Student Learning Approaches

for Tomorrow's World

RESULTS OF NEW ZEALAND
15-YEAR-OLDS IN THE 2003 PISA SURVEY

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

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Graphics presented in this report are schematic and are not necessarily to precise scale.

Acknowledgements

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We also wish to acknowledge the assistance from our international colleagues from the Australian Council for Educational Research (ACER) and the Statistics and Indicators Division of the Organisation for Economic Co-operation and Development (OECD) for the work done in preparing the international report on which this summary report is based.

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Introduction and note to readers

This report presents the New Zealand results from the PISA 2003 survey on various characteristics of 15-year-old students as learners. As well as assessing students' knowledge and skills in mathematics, science, problem solving and reading, students were given a questionnaire which included questions on student background, engagement, motivation, self-belief, and learning strategies. Since the main focus of the 2003 assessment is mathematics, this report primarily focuses on student approaches to learning alongside their performance in mathematics.

Important note on interpretation

The approaches to learning indicators are all based on self-reporting through the student questionnaire. They do not, therefore, measure directly what students do when they learn; they measure their own perceptions of what they are like as learners.

The report is based around ten indicators constructed by the OECD. Each indicator comprises an index of scores for each student based on their answers to a range of questions. The indicators and the categories in which they are grouped are:

Category	**Indicators**			
Engagement and motivation	Attitude towards school	Interest and enjoyment of mathematics	Instrumental motivation	Sense of belonging at school
Self-belief and emotion	Self-concept in mathematics	Self-efficacy in mathematics	Anxiety in mathematics	
Learning strategies	Use of control strategies	Use of elaboration strategies	Use of memorisation strategies	

Evidence from earlier research played an important part in the construction of these indicators. PISA identified student characteristics that make positive approaches to learning more likely, and students were asked several questions about each characteristic. However readers should bear in mind that constructs such as motivation and enjoyment of mathematics and the use of particular learning strategies are based on self-reporting by students rather than direct evidence on the extent to which such strategies are used.

Overview

What is PISA?

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

What does PISA tell us about student approaches to learning?

PISA tells us about the extent to which students feel engaged in learning, display self-belief in learning particular subjects, and adopt various learning strategies – all according to the students' own responses to the PISA questionnaire.

Do New Zealand students display stronger approaches to learning than students in other countries?

In general, New Zealand students do not differ markedly from the international average in their approaches to learning. However, comparisons between countries need to be viewed with caution because of cultural differences in the ways such questions are answered. Analysis of PISA 2000 data showed that for some self-reported characteristics, cross-country comparisons are difficult to make. This report focuses on differences among sub-groups within New Zealand and on the relationship between mathematics performance and approaches to learning, which may provide more useful information.

Are some groups in New Zealand better equipped to learn than others?

In New Zealand, the majority of students from all ethnic groups, both boys and girls, acknowledge the importance of school and of learning mathematics. However, boys and Pasifika and Mäori students express greater interest in and enjoyment of mathematics. On the other hand, Pasifika and Mäori students are more likely to report low belief in their ability to tackle difficult mathematical problems and anxiety in this regard. Asian students and boys generally report stronger self-belief. There are fewer differences across groups when it comes to reported learning strategies, but Asian students report a strong inclination to control their own learning, whereas Pasifika students report heavy use of memorisation strategies.

Are certain approaches to learning linked to better results in mathematics?

A survey of this kind cannot demonstrate causal links between how students learn and their performance in mathematics tasks. However, it can highlight a number of areas where there are associations between positive learning characteristics and higher achievement. The strongest associations, unsurprisingly, are between the reported self-belief of learners and higher performance; these two attributes are likely to be mutually reinforcing. Päkehä/European and Asian students, who express a strong interest in the subject, are more likely to do well in mathematics. However, this is not the case among Pasifika or Mäori students, for whom the external motivation of recognising the importance of mathematics to their futures is a better predictor of doing relatively well in mathematics. In the case of learning strategies, links with performance are not generally clear-cut, but students whose responses suggest that they do not control their own learning appear to be at particular risk of performing less well in mathematics.

Background: the PISA survey

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

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

- Well over a quarter of a million students in 41 countries took part. All 30 OECD member countries participated, as well as 'partner countries' in Asia, Africa, Eastern Europe, and Latin America.
- Each student took a two-hour written test in their school.
- Students were assessed in mathematics, reading, science, and problem solving. Mathematics was the main focus in 2003, while reading was the main focus in the first survey in 2000. The next PISA assessment in 2006 will focus on student performance in science.
- The assessment used a continuous scale to measure students' capacity to apply knowledge and skills in key subject areas and to analyse, reason, and communicate effectively as they posed, solved, and interpreted problems in a variety of situations.

The key features of the PISA approach are:

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

Overall, New Zealand students perform well in the PISA assessment. They are consistently in the top third among OECD countries across all the domains surveyed. In mathematics, New Zealand students are estimated to be ranked between seventh and tenth out of the 29 OECD countries who reported valid results.

What PISA tells us about students as learners

What are students like as learners at age 15? Students who say they are well motivated, believe in their own abilities, and regularly adopt effective learning strategies tend to show stronger performance in PISA. Positive approaches to learning are outcomes of education in themselves, as well as contributing to students' acquisition of knowledge and skills. Students who have become effective learners by the time they leave school, particularly those who have learned to regulate their learning effectively, are more likely to carry learning skills into later life.[1]

In PISA, evidence of student approaches to learning is based on student self-reports. In a questionnaire, students were asked about the strength of their agreement or disagreement with certain statements or the frequency with which they undertook certain learning practices.

In general, PISA self-reports have been shown to be problematic in comparing student approaches to learning reliably across countries but they are useful in looking at patterns within countries. In general, within each country taking part in PISA, students who say that they are more motivated, believe in their abilities and control their learning also tend to perform at a higher level in both reading and mathematics.

On the other hand, the validity of cross-national comparisons is limited by the fact that in some countries students perform extremely well in mathematics they express below-average self-belief and motivation, whereas in other poor-performing countries, the reverse is true. This finding suggests that student responses may have different meanings from one country to another.

This report focuses on the results within New Zealand, although in each category there is reference to how the results compare with other countries. New Zealand is close to the international average on most of the learning indicators. This report explores gender and ethnic group differences in self-reported learning characteristics and examines the extent to which various approaches to learning within New Zealand are associated with stronger student performance. It should be noted that making causal links between attitudes to learning approaches and achievement may be problematic, as the relationship may be one of mutual reinforcement.

Three areas of student approaches to learning

This report looks at ten specific features of student approaches to learning mathematics in New Zealand. They are grouped into three categories: engagement/motivation; self-belief/emotional factors; and learning strategies. Before discussing these in detail, it is useful to summarise which indicators are being considered, how they relate to each other, and the overall picture for New Zealand students.

Engagement and motivation: how well do New Zealand students engage in learning?

Students' engagement at school, their attitudes towards their studies and their motivation are often considered to be the driving forces behind learning. There are four characteristics which make up this category:

- *Interest in and enjoyment of mathematics* (or intrinsic motivation), which may encourage students to study mathematics and enjoy learning for its own sake.

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[1] OECD (2003) Learners for life - Student Approaches to Learning. OECD, Paris, pp.9–10.

- *Instrumental motivation*, which shows how important students think learning mathematics will be for their futures. This is an external form of motivation; being keen to study the subject for the benefits it will bring.
- *Attitudes towards school,* which relates to general engagement with school. Students are asked about their perceptions of how well school has prepared them for adult life.
- *Sense of belonging at school* shows whether students feel comfortable in the school environment, especially in a social context.

Like students in other countries, New Zealand students are generally positive about being at school and recognise the benefits of education, but they have mixed views about studying mathematics. Most students are highly aware of the importance of studying mathematics, but only a minority express a love for the subject. New Zealand students who report greater interest in mathematics tend to show stronger mathematics performance, but so do those with a higher 'instrumental' motivation, which indicates that there is more than one way to get students engaged in learning. Indeed, it appears that for Mäori and Pasifika students, interest and enjoyment makes little difference, but being motivated to learn through an awareness of the importance of mathematics in getting a job or to future studies is associated with stronger mathematical literacy.

Self-related beliefs: how do students feel about themselves as learners of mathematics?

Students taking part in PISA were asked for their beliefs about their own academic abilities, their ability to handle tasks and overcome difficulties and emotional factors when learning mathematics. It would seem likely that those who are better at doing mathematical tasks tend to believe in their own abilities, yet these self-beliefs are not just a mirror of performance; they can also feed improvements in mathematical proficiency. Self-regulated learning depends on the interaction between what students know and can do on one hand and their motivations on the other.[2]

Three indicators are used to measure self-belief in mathematics. *Self-concept in mathematics* considers students' views of their overall ability to succeed at mathematics. *Mathematical self-efficacy* looks more specifically at how well students think they can cope with challenging mathematical problems. Students who show self-efficacy believe that they can succeed when tackling problems that they may find difficult, which influences their motivation to tackle such problems. The emotion-based indicator *Mathematics anxiety* describes the extent to which students say they worry about their ability to carry out mathematical tasks.

Overall, New Zealand students are average or slightly above average in their self-belief about doing mathematics. Both boys and Asian students report higher-than-average self-belief. Girls are less likely than boys to report very high levels of belief in their ability to tackle individual problems (self-efficacy) or to be free of anxieties about doing so. However, they are no more likely to have high mathematical anxiety or extremely low self-efficacy, even though more girls than boys have an extremely low opinion of their overall mathematical abilities. This seems to suggest that, despite being more likely than boys to have a low general belief in their abilities (self-concept), girls are not significantly more likely to have a 'mental block' about doing mathematics or to become stressed when tackling mathematics problems.

In contrast, Mäori and Pasifika students are more likely to express high anxiety about their ability to do mathematics than Päkehä/European students. Self-belief in general is more of an issue for lower-achieving Mäori and Pasifika students; high mathematics achievers tend to have high levels of self-belief. However, the

2 OECD (2003) Learners for life - Student Approaches to Learning. OECD, Paris, p.11.

evidence suggests that a focus on building the self-belief of Mäori and Pasifika students in their mathematics ability would be appropriate.

Learning strategies: what learning strategies do New Zealand students employ?

Students do not passively receive and process information. They are active participants in the learning process, and so the strategies that they adopt in learning can be important for learning outcomes. Ultimately, they need to become managers of their own learning. For this reason, 'metacognitive' learning styles, in which students are aware of their own learning, are particularly important.

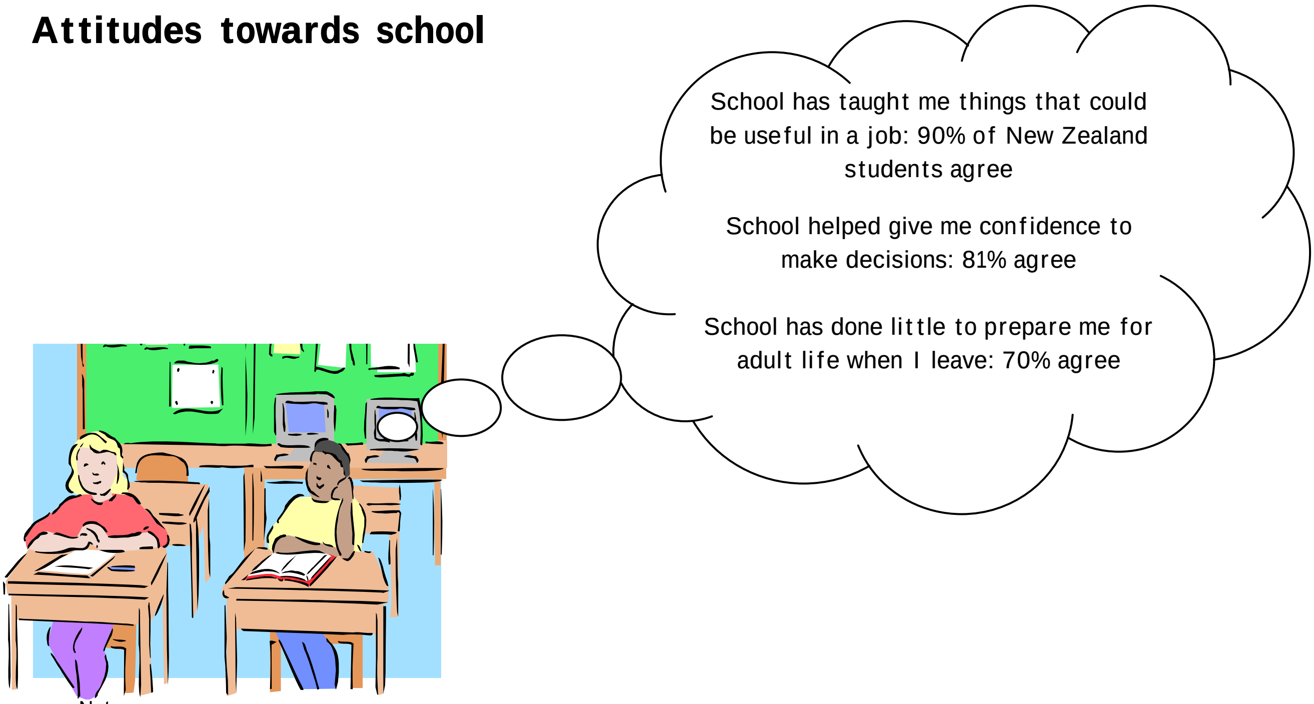
PISA asked students questions about three aspects of their learning.

- The use of *control strategies* to think about what they need to learn and find ways of ensuring that they meet learning goals.
- The use of *elaboration strategies*, which involve relating new learning to existing knowledge and applying it to other contexts.
- The extent to which students adopt strategies to *memorise* the things that they are taught.

New Zealand students are about average in the extent to which they report adopting these three strategies but different ethnic groups in New Zealand report using them to varying degrees. Pasifika students report particularly high use of memorisation and elaboration, and Asian students report high use of control strategies. These self-reports need, however, to be interpreted with some caution – for example, Pasifika students report using all three strategies relatively often, which could be partly explained by a greater-than-average tendency to answer *often* or *always* to questions of this type when compared with other students with similar frequency of actual use.

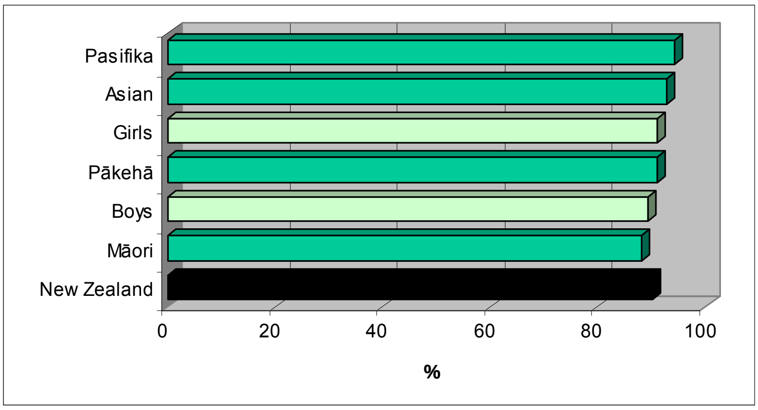
However, even if cultural response bias does exist, it is worth noting where higher use of these learning strategies seems to be associated with stronger performance. Two such cases stand out in the evidence presented below. Firstly, New Zealand students who report that they have less control over their learning do less well in mathematics on average. This suggests that thinking about what they need to know and managing their own learning to some degree is essential for students to succeed. A second area of note is that Pasifika students seem to perform basic mathematics tasks by using memorisation strategies. Used alone, these strategies cannot enable students to perform high-level tasks, but they can have an important function for groups whose members often struggle to master the basics of mathematics.

Attitudes towards school



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into two categories

Figure 1a: Percentage of New Zealand students with overall positive attitudes to school



Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Attitudes towards school: what the results show

Most 15-year-old New Zealand students recognise that school has brought them benefits and what they have learnt at school will be relevant to their futures. Nine out of ten students gave more positive than negative answers when asked about whether school had been worthwhile.

However, a minority of students also expressed negative feelings about at least some aspects of their schooling. Around 8% thought that school had been a complete waste of time, and 30% said that it had done little to prepare them for adult life. This picture is similar to that in other countries; New Zealand students are equally as likely to express negative attitudes about school as the OECD average.

There is little variation in general attitudes to school by gender or ethnic group. Although these groups differ in terms of their motivation, self-belief, and learning strategies, they all show a strong recognition of the basic benefits of schooling. This demonstrates a solid foundation on which to improve approaches to learning; few students at age 15 are completely negative about their education.

Figure 1b: Relationship between mathematics performance and attitude towards school[3]

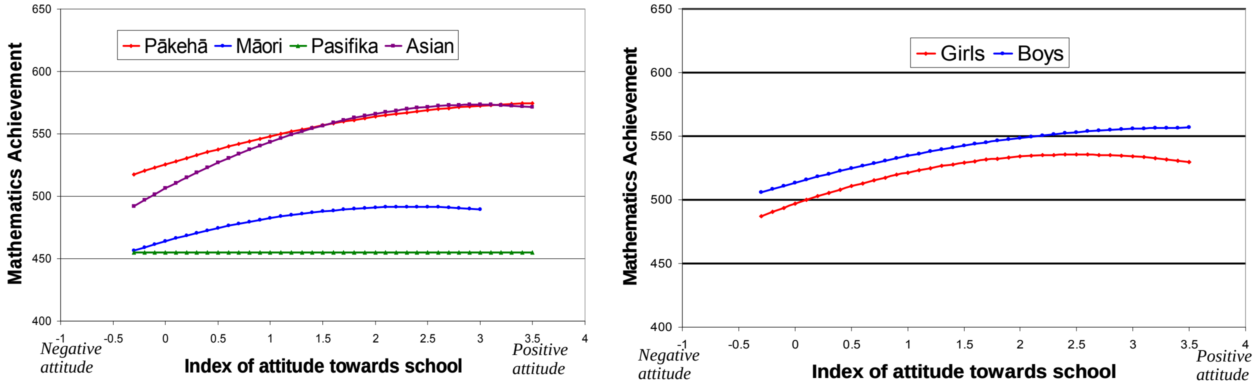


Figure 1a shows the extent to which positive and negative attitudes to school are associated with mathematics performance. For each group, the line shows the average performance of students at points on the index of attitudes to school scale. Students in most groups who are more positive about school are more likely to do well in mathematics, as Figure 1b illustrates. The exception is Pasifika students, for which there is no such relationship. For other ethnic groups and for boys and girls, students who are negative overall or comparatively less positive about school tend to perform below average. On the other hand, as shown in Figure 1b, there is little difference in performance at the positive end of the scale. This finding suggests that a focus on students with negative attitudes to mathematics may help to lift performance, apart from Pasifika students, where there is no clear relationship between attitudes to school and mathematics achievement.

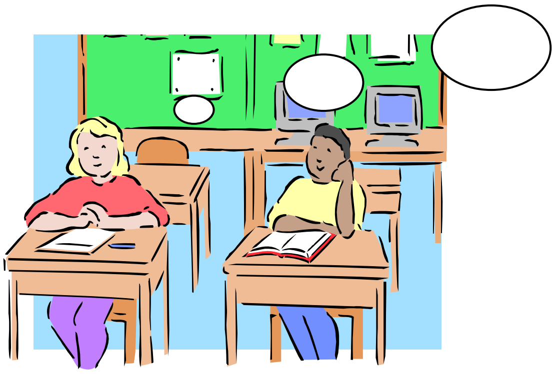
[3] The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Interest in and enjoyment of mathematics

I am interested in the things I learn in mathematics: 56% of New Zealand students agree

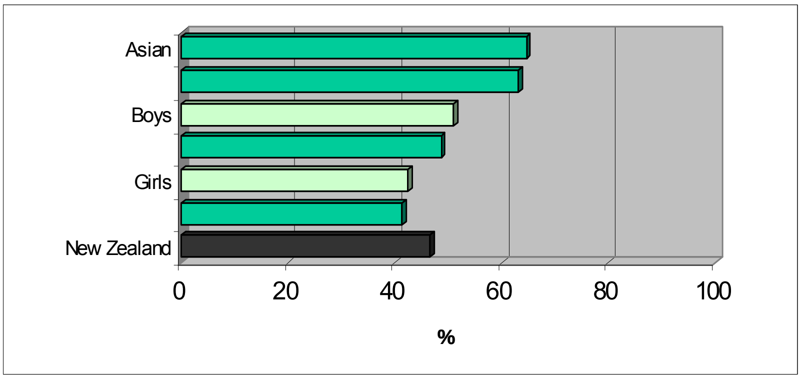
I look forward to my mathematics lessons: 41% agree

I do mathematics because I enjoy it: 39% agree



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into two categories.

Figure 2a: Percentage of New Zealand students with interest in and enjoyment of mathematics

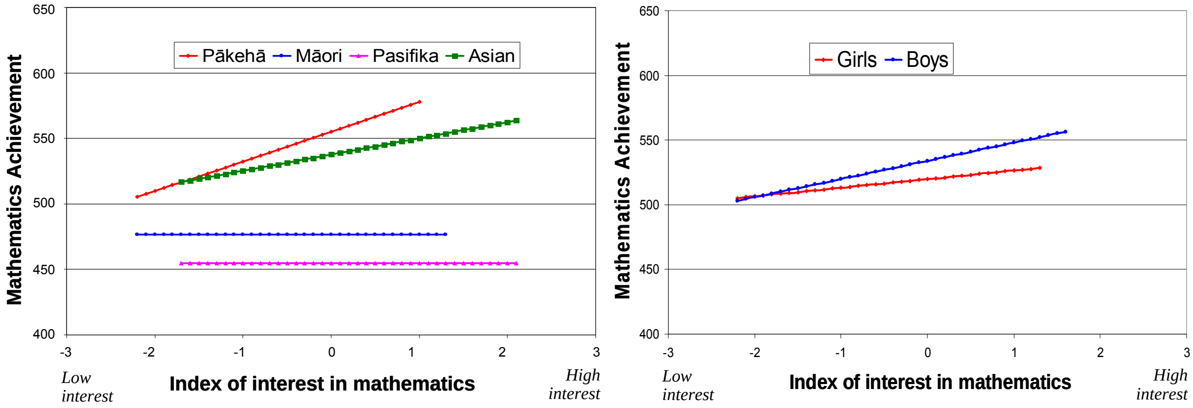


Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Interest in and enjoyment of mathematics: what the results show

While almost all students recognise the overall benefits of schooling, the degree of interest and enjoyment they express in the subjects taught is much more mixed. Although just over half (56%)of New Zealand students say that they are interested in what they learn in mathematics, only 39% say that they enjoy mathematics. In total, 47% of students had a positive response overall to the set of questions about interest and enjoyment of mathematics, as Figure 2a shows. New Zealand students' level of interest in mathematics is close to the OECD average. Of the main ethnic groups, Asian and Pasifika students have the most positive attitudes to mathematics on this index as Figure 2a shows.

Figure 2b: Relationship between mathematics performance and interest in and enjoyment of mathematics[4]



It is interesting to note that Mäori and Pasifika students, who have less proficiency in mathematics on average, have more positive attitudes to mathematics than Päkehä/European students. For example, 57% of Pasifika students and 44% of Mäori students say that they look forward to their mathematics lessons compared with only 36% of Päkehä/European students.

Figure 2b shows the relationship between interest and achievement in mathematics; for Päkehä/European and Asian students, but not for Pasifika or Mäori students, being more interested in mathematics is associated with doing better in the PISA assessment. Why should some Pasifika and Mäori students express such positive feelings about mathematics even though they are much less proficient in maths than an average Päkehä/European student? There are two possibilities, and these need to be probed further. One is that there is cultural bias in the way that students interpret the questions and Pasifika and Mäori students do not attach a consistent meaning towards them. Across the countries taking part in PISA, there was found to be cultural bias in the extent of interest expressed by students, although *within* each country and unlike the results for Mäori and Pasifika, students who are more interested in mathematics tend to perform better. The other possibility is that students from some ethnic backgrounds are not managing to translate their interest and enthusiasm about mathematics into stronger performance.

Across the PISA countries, females consistently report much lower interest and enjoyment in mathematics, but their overall performance in mathematics is not much below males. In New Zealand, boys are more interested in mathematics than girls and they also perform significantly better than girls, although their advantage is relatively small. In Figure 2b, the steeper gradient of the line for boys shows that they may be better at translating their interest into stronger performance or vice versa. These gender differences are not great but they do suggest that girls should be encouraged to take a greater interest in mathematics.

[4] The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Instrumental motivation (learning for a purpose)

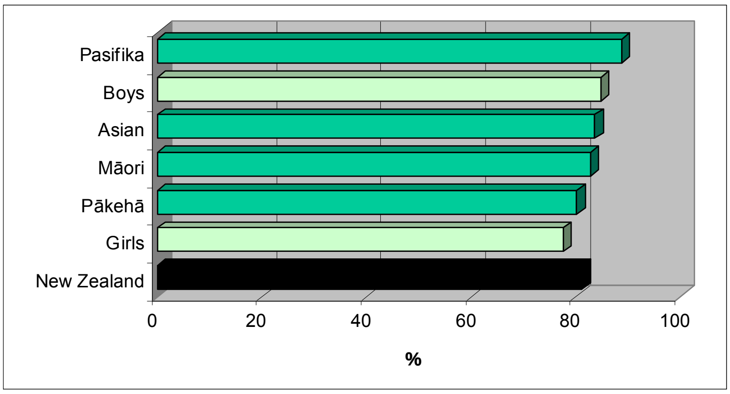
Learning mathematics is important because it will help me with the subjects that I want to study further on in school: 89% of New Zealand students agree

I will learn many things in mathematics that will help me get a job: 85% agree

Mathematics is an important subject for me because I need it for what I want to study later on: 77% agree

Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 3a: Percentage of New Zealand students with positive responses to instrumental motivation statements about learning mathematics



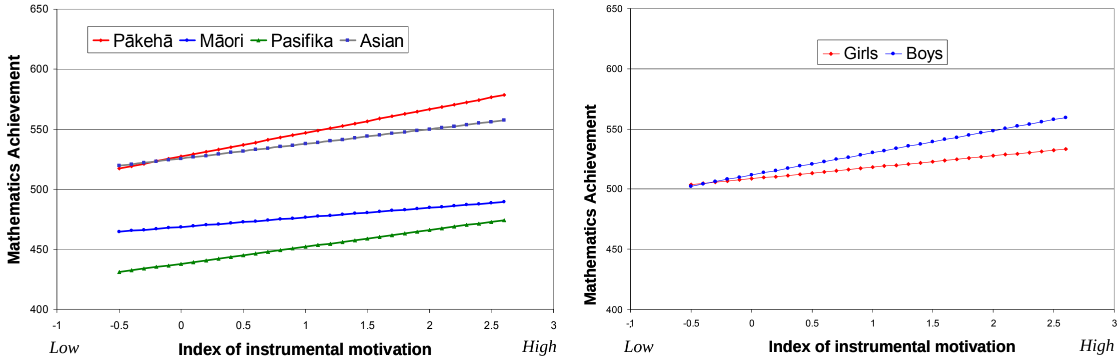
Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Instrumental motivation: what the results show

In contrast to the mixed degree to which students find mathematics interesting or enjoyable, the overwhelming majority of students in New Zealand appreciate that it is important to study mathematics because of the future benefits it will bring. Such instrumental motivation is stronger among New Zealand students than those in all but three other OECD countries. For example, 82% of New Zealand students are motivated to learn things in mathematics to help them get a job, but the average across the OECD is 70%. In eight countries, more than twice as many students as in New Zealand do not recognise this advantage of studying mathematics.

Within New Zealand, students from all ethnic groups recognise the importance of mathematics for their lives in the future and there is little difference by ethnic group. Boys are somewhat more likely to do so than girls, which is not surprising given that boys have a greater tendency to go on to further study in disciplines that demand an understanding of mathematics. Yet New Zealand students do not conform to a stereotype in which girls think that mathematics is irrelevant to their futures. Nearly three-quarters (72%) of 15-year-old girls think that it will be relevant to their studies in the future, and most girls (79%) also believe that maths will be relevant to their getting a job. Pasifika students are also somewhat more likely than the average New Zealand student to express strong instrumental motivation.

Figure 3b: Relationship between mathematics performance and index of instrumental motivation[5]



As Figure 3b shows, students with greater instrumental motivation are more likely to do well in mathematics. This finding contrasts with earlier PISA evidence on reading. Fifteen-year-olds who value reading skills in relation to getting a job or getting on in life are not necessarily better readers. This might be because lower-performing students are more likely to leave school earlier and are therefore aware of the 'instrumental' purposes of reading in terms of getting a job. Higher achievers tend to have an intrinsic interest in reading – to enjoy it – rather than thinking about it in instrumental terms. But in the case of mathematics, which fewer students enjoy for its own sake, students who think about its usefulness for their future study or career are more likely to do well.

In fact, instrumental motivation is more closely related to mathematics achievement than interest and enjoyment in mathematics. This suggests that schools might be more successful in raising achievement among these groups by raising their awareness of the importance of mathematics to their futures rather than by cultivating an interest in the subject for its own sake.

5 The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Sense of belonging at school

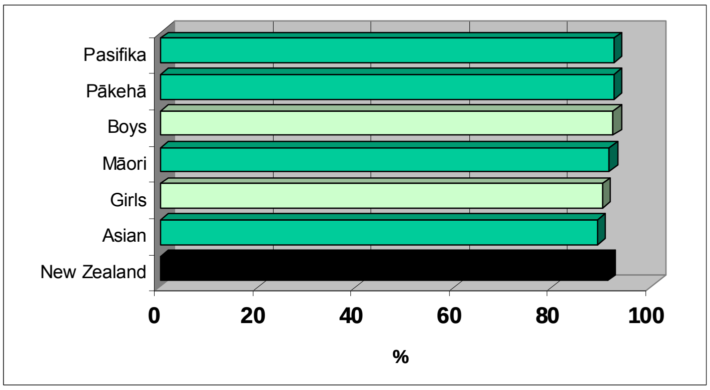
School is a place where I feel lonely: 93% of New Zealand students disagree

School is a place where I feel awkward and out of place: 89% disagree

School is a place where I feel like I belong: 86% agree

Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 4a: Percentage of New Zealand students who agree with positive statements about belonging at school



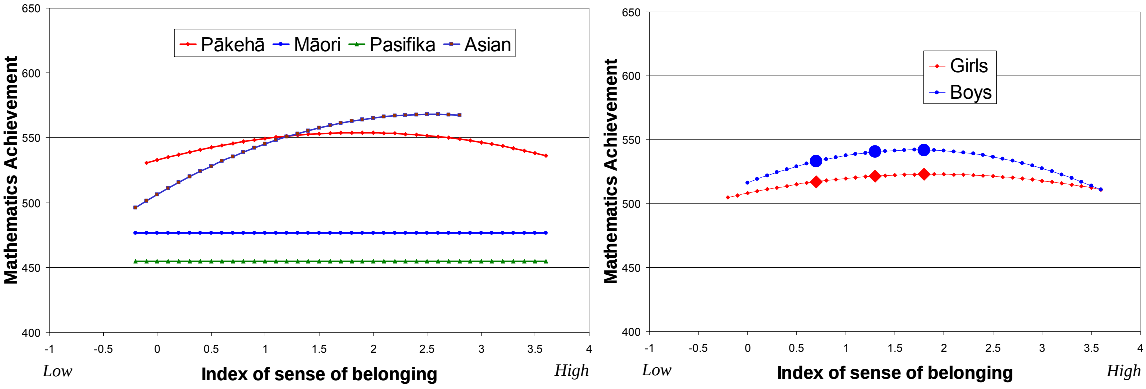
Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Sense of belonging: what the results show

Some students feel out of place at school and this can potentially harm their studies and, in the worst cases, cause them to stop attending school. In the PISA survey, a minority of students said that they felt lonely or out of place in school. One-seventh (14%) of New Zealand students did not agree that school is a place where they feel they belong. This is close to the average for OECD countries. There was little difference between boys and girls or across ethnic groups in general. However, on average, twice as many Asian students than New Zealand students say that they feel as though they are 'outsiders' (15% compared with 8%).

How high is the risk of these lonely or alienated students of failing? The PISA study does not show strong links between a student's sense of belonging and their performance. It is likely that attributes such as feeling lonely or finding it difficult to make friends will apply to high academic achievers as well as low academic achievers.

Figure 4b: Relationship between mathematics performance and students' sense of belonging at school[6]

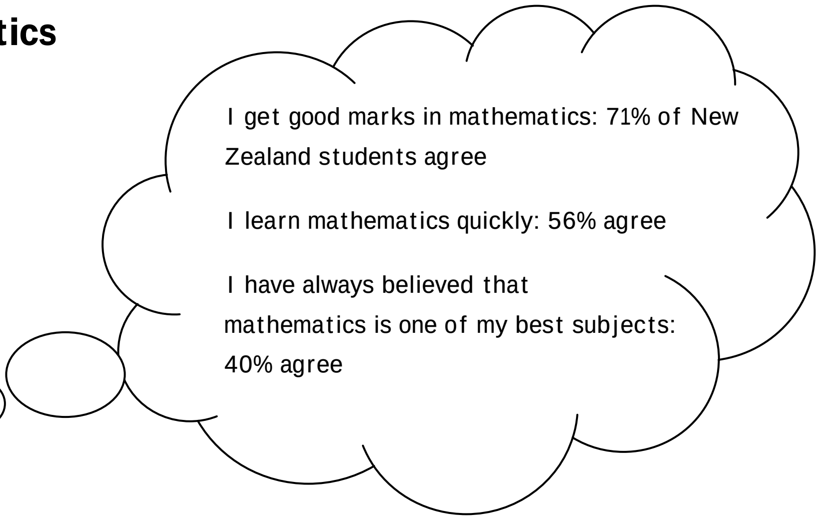


The link between sense of belonging and performance is not strong, as Figure 4b shows. However, two aspects are worth noting here: Asian students, whose sense of belonging is weakest among the main ethnic groups, have a closer association with performance, particularly among those with a below-average sense of belonging. It would seem that a number of Asian students who feel like outsiders at school are underperforming, although there is no reason to believe that there is a causal link between the two factors.

Figure 4b also highlights that for boys and Päkehä/European students in particular, students with a very high or very low sense of belonging do somewhat less well in mathematics. This indicates that students who feel unhappy and excluded at school might find their schoolwork suffering, although students who are highly socialised do not always do well academically.

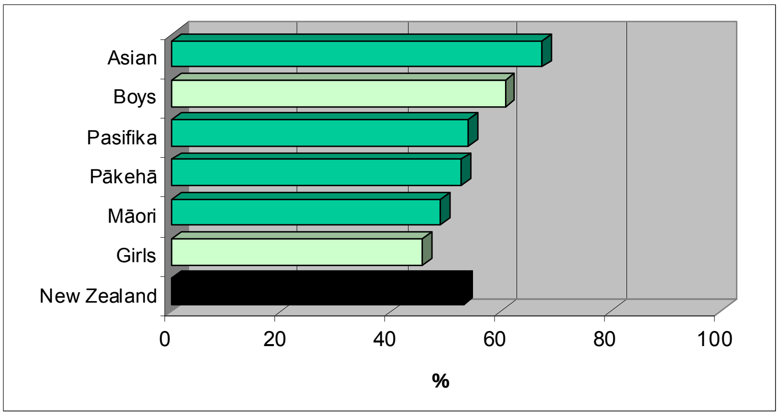
6 The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Self-concept in mathematics



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 5a: Percentage of New Zealand students who have a positive self-concept in mathematics



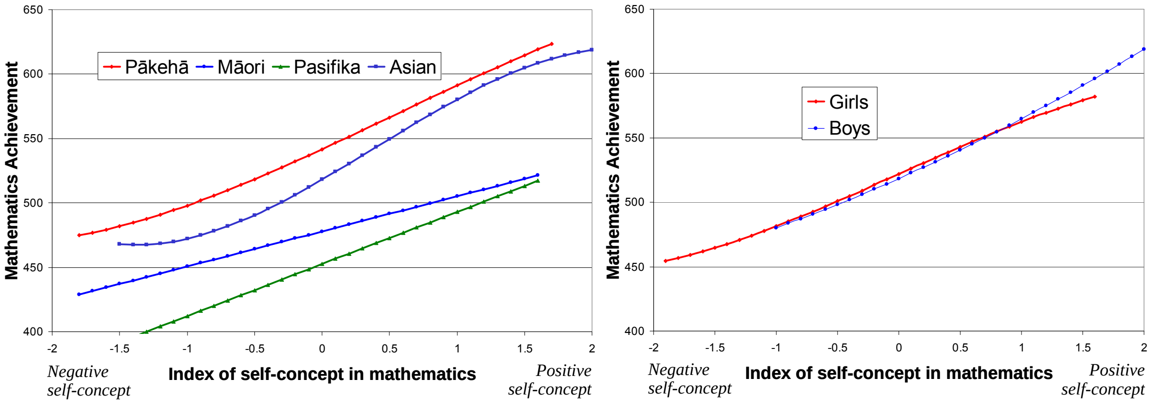
Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Self-concept in mathematics: what the results show

Students in New Zealand have highly mixed views of their own abilities in mathematics. About a third (33%) say that they are 'just no good' at mathematics, but over two-thirds (71%) say that they get good marks and over half of all students (56%) say that they learn mathematics quickly. New Zealand students generally have higher opinions of their mathematics ability than students in the OECD on average. The proportion of New Zealand students who say they get good marks is higher than in any other country except the United States. In contrast, only one-third of students in Japan and Korea say that they get good marks, even though Japanese and Korean students are among the top scorers in the PISA mathematics assessment. This suggests that the students in those countries judge themselves against more exacting standards than those in New Zealand or that their teachers' feedback is tougher.

Asian students in New Zealand have a significantly more favourable mathematics self-concept, on average, than students from other ethnic groups and boys express a higher belief in their maths abilities than girls do.

Figure 5b: Relationship between performance and index of self-concept in mathematics[7]



As shown in Figure 5b, expressing a positive self-concept of mathematics abilities is closely related to mathematics performance. This is the case for both boys and girls, as the graph on the right illustrates, but there are also some gender differences in mathematics self-concept. Across the middle of the distribution, most boys and girls have a similar pattern of achievement and self-concept in mathematics. The differences are at each end of the distribution. A small number of boys have very high mathematics abilities and self-concept, which is rare for girls. As the graph shows, the boys' line extends further to the right than the girls' line, showing that, at the 95th percentile, boys have a stronger self-concept than girls. Similarly, a number of girls, as shown on the left of the graph, have a poor self-concept and a level of mathematics ability that is very low by New Zealand standards. However, it is not true to say that these girls cannot do mathematics. Even the 5 percent of girls at the lowest level of self-concept in mathematics are likely to score around 450 in mathematics, which is at Level 2 of the six proficiency levels on the mathematics scale.

For all ethnic groups, there is a positive relationship between self-concept in mathematics and performance in PISA, apart from Asian students, where the relationship is weak for those students at the extremes, with either very low or very high self-concept.

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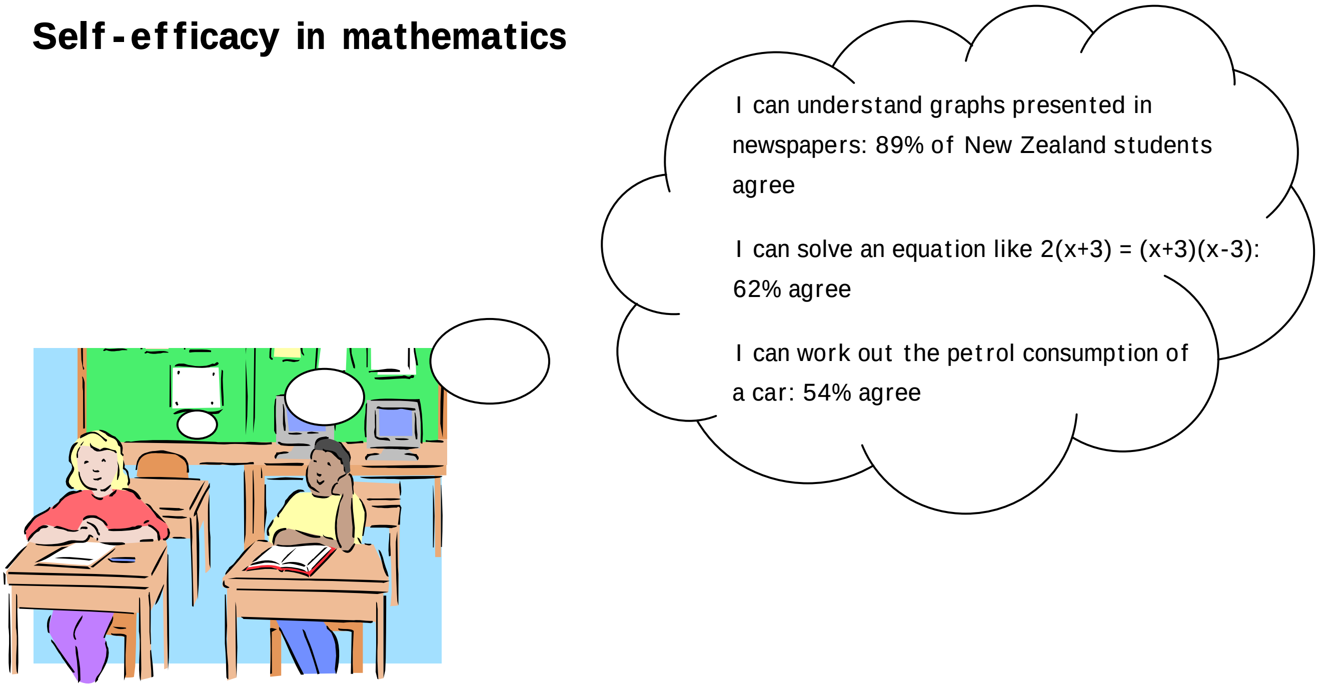
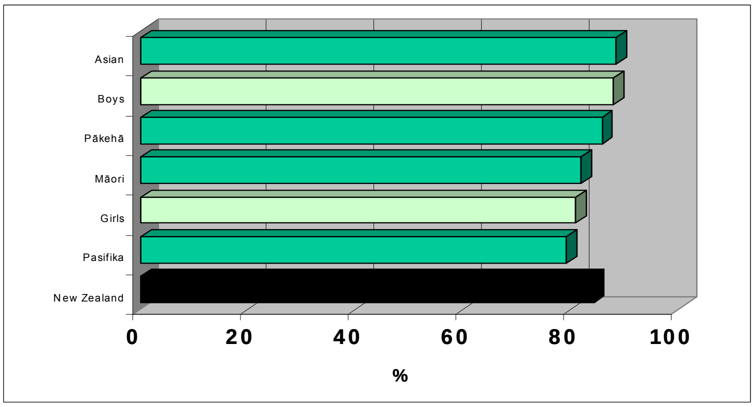
7 The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Self-efficacy in mathematics



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 6a: Percentage of New Zealand students who agree more with statements about self-efficacy in mathematics than disagree



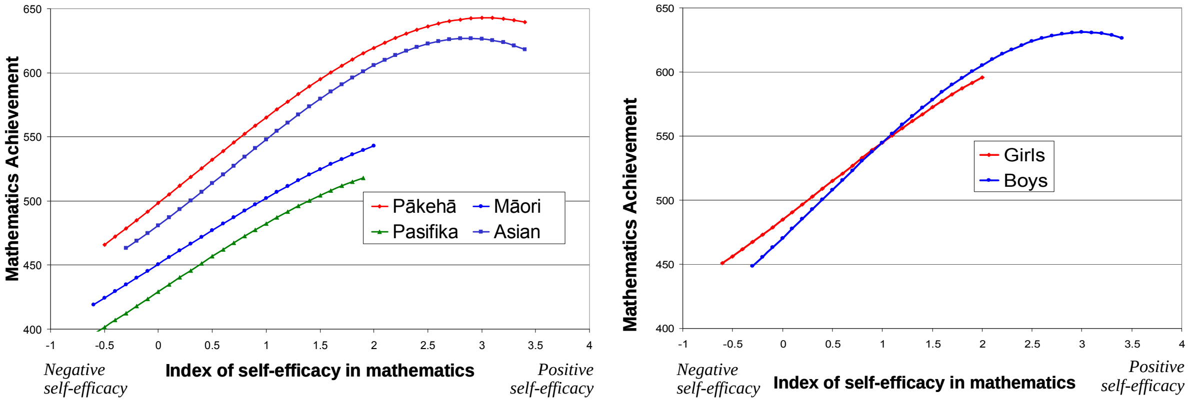
Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Self-efficacy: what the results show

Self-efficacy in mathematics indicates students' self-belief in their ability to overcome difficulties or obstacles to solving maths problems. Such a belief has been shown to be important to motivation because confidence that one will be able to solve a problem is a precursor to investing the time and effort needed to tackle it.

As an indicator of self-efficacy, students were asked whether they would expect to be able to succeed at various specific mathematics tasks. Responses varied according to the difficulty of the task but overall, a similar proportion of New Zealand students said that they could complete a task compared with the average student across all OECD countries.

Figure 6b: Relationship between mathematics performance and index of self-efficacy[8]



On this measure, as with self-concept, boys in New Zealand expressed stronger self-belief than girls. Asian students had higher self-efficacy than those from other ethnic groups. Also, relative levels of self-belief among Asian students seemed to be higher than the average New Zealand student on theoretical computations.

Self-efficacy is even more closely correlated with mathematics performance than self-concept, and the relationship is strong for all groups. Some interesting differences are notable, however, when comparing the graphs at the top of this page with the equivalent graphs for self-concept:

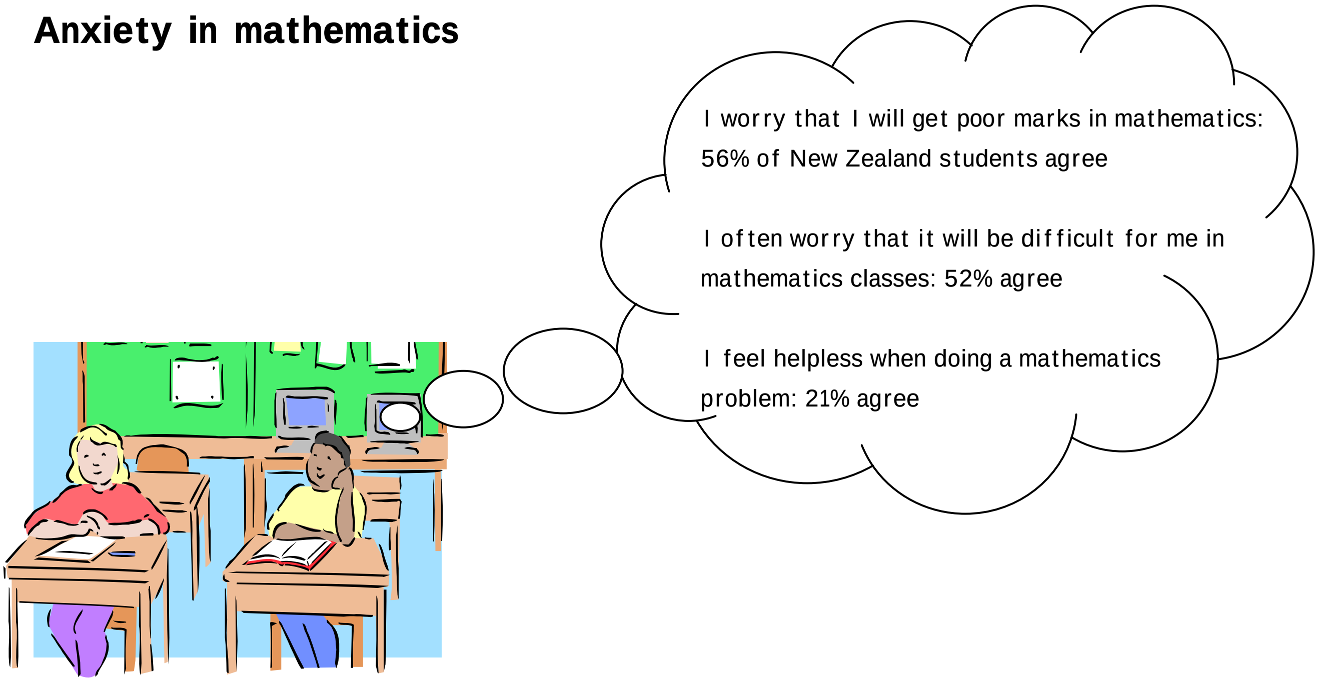
- Mäori and Pasifika students appear less likely to achieve high levels of self-efficacy than self-concept (shown by the lengths of the lines). Even though some such students consider themselves good at mathematics in general terms, they report with less confidence that they will be able to tackle certain specific problems. This form of self-belief, which encourages students to attempt to solve a problem, is an important attribute to work on.

- Girls have a smaller incidence of strong self-belief on both measures than boys, but on the efficacy scale (unlike the self-concept scale) they are no more likely than boys to have very low levels of self-belief. This result suggests that even if girls do not think that they are good at mathematics, they are reasonably confident about being able to do easy maths problems. It also suggests that relatively few girls have strong confidence in being able to do the hardest problems.

- There is a pronounced 'flattening' of the curves at the upper end for Päkehä/European and Asian students and for boys. This could indicate that once a student's self-efficacy reaches a certain high level, performance will not improve even if self-efficacy rises even higher. However, it could also be that the difficulty of the examples given in this part of the questionnaire were not high enough to distinguish the students who were able to do the hardest of the tested items.

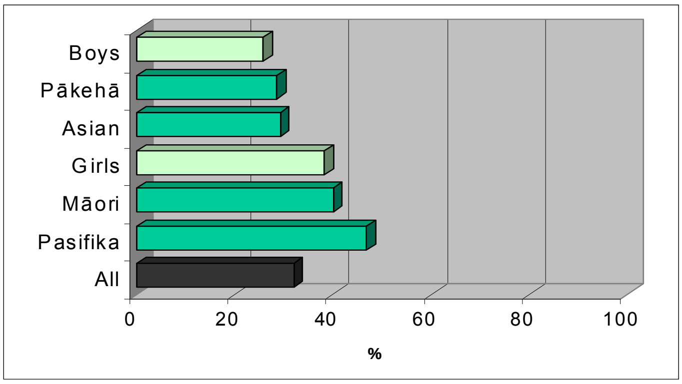
8 The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Anxiety in mathematics



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 7a: Percentage of New Zealand students who agree with statements about their anxiety in mathematics



Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

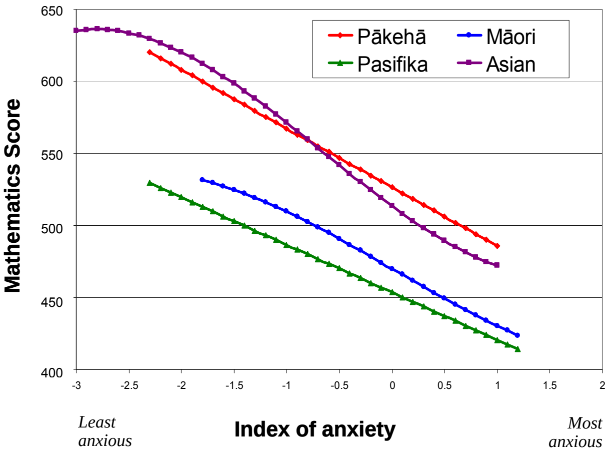
Mathematics anxiety: what the results show

Beyond a self-assessment by students about their ability to do certain mathematics tasks (self-efficacy), students' reports on their emotional views about their mathematical competence can also be revealing. As an innovative feature of PISA 2003, the OECD used the responses to statements such as those shown above to construct an index of anxiety in mathematics.

The majority of students have at least some worries about being able to do mathematics, but their anxieties are contained at a relatively low level. On the other hand, about one-fifth of students report more intense anxieties; feeling tense and even helpless when confronted with mathematical problems. New Zealand students express an average level of anxiety overall when compared with students in all the OECD countries, but slightly fewer than average say that they feel 'helpless' or 'tense' when doing mathematics.

Within New Zealand, some groups of students are much more likely than others to report experiencing high levels of anxiety when doing mathematics. Only about a quarter of Päkehä/European students have a negative score overall when asked questions about anxiety in mathematics, compared with well over a third of Mäori and nearly half of Pasifika students. Negative scores are also seen among a quarter of boys but over a third of girls.

Figure 7b: Relationship between mathematics performance and anxiety levels[9]



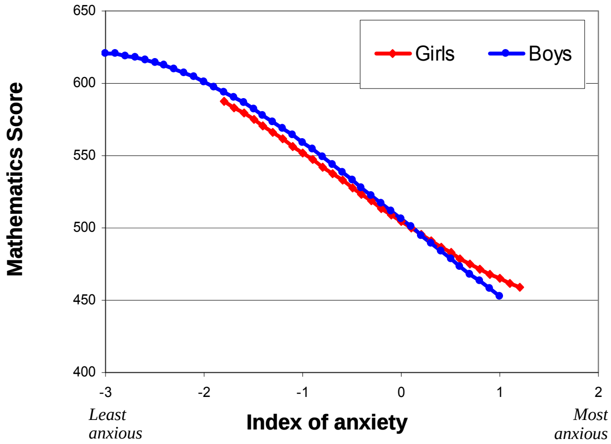
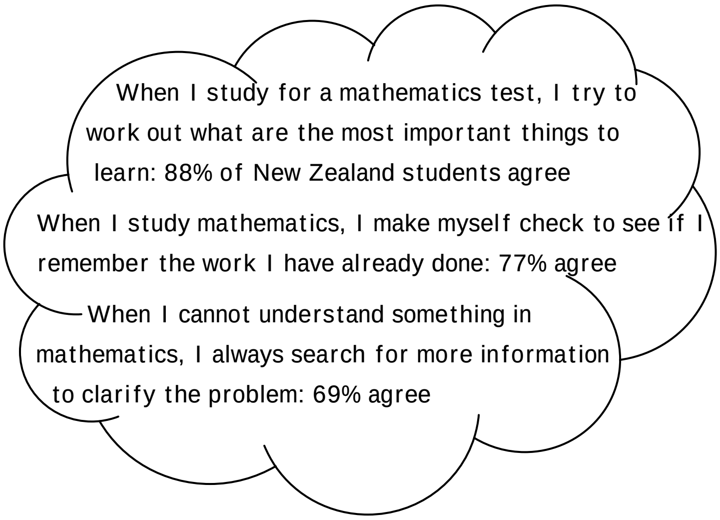


Figure 7b above shows the relationship between anxiety when attempting mathematical problems and mathematics performance. This does not tell us the extent to which high anxiety causes poor performance or the other way around, but there is likely to be a two-way interaction.

For all groups, higher anxiety is associated with lower performance in mathematics. In two groups, Asian students and boys, more students report very low anxiety, shown on the left of the graph) than students in other groups. However, below a certain level, having less anxiety becomes less of an advantage for these two groups: the slope of each line flattens. A similar flattening of the right-hand end of the line for girls shows that even though there are a few girls with particularly high levels of anxiety about maths, the most anxious girls do no worse than the most anxious boys. Overall, boys' advantage over girls stems mainly from a higher proportion of boys reporting very few worries about doing mathematics; the incidence of high anxiety shows less gender difference.

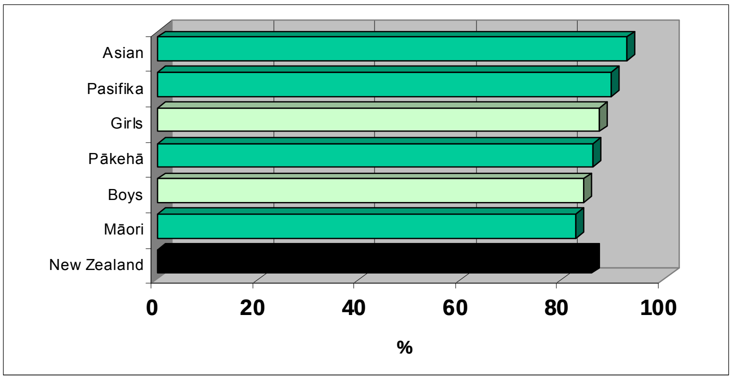
[9] The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Use of control strategies



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 8a: Percentage of New Zealand students who use control strategies in mathematics



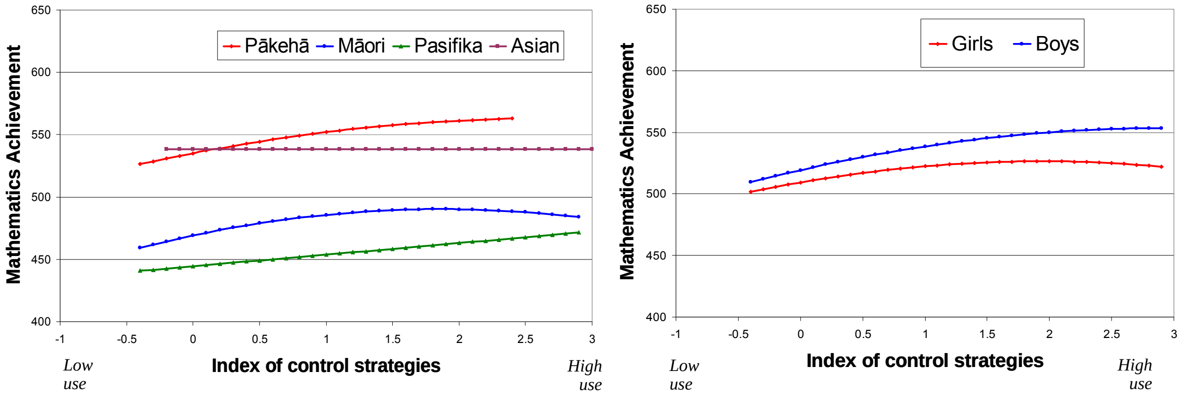
Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

Control strategies: what the results show

Students who control their own learning are on the way to becoming autonomous learners. Most students in New Zealand say that they think about what they are learning in mathematics, employing various control strategies like checking what more they need to know and prioritising their learning goals. Some practices are more common than others. For example, nine out of ten students (88%) say that they try to prioritise important items when studying for a test, whereas just over two-thirds (69%) take the initiative to look for clarification when they do not understand a problem. On average, students in New Zealand use such strategies to a similar extent as students in the other OECD countries.

There is no significant gender difference in the use of control strategies. There are minor differences in reporting control strategies between ethnic groups, with Pasifika students using them more often and Asian students less often than average. Asian students, particularly, are more likely to control their learning by seeking further information when they do not understand or by working out exactly what they need to learn than other New Zealand students.

Figure 8b: Relationship between mathematics performance and use of control strategies[10]

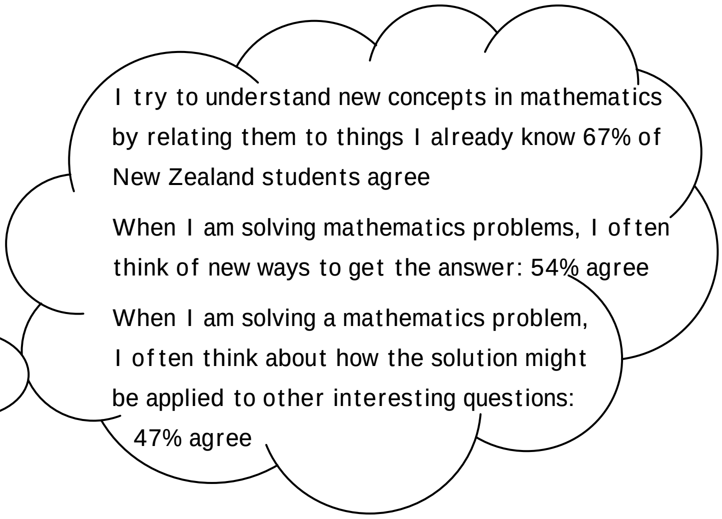


Despite the proven value of control strategies to learning, their reported use in mathematics does not have a direct, measurable effect on PISA results in all the OECD countries. Figure 8b shows that there is no clear pattern between use of control strategies and achievement in mathematics for New Zealand students and high use of control strategies appears to have little effect on performance.

Overall it seems that students do not expect to be spoon-fed information and knowledge but expect to take the initiative in controlling their learning. Those who do not yet do so may fail to develop relevant knowledge and skills at school and may be less well-equipped to become lifelong learners.

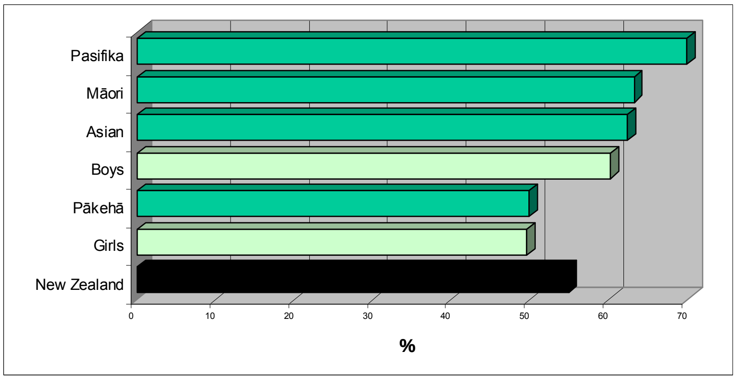
10 The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Use of elaboration strategies



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Strongly agree/agree and strongly disagree/disagree responses have been collapsed into agree and disagree categories.

Figure 9a: Percentage of New Zealand students who use elaboration strategies in mathematics



Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

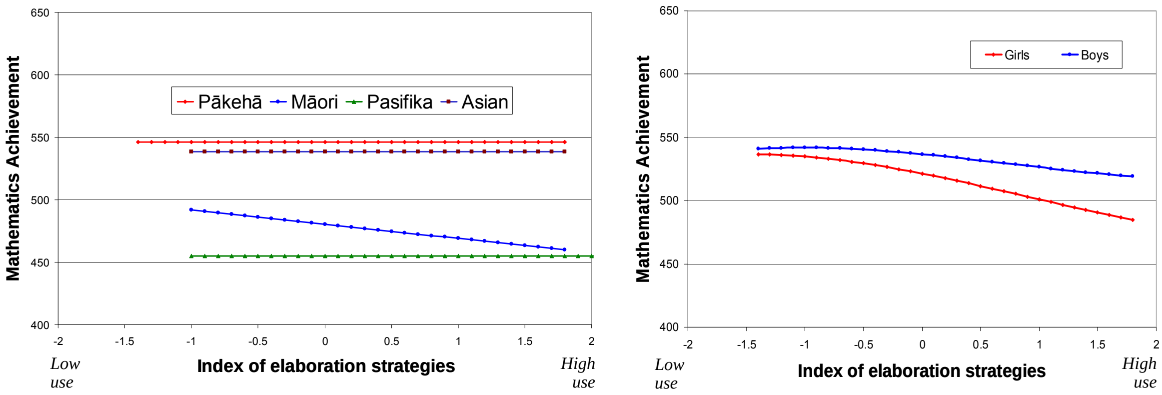
Elaboration strategies: what the results show

Another 'metacognitive strategy', or one that requires students to think about the learning process, recognised to be important to learning is *elaboration*. This term refers to the conscious integration of new learning material into what students already know, and to thinking about its further uses and applications.

New Zealand students are less likely to report using elaboration strategies than control strategies: only just over half agree that they do so regularly. This is in line with the results for other OECD countries in PISA 2003. New Zealand students' use of elaboration is slightly above the average.

Boys in New Zealand report using elaboration more than girls do, and Pasifika students report using this strategy more than members of other ethnic groups. The item that most distinguishes different groups is reflectiveness, that is whether they think about how the solution to a mathematical problem might be applied to other interesting questions. Among Pasifika students, 60% report thinking in this way compared with only 38% of Päkehä/European students. There is also a gender difference: 48% of boys compared with 38% of girls say that they reflect in this way.

Figure 9b: Relationship between mathematics performance and students' use of elaboration strategies[11]



Across countries, there is no systematic relationship between the adoption of elaboration strategies and performance in mathematics. This does not mean that adopting elaboration strategies does not help students to do better, just that the students who are adopting these strategies are no more likely than others to be high performers. In New Zealand, for Mäori students and for girls, there is a negative relationship between use of elaboration strategies and mathematics performance. This suggests that weaker students have a greater tendency to adopt these strategies, perhaps as a means of compensating for other limitations.

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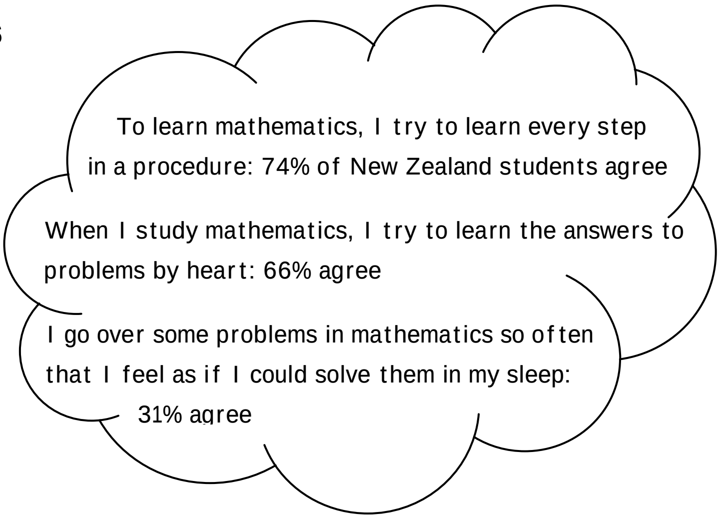
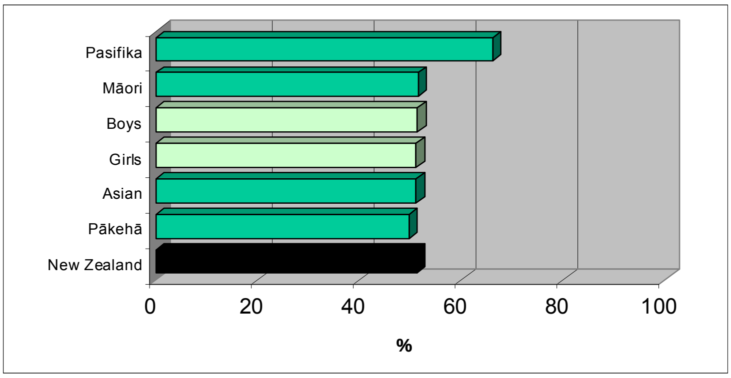
[11] The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Use of memorisation strategies



Notes:
1. Examples provided are a sub-set of the questions PISA asks students on each topic.
2. Always/often responses and sometimes/never responses were collapsed into one category

Figure 10a: Percentage of New Zealand students who use memorisation strategies in mathematics



Note: Graph uses an index of responses to a set of questions and represents the percentage of students with an index value greater than zero (or students who gave more positive than negative responses).

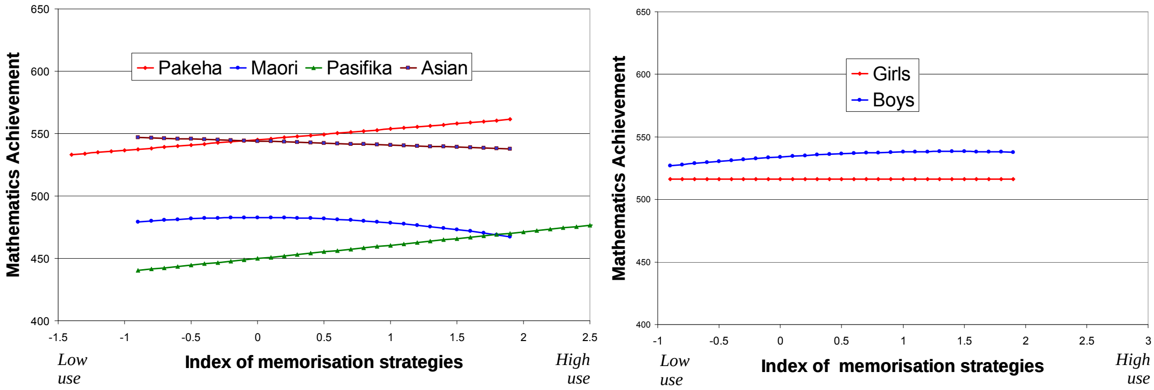
Memorisation strategies: what the results show

The use of memorisation can be important to the performance of many tasks learned in mathematics and other disciplines. However, memorisation strategies commonly lead only to the repetition of knowledge and are not on their own sufficient to tackle tasks that require deeper understanding. Memorising information in combination with elaborating it, or relating it to their wider knowledge base, is often necessary. For this reason, although memorisation is an important tool, it may not lead to higher levels of proficiency on its own.

Most students in New Zealand commonly engage in a number of memorisation practices related to mathematics, with three-quarters (74%) saying that they aim to learn each step in a mathematical procedure. On the other hand, only a minority take memorisation to an extreme. For example, 31% say that they repeatedly go over problems so they could solve them in their sleep. Overall, the use of memorisation is close to the OECD average, but some tasks are reported more commonly than in the average OECD country. For example, two-thirds of our students (66%) report that they try to learn mathematical solutions by heart.

Almost all sub-groups in New Zealand show the same propensity to use memorisation, as Figure 10a shows, with around half of all students reporting that they use memorisation more often than not in the examples given. The one exception is Pasifika students, where two-thirds (66%) report that they use memorisation strategies, when averaged across the set of relevant questions. For example, nearly three-quarters of Pasifika students report learning mathematical solutions by heart.

Figure 10b: Relationship between mathematics performance and use of memorisation strategies[12]



Across countries, there is no consistency in the ways in which the adoption of memorisation strategies is associated with mathematics performance. In some countries there is a positive relationship, and this suggests that memorising may contribute to students' ability to do mathematics, but in others there is a negative relationship, which indicates a greater tendency for weaker students to employ memorisation as a strategy.

The results for different ethnic groups in New Zealand are similarly mixed. Päkehä/European and Pasifika students who tend to use memorisation strategies have slightly better mathematics scores on average, whereas for Asian students it is the reverse. Use of memorisation strategies may have a negative effect on the performance of Mäori students, as Figure 10b shows. However, there is no relationship between girls.

It is not clear whether the use of memorisation strategies by Pasifika students helps them with their mathematics performance, although there is a positive relationship for Pasifika between the use of such strategies and achievement. However, the average level of Pasifika students' performance is low in comparison to other ethnic groups. Pasifika students who use memorisation strategies most often can, on average, perform some of the more difficult tasks at Proficiency Level 2; those who use it less can perform only some of the easier tasks at this level. This is consistent with the idea that memorisation can help to improve students' ability to do straightforward tasks but not more complex ones.

The results achieved by using different approaches to learning suggest that learning tools should be adapted to suit different students rather than following a 'one size fits all' style of teaching and learning.

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12 The units on the scale are standardised to give consistent meaning to the distribution of responses among New Zealand students (1 unit = 1 standard deviation). The numbers on the scale represent the average response by each student (from the 5th to the 95th percentile) to a series of questions about attitudes to school. Positive values on the scale indicate that students had more positive than negative responses to the set of questions on which the index is based.

Conclusion

This report has shown that New Zealand students are about average in the strength of their engagement as learners, compared with students across other OECD countries in PISA 2003. However, there are different patterns of learning between different groups of students in New Zealand. Boys believe more strongly in their overall mathematical abilities than girls and show greater interest in the subject. However, girls recognise the importance of mathematics, so when students are confronted with specific tasks, gender differences in terms of self-belief diminish.

Two ethnic groups that perform worse than average in mathematics, Mäori and Pasifika students, have some disadvantages in their reported approaches to learning. In particular, they are less likely to believe in their own mathematical abilities. However, in some other areas, they report positive approaches to mathematics, expressing a strong interest in the subject. In the case of Pasifika students there is a strong tendency to adopt certain learning strategies. Some of these differences may be related to cultural bias in answering this type of question. However, it is also possible that it reflects some differences in learning styles among groups of students. Further investigation into different approaches to learning may help students to study more effectively.

Evidence on the relationship between approaches to learning and learning outcomes, as represented by performance in the PISA mathematics assessment, is also varied. Some factors, such as self-belief and instrumental motivation, show consistent, positive associations with performance across groups. Others seem to show an association among some groups but not others. For Pasifika students, expressing greater interest in or enjoyment of mathematics is not associated with higher performance. However, greater instrumental motivation is strongly associated with performance relative to other groups, as is the use of memorisation strategies.

Again, these results are suggestive rather than definitive in relation to which aspects of approaches to learning are the most important in determining student outcomes. But they again raise the possibility for New Zealand educators that different approaches may work better for different groups of students. The implication is that a 'one size fits all' approach to helping students to become better learners may not be appropriate.

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.

For further information in New Zealand

Enquiries about this project may be directed to the:

National Project Manager
PISA 2003
Research Division
Ministry of Education
P O Box 1666 Wellington
EMAIL: research.info@ minedu.govt.nz
or PHONE: 0800 846 777
or FAX: 64-4-463 8312