, including a small proportion (39%) confident in their abilities to learn advanced science topics, while students in Hong Kong-China were less confident in their science abilities in general (ranging from 35% to 56% for the statements) than New Zealand students. This is interesting considering Hong Kong-China and Australia, along with New Zealand, were high-performing countries in science in PISA 2006.

Table 5: Proportion of students agreeing with statements on self-concept in science

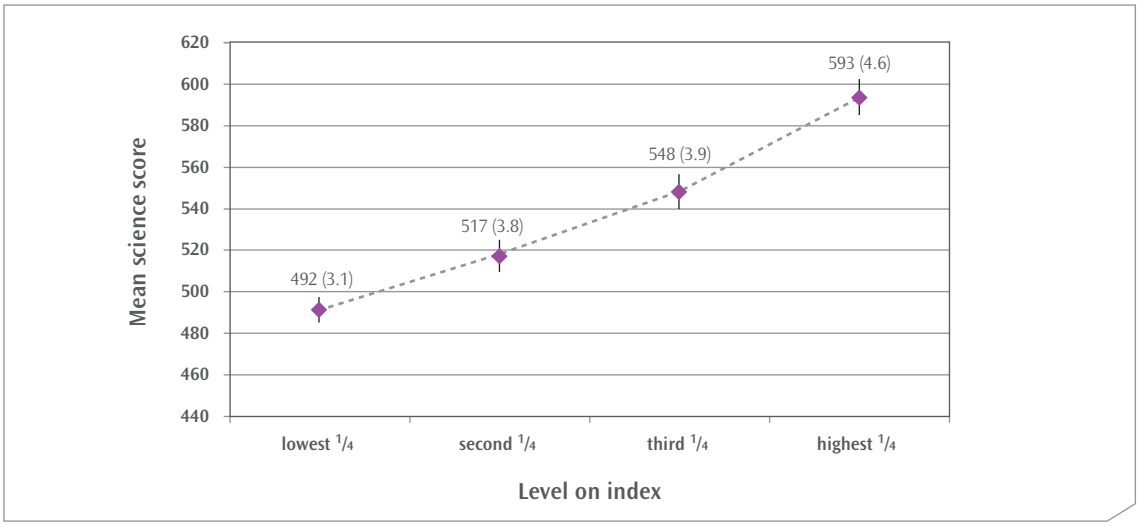
Statement on student self-concept in science	Proportion of students agreeing (%)	
	New Zealand	OECD average
I can usually give good answers to test questions on science topics	68	65
When I am being taught science, I can understand the concepts very well	59	59
I can easily understand new ideas in science	57	55
I learn science topics quickly	53	56
Science topics are easy for me	44	47
Learning advanced science topics would be easy for me	40	47

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. Proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

An index of self-concept in science was created using students' responses to these six statements. The index was constructed so that, in general, students who agreed with these statements were higher on the index, and students who reacted more negatively to the statements were lower on the index. The New Zealand average on the scale was lower than the OECD average, but higher than the averages in some of the other relatively high-performing countries, including Hong Kong-China, Chinese Taipei, Korea, Japan, and the Netherlands.

Students with a higher self-concept in science in general had higher achievement than those with a lower self-concept, as shown in Figure 6. The strength of the relationship between self-concept and achievement observed for New Zealand students was similar to that found in both Australia and Finland. A positive relationship between achievement and self-concept in science was found in all of the countries performing above the OECD average.

Figure 6: Mean scientific literacy of students in each quarter of the index of self-concept in science



Notes: The student index of self-concept in science combines the responses to the six statements presented in Table 5. Students in the lowest ¼ of the index did not necessarily disagree with all statements on self-concept of science; rather, they were less likely to report agreement in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Ease of doing scientific literacy tasks (self-efficacy)

The notion of self-efficacy is different from self-concept as it includes both a student's confidence in their ability to do science as well as a student's belief in their ability to overcome difficulties when attempting scientific tasks. A student who believes they are good at science and can overcome any difficulties they may face as a learner seems more likely to be motivated to undertake a scientific literacy task and to expend the effort required to tackle a learning opportunity.

In order to gather information from PISA students on their self-efficacy beliefs, students were asked how easy they would find performing eight tasks on their own, with the response options: *I could do this easily*, *I could do this with a bit of effort*, *I would struggle to do this on my own*, *I couldn't do this*. The list of tasks presented to students is given in Table 6. Around three-quarters of students believed that they could *explain why earthquakes occur more frequently in some areas than in others* (78%) and *recognise the science question that underlies a newspaper report on a health issue* (73%). The tasks where students were asked if they could *identify the better of two explanations for the formation of acid rain* (48%) and *discuss how new evidence can lead you to change your understanding about the possibility of life on Mars* (50%) proved to be more difficult for students in general.

As shown in Table 6, with the exception of the acid rain task, the ease with which New Zealand students reported they could do tasks was similar to that found on average within OECD countries. The greater apparent ease of the task on earthquakes in comparison to acid rain for New Zealand students is probably not surprising given the fact that as a small group of islands and a Pacific Rim nation, we are subject to earthquakes rather than acid rain.

Table 6: Proportion of students agreeing they could complete scientific literacy tasks

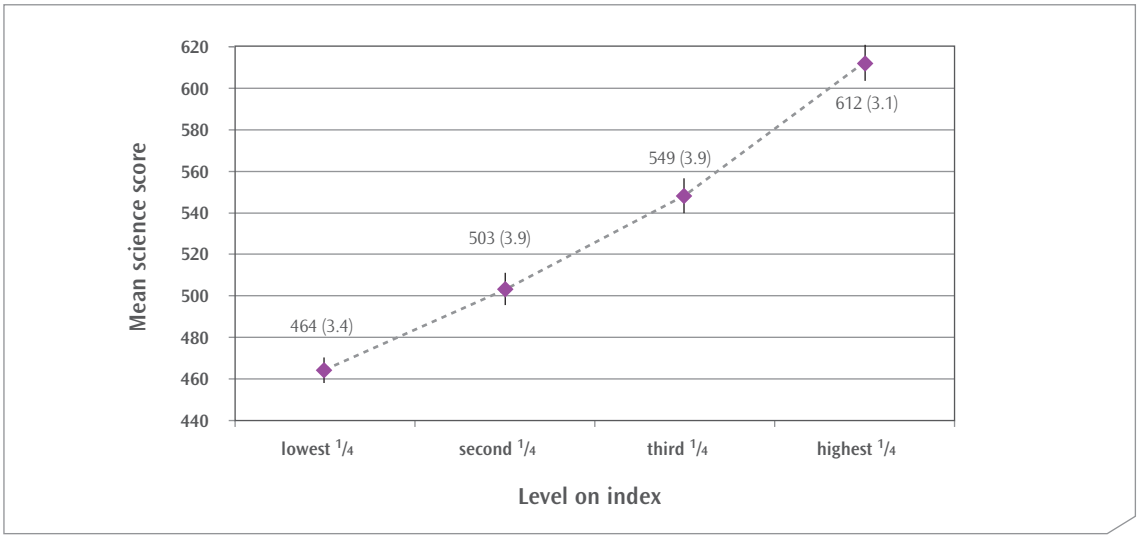
Task	Proportion of students agreeing they could complete the task (easily or with some effort) (%)	
	New Zealand	OECD average
Explain why earthquakes occur more frequently in some areas than in others	78	76
Recognise the science question that underlies a newspaper report on a health issue	73	73
Interpret the scientific information provided on the labelling of food items	64	64
Predict how changes to an environment will affect the survival of certain species	68	64
Identify the science question associated with the disposal of rubbish	58	62
Describe the role of antibiotics in the treatment of disease	58	59
Identify the better of two explanations for the formation of acid rain	48	58
Discuss how new evidence can lead you to change your understanding about the possibility of life on Mars	50	51

Note: Response options for each statement were: I could do this easily, I could do this with a bit of effort, I would struggle to do this on my own, and I couldn't do this. The proportions for agreement shown in this table combine those who could do this easily and those who could do it with a bit of effort.

An index of self-efficacy in science was created using students' responses to these eight tasks. The index was constructed so that, in general, students who agreed they could do these tasks were higher on the index, and students who reacted more negatively were lower on the index. The New Zealand average on the scale was about the same as the OECD average, but higher than the averages for Korea and Japan.

Students' self-efficacy had a strong relationship with achievement, as shown in Figure 7. That is, students with a greater self-efficacy had significantly higher achievement than those with lower self-efficacy. It is worth noting that this relationship was even stronger than for the enjoyment index. The relationship between self-efficacy and achievement observed for New Zealand students was similar to that found in the United Kingdom, France, Austria, Australia, Germany, and Poland.

Figure 7: Mean scientific literacy of students in each quarter of the index of self-efficacy in science



Notes: The student index of self-efficacy in science combines the responses to the eight tasks presented in Table 6. Students in the lowest ¼ of the index did not necessarily disagree they could complete all tasks; rather, they were less likely to report agreement in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Gender differences in beliefs in own abilities in science

New Zealand male students were more likely to report they were good at science (have a high self-concept) and were more likely to report they would be able to perform a selection of scientific literacy tasks (have a high self-efficacy) than female students. Given the gender difference in achievement, with boys having higher achievement on average in scientific literacy than girls (Telford & Caygill 2007), this result is not unexpected.

Ethnic differences in beliefs in own abilities in science

Asian students in New Zealand were more likely to report they were good at science (have a high self-concept) and were more likely to report they would be able to perform a selection of scientific literacy tasks (have a high self-efficacy) than were their Pākehā/European, Māori, and Pasifika peers. Māori students were the least likely to report they were good at science (have a high self-concept). Both Māori, and Pasifika students were the least likely to report they would be able to perform a selection of scientific literacy tasks (have a high self-efficacy) than their peers in the Pākehā/European and Asian ethnic groupings.

Given the ethnic differences in achievement, with Māori and Pasifika students having a lower mean achievement than their Asian and Pākehā/European peers (Telford & Caygill 2007), this lower self-concept among Māori and Pasifika students is perhaps not a surprising finding. However, the relatively higher means on the self-concept and self-efficacy indices for Asian students compared with Pākehā/European students is perhaps a little surprising given that the average achievement of Pākehā/European students was higher than that of Asian students.

Socio-economic differences in beliefs in own abilities in science

Students from higher socio-economic backgrounds tended to report higher scientific self-belief on average than those from lower socio-economic backgrounds.

Chapter 4: Science-related leisure activities

Students' interest in science may be further gauged by the degree to which they engage in science-related activities in their leisure time. Few New Zealand students regularly engaged in any of the science-related activities listed in the questionnaire, with the most popular activity being watching TV programmes about science (16% reported doing this regularly or very often). Half the students reported that they sometimes watched TV programmes about science. The next most popular activities among New Zealand 15-year-old students were visiting websites and reading magazines or newspaper articles on science topics, with nearly half of all students reporting they visited science topic websites at least sometimes.

As shown in Table 7, the proportions of New Zealand students regularly engaging in science-related activities are lower than the average across OECD countries. However, the New Zealand proportions are not that different from Finland, Australia or the United Kingdom.

Table 7: Frequency of students doing science-related leisure activities

Science-related leisure activity	Proportion of students doing activity (%)					
	Regularly or very often		Sometimes		Hardly ever	
	New Zealand	*OECD average*	New Zealand	*OECD average*	New Zealand	*OECD average*
Watch TV programmes about science	16	*21*	50	*53*	33	*26*
Visit websites about science topics	10	*13*	39	*36*	51	*50*
Read science magazines or science articles in newspapers	10	*20*	34	*40*	56	*40*
Borrow or buy books on science topics	7	*8*	33	*32*	60	*59*
Listen to radio programmes about advances in science	3	*7*	17	*25*	79	*68*
Attend a science club	1	*4*	3	*9*	95	*86*

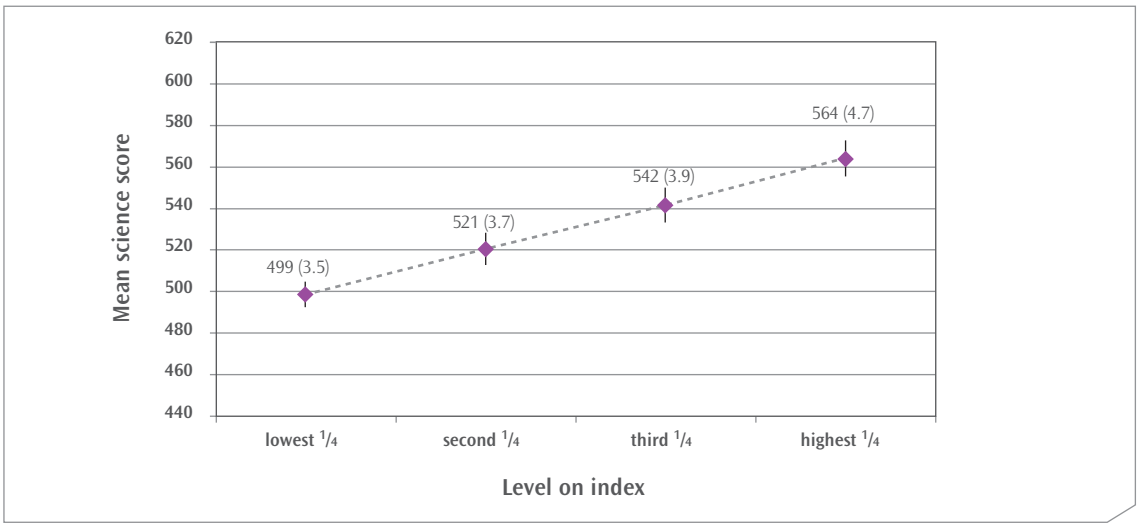
Note: Less than 1% of students did not answer parts of this question, both in New Zealand and across the OECD.

An index of science-related activities was created using students' responses to these six activities. The index was constructed so that, in general, students who did these activities regularly were higher on the index, and students

who hardly ever engaged in these activities were lower on the index. The New Zealand average on the scale was lower than the OECD average, but higher than the average for Japan. The higher-achieving countries, Finland and Hong Kong-China, had higher values on this index than New Zealand.

The index of science-related activities was found to have a positive relationship with achievement for New Zealand students, as shown in Figure 8. That is, students with a greater regularity of engagement in science-related activities during their leisure time had significantly higher achievement than those who were less likely to engage in these activities. The strength of the relationship between the index and achievement observed for New Zealand students was similar to that found in Ireland, Sweden, Finland and the United Kingdom.

Figure 8: Mean scientific literacy of students in each quarter of the index of science-related activities



Notes: The student index of science-related activities combines the responses to the six activities presented in Table 7. Students in the lowest ¼ of the index did not necessarily never engage in the activities; rather, they were less likely to report engagement in general than their counterparts in the other groupings.

Standard errors appear in parentheses.

Gender differences in science-related leisure activities

New Zealand male students were more likely to report engagement in science-related leisure activities (have a high value on the index of science-related activities) than female students.

Ethnic differences in science-related leisure activities

Asian students were more likely to report engagement in science-related leisure activities (have a high value on the index of science-related activities) than students in any of the other ethnic groupings. Pasifika students were more likely to report engagement in science-related leisure activities than their Māori and Pākehā/European counterparts. There was no significant difference between Māori and Pākehā/European students in terms of their engagement in science-related leisure activities.

Socio-economic differences in science-related leisure activities

Students from higher socio-economic backgrounds were more likely to report engagement in science-related leisure activities, on average, than those from lower socio-economic backgrounds.

Chapter 5: Value beliefs regarding science

There are two aspects to value beliefs regarding science: the value of science for humanity in general and the value of science to the student personally. These two aspects are examined separately in PISA, because while students may think advances in science are important and useful (a more general value of science), they may or may not wish to pursue scientific studies or careers and hence contribute to scientific advances (a more personal value of science).

General value of science

In general, most 15-year-old students in New Zealand – and indeed across all countries in PISA – felt that science was of value to society and advances in science were important (see Table 8). However, one-third of New Zealand students did not agree that *advances in science and technology usually bring social benefits*. This statement was the one that showed the greatest variation across countries, with around three-quarters of students agreeing across the OECD on average (75%), but as many as 97 percent agreeing in Thailand and as few as 53 percent agreeing in Iceland.

Table 8: Proportion of students agreeing with statements on the general value of science

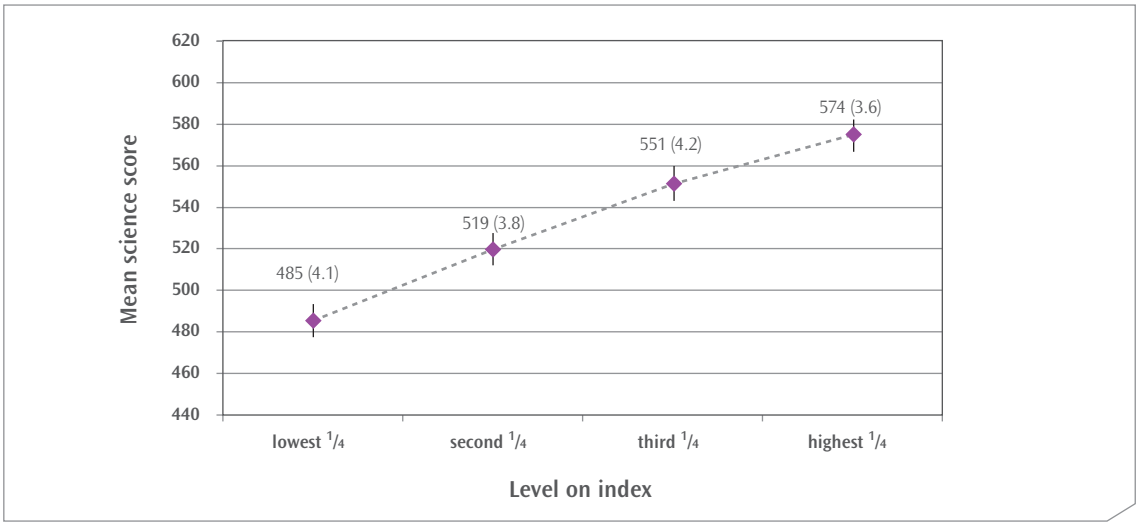
Statement on general value of science	Proportion of students agreeing (%)	
	New Zealand	OECD average
Science is important for helping us to understand the natural world	93	93
Advances in science and technology usually improve people's living conditions	89	92
Science is valuable to society	87	87
Advances in science and technology usually help improve the economy	86	80
Advances in science and technology usually bring social benefits	66	75

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. Proportions for agreement shown in this table combine both those who agreed and those who strongly agreed.

An index of the general value of science was created using students' responses to these five statements. The index was constructed so that, in general, students who agreed with these statements were higher on the index, and students who reacted more negatively to the statements were lower on the index. The New Zealand average on the scale was lower than the OECD average but higher than the average for the Netherlands. The higher-achieving countries, Finland and Hong Kong-China, had much higher values on this index than New Zealand.

The index of the general value of science was found to have a positive relationship with achievement, as shown in Figure 9. That is, students with a greater general value of science had significantly higher achievement than those with a lower value of science. This relationship was observed for all the countries involved in PISA 2006. The strength of the relationship between the perceived general value of science and achievement observed for New Zealand students was high relative to other countries, and similar to that found in Australia and the United Kingdom.

Figure 9: Mean scientific literacy of students in each quarter of the index of the general value of science



Notes: The student index of general value of science combines the responses to the five statements presented in Table 8. Students in the lowest ¼ of the index did not necessarily disagree with all statements on the general value of science; rather, they were less likely to report agreement in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Support for scientific enquiry

In order to further investigate the students' general value of science, specific questions were asked within the context of three of the assessment units. That is, following each of three assessment units, students were asked for their agreement on the importance of scientific study or evidence in the area presented in the assessment unit. Most New Zealand students agreed with the statements, with the proportion ranging from 67 percent agreeing that *action to protect National Parks from damage should be based on scientific evidence*, to 90 percent agreeing that they were *in favour of research to develop vaccines for new strains of influenza*, as shown in Table 9. The relatively lower proportion of students agreeing with the statement on national parks may be because for many New Zealand students national parks and preserving New Zealand's flora and fauna are entwined with national identity. Thus it may be that they think that protection of national parks is important regardless of scientific evidence, rather than thinking that protection of national parks is unimportant or that science is unimportant. In addition, some students may feel that waiting for scientific evidence may cause an unacceptable delay or have irreversible consequences. This may explain why the proportion of New Zealand students agreeing with this statement is low compared with other statements and with students in other countries (ranging from 59% in Finland to 93% in Thailand).

It is perhaps not surprising that nine out of ten New Zealand students and nearly all students in all countries agreed that they were *in favour of research to develop vaccines for new strains of influenza* given that they would all benefit directly from this kind of research. In general, the majority of students showed support for scientific enquiry in their responses to these questions.

Table 9: Proportion of students agreeing with statements on scientific enquiry

Statement on scientific enquiry	Proportion of students agreeing (%)	
	New Zealand	OECD average
Acid rain unit		
Preservation of ancient ruins should be based on scientific evidence concerning the causes of damage.	78	74
Statements about the causes of acid rain should be based on scientific research	86	85
Grand Canyon unit		
The systematic study of fossils is important	81	86
Action to protect national parks from damage should be based on scientific evidence	67	74
Scientific investigation of geological layers is important	81	86
Mary Montagu and inoculations unit		
I am in favour of research to develop vaccines for new strains of influenza	90	94
The cause of disease can only be identified by scientific research	71	70
The effectiveness of unconventional treatments for diseases should be subject to scientific investigation	82	87

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. The proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

Personal value of science

As mentioned earlier, fewer New Zealand students reported it was as important for them to do well in science compared to mathematics and reading. Therefore it might be expected that students would be less likely to agree that science was of value to them personally than it was for society in general. This was the case, with a range from just over half (56%) up to around three-quarters (77%) of students agreeing with the statements on the personal value of science compared with agreement on the general value of science, which ranged from 66 percent up to 93 percent.

As shown in Table 10, students were more likely to find science helpful for understanding the things around them (77%) than they were to agree that there would be many opportunities to use science when they left school (65%) and that science was very relevant to them (56%).

Table 10: Proportion of students agreeing with statements on the personal value of science

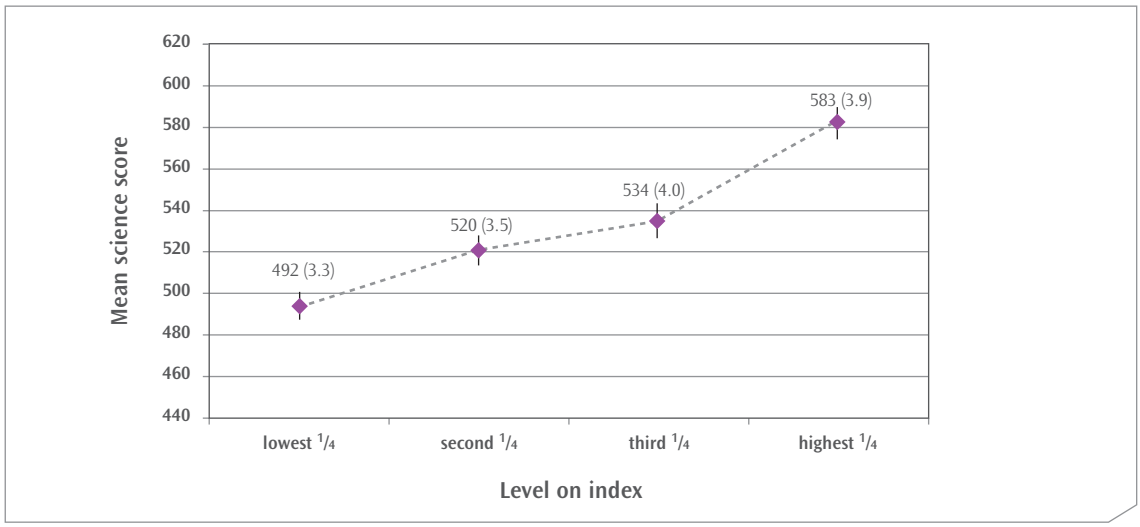
Statement on personal value of science	Proportion of students agreeing (%)	
	New Zealand	OECD average
I find that science helps me to understand the things around me	77	75
I will use science in many ways when I am an adult	65	64
Some concepts in science help me see how I relate to other people	61	61
When I leave school there will be many opportunities for me to use science	65	59
Science is very relevant to me	56	57

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. The proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

The student responses to these five statements were combined into the personal value of science index. The index was constructed so that, in general, students who agreed with these statements were higher on the index and students who reacted more negatively to the statements were lower on the index. The New Zealand average on the index was higher than the OECD average, and higher than the averages in Finland, Japan, the Netherlands, and Korea. In contrast, Hong Kong-China had a much higher value on this index than New Zealand.

As with the general value of science index, the personal value of science index was found to have a positive relationship with achievement, as shown in Figure 10. That is, students who reported a greater personal value of science had significantly higher achievement than those with a lower value of science. This relationship was observed for many but not all of the countries involved in PISA 2006. As for the general value of science, the strength of the relationship between personal value of science and achievement observed for New Zealand students was high relative to other countries (both OECD and non-OECD) and similar to that found in Australia and the United Kingdom.

Figure 10: Mean scientific literacy of students in each quarter of the index of personal value of science



Notes: The student index of personal value of science combines the responses to the five statements presented in Table 10. Students in the lowest ¼ of the index did not necessarily disagree with all statements on personal value of science; rather, they were less likely to report agreement in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Gender differences in value beliefs regarding science

New Zealand male students were more likely to report that advances in science are important and useful (have a high general value of science) than were female students. In contrast with the general value of science, New Zealand girls were just as likely to report wishing to pursue scientific studies or careers, and hence contribute to scientific advances (have a high personal value of science), as the boys.

Ethnic differences in value beliefs regarding science

Asian students in New Zealand were more likely to report advances in science are important and useful (have a high general value of science) and were more likely to report wishing to pursue scientific studies or careers, and hence contribute to scientific advances (have a high personal value of science), than their Pākehā/European, Māori, and Pasifika peers. Māori students were the least likely to report advances in science are important and useful (have a high general value of science) and were also least likely to report wishing to pursue scientific studies or careers, and hence contribute to scientific advances (have a high personal value of science).

Socio-economic differences in value beliefs regarding science

Students from higher socio-economic backgrounds tended to have higher value beliefs regarding science on average than those from lower socio-economic backgrounds.

Chapter 6: Scientific literacy and the environment

Students' attitudes toward and behaviours with regard to the environment can potentially have a major impact on the future of the environment. Well-informed citizens, who care for the environment and take personal responsibility for it, are what many countries aspire to as a long-term goal. This section examines the questions PISA asked students about their knowledge of, level of concern for, and optimism about environmental issues, along with their personal feelings of responsibility.

Awareness of environmental issues

In order to gauge their environmental awareness, students were asked how informed they were about the five environmental issues listed in Table 11. They were given four possible response options:

- I have never heard of this;
- I have heard about this but I would not be able to explain what it is really about;
- I know something about this and could explain the general issue; and
- I am familiar with this and I would be able to explain this well.

Among the issues asked about, New Zealand 15-year-old students were most familiar with the *consequences of clearing forests for other land use* (71% familiar or know something about this issue and would be able to explain it); this proportion was similar to that found in other OECD countries on average. In contrast, less than half of New Zealand 15-year-olds (40%) felt knowledgeable enough to explain the environmental issue of nuclear waste. On average across the OECD, a significantly higher proportion of students (53%) felt knowledgeable enough to explain nuclear waste. The lower figure for New Zealand might reflect the general lack of exposure to this issue due to our anti-nuclear status.

New Zealand students were also less likely to report they were knowledgeable enough to explain acid rain (44%) compared with their OECD counterparts (60%); given that acid rain is not likely to be discussed often as an environmental issue in New Zealand, this finding is not too surprising. In contrast, New Zealand students were more likely to report they were knowledgeable enough to explain the use of genetically modified organisms (48%) compared to their OECD counterparts (35%).

Table 11: Proportion of students who are familiar with or know something about environmental issues

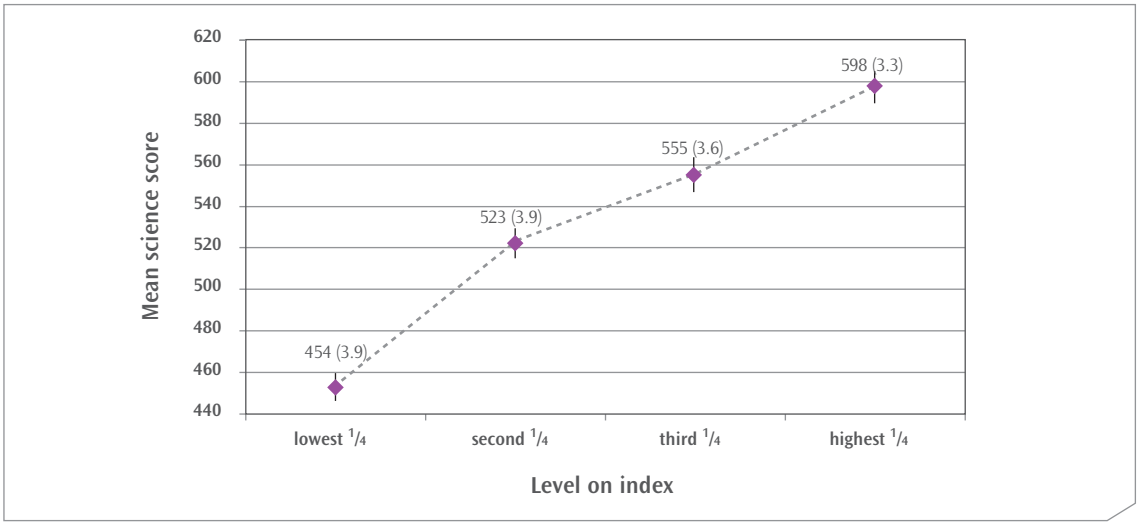
Environmental issue	Proportion of students who are familiar with or know something about the issue (%)	
	New Zealand	OECD average
The consequences of clearing forests for other land use	71	73
The increase of greenhouse gases in the atmosphere	54	58
Use of genetically modified (GM) organisms	48	35
Acid rain	44	60
Nuclear waste	40	53

Note: Response options for each statement were: I have never heard of this; I have heard about this but I would not be able to explain what it is really about; I know something about this and could explain the general issue; and I am familiar with this and I would be able to explain this well. The proportions shown in this table combine those who reported knowing something about the issue and could explain it generally and those who reported they were familiar with the issue and would be able to explain it well.

An index of students' awareness of environmental issues was created using students' responses to these five statements. The index was constructed so that, in general, students who were familiar with these issues were higher on the index, and students who knew little about the issues were lower on the index. The New Zealand average on the scale was lower than the OECD average but higher than the average for Korea. The higher-achieving countries, Finland and Hong Kong-China, had higher values on this index than New Zealand.

Students' reported environmental awareness had a strong relationship with achievement, as shown in Figure 11. That is, students with a greater environmental awareness had significantly higher achievement than those with lower environmental awareness. The relationship between environmental awareness and achievement observed for New Zealand students was similar to that found in Belgium and Japan.

Figure 11: Mean scientific literacy of students in each quarter of the index of students' awareness of environmental issues



Notes: The student index of awareness of environmental issues combines the responses to the five statements presented in Table 11. Students in the lowest ¼ of the index did not necessarily know nothing about the issues; rather, they were less likely to report familiarity in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Level of concern for environmental issues

Students were asked how concerned they were about the six environmental issues listed in Table 12. They were given four possible response options:

- this is a serious concern for me personally as well as others;
- this is a serious concern for other people in my country but not me personally;
- this is a serious concern only for people in other countries; and
- this is not a serious concern to anyone.

As shown in Table 12, around eight out of every ten 15-year-old students in New Zealand believed the environmental issues of *energy shortages*, *air pollution*, *extinction of plants and animals*, *clearing of forests* and *water shortages* were of serious concern for themselves or other New Zealanders. The issue of *nuclear waste* was of less concern, with only 60 percent of students believing it to be serious to them or other New Zealanders. The 40 percent of students who felt this was not a concern for them or other people in New Zealand were possibly influenced by the fact that New Zealand does not have nuclear facilities and therefore there is little nuclear waste to worry about.

Across OECD countries, on average, *air pollution* and *nuclear waste* were considered to be of serious concern by a greater proportion of students than in New Zealand. Indeed, New Zealand had the lowest proportion of students reporting that *air pollution* was of serious concern, while only Iceland and Tunisia had lower proportions of students who believed that *nuclear waste* was of serious concern. Again, the lack of nuclear facilities and students' belief in New Zealand's 'clean, green' image may have influenced these results.

Table 12: Proportion of students who believe environmental issues to be of serious concern for themselves or other people in their country

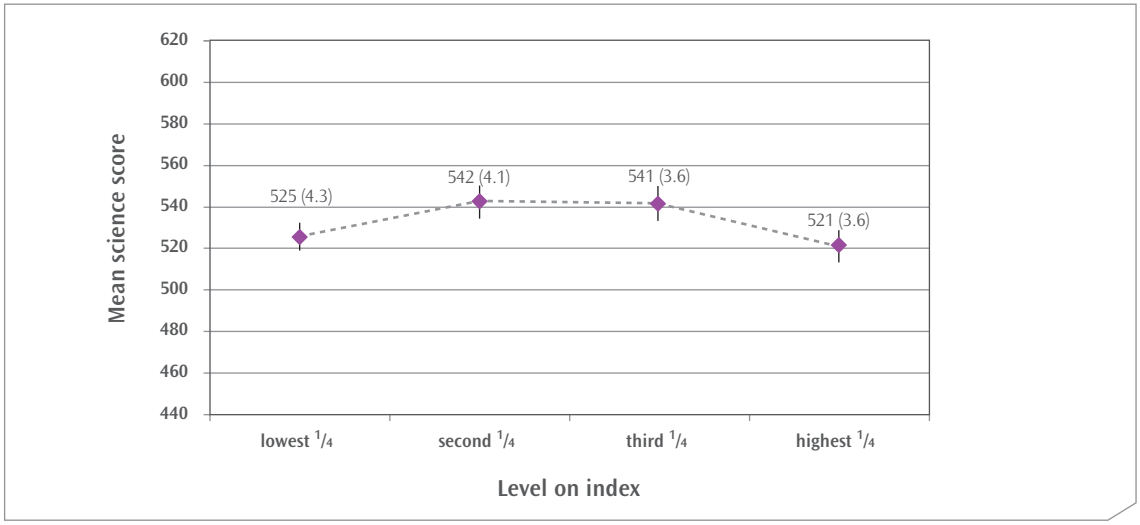
Environmental issue	Proportion of students who believe the issue to be of serious concern for themselves or other people in their country (%)	
	New Zealand	OECD average
Energy shortages	84	82
Air pollution	82	92
Extinction of plants and animals	82	84
Clearing of forests for other land use	81	83
Water shortages	80	76
Nuclear waste	60	78

Notes: Response options for each statement were: this is a serious concern for me personally as well as others; this is a serious concern for other people in my country but not me personally; this is a serious concern only for people in other countries; and this is not a serious concern to anyone. Proportions for agreement shown in this table combine this is a serious concern for me personally as well as others and this is a serious concern for other people in my country but not me personally.

An index of students' level of concern for environmental issues was created using students' responses to these six statements. The index was constructed so that, in general, students who believed these issues were of serious concern for themselves or their country were higher on the index, and students who were less concerned about the issues were lower on the index. The New Zealand average on the scale was lower than the OECD average, but higher than the average for Finland.

Interestingly, there was no relationship between the index of level of concern for environmental issues and student achievement in scientific literacy, as shown in Figure 12. That is, students with a higher concern about environmental issues had similar achievement to those with less concern.

Figure 12: Mean scientific literacy of students in each quarter of the index of students' level of concern for environmental issues



Notes: The student index of level of concern for environmental issues combines the responses to the six issues presented in Table 12. Students in the lowest ¼ of the index did not necessarily believe all the issues to be unimportant; rather, they were less likely to report them to be of serious concern in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Environmental optimism

Students were asked whether they believed that the problems associated with the six environmental issues listed in Table 13 would improve or get worse over the next 20 years. They were also given the response option of *stay about the same*, but this option was not included in the wording of the question stem, only in the response table.

In general, few New Zealand students were optimistic that problems associated with environmental issues would improve over the next 20 years, with proportions ranging from 8 percent to 20 percent. Students were most likely to be optimistic about *energy shortages* and least likely to be optimistic about the *clearing of forests for other land use*. The pattern of general lack of optimism found in New Zealand is similar to that found in many countries in the study.

Air pollution (73%) and clearing forests for other land use (72%) were the two issues the largest proportion of students thought would get worse over the next 20 years.

Table 13: Proportion of students who believe problems associated with environmental issues will improve over the next 20 years

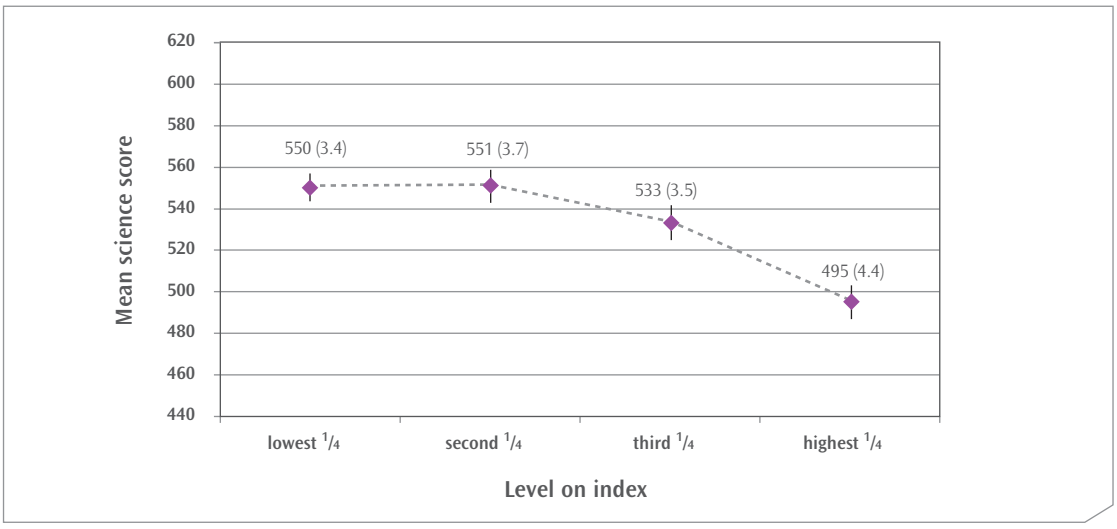
Environmental issue	Proportion of students who believe the problems associated with the issue will improve over the next 20 years (%)	
	New Zealand	OECD average
Energy shortages	20	21
Water shortages	14	18
Extinction of plants and animals	12	14
Air pollution	10	16
Nuclear waste	10	15
Clearing of forests for other land use	8	13

Note: Response options for each statement were: improve, stay about the same, and get worse. The proportions for agreement shown in this table include only improve.

An index of students' optimism regarding environmental issues was created using students' responses to these six issues. The index was constructed so that, in general, students who were optimistic about these issues were higher on the index, and students who were more pessimistic about the issues were lower on the index. The New Zealand average on the scale was lower than the OECD average. Along with Canada and Croatia, New Zealand was among those countries that were least optimistic regarding environmental issues.

Optimism for environmental issues was found to be negatively associated with achievement in scientific literacy, as shown in Figure 13. That is, students who were less optimistic tended to be those with higher achievement, while the more optimistic students tended to have lower achievement. This pattern was observed for all countries in the study except for Kyrgyzstan, where there was no difference in achievement across the index.

Figure 13: Mean scientific literacy of students in each quarter of the index of students' optimism regarding environmental issues



Notes: The student index of optimism regarding environmental issues combines the responses to the six issues presented in Table 13. Students in the lowest ¼ of the index did not necessarily feel pessimistic with regard to all the issues; rather, they were less likely to report optimism in general than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Responsibility for sustainable development

In order to gauge the extent to which students link societies' actions with environmental issues and feel some sense of responsibility for these issues, students were asked about their agreement with seven statements related to issues of sustainable development (listed in Table 14). Three of the statements drew strong support from New Zealand students, with at least nine out of every 10 students in favour of protecting the habitats of endangered species, requiring industries to safely dispose of waste, and make regular checks on the emissions of cars as a condition of their use. The issue of minimising the use of plastic packaging also drew fairly high support (83% agreeing). This finding aligns with the move among supermarkets in New Zealand to encourage customers to bring their own carry bags rather than use new plastic carry bags each visit (New Zealand Press Association 2007). The findings for New Zealand on these four statements are similar to those on average across the OECD countries (see Table 14).

While three-quarters of New Zealand students agreed that electricity should be produced from renewable sources as much as possible, far fewer (58%) were disturbed by wastage of electricity. Fewer New Zealand students were likely to be worried about wastage of electricity when compared with the average among OECD countries, although the proportion was similar to that of students in Denmark, Norway, the Czech Republic, and Sweden.

Just under half of 15-year-old students in New Zealand were in favour of laws that regulate factory emissions regardless of the impact on the price of products. This proportion was one of the smallest found in the countries in PISA, with only Israel having a smaller proportion (37%).

Table 14: Proportion of students who agree with statements on responsibility for sustainable development

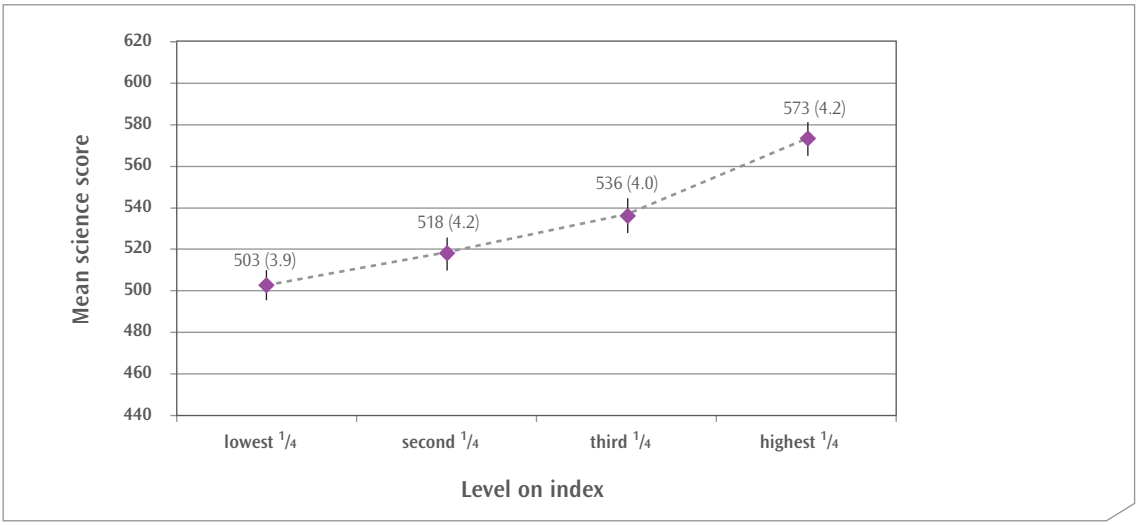
Statement on sustainable development issue	Proportion of students agreeing (%)	
	New Zealand	OECD average
I am in favour of having laws that protect the habitats of endangered species	92	92
Industries should be required to prove that they safely dispose of dangerous waste materials	90	92
It is important to carry out regular checks on the emissions from cars as a condition of their use	90	91
To reduce waste, the use of plastic packaging should be kept to a minimum	83	82
Electricity should be produced from renewable sources as much as possible, even if this increases the cost	75	79
It disturbs me when energy is wasted through the unnecessary use of electrical appliances	58	69
I am in favour of having laws that regulate factory emissions even if this would increase the price of products	49	69

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. The proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

An index of responsibility for sustainable development was created by combining students' responses to the seven issues. The index was constructed so that, in general, students who agreed with these statements were higher on the index, and students who disagreed were lower on the index. The New Zealand average on the index was lower than the OECD average, but higher than the average for the Netherlands. The higher-achieving countries, Finland and Hong Kong-China, had higher values on this index than New Zealand.

New Zealand students' reported responsibility for sustainable development was positively associated with achievement in scientific literacy, as shown in Figure 14. That is, students who reported a greater sense of society's responsibility for sustainable development (i.e. who were higher on the index) generally had higher achievement than those with a lower sense of responsibility (i.e. were lower on the index, see Figure 14). This positive relationship with achievement was observed for all countries except Israel, and was particularly strong for New Zealand students, along with their counterparts in Greece, Ireland, the United Kingdom, Australia, and France.

Figure 14: Mean scientific literacy of students in each quarter of the index of responsibility for sustainable development



Notes: The student index of responsibility for sustainable development combines the responses to the seven issues presented in Table 14. Students in the lowest ¼ of the index were not necessarily strongly negative; rather, they were less likely to agree or strongly agree with statements than were their counterparts in the other groupings.

Standard errors appear in parentheses.

Gender differences for scientific literacy and the environment

New Zealand boys were more likely to report having a high environmental awareness than girls. Contrary to this, girls were more likely to report high levels of concern for the environment, tended to be less optimistic about environmental issues, and were more likely to report having a higher sense of responsibility for sustainable development than boys.

Ethnic differences for scientific literacy and the environment

Asian students were more likely to report having higher environmental awareness and were more likely to have a higher sense of responsibility for sustainable development on average than their Pākehā/European, Pasifika and Māori peers. Students' level of concern for environmental issues did not differ markedly among ethnic groupings on average. With regard to optimism that environmental issues would improve, Asian and Pasifika students were more likely to report optimism, while Pākehā/European students were least likely.

Socio-economic differences for scientific literacy and the environment

Students from higher socio-economic backgrounds were more likely to report having higher environmental awareness and were more likely to report having a higher sense of responsibility for sustainable development on average than those from lower socio-economic backgrounds. However, there was no difference in the level of concern for the environment. Similar to the negative relationship with achievement found for environmental optimism, students from lower socio-economic backgrounds tended to report having higher optimism for the environment than students from higher socio-economic backgrounds.

Chapter 7: Conclusion

This report has examined the attitudes of New Zealand 15-year-old students to science, along with a measure of their engagement with science. The relationship between students' achievement in scientific literacy and their attitudes to and engagement with science was also examined, and comparisons made by gender, main ethnic grouping and socio-economic background.

What were New Zealand students' attitudes to and engagement with science?

New Zealand 15-year-old students were generally interested in science, and as many as a quarter of students indicated they thought they might be in a science-related career at age 30. Relative to students in other participating countries, they did not have particularly strong positive beliefs in their own abilities in science and did not tend to engage in many science-related activities in their leisure time. However, many New Zealand students agreed that science was of value to society and that advances in science were important. In general, they were concerned about environmental issues and not very optimistic for future improvement.

What was the relationship between attitudes and engagement and scientific literacy achievement?

A number of aspects of attitudes to and engagement with science were found to be associated with higher scientific literacy achievement. Overall, students who reported a higher interest in science, reported higher positive beliefs in their own abilities, placed a higher value on science and reported high environmental concerns, also had higher levels of achievement.

What were the attitudes and engagement of boys and girls?

There were some distinct differences between boys and girls with regard to their attitudes to and engagement with science. New Zealand 15-year-old boys were more likely to report enjoying science, reported higher levels of engagement in science-related leisure activities, reported higher self-belief, and expressed a high general value of science than girls. However, a higher proportion of girls expected to be in a science-related career at age 30, and girls were more likely to report high levels of concern and responsibility for the environment than boys.

What were the attitudes and engagement of students in each ethnic grouping?

Some differences were found between students in the main ethnic groupings in New Zealand with regard to their attitudes to and engagement with science. Asian students were more positive in their views on engagement with science, were more likely to report higher self-belief in science, reported higher levels of engagement in science-related leisure activities, and were more likely to express a higher value of science, both generally and personally. In contrast, Māori students were the least positive with regard to their views on engagement with science, and were least likely to report having higher self-belief in science or to express a high value of science, both generally and personally.

What were the attitudes and engagement of students by socio-economic background?

Students from higher socio-economic backgrounds tended to report higher levels of engagement, higher scientific self-belief, higher value beliefs, higher environmental awareness, and a higher sense of responsibility for sustainable development, on average, than those from lower socio-economic backgrounds.

Final note

The Ministry of Education's current focus is on presence, engagement and achievement (Ministry of Education 2007). This report adds to the evidence base supporting this focus, particularly in the aspects of engagement and achievement. Given the finding that, in general, attitudes to and engagement with science are positively related to scientific literacy achievement, this report is an important addition to the suite of reporting into New Zealand's participation in PISA 2006.

Appendices

Appendix 1: Countries participating in PISA 2006

Argentina*	Australia	Austria
Azerbaijan*	Belgium	Brazil*
Bulgaria*	Canada	Chile*
Colombia*	Croatia*	Czech Republic
Denmark	Estonia*	Finland
France	Germany	Greece
Hong Kong-China*	Hungary	Iceland
Indonesia*	Ireland	Israel*
Italy	Japan	Jordan*
Korea	Kyrgyzstan*	Latvia*
Liechtenstein*	Lithuania*	Luxembourg
Macao-China*	Mexico	Montenegro*
The Netherlands	New Zealand	Norway
Poland	Portugal	Qatar*
Romania*	Russian Federation*	Serbia*
Slovak Republic	Slovenia*	Spain
Sweden	Switzerland	Chinese Taipei*
Thailand*	Tunisia*	Turkey
United Kingdom	United States	Uruguay*

** Denotes non-OECD countries.*

Appendix 2: Proportions of New Zealand students and levels of interest in general topics in science

General topic in science	High interest		Medium interest		Low interest		No interest	
	%	(s.e.)	%	(s.e.)	%	(s.e.)	%	(s.e.)
Physics	15	(0.6)	34	(0.7)	34	(0.8)	17	(0.6)
Chemistry	21	(0.8)	34	(0.8)	30	(0.8)	16	(0.6)
Plant biology	14	(0.6)	30	(0.7)	38	(0.8)	18	(0.7)
Human biology	30	(1.1)	36	(0.8)	23	(0.8)	11	(0.5)
Astronomy	18	(0.7)	31	(0.7)	32	(0.8)	18	(0.6)
Geology	8	(0.4)	28	(0.7)	41	(0.7)	22	(0.6)
Experiments	9	(0.5)	29	(0.7)	39	(0.8)	23	(0.7)
Explanations	6	(0.4)	24	(0.7)	42	(0.8)	28	(0.8)

Notes: Standard errors (s.e.) are presented in parentheses.

Proportions should add up to 100%; inconsistencies are due to rounding.

Appendix 3: Proportion of students agreeing with statements on instrumental motivation to learn science

Statement on instrumental motivation to learn science	Proportion of students agreeing		
	Australia	United Kingdom	United States
I study science because I know it is useful for me	69	75	77
Making an effort in my science subject(s) is worth it because this will help me in the work I want to do later on	66	71	78
Studying my science subject(s) is worthwhile for me because what I learn will improve my career prospects	64	71	70
I will learn many things in my science subject(s) that will help me get a job	62	65	70
What I learn in my science subject(s) is worthwhile for me because I need this for what I want to study later on	55	54	68

Note: Response options for each statement were: strongly agree, agree, disagree, and strongly disagree. The proportions for agreement shown in this table combine those who agreed and those who strongly agreed.

References

Caygill, R., Marshall, N., & May, S. (2008). *PISA 2006: mathematical literacy – how ready are our 15-year-olds for tomorrow's world?* Wellington: Ministry of Education.

Chamberlain, M. (2007). *Mathematics and science achievement in New Zealand: summing up New Zealand's participation in three cycles of TIMSS at Year 9*. Wellington: Ministry of Education.

Chiu, M.M., & McBride-Chang, C. (2006). Gender, context, and reading: a comparison of students in 43 countries. *Scientific Studies of Reading*, 10(4), 331-362.

Crean, M. (2007, February 10). Scientific legacy. *The Press*, p. D17.

Cullen, T. (2006). Thinking outside the square to enable reluctant readers to undertake high reading mileage. *Reading Forum NZ*, 21(2), 24-33.

Department of Labour. (2007). *Occupations in shortage in New Zealand: 2006.* Wellington: Department of Labour. Retrieved 31 August 2007 from: www.dol.govt.nz/PDFs/jvm-shortage2006.pdf.

Department of Labour. (2000). *Cultivating the knowledge economy in New Zealand.* Wellington: Department of Labour. Retrieved 20 February 2008 from: www.dol.govt.nz/PDFs/Cultivating%20the%20knowledge%20Economy%20in%20New%20Zealand.pdf

Koslow, S. (2005). *If creative scientists sustain New Zealand's knowledge economy, how is science education doing? Insights from recent university science graduates.* Wellington: the Royal Society of New Zealand. Retrieved 20 February 2008 from www.rsnz.org/policy/koslowreport81.pdf.

Marshall, N., Caygill, R., and May, S. (2008). *PISA 2006: reading literacy – how ready are our 15-year-olds for tomorrow's world?* Wellington: Ministry of Education.

Ministry of Education. (2007). *Statement of intent 2007-2012.*Wellington: Ministry of Education.

New Zealand Press Association. (2007, August 1). *Supermarkets reduce plastic bag use.* Retrieved 1 April 2008 from: www.stuff.co.nz/stuff/4147763a7693.html.

OECD. (2006). *Assessing scientific, reading and mathematical literacy: a framework for PISA 2006*. Paris: OECD.

OECD. (2007a). *PISA 2006: science competencies for tomorrow's world, vol. 1: analysis*. Paris: OECD.

OECD. (2007b). *PISA 2006: science competencies for tomorrow's world, vol. 2: data*. Paris: OECD.

OECD (n.d.). *Technical notes*. Retrieved 28 March 2008 from: www.pisa.oecd.org/document/9/0,3343,en_32252351_32235731_39736777_1_1_1_1,00.html

Telford, M., & Caygill, R. (2007). *PISA 2006: how ready are our 15-year-olds for tomorrow's world?* Wellington: Ministry of Education.

Definitions and technical notes

Mean

Student performances in PISA are reported using means, which is a type of average, for groupings of students. In general, the mean of a set of scores is the sum of the scores divided by the number of scores, and is often referred to as 'the average'. Note that for PISA, as with other large-scale studies, the means for a country are adjusted slightly (in technical terms 'weighted') to reflect the total population of 15-year-olds rather than just the sample.

Minimum group size for reporting achievement data

In this report student achievement data are not reported where the group size is less than 30 students.

OECD mean or average

The OECD mean, sometimes referred to as the OECD average, includes only the OECD countries – no non-OECD (partner) countries are included in this average. The OECD mean is the average of the means for the OECD countries.

Percentile

The percentages of students performing below or above particular points on the scale can be used to describe the range of achievement. The lowest outer limit of achievement is the 5th percentile – the score at which only 5 percent of students achieved a lower score and 95 percent of students achieved a higher score. The highest outer limit is the 95th percentile – the score at which only 5 percent of students achieved a higher score and 95 percent of students a lower score; thus 90 percent of the 15-year-old student scores lie between the 5th and 95th percentiles.

Proficiency scale

PISA developed proficiency levels to describe the range in literacy across 15-year-old students. The proficiency levels describe the competencies of students achieving at that level and are anchored at certain score points on the achievement scale. Note that students were considered to be proficient at a particular level if, on the basis of their overall performance, they could be expected to answer at least half of the items in that level correctly. Typically, students who were proficient at higher levels had also demonstrated their abilities and knowledge at lower levels

Scale score points

The design of PISA allows for a large number of questions to be used in mathematics, science and reading; each student answers only a portion of these questions. PISA employs techniques to enable population estimates of achievement to be produced for each country even though a sample of students responded to differing selections of questions. These techniques result in scaled scores which are on a scale with a mean of 500 and a standard deviation of 100. The OECD mean score of 500 points was established as the benchmark against which performance has since been measured in the first cycle of PISA in which a subject was the major focus: in PISA 2000 for reading, in PISA 2003 for mathematics, and in PISA 2006 for science.

Standard error

Because of the technical nature of PISA, the calculation of statistics such as means and proportions have some uncertainty due to (i) generalising from the sample to the total 15-year-old school population, and (ii) inferring each student's proficiency from their performance on a subset of items. The standard errors provide a measure of this uncertainty. In general, we can be 95 percent confident that the true population value lies within an interval 1.96 standard errors either side of the given statistic.

Statistically significant

In order to determine whether a difference between two means is actual, it is usual to undertake tests of significance. These tests take into account the means and the error associated with them. If a result is reported as not being statistically significant, then although the means might be slightly different, we do not have sufficient evidence to infer that they are different. All tests of statistical significance referred to in this report are at the 95 percent confidence level.

Further information

New Zealand's PISA 2006 web page is at www.educationcounts.govt.nz/goto/pisa. The OECD's PISA 2006 international report can be accessed from the OECD PISA website www.pisa.oecd.org. An interactive data selection facility, which allows selected analyses of international contextual information and student performance, is also available from this site, along with the international versions of the student, school and parent questionnaires. Further reporting of New Zealand PISA 2006 results will be available later in 2008.

PISA will be administered in New Zealand again during July and August 2009. The PISA 2009 results will be published by the OECD in December 2010.

List of countries participating in PISA 2006


Argentina*


Azerbaijan*


Bulgaria*


Colombia*


Denmark


France


Hong Kong-China*


Indonesia*


Italy


Korea


Liechtenstein*


Macao-China*


New Zealand


Portugal


Russian Federation*


Slovenia*


Switzerland


Tunisia*


United States


Australia


Belgium


Canada


Croatia*


Estonia*


Germany


Hungary


Ireland


Japan


Kyrgyzstan*


Lithuania*


Mexico


Norway


Qatar*


Serbia & Montenegro*


Spain


Chinese Taipei*


Turkey


Uruguay*


Austria


Brazil*

Chile*

Czech Republic

Finland

Greece

Iceland

Israel*

Jordan*

Latvia*

Luxembourg

The Netherlands

Poland

Romania*

Slovak Republic

Sweden

Thailand*

United Kingdom

* Non-OECD countries

Note: Serbia and Montenegro equal two countries.

Published by:

Comparative Education Research Unit
Research Division
Ministry of Education
PO Box 1666
Wellington 6140
New Zealand

Email: research.info@minedu.govt.nz
Fax: 64-4-463 8312 Phone: 64-4-463 8000

June 2008
ISBN: 978-0-478-13876-4 ISBN Web: 978-0-478-13877-1
RMR-898

Contact Information

Maree Telford
PISA 2006 National Project Manager
Phone: 04 463 8831 Email: info.pisa@minedu.govt.nz

This report is available from the Education Counts website: www.educationcounts.govt.nz/goto/pisa

newzealand.govt.nz