

Learning for Tomorrow's World

Programme for International Student Assessment (PISA) 2003 - New Zealand Summary Report

The Programme for International Student Assessment 2003 (PISA 2003) is the second cycle of this international study assessing the knowledge and skills of 15-year-old students in three key areas: reading literacy, mathematical literacy and scientific literacy. It was commissioned by the Organisation for Economic Co-operation and Development (OECD). New Zealand was one of 41 countries that took part, 30 of which are members of the OECD. This report summarises some of the main results for New Zealand, placed in an international context.

Key Points

- The New Zealand student mean score in each of reading, mathematics and science placed New Zealand within the group of second highest performing countries for each subject area, along with countries such as Australia, Canada and Japan.
- New Zealand had a wide distribution of achievement scores in each of reading, mathematics and science.
- The achievement of New Zealand students did not change significantly¹ between the 2000 and 2003 PISA assessments in reading, mathematics or science. Internationally, average mathematics performance increased in one of two content areas over this period, while performances in reading and science have essentially remained unchanged.
- New Zealand students also performed well in the cross-curricular competency of problem solving. New Zealand's mean score was in line with those of countries, such as Australia, Canada, Hong Kong-China and Japan, that recorded the second highest level of achievement in problem solving.
- In terms of some of the cognitive, affective and attitudinal outcomes of learning measured in PISA, students in New Zealand are generally well placed to meet the challenges they may face once they leave school. For example, their reported self-confidence in mathematics was high relative to the average across OECD countries, and they were among the more frequent users of both memorisation and elaboration learning strategies.
- Principals in New Zealand schools tended to be more positive than principals across the OECD in their views on the effect of possible resource shortages in their schools, reporting that such shortages generally had no or minimal impact on schools' ability to provide instruction.

¹ The use of the term 'significant' refers to statistical significance at the .05 level.



This summary report

This report summarises the main results from PISA 2003 for New Zealand and places these results in the international context of the other participating countries. It is based on *Learning for Tomorrow's World - First Results from PISA 2003* and *Problem Solving for Tomorrow's World - First Measures of Cross-Curricular Skills from PISA 2003*, the international reports prepared by the OECD².

A more detailed New Zealand national report for the PISA 2003 study is planned for 2005. As well as a more thorough coverage of the results presented in this summary report, the national report will have additional subpopulation analyses, for example, for students from different ethnic groupings or school deciles. These New Zealand-specific results are not reported in this summary, nor are they covered in the international reports for PISA 2003.

This summary begins with a brief recap of the background to PISA, followed by a description of the assessments and the way the results are reported. Next, the assessment results for each of the three subject areas and problem solving are presented. The following section covers some of the general outcomes of learning, such as student attitudes, beliefs and learning strategies. These achievement results and student characteristics are then placed in the context of a selection of home and school background factors. The relationship between achievement in mathematics, the major domain in PISA 2003, and the general outcomes of learning and home and school background factors is examined where appropriate.

An Overview of PISA

PISA is a collaborative effort among the participating countries. It seeks to measure student achievement across the countries in order to assess how well young adults at age 15³, and therefore near the end of compulsory schooling, are prepared to meet the challenges of today's knowledge societies.⁴ This second cycle of PISA involved 41 countries⁵ and well over a quarter of a million students internationally. In New Zealand, around 4500 students from 173 secondary schools participated in this study.

PISA was first administered in 2000 and will continue to be administered every three years. Although each area of knowledge and skill is assessed on each occasion, the focus of the study changes. In 2000 the focus was on reading literacy, in 2003 it was on mathematical literacy and in 2006 it will be on scientific literacy. In addition, PISA 2003 assessed problem solving, a generic student competency that crosses curricular areas. In each cycle information is also collected from students and school principals. These data provide information regarding student attitudes, beliefs and learning strategies, as well as the home and school contexts within which students learn.

The assessments

PISA 2003 assessed reading literacy, mathematical literacy and scientific literacy, known in this study as *domains*, plus the cross-curricular competency of problem solving. However, these assessments did not focus on student knowledge alone. They also examined the ability of 15-year-olds to reflect on that knowledge and on their own experience, and to apply that knowledge and experience to real world issues. As such, PISA is not limited to mastery of specific school curricula, and the tasks are not specifically drawn from language, mathematics or science curricula among the participating countries.

² OECD (2004a) and OECD (2004b). Please refer to the end of this report for the full references for these publications.

³ Students were aged from 15 years 3 months to 16 years 2 months but, as most are 15-year-olds, this report refers to these students as "15-year-olds" for brevity.

⁴ Please refer to the end of this report for the full references for the PISA Framework (OECD, 2003) and the Technical Report (OECD, 2004c).

⁵ A full list of the participating countries can be found at the end of this report.

Each student was assessed for about two hours on pencil-and-paper items. Students were given different combinations of tasks so that overall, for each country, it was possible to include a larger pool of tasks. Multiple-choice items were combined with questions requiring students to construct their own answers. Tasks were typically organised around a passage or situation of the kind that students might encounter in real life.

In addition to the cognitive assessment, students answered a questionnaire seeking information on their family background, attitudes, beliefs and learning strategies. School principals also completed a questionnaire about their schools. These provided information used to relate the achievement results to some of the contextual factors associated with student performance.

When a domain is the main focus of PISA, as mathematics is in this cycle, more tasks are assessed overall than on the other domains. As a consequence, in PISA 2003 it is possible to report in more detail about student performance in mathematics than is possible with reading, science and problem solving.

Reporting achievement results

Student achievement results in PISA can be reported in the following ways:

- Examine the mean scores achieved by students, and subgroups of students, within and across countries in reading, mathematics, science and problem solving.
- Look at the spread, or distribution, of scores within countries in these four areas.
- Assess the levels of proficiency that students achieve, which allows a description of exactly what students can do. There are six levels of mathematics proficiency defined in PISA 2003. Five reading proficiency levels were defined in PISA 2000 and are therefore available for this cycle. Science will be a major domain in the next round of PISA in 2006, at which time proficiency levels for science will be defined. Problem solving, new in PISA 2003, has four proficiency levels.

In addition, the following comparisons are possible:

- Comparing students' achievement with their overseas counterparts in PISA 2003 (*international* comparison).
- A first estimate of change in student knowledge and skills over time between the assessments in 2000 and 2003 (*historical* trend). Although informative, this is considered indicative only at this stage of the PISA study as there are currently just two points of comparison (PISA 2000 and PISA 2003).

A Profile of Student Achievement in Mathematical Literacy⁶

The focus of PISA is not on assessing the most basic mathematical skills, but rather on assessing the use of these skills in real-life situations. Mathematical literacy is defined in PISA as:

“the capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen.” (OECD, 2004a, Chapter 2)

⁶ A full description of the conceptual framework underlying the PISA assessment of mathematics is provided in OECD (2003).



How mathematics is measured in PISA

About two-thirds of the PISA 2003 assessment was devoted to the assessment of mathematics. Scores were assigned according to students' ability to answer task-related questions on four scales, namely *quantity, uncertainty, space and shape*, and *change and relationships*. There is no hierarchical relationship assumed among these scales. That is, they are considered to be of equal difficulty with each scale having easy, moderate and hard tasks. The results from the four mathematics scales can be reported separately or summarised in a combined mathematics scale.⁷

The mean performance of countries in mathematics

One way of summarising student performance in mathematics is to look at the mean scores for each country. These are presented in Figure 1. The shading of the countries in the figure indicates whether a country's mean score was significantly lower, not significantly different, or significantly higher than that of New Zealand.

The mean score of New Zealand 15-year-olds placed New Zealand within the second highest achieving group of countries on the combined mathematics scale. The New Zealand mean score of 523 was significantly above the OECD average, but it was not significantly different from the mean scores of the 10 countries, including Japan, Canada and Australia, that shared this second group placing. Hong Kong-China, Finland, Korea and the Netherlands were the highest achieving countries.

New Zealand students also performed in the second highest group on each of the four individual mathematics scales. For each scale they achieved significantly above the OECD mean. New Zealand's mean scores tended to cluster with Australia, Canada, Japan, Belgium and Macao-China, although this did vary somewhat depending on the particular scale. The relative performance of countries in the four mathematics content areas provides an insight into potential strengths and weaknesses of each country's intended curricula and the effectiveness with which these curricula are delivered. According to the PISA results, *quantity* appeared to be the weakest content area for New Zealand students.

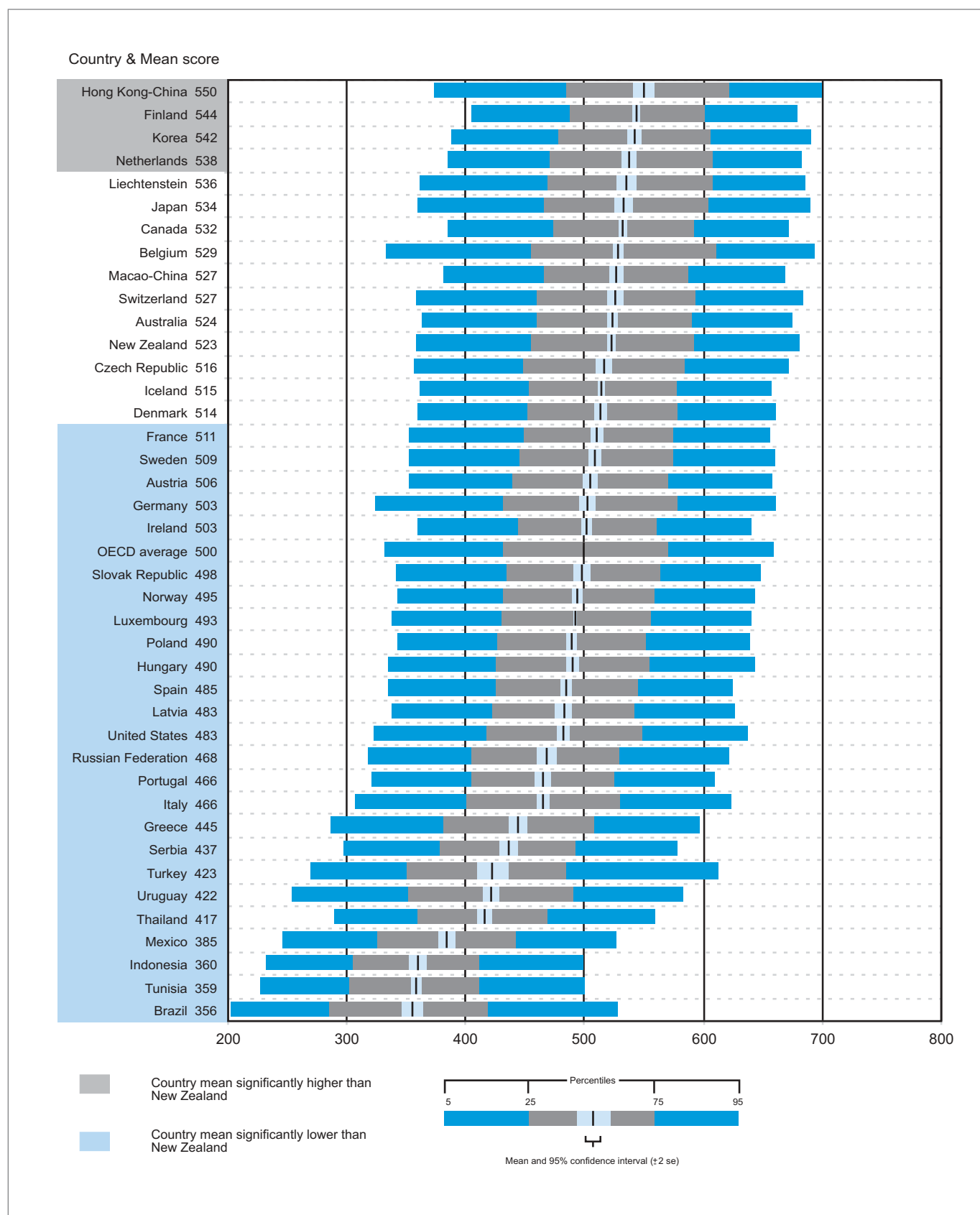
The distribution of mathematics performance within countries

The distribution of scores within countries focuses on the relative dispersion of scores, that is, the range of scores between the highest and lowest performing students. As evident in Figure 1, there was wide variation in overall student performance on the combined mathematics scale within each country. A measure of the gap that exists between students with the highest and the lowest levels of performance is an important indicator of the equality of educational outcomes in mathematics. Typically, the gap between students at the 75th and 25th percentiles provides an indication of the extent of the disparity among the mid range of performance in a country.

The within-country variation in performance in mathematics in this mid range varies widely among countries, ranging from less than 120 score points on the combined mathematics scale in some countries to more than 140 score points in others. Countries with similar levels of average performance showed a considerable variation in disparity of student performance. For example, the mean scores for Canada and New Zealand were not significantly different but, while Canada recorded one of the narrowest distributions (119 points) in this mid range, New Zealand is at the upper end of score dispersion with a difference of 138 points between the 75th and 25th percentiles. This suggests that educational programmes, schools and teachers may not be appropriately addressing the wide range of student knowledge and skills that exists within the New Zealand education system.

⁷ To allow comparison across all participating countries, students' scores have been placed on a common scale with the mean score set at 500. The scale is also set so that two-thirds of the students across all OECD countries will score between 400 and 600 points on this scale, although the range for individual countries will vary from this.

Figure 1: Distribution of student performance on the combined mathematical literacy scale in PISA 2003



Source: Table 2.5c in OECD (2004a), with adaptations

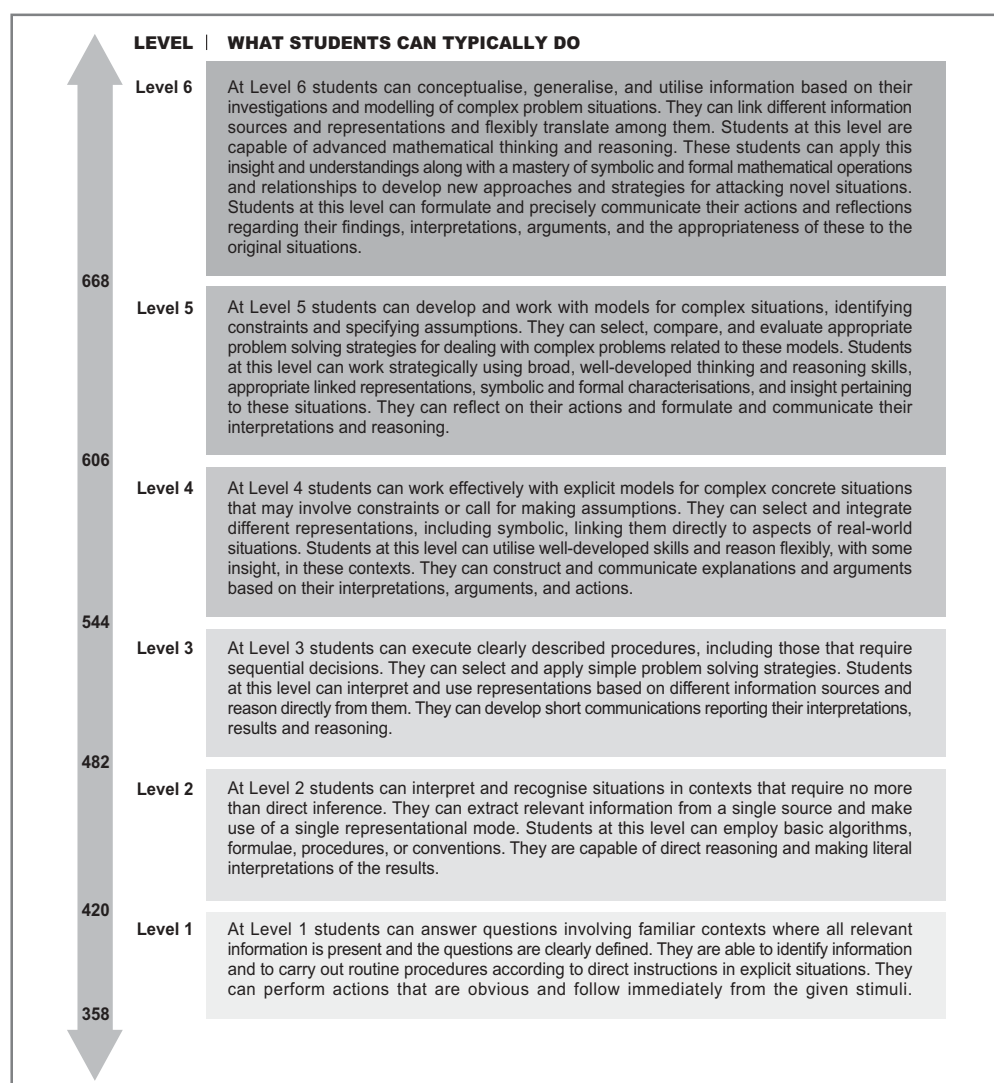
The mathematical literacy proficiency levels

The combined mathematics scale and each of the four mathematics subscales were divided into six levels of knowledge and skills. By assessing the different proficiency levels that students achieve in mathematics it is possible not only to have a better understanding of how students perform relative to one another, but also to describe the kind of mathematical competency that a student needs in order to reach each level. For example, students who are in the lower proficiency levels tend to be able to identify information and carry out routine procedures. Students who are in the higher levels of proficiency tend to be able to conceptualise, generalise and utilise information based on their investigations and modelling of complex problem situations.

Students were considered to be at a particular level of proficiency if they had answered at least half of the items in that level correctly. Typically this means that they not only had demonstrated the knowledge and skills associated with tasks at a particular level of proficiency, but also the knowledge and skills associated with lower levels. For example, all students proficient with Level 3 tasks were typically also proficient at Levels 1 and 2.

A difference of 62 score points represents one proficiency level on the PISA mathematics scales, which can be considered a comparatively large difference in student performance. A description of these levels is given in Figure 2, while Box 1 contains descriptions of some mathematics tasks in the PISA assessments.

Figure 2: What the mathematical proficiency levels in PISA 2003 mean



Source: Fig 2.2 in OECD (2004a)

Box 1

A difficult mathematical literacy task

Content area: Uncertainty. Students were presented with a truncated bar graph showing the number of robberies per year in two specified years. A television reporter's statement interpreting the graph was given. Students were asked to consider whether or not the reporter's statement was a reasonable interpretation of the graph, and to give an explanation as to why. The graph itself is a little unusual, and requires some interpretation. The reporter's statement must be interpreted in relation to the graph. Then, some mathematical understanding and reasoning must be applied to determine a suitable meaning of the phrase 'reasonable interpretation' in this context. Finally, the conclusion must be articulated clearly in a written explanation.

A medium mathematical literacy task

Content area: Change and Relationships. Students were presented with a graph of the average height of young males and young females from the ages of 10 to 20 years. Students were asked to identify the period in their life when females are taller than males of the same age. Students have to interpret the graph to understand exactly what is being displayed; they have to relate the graphs for males and females to each other and determine how the specified period is shown, then accurately read the relevant values from the horizontal scale. Students were also invited to give a written explanation as to how the graph shows a slow-down in growth rate for girls after a particular age. To successfully answer this question, students must first understand how growth rate is displayed in such a graph, must identify what is changing at the specified point in the graph in comparison to the period earlier than that, and must be able to articulate their explanation clearly in words.

An easy mathematical literacy task

Content area: Quantity. Students were presented with a simple rate for exchanging Singapore Dollars (SGD) into South African Rand (ZAR). The question required students to apply the rate to convert 3000 SGD into ZAR. The rate was presented in the form of a familiar equation, and the mathematical step required was direct and reasonably obvious.

Source: OECD (2004a), Chapter 2

Student proficiency at each level in mathematics

The proportion of students at each of the six levels of proficiency within each country on the combined mathematical literacy score is displayed in Figure 3. The highest level on this scale is Level 6. On average, one in 25 (4%) students assessed internationally in PISA 2003 were proficient at this top level. In New Zealand the proportion of students in Level 6 (7%) was somewhat higher than the international average. This relatively high representation in the top level of mathematics performance was also evident on three of the four subscales, on which eight or nine percent of New Zealand students reached Level 6. The *quantity* subscale was the exception, with five percent achieving at or above the highest level of proficiency. At the other end of the continuum, about 21 percent of students across OECD countries performed at Level 1 and below compared with 15 percent in New Zealand.

The spread of results among New Zealand students was broad, as it was in Australia and Japan. These countries had relatively high proportions of students at the highest levels of proficiency, but also relatively high proportions at the lower levels.

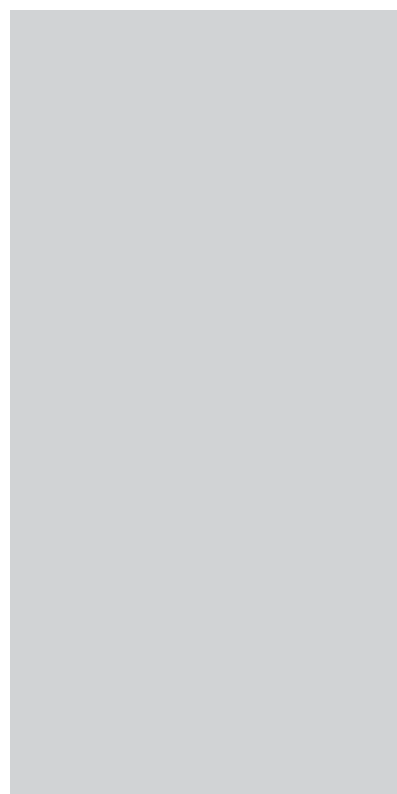
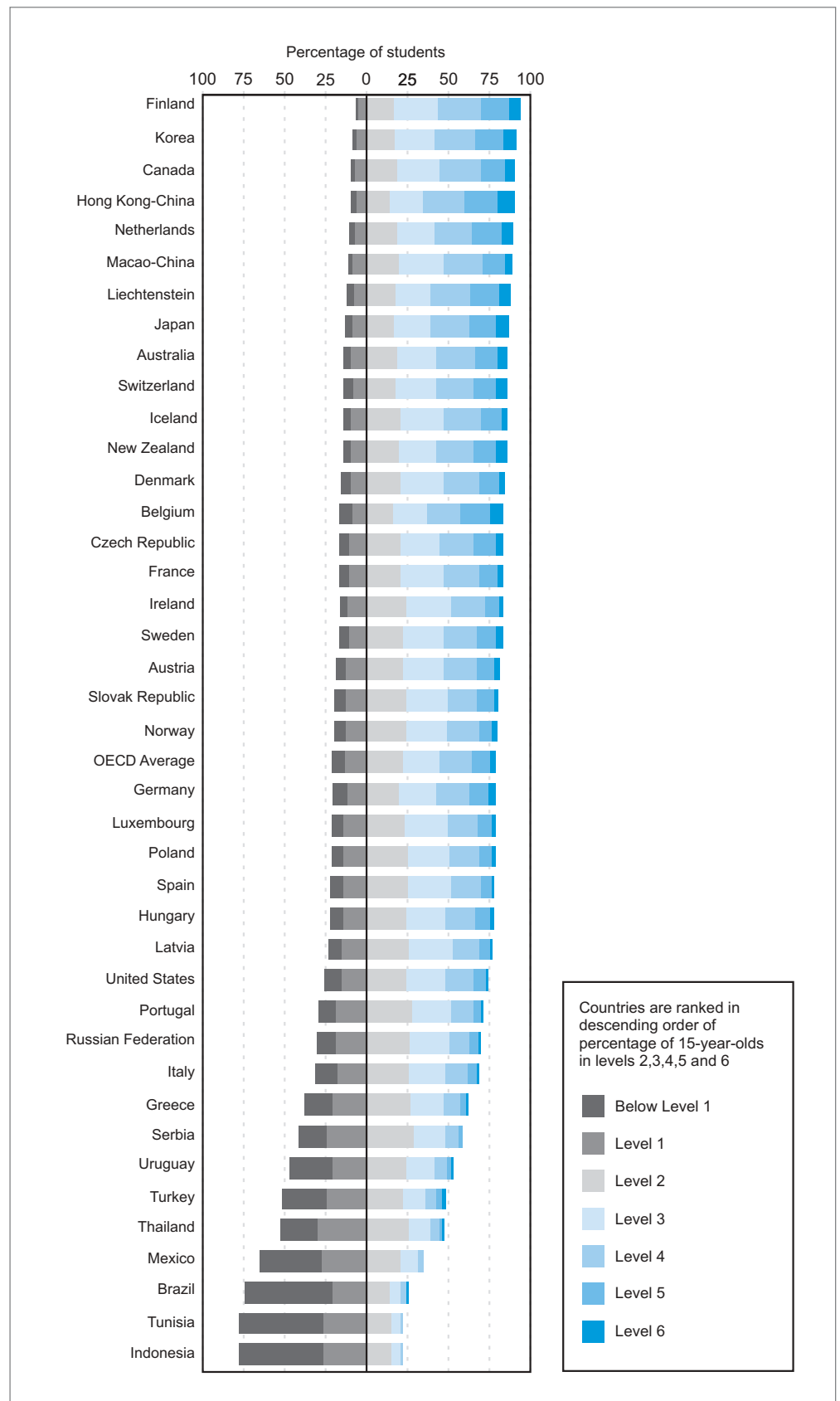


Figure 3: Percentage of students performing at each of the proficiency levels on the combined mathematical literacy scale in PISA 2003



Source: Figure 2.16a in OECD (2004a), with adaptations

Relative strengths and weaknesses in different areas of mathematical content

Comparing the mean scores in the different content areas of mathematics allows each country to examine their relative strengths and weaknesses across content areas within this subject. It is not appropriate to compare numerical scale scores directly between the different content areas, but an examination of their relative rank-order positions on the respective scales is informative. For some countries the relative standing was very similar across the four content areas. By contrast, in eleven countries including New Zealand, Canada, Ireland, and Japan, performance differences among the subscales were particularly large. New Zealand students showed stronger performance on the *uncertainty* scale than on the other three scales, whereas they showed the weakest performance on the *quantity* scale.

Gender differences in mathematics

The gender differences in mathematics in PISA 2003 were fairly consistent across countries. In every country except Iceland, males performed better, on average, than females. These differences in favour of males were significant across the OECD countries as a whole and in 27 individual countries, including New Zealand. Although significant, the difference tended to be small internationally, an average of 11 points, and was much smaller than that observed in PISA 2000 in favour of girls in reading. Among the four mathematics content areas, the largest differences in favour of boys were observed in *uncertainty* and *space and shape*.

Male New Zealanders scored, on average, 14 points higher in the PISA mathematics assessments than did their female counterparts, a small but significant difference. The differences in performance in favour of boys in New Zealand were quite even across the four mathematics subscales. Nevertheless, New Zealand girls generally did perform well, scoring, on average, above the OECD mean on each of the four subscales as well as on the combined mathematics scale. A similar pattern was evident in Canada, Ireland and Korea.

Changes in mathematics achievement between PISA 2000 and PISA 2003

Mathematics was a minor domain in PISA 2000. Just two of the four content areas, *change and relationships* and *space and shape*, were assessed and fewer items were included. Although indicative only, it is possible to compare mathematical performance in 2003 with that measured in 2000 using the two common scales. Internationally, average mathematics performance increased in *change and relationship* but not in *space and shape* over this period. There was no difference on either scale for New Zealand, Australia, Ireland, Japan and Norway.

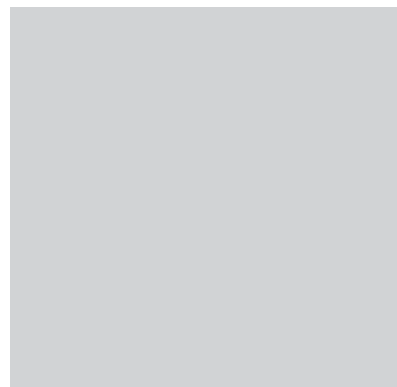
Student Performance in Reading and Science⁸

Student achievement in reading

The focus in PISA is not on assessing the most basic reading skills; rather, it is on “reading to learn”. Students are expected to demonstrate their skills in retrieving information, understanding texts at a general level, interpreting them, reflecting on the content and form of texts in relation to their own knowledge and evaluating and arguing their own point of view. Reading literacy is defined here as:

“understanding, using and reflecting on written texts in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate effectively in society.”
(OECD 2004a, Chapter 6)

⁸ A full description of the conceptual framework underlying the PISA assessments of reading and science is provided in OECD (2003).



How reading is measured in PISA 2003

The PISA 2003 assessment tasks in reading encompass a wide range of both continuous prose passages (which may be narrative, descriptive, explanatory or present an argument), and non-continuous texts (such as tables, lists, forms, graphs and diagrams). The reading results in this cycle are based on the reading proficiency scale that was developed for PISA 2000, when reading was the major domain. Therefore, the five proficiency levels defined at that time can be applied in the current cycle.

The mean performance of countries and proficiency levels in reading

As seen in Figure 4, New Zealand students were in the second highest performing group of countries in mean reading achievement. The mean scores achieved by the countries in this group, which includes Canada, Australia and Ireland, did not differ significantly from each other but were significantly above the OECD mean score. Finland was the only country to score significantly higher than New Zealand.

Across OECD countries, on average, eight percent of the students were at Level 5, the top level of proficiency in reading. More than 16 percent of the students in New Zealand performed at this level, the highest percentage among OECD countries. Australia, Canada and Korea also recorded a relatively high proportion of students at Level 5. However, there was also a relatively high proportion of New Zealand students at Level 1 (8%) or below (3%), indicating a wide distribution of scores in this country. The corresponding international figures at the lower levels of proficiency were 10 percent and four percent respectively.

The distribution of reading performance within countries

The distribution of student performance on the combined reading scale was much greater in some countries than in others. In New Zealand the gap between the 75th and 25th percentiles was 143 scale score points, slightly above the average of 135 points internationally. This indicates, on the basis of the PISA results, that a significant gap existed between the most and least reading literate students in New Zealand. This gap was also evident across OECD countries taken together. The smaller difference of 118 points observed in Canada suggests that high average reading performance can be achieved alongside relatively small disparity among students. These data are presented in Figure 4.

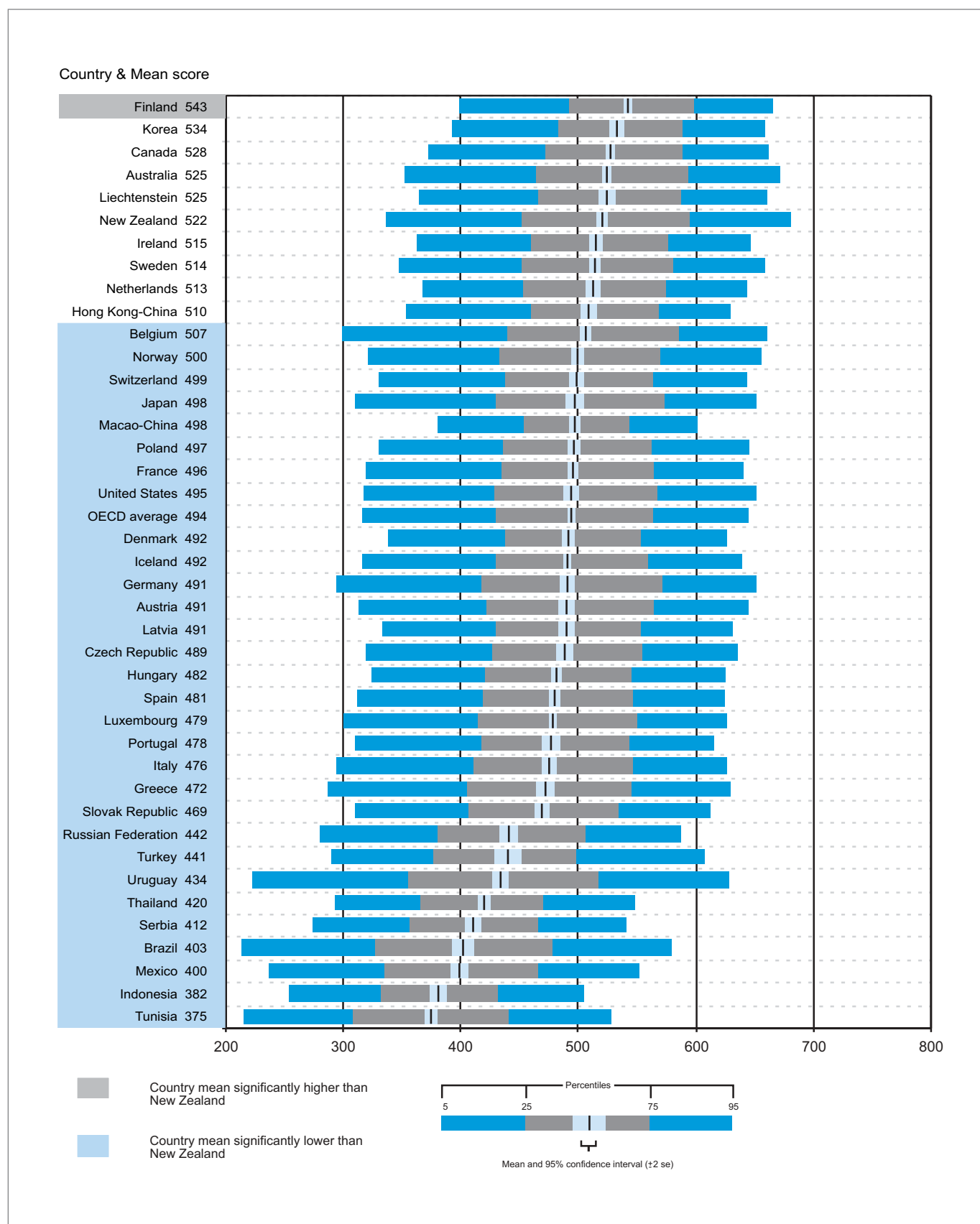
Gender differences in reading

The gender difference evident in reading achievement in PISA 2003 reflected that observed in PISA 2000. In the current cycle, females recorded a significantly higher average performance in reading in all countries except Liechtenstein. The average gap in reading was 34 score points in favour of girls. In New Zealand girls scored, on average, 28 points higher than boys.

Changes in reading achievement between PISA 2000 and PISA 2003

The high proportion of New Zealand students at the top proficiency level in reading, as well as the wide spread of reading scores among New Zealand students, were also observed in PISA 2000. There was not a significant difference in mean reading scores between the 2000 and 2003 assessments, on average, internationally or for New Zealand, Belgian, Norwegian and Swedish students.

Figure 4: Distribution of student performance on the reading literacy scale in PISA 2003



Source: Table 6.2 in OECD (2004a), with adaptations

Student achievement in science

Students in PISA are asked to demonstrate their ability to think scientifically by way of understanding key scientific concepts and by interpreting and acting on evidence, primarily in everyday situations, where science can be applied. The assessment examines five scientific processes: the recognition of scientific questions; the identification of evidence; the drawing of conclusions; the communication of these conclusions; and the demonstration of understanding of scientific concepts. Scientific literacy in PISA is defined as:

“the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.” (OECD, 2004a, Chapter 6)

How science is measured in PISA 2003

Science was a minor domain in the present cycle of PISA, as it was in 2000. Performance in science was, therefore, scored on a single scale and proficiency levels were not calculated. In the third PISA cycle in 2006 science will be the major domain, at which time proficiency levels will be defined.

The mean performance of countries in science

As shown in Figure 5, New Zealand was in the group of second highest performing countries in science, along with eight others, including Australia and Canada. The average scores for countries in this group were not significantly different from each other, but were significantly above the mean for all OECD countries combined. The highest achieving countries were Finland, Japan, Hong Kong-China and Korea.

The distribution of science performance within countries

The distribution of scores for science within countries can also be seen in Figure 5. As was observed with mathematics and reading, New Zealand had a relatively large gap (148 points) between the mean scores of students in the 75th and 25th percentiles of science achievement in PISA. This significant gap between the most and least scientifically literate students was similar to that recorded in Canada and the United States, as well as generally across all OECD countries.

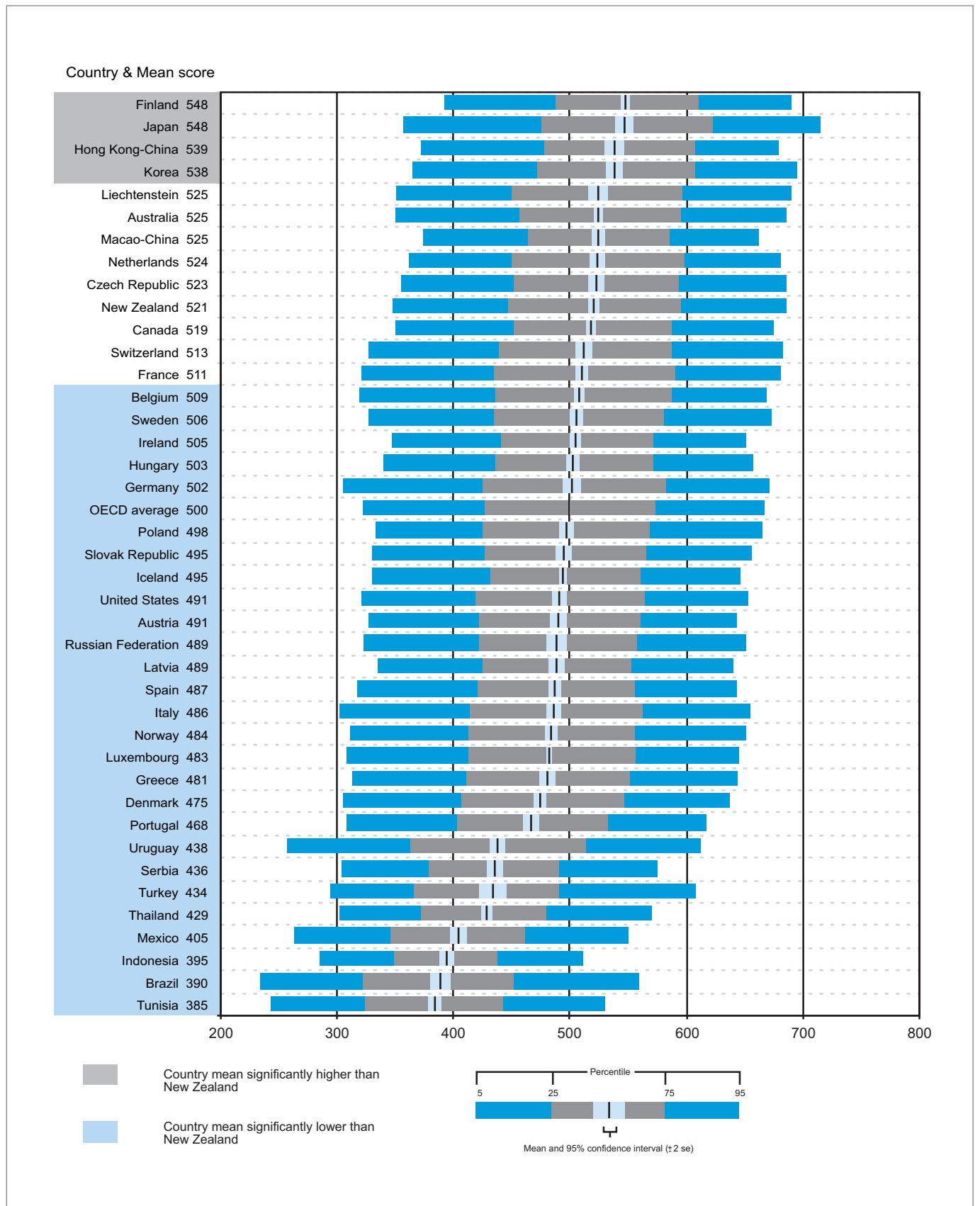
Gender differences in science

The smallest gender differences among all subject areas assessed in PISA 2003 was observed in science. Although small, the six-point difference in favour of boys was significant. Both female and male students in New Zealand achieved relatively high scores compared to the OECD mean, but the boys scored, on average, significantly above the girls (16 points).

Changes in science achievement between PISA 2000 and PISA 2003

When science achievement between PISA 2000 and PISA 2003 was compared across all countries, no clear pattern emerged. For example, countries such as Belgium and Finland recorded a significant increase in mean scores between the two testing periods, while countries like Canada and Korea showed a significant decline in performance. In New Zealand, as well as in Ireland and the United States, there was no significant difference in science achievement between PISA 2000 and 2003.

Figure 5: Distribution of student performance on the scientific literacy scale in PISA 2003



Source: Table 6.6 in OECD (2004a), with adaptations

Student Performance in Problem Solving⁹

The focus in this new area of investigation in PISA 2003 is on students' overall capability to solve problems in real-life situations using solutions that are not identified with a particular part of the school curriculum. Problem solving literacy in PISA is defined as:

“an individual’s ability to use cognitive processes to confront and resolve real, cross-disciplinary situations where the solution path is not immediately obvious and where the literacy domains or curricular areas that might be applicable are not within a single domain of mathematics, science or reading.” (OECD, 2004b, Chapter 2)

To solve the problems included in the PISA assessment, a student must combine many different cognitive processes. The selection of problems covered decision making, system analysis and design, and trouble shooting. Student performance was rated on a scale that is subdivided into four distinct, describable proficiency levels. On the basis of these four problem solving proficiency levels, students are described as: reflective, communicative problem solvers (Level 3); reasoning, decision-making problem solvers (Level 2); basic problem solvers (Level 1); and weak or emergent problem solvers (Below Level 1). The example of a problem solving item in Box 2 illustrates problems at proficiency Levels 1 and 2.

Box 2: The Cinema Outing problem

The *Cinema Outing* is a *decision making* problem, which presents students with a significant amount of information and a set of well-defined decisions to make based on the information. Students proficient at level 2 will typically be able to respond correctly to the first question, *Cinema 1*. Such students are capable of making decisions while considering a wide variety of boundary constraints and reasoning through what works and what does not work. Most of the decisions require the use of two or more pieces of the provided information. In addition, the student has to merge information constraints in the stated context, *e.g.*, information about individuals' weekly schedules, commitments, and movies they had already seen, as well as noting which movies are showing, the showing times and film lengths, and the film ratings. *Cinema 2* is a less demanding task. It requires students to make a decision when only temporal constraints have to be satisfied. Students can use the constraints on times when Fred, Stanley, and Isaac can see movies, match these against the showing times for “Children in the Net” in the table and determine the correct answer. A correct performance on *Cinema 2* corresponds to Level 1 on the PISA problem solving proficiency scale, as students only need to understand and check some information that is easily retrievable from the problem statement.

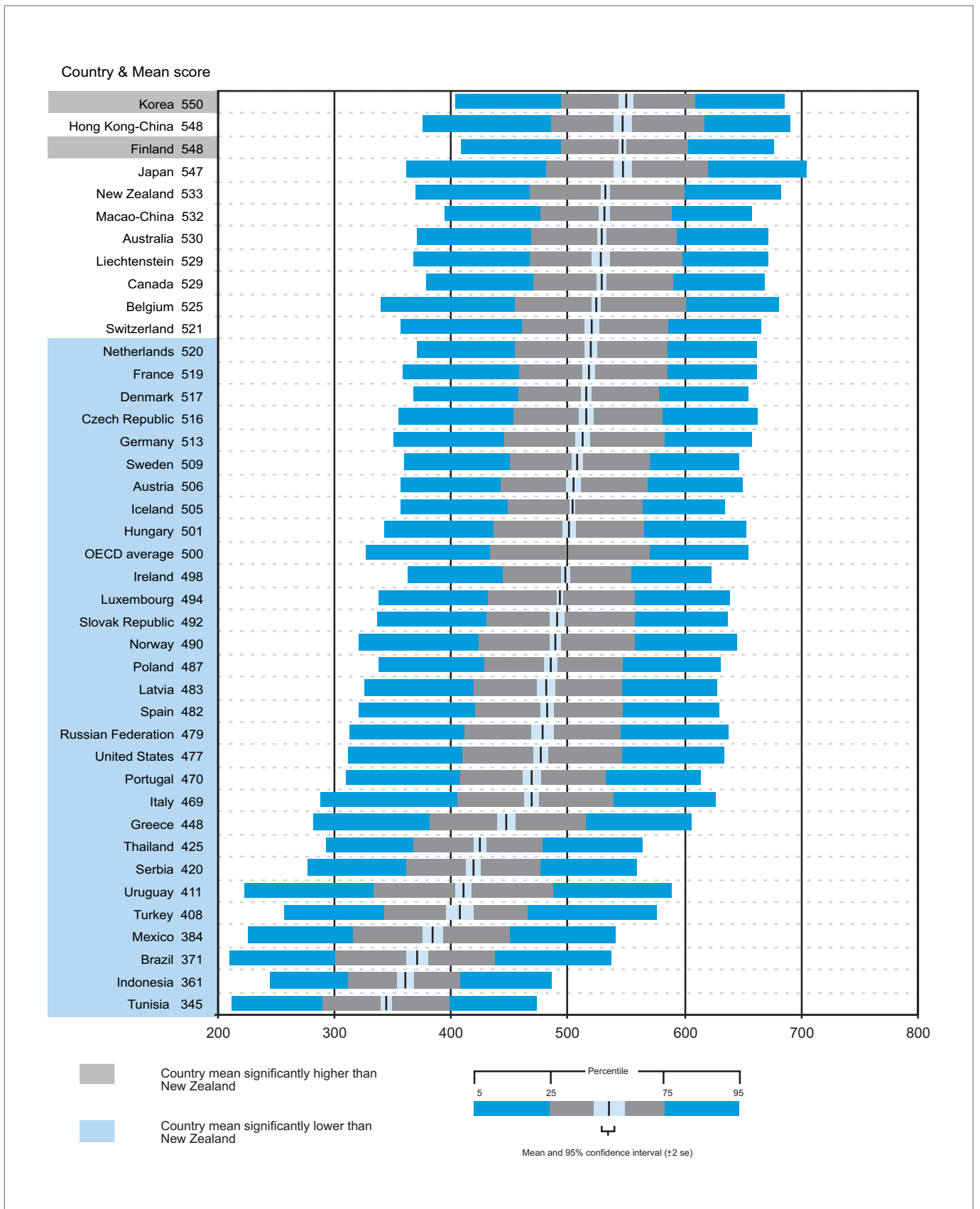
Source: OECD (2004b), Chapter 2

Student achievement in problem solving

Two countries, Korea and Finland, recorded mean problem solving scores that were significantly higher than those of all other countries. New Zealand was placed within a second group of eight countries, including Hong Kong-China, Japan, Australia and Canada, whose mean scores were not significantly different from each other. All these countries were among the 19 that scored significantly above the OECD average. These data are presented in Figure 6.

⁹ A full description of the conceptual framework underlying the PISA assessment of problem solving is provided in OECD, 2003.

Figure 6: Distribution of student performance on the problem solving scale in PISA 2003



Source: Table 2.2 in OECD (2004b), with adaptations

Student proficiency at each level in problem solving

In terms of the constructed levels of proficiency in problem solving, across all OECD countries, 18 percent of students in PISA achieved at or above Level 3. Twenty-eight percent of New Zealand participants were in this top level, a result in line with Canada (25%), Australia (26%), Belgium (28%), and Finland (30%). At the other extreme, one in 10 New Zealand students was unable to solve basic problems at Level 1. This was comparable to the proportion of Hong Kong-Chinese (8%), Canadian (8%), Australian (9%), Danish (10%), Dutch (11%) and Swiss students (11%) found to be performing below Level 1. Internationally there were 17 percent of OECD students in this category.

The distribution of problem solving performance within countries

The variation in student performance that exists in the mid range between groups of students at the 75th and 25th percentiles within countries is informative. For example, New Zealand students towards the top of the distribution performed at similar levels to their counterparts in Korea and Finland, the two top performing countries. However, the performance of students at the other end of the distribution in New Zealand was further below the top-performing New Zealanders than was the case for the corresponding students in Korea and Finland. In other words, there was a greater range of performance in New Zealand, a pattern also observed in Australia and Belgium.

Gender differences in problem solving

There were no clear gender differences in the mean problem solving scores internationally, or in New Zealand. Although across all participating countries boys were typically over-represented at the lowest and the highest proficiency levels, this pattern was not evident in New Zealand.

The Relationship between Problem Solving and Mathematics, Reading and Science

The key skill needed to solve problems is analytical reasoning, which is also an important requirement for mathematics tasks. The strong relationship between problem solving and mathematics was demonstrated in PISA 2003 by the high correlation of .89 between the two domains. The correlations between problem solving and reading and science were lower, at .82 and .80 respectively. In New Zealand, students typically performed better in problem solving than in mathematics. The difference was significant, as it was for countries such as Japan, Korea and Australia. According to the OECD, a relatively better performance in mathematics indicates that students have generic problem solving skills that the mathematics curriculum in these countries might use to better advantage (2004b, Chapter 3).

Student Learning: Strategies, Attitudes and Engagement¹⁰

In addition to measures of student performance in mathematics, reading, science and problem solving, PISA provides an opportunity to look at more general outcomes of learning that underlie the capacity to continue learning throughout life. These cognitive, affective and attitudinal outcomes are important for students, not only in the school environment but also for them as young adults once they have left school. As such, they are as important an outcome of a student's education as is academic achievement.

In order to assess these outcomes of learning, PISA 2003 asked students several questions covering each of the four broad elements of motivation, beliefs, emotional factors and learning strategies in the context of mathematics.¹¹

¹⁰ *The relationship between these student factors and mathematics achievement in PISA 2003 is discussed where appropriate.*

¹¹ *To allow comparison between countries a common scale was constructed for each of these outcomes. These scales were constructed so that the scores of two-thirds of the students taking part in PISA fall between the values of -1 and 1, with an average score of zero.*

Engagement with mathematics and with school

Interest and enjoyment in mathematics

Students were asked about their interest in mathematics as a subject as well as their enjoyment of learning mathematics. New Zealand students were generally positive about mathematics, as shown by their relatively high positive score on the index that summarises interest and enjoyment in this subject. Within any country, students with greater interest and enjoyment in mathematics tended to achieve better results than those expressing less interest and enjoyment. New Zealand results were consistent with this pattern. New Zealand students in the top quartile of interest and enjoyment in mathematics achieved, on average, 21 points more than those in the quartile with the lowest reported level of interest and enjoyment.

In all but four OECD countries, males expressed much stronger interest in mathematics than did females. This was the case in New Zealand as well. The magnitude of the gender difference in expressed interest and enjoyment in mathematics was not mirrored by performance on the PISA mathematics assessments where the difference between males and females was small.

Attitudes towards school

Typical students in OECD countries agreed that ‘school helped give them confidence to make decisions’ and that ‘school has taught them things that could be useful in a job’. Conversely, they disagreed that ‘school has done little to prepare them for adult life when they leave school’ or that ‘school has been a waste of time’. New Zealand students generally shared this positive attitude toward school. In almost all countries girls reported a significantly more positive attitude towards school than did boys. In New Zealand, however, this difference in favour of girls was small and non-significant.

Internationally, there was virtually no difference in mathematics performance between students in the top and bottom quartiles on the PISA measure of attitudes towards school. In New Zealand (43 points) and Australia (38 points) a difference roughly equivalent to half a proficiency level separated the two groups of students.

Students’ beliefs about themselves

PISA investigated three dimensions of students’ views about their own competence and learning characteristics. One dimension defines these beliefs in terms of students’ beliefs in their own abilities - self-concept; another is how well students think that they can handle tasks that are difficult, even given their own abilities - self-efficacy. A third dimension relates to emotional factors, such as feelings of helplessness and emotional stress when dealing with mathematics.

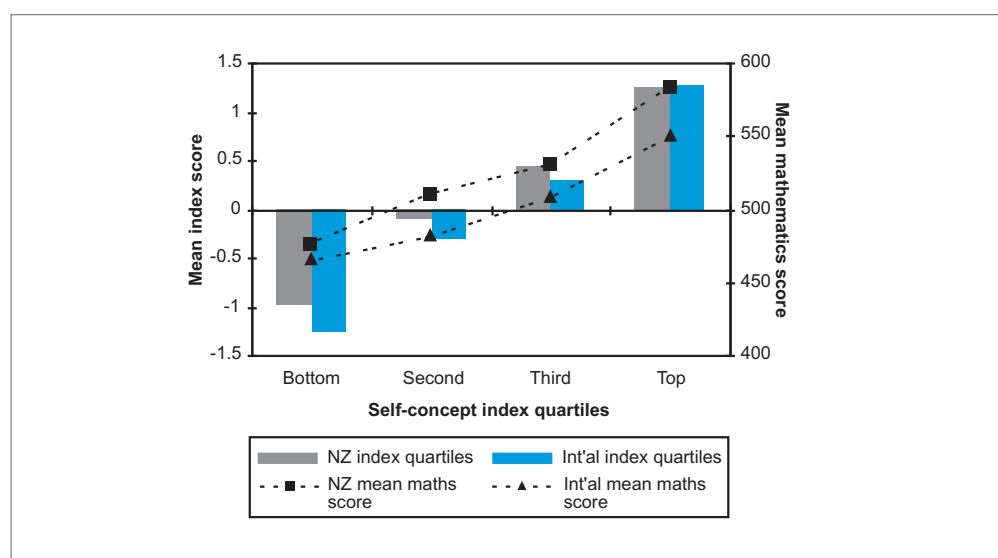


Students' self-concept in mathematics

Student self-concept is seen as both a driver of, and an outcome of, successful learning. On the index based on questions such as whether or not they are good at mathematics, New Zealand students were among those reporting the most confidence in their mathematical abilities. Canadian and American students were also confident learners of mathematics. In almost all countries, including New Zealand, males tended to report significantly higher levels of self-concept in mathematics than did their female counterparts.

Student self-confidence in mathematics was closely related to student performance on the PISA 2003 mathematics assessment. As seen in Figure 7, the difference in achievement between students in the top and bottom quarters of the index was 107 points in New Zealand, about one and a half proficiency levels. The gap observed in Canada (100 points), Australia (100 points) and the United States (93 points) was similar to that seen in New Zealand, although across all OECD countries it was slightly lower (83 points).

Figure 7: Mean index score and mean mathematics score at each quartile of the index of self-concept in mathematics



Source: Table 3.6 in OECD (2004a)

Students' self-efficacy in mathematics

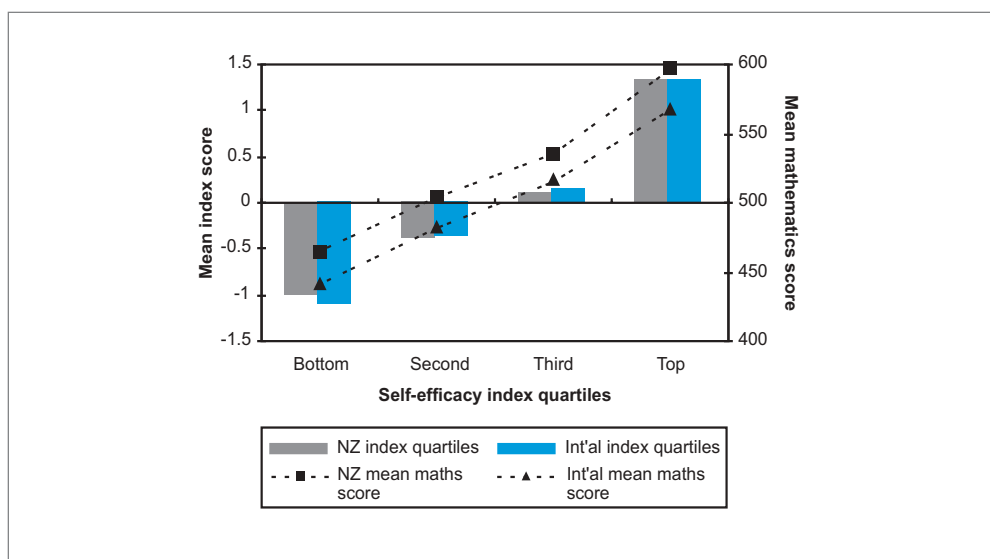
Self-efficacy goes beyond how good students think they are in subjects such as mathematics and is more concerned with the kind of confidence that is needed for them to take on learning tasks that they find challenging. Questions tapping self-efficacy asked students how confident they felt about doing several different calculations, for example understanding graphs presented in newspapers. Self-efficacy, like self-confidence, is an important outcome of education in its own right.

According to the PISA results, student self-efficacy in mathematics was even more closely related to mathematics performance than was self-confidence in mathematics. Indeed, self-efficacy was one of the strongest predictors of performance in PISA, both internationally and for individual countries. In New Zealand the difference in mathematics achievement between students in the top and bottom quartiles on the index of self-efficacy was 133 score points, approximately two proficiency levels (Figure

8). Australia (132), Canada (124), and the United States (129) recorded differentials of similar magnitude. Internationally the achievement difference between the two groups of students was 126 score points.

New Zealand students reported a degree of self-efficacy in mathematics that was typical of OECD students as a whole, but lower than that reported by Australian, Canadian or American students. Both internationally and in New Zealand, boys reported substantially higher self-efficacy in mathematics than did girls.

Figure 8: Mean index score and mean mathematics score at each quartile of the index of self-efficacy in mathematics



Source: Table 3.7 in OECD (2004a)

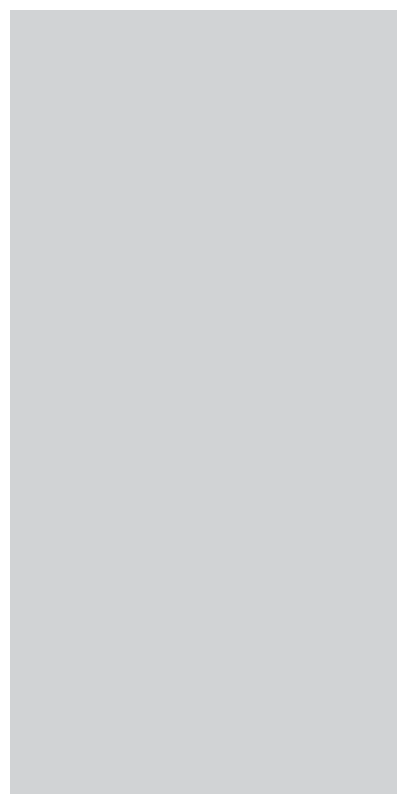
Learning strategies

Once students leave school they must manage most of their learning for themselves. Therefore, instilling in students a well-developed ability to manage their own learning should be a major goal of schooling. To measure the extent to which students are active learners, PISA collected data from students related to three learning strategies. These are: control strategies, e.g. those that involve planning, monitoring and regulation; memorisation strategies, e.g. learning key terms or repeated learning of material; and elaboration strategies, e.g. making connections to related areas or thinking about alternative solutions.

Controlling the learning process

Students were asked questions that tapped into strategies they have for controlling their own learning in mathematics, such as working out the most important aspects they need to learn, making themselves check to see if they remembered work already done, and trying to figure out which concept they still have not understood. New Zealand students, on average, were placed at about the OECD mean on this index, indicating that students in this country controlled their own learning to the same extent as students did typically in OECD countries. Girls were more likely to report using these control strategies than were boys, both internationally and in New Zealand.

Overall, the relationship between the reported use of control strategies and student performance was weak. However, the score point difference separating New Zealand students in the top and bottom quartiles of the index was 31, suggesting a moderate relationship between control strategies and mathematics achievement.



Memorisation and elaboration

While memorisation (e.g. learning facts or rehearsal of examples) is an important strategy for many tasks, elaboration (e.g. integrating new information into a prior knowledge base) is a more effective strategy to achieve understanding. Both these strategies were measured in PISA.

New Zealand students were among the more frequent users of both memorisation strategies and elaboration strategies. There was little difference between the ratings of males and females on the memorisation index, but New Zealand boys were more likely to report using elaboration strategies than were girls. This pattern was also observed, on average, in Australia and Canada as well as across all OECD countries.

Contextual Factors - Key Characteristics of Home Background and Schools¹²

The questionnaires completed by participating students and their school principals provided key information about the context within which the PISA students learn. These contextual factors can be grouped into two categories: those that relate to the students' home background and those that relate to the learning environment and organisation of schooling.

Students' home background

Both high and low achievers in PISA come from a wide variety of home, socio-economic and cultural backgrounds. Although poor performance in school does not automatically follow from a disadvantaged home background, it remains one of the most powerful factors influencing performance.

Parents' occupational status

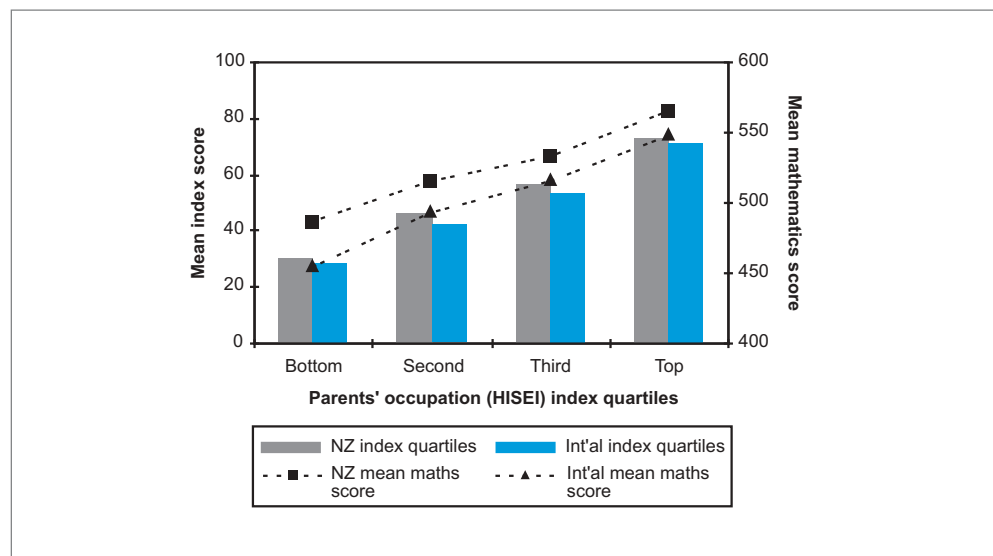
The results from PISA 2003 demonstrate that parental occupation status has a strong association with student performance. The average performance gap across the OECD countries in mathematics between students in the top quarter of PISA's socio-economic index of occupational status (HISEI)¹³, whose parents have occupations like medicine, university teaching and law, and those in the bottom quarter, whose parents have occupations such as small-scale farming, truck driving and servicing in restaurants, amounts to an average of 93 score points. This equates to one and a half proficiency levels in mathematics.

However, this gap in mathematics performance differed significantly among countries. In New Zealand the gap was 79 score points, which was in line with that observed in Australia (77 points) and the United States (82 points) but greater than in countries such as Canada (63 points) and Hong Kong-China (43 points). Despite this large score differential, New Zealand students in the bottom quartile achieved a mean mathematics score of 485 points, which was 30 points above the corresponding international mean score for this group. New Zealand's results, shown in Figure 9, demonstrate the fact that, although within a country students whose parents have a lower occupational status generally achieved lower mean scores than their colleagues whose parents have a higher occupational status, they do not necessarily perform poorly when compared with students in other countries.

¹² *The relationship between these contextual factors and mathematics achievement in PISA 2003 is discussed where appropriate.*

¹³ *Information on parents' occupation was used to generate a socio-economic index of parental occupational status (HISEI), which captures the attributes of occupations that convert parents' education into income.*

Figure 9: Percentage of students and mean mathematics score at each quartile of the socio-economic index of occupational status (HISEI)



Source: Table 4.2a in OECD (2004a)

Parental education

The mother's level of education, rather than the father's, is commonly identified as a stronger predictor of student performance. The relationship between mothers' level of education and students' performance on the PISA 2003 mathematics assessments was positive and significant in all participating countries. In most OECD countries, students whose mothers have completed upper secondary education typically achieved higher levels of performance in mathematics than did students whose mothers have completed primary or lower secondary education only. The average difference was 64 score points, equivalent to one proficiency level. Those with tertiary educated mothers achieved even higher levels of performance, although the difference between upper secondary and tertiary was smaller (22 points).

In New Zealand also, the largest gap, on average, in mathematics achievement (47 points) was evident between students with primary/lower secondary educated mothers and those whose mothers have an upper secondary education. A mother with tertiary level education added, on average, 13 score points. The pattern observed in the United States was similar to that shown in New Zealand. The data for New Zealand are presented in Figure 10.

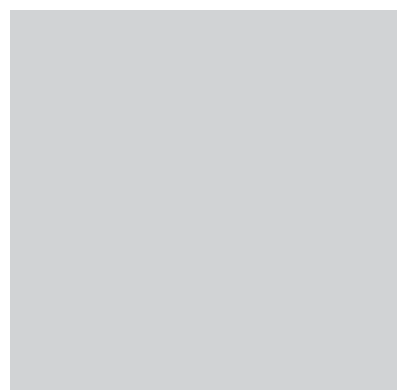
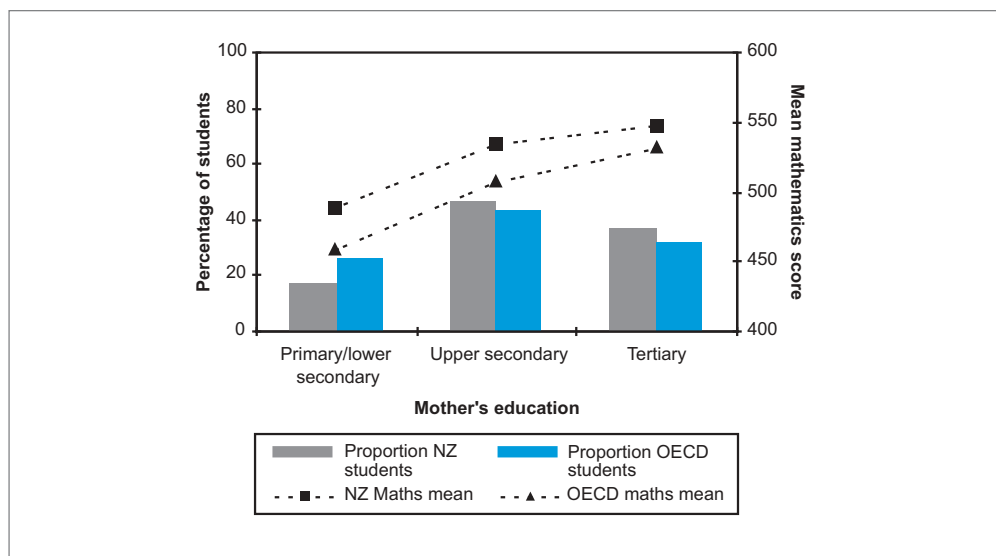


Figure 10: Percentage of students and mean mathematics score by highest level of mothers' education



Source: Table 4.2b in OECD (2004a)

Place of birth

Although information on students' ethnic identity was not part of the international PISA 2003 study, these data were collected in New Zealand as a national option and will be covered in the extended national report to be published in 2005. Nevertheless, all students in PISA were asked about their place of birth and that of their parents. To enable comparisons of place of birth across countries, the OECD adopted a specific terminology to categorise where students and, in some cases, their parents were born. Note that the descriptions of *non-native* and *first-generation* students do not take account of where students or their parents were born. In this terminology, students are described as:

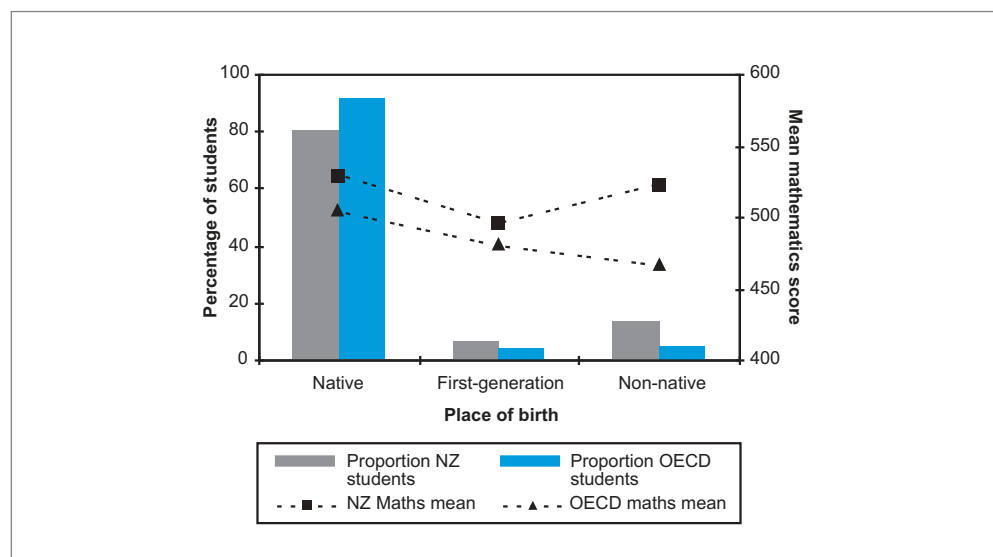
- *native* if they, and at least one of their parents, were born in the country in which they are currently living. The term native includes both indigenous students and those who are second-generation or more.
- *non-native* if they and their parents were born outside the country in which they are currently living.
- *first-generation* if they were born in the country in which they now live but their parents were born outside that country.

There was a relatively high proportion of *non-native* students among PISA participants in New Zealand (13%), compared with the OECD average (5%). Only Hong Kong-China (20%), Macao-China (18%) and Luxembourg (17%) reported higher proportions of *non-native* students. In Australia, Canada and Switzerland *non-native* students accounted for 11 percent of the PISA samples, a proportion in line with that of New Zealand. In contrast, New Zealand had relatively fewer students classified as *first-generation* (7%) than did Australia (12%). Hong Kong-China (23%), Macao-China (58%) and Luxembourg (16%) were the countries with the highest proportions of *first-generation* students as well. Internationally, the proportion of *first-generation* students (4%) was about the same as *non-native* students (5%).

There were 14 OECD countries, including New Zealand, in which *first-generation* students represented at least three percent of the students assessed in PISA 2003. A comparison of the mathematics performance of *first-generation* students with that of *native* students in these countries revealed statistically significant differences in mathematics in favour of *native* students in all countries except Australia and Canada where the difference was not significant. On average, across these countries, this difference was 24 score points. *Non-native* students tended to score a further 15 points less.

As seen in Figure 11, the picture in New Zealand differs somewhat from that observed internationally. Here, as in the OECD, *native* students recorded the highest mean score in mathematics. In contrast to the OECD, however, the group recording the lowest mean score among the New Zealand sample was the one defined as *first-generation* students. The difference of 32 points in favour of *native* students compared with *first-generation* was statistically significant. *Non-native* New Zealand students achieved, on average, a negligible five score points below *native* students.

Figure 11: Percentage of students and mean mathematics score by place of birth of student and parents



Source: Table 4.2f in OECD (2004a)

Home Language

The language that students usually speak at home in relation to the PISA assessments is another facet of the home environment that is of interest. In PISA, *majority-language* students are defined as those who speak the language of the test or another national language or dialect at home most of the time, while *minority-language* students are those who routinely converse with their parents and siblings in another language.

The proportion of *minority-language* students in New Zealand's PISA sample (9%) was greater than the proportion across all OECD countries (5%), but on a par with Australia (9%), Canada (11%), and the United States (9%). Internationally, *minority-language* students achieved a mathematics mean score 38 points below their *majority-language* counterparts. This difference was statistically significant. In New Zealand the differential was smaller (16 points), but still significant. Nevertheless, as evident in Figure 12, the New Zealand *minority-language* students still performed well above the international mean score.

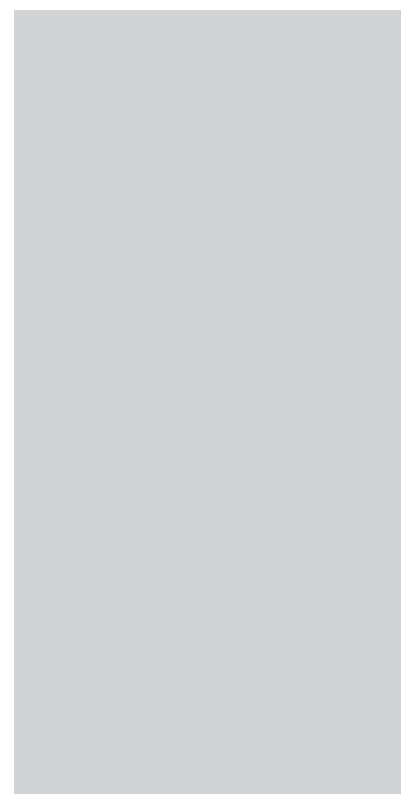
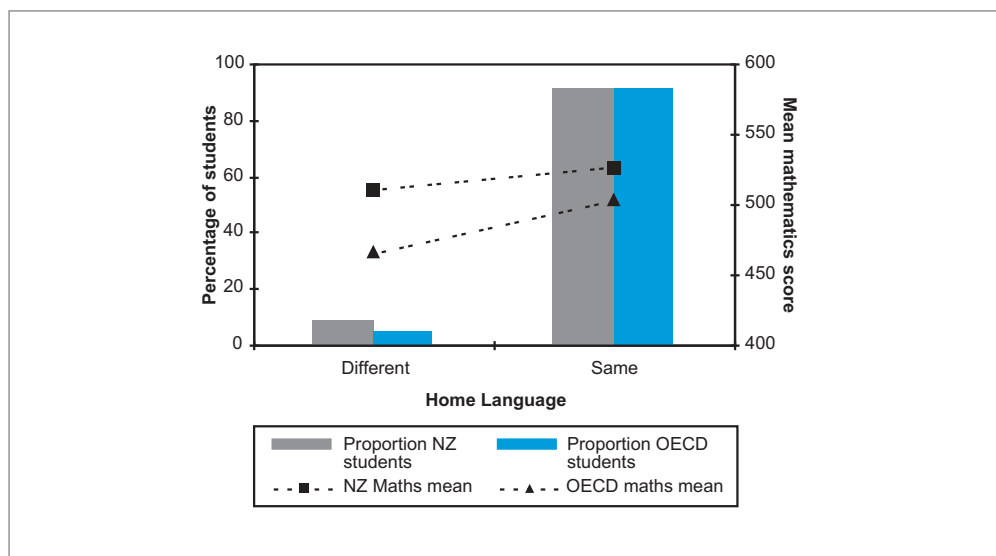


Figure 12: Percentage of students and mean mathematics score by language spoken at home



Source: Table 4.2g in OECD (2004a)

The learning environment and the organisation of schooling

Results from the first cycle of PISA in 2000 identified aspects of the school environment that were associated with better student performance on the PISA tasks. These included high expectations of students, a strong disciplinary climate, and good teacher-student relations. The current cycle of PISA further examined a number of these school-level characteristics. Note that no data were obtained from teachers. Thus inferences on teaching and learning can be made only from the perspective of students and school principals. Note also that information from principals has been adjusted (weighted) so that it reflects the number of 15-year-olds enrolled in each school.

School and classroom climate

Teacher support

In order to examine the extent to which students receive individual support from teachers they were asked to indicate the frequency with which teachers in their mathematics lessons show an interest in every student's learning, give students extra help when they need it, help students with their learning, continue to teach until students understand, and give students an opportunity to express their opinions.

It was clear from their responses to these questions that students in New Zealand considered their teachers to be supportive. In fact, New Zealand students, along with their counterparts in Australia, Canada, Denmark, Iceland, Portugal and Sweden, expressed the most positive perceptions of their teachers' support for individual learning. The relationship between supportive teachers and student outcomes in mathematics was mixed and generally weak across the OECD countries.

Student-related factors affecting the learning climate

To examine factors affecting the school climate for learning, PISA drew on information provided by both students and their school principals. Principals were asked to indicate the extent to which learning was hindered by such things as student absenteeism, students' use of alcohol or drugs, and disruption of classes by students. They were also asked to assess student morale, with questions such as whether students enjoy being in school, work with enthusiasm, take pride in their school, value academic achievement, and are cooperative and respectful. Students, for their part, were asked how frequently certain disruptive situations, e.g. noise and disorder, occurred in their mathematics classes. Although students and principals were asked to respond to different questions, there was a high level of agreement between their stated perceptions, both internationally and in New Zealand.

Both principals and students in New Zealand held generally negative perceptions of the disciplinary climate in their schools/mathematics class. In other words, they felt that the learning climate and discipline were worse in New Zealand than the average expressed across the OECD. Principals in the United States and Canada also held relatively negative views, as did students in Finland and Norway. In all OECD countries about half of principals (49%) identified student absenteeism as the most frequent obstacle to learning. This was also the case in New Zealand where almost two-thirds (63%) identified absenteeism as an impediment to learning. From the students' perspective, noise and disorder was the most frequently reported disciplinary problem in their mathematics classes. Thirty-six percent of students internationally, and 47 percent of New Zealand students, reported the occurrence of noise and disorder in every/most lessons.

Overall, the pattern of responses from students and school principals in this cycle was reasonably consistent with those observed in PISA 2000, although there were some exceptions. For example, in New Zealand and Denmark the percentage of 15-year-olds enrolled in schools whose principals reported that learning was hindered by students disrupting classes increased between 10 and 20 percentage points between the two cycles of the study.

As also observed in PISA 2000, there was a positive relationship between the learning climate, both as perceived by principals and by students, and student performance on the PISA tasks. This was evident across all OECD countries as well as in New Zealand. Students who reported fewer disruptive situations in class tended to achieve higher scores than students who reported more frequent occurrences of disruption. Similarly, students who attended schools where the principals reported fewer student-related factors hindering learning achieved higher scores than students in schools where principals reported more frequent student-related problems. The differences were of similar magnitude, on average, in New Zealand and internationally. On the students' index the performance gap was 54 points in New Zealand and 50 points across all countries, while on the principals' index the corresponding figures were 41 and 44. These data are presented in Figure 13.

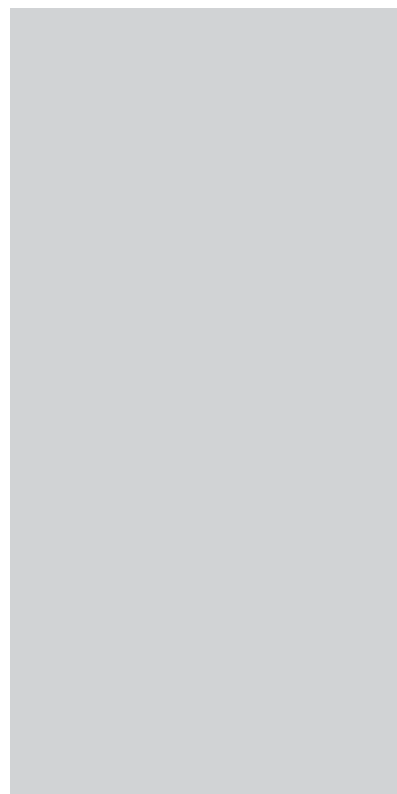
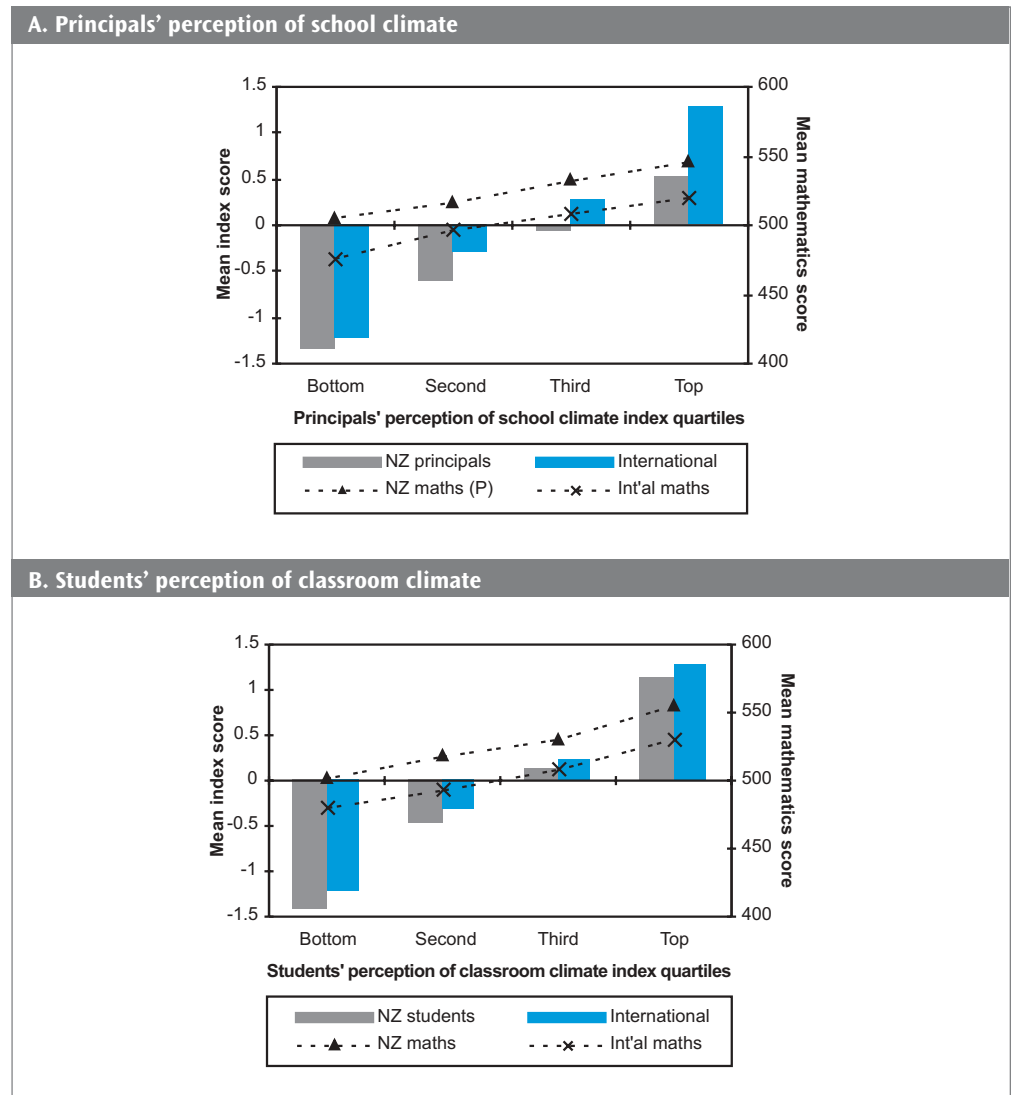


Figure 13: Mean index score and mean mathematics score at each quartile of the indices of principals' and students' perceptions of student-related factors affecting school/classroom climate



Source: Tables 5.2a and 5.3a in OECD (2004a)

Teacher-related factors affecting the learning climate

Principals' perceptions of teacher-related factors that could affect the learning climate in their schools were also sought. Specifically, principals were asked to indicate the extent to which they perceived learning in their schools to be hindered by such factors as the low expectations of teachers, poor student-teacher relations, absenteeism among teachers, staff resistance to change, teachers not meeting individual students' needs, and students not being encouraged to achieve their full potential.

On average across OECD countries, school principals gave a fairly positive picture regarding teacher-related factors and student learning. But in some countries, such as New Zealand, Australia, Ireland, and Japan, school principals were more inclined to perceive problems with regard to teacher-related factors affecting the learning climate than were principals generally across the OECD countries.

Typically the relationship between school principals' perceptions of teacher-related factors that might affect school climate and mathematics performance tended to be positive but weak internationally. In New Zealand, students attending schools where principals considered that their teachers demonstrated desirable professional traits to

a greater extent achieved higher scores than did students in schools where this was reported to occur to a lesser extent. The difference in achievement for New Zealand students between the top and bottom quartiles on this index was 41 mathematics scale points, more than half a proficiency level.

Resources invested in education

The quality of schools' physical infrastructure and educational resources

Principals responded to a series of questions about the perceived extent to which a lack of material and educational resources hindered learning among 15-year-old students in their schools. From this information two indices were developed: one for the perceived quality of the school's physical infrastructure and the other for the perceived quality of the school's educational resources.

Relative to principals across the OECD countries, New Zealand principals were generally positive about both aspects of their schools and felt that there was little impact on students' learning for either category of resources. The relationship with student performance was weak for both indices across the OECD countries, although it tended to be slightly stronger for the quality of educational resources than with regard to the physical infrastructure of schools. The association with achievement in New Zealand reflected that observed internationally.

Finally

This summary has merely touched on some of the key findings, particularly as they relate to the contextual data, generated by PISA 2003. It is recommended that the findings presented here are not viewed in isolation, and that readers refer to the international publications for more detail.

The PISA study provides a wealth of information about 15-year-old students in New Zealand and further analysis of these data will add to this. But it is only one source of such information. Results from this study should be considered alongside all the other information available on young adults in determining the needs of students, the education system and society as a whole.

Further information

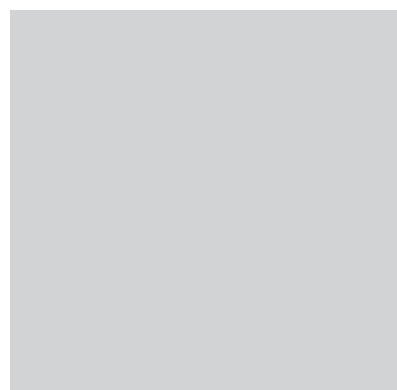
More detailed information about the international results, including the full international report and supporting data, can be found at the international PISA web-site: www.pisa.oecd.org

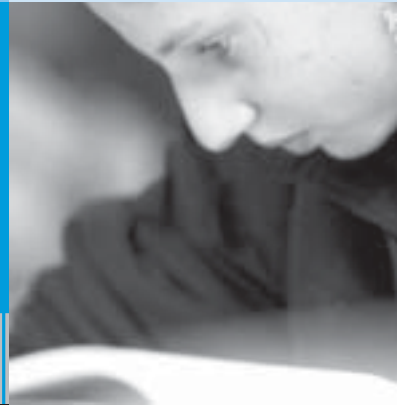
The full New Zealand national report for PISA 2003 will be published in 2005, and copies will be distributed to schools when they are available. This summary report and further reports and information about PISA in New Zealand are available from the Ministry of Education web-site at: www.minedu.govt.nz/goto/pisa.

NOTES: Participating countries:

New Zealand was one of 41 countries that took part in PISA 2003, 30 of which are members of the OECD. These countries were:

Australia	Indonesia	Portugal	Austria
Ireland	Russian Federation	Belgium	Italy
Serbia & Montenegro (Ser.)	Brazil	Japan	Slovak Republic
Canada	Korea	Spain	Czech Republic
Latvia	Sweden	Denmark	Liechtenstein
Switzerland	Finland	Luxembourg	Thailand
France	Macao - China	Tunisia	Germany
Mexico	Turkey	Greece	Netherlands
United Kingdom	Hong Kong - China	New Zealand	United States
Hungary	Norway	Uruguay	Iceland
Poland			





Administration of PISA 2003

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

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

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

Sources for this summary

OECD (2003). *The PISA 2003 Assessment Framework: Mathematics, Reading, Science and Problem Solving Knowledge and Skills*. Paris: OECD Publications.

OECD (2004a). *Learning for Tomorrow's World - First Results from PISA 2003*. Paris: OECD Publications.

OECD (2004b). *Problem Solving for Tomorrow's World - First Measures of Cross-Curricular Skills from PISA 2003*. Paris: OECD Publications.

OECD (2004c). *PISA 2003 Technical Report*. Paris: OECD Publications.

Acknowledgements

We are indebted to the many students, teachers and principals who participated in this study. Their efforts and assistance have provided our country with a valuable resource.

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New Zealand

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