Wānangatia te Putanga Tauira
National Monitoring Study of Student Achievement

Mathematics and Statistics 2013

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Educational Assessment Research Unit
and
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NMSSA Report 4

Report 4

National Monitoring Study of Student Achievement, Mathematics and Statistics 2013

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National Monitoring Study of Student Achievement
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- Members of the curriculum advisory panels in health and physical education and mathematics and statistics
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Executive Summary

The National Monitoring Study of Student Achievement (NMSSA) – Wānangatia Te Putanga Tauira – is designed to assess and understand student achievement across the New Zealand Curriculum (NZC) at Year 4 and Year 8 in New Zealand's English-medium state schools. The main purposes of NMSSA are:

- to provide a snapshot of student achievement against the NZC;
- to identify factors that are associated with achievement;
- to assess strengths and weaknesses across the curriculum;
- to measure change in student achievement over time; and
- to provide high quality, robust information for policy makers, curriculum planners and educators.

NMSSA began in 2012 and is carried out over a five-year cycle. It focusses on two learning areas of the NZC each year. During the first cycle we are setting the baseline for measuring change in student achievement over time in subsequent cycles. This report is the full technical report of the national level findings from NMSSA prepared for the Ministry of Education.

In 2013, NMSSA assessed student achievement in mathematics and statistics, and health and physical education. Data collection was carried out in Term 3. This report focuses on mathematics and statistics.

The NZC expresses learning expectations in mathematics and statistics as achievement objectives that describe the mathematical and statistical knowledge and skills students should be able to display as they progress from one curriculum level to the next. Each level builds on the one before, as well as introducing new ideas and applications. Achievement objectives are presented across three strands: number and algebra; geometry and measurement; and statistics.

NMSSA assessed achievement in mathematics and statistics using two measures: the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) group-administered assessment and the Mathematical and Statistical Proficiencies (MSP) individual-based assessment. Performance on the KAMSI measure, which was completed by a larger sample of students, was aligned to the levels of the NZC. Other data related to students', teachers', and principals' views of teaching and learning in mathematics and statistics were also collected via questionnaires and student interviews.

Results from NMSSA's 2013 study in mathematics and statistics suggest a mismatch at Year 8 between student achievement levels and curriculum expectations. The curriculum expectation at Year 8 is that students will be working solidly at Level 4. About 41 percent of Year 8 students achieved at Level 4 or higher on the KAMSI assessment. An analysis of KAMSI items indicates that in general, Year 8 students are not having the success expected on Level 4 items involving fractions, decimals, percentages, and pro-numerals.

Performance at Year 4 was more in-line with curriculum expectations. About 81 percent of students achieved within the Curriculum Level 2 band or higher. The expectation for students at Year 4 is to achieve solidly in this band.

There is considerable variation in performance at both Year 4 and Year 8, as well as some overlap between score distributions for each year levels.

Socio-economic factors were strongly associated with performance. On average, students from low decile schools (deciles 1, 2 and 3) scored lower than those who attended high decile schools (deciles 8, 9 and 10). On both achievement measures and at both year levels the difference in average scores was equivalent to the amount of progress expected over about two years of schooling. Māori and Pasifika students, who as a group were more likely than other students to attend mid and lower decile schools, on average scored lower

than students from other ethnic groups. A regression analysis did indicate that score differences related to ethnicity could be detected after decile was taken into account. When scale score differences between Year 4 and Year 8 are taken as a proxy for progress, there is some indication that Pasifika students have made less ‘progress’ on average than non-Pasifika students. On average, Asian students scored more highly and made more ‘progress’ than other students.

The study provides some evidence that non-cognitive factors related to attitudes and beliefs are associated with achievement. Students with a positive view of their own general ability in mathematics and statistics, and of mathematics itself tended to score more highly on average. There was also some indication that students who subscribed to the view that learning potential in mathematics was malleable, rather than fixed scored higher on average. Students from higher decile schools had performance expectations in mathematics and statistics that were more closely aligned with their results in NMSSA than students from lower decile schools.

A high proportion of teachers at both year levels indicated that they felt confident in their teaching, and that they were able to engage and meet the needs of their students. Very few teachers reported that they did not enjoy maths or like teaching it.

1 Overview of the National Monitoring Study of Student Achievement

1. Purpose of national monitoring

The National Monitoring Study of Student Achievement (NMSSA) – Wānangatia Te Putanga Tauira – is designed to assess and understand student achievement across the New Zealand Curriculum (NZC) at Year 4 and Year 8 in New Zealand's English-medium state schools. The main purposes of NMSSA are:

- to provide a snapshot of student achievement against the NZC;
- to identify factors that are associated with achievement;
- to assess strengths and weaknesses across the curriculum;
- to measure change in student achievement over time; and
- to provide high quality, robust information for policy makers, curriculum planners and educators.

NMSSA began in 2012 and is carried out over a five-year cycle. It focusses on two learning areas of the NZC each year. During the first cycle we are setting the baseline for measuring change in student achievement over time in subsequent cycles. This report is the full technical report of the national level findings from NMSSA prepared for the Ministry of Education.

The information on educational outcomes and associated factors that is provided through NMSSA will continue the monitoring undertaken by the National Education Monitoring Project (NEMP) between 1995 and 2010 and complement international studies such as the Trends in International Mathematics and Science Study (TIMSS) and the Progress in International Reading Literacy Study (PIRLS) and other national evaluation studies.

The project covers all areas of the NZC, and includes a focus on both key competencies and literacy and mathematics across the curriculum. NMSSA has a particular focus on Māori students, Pasifika students and students with special education needs.

Contextual information is collected to help understand the factors that are associated with students' achievement. This includes students' attitudes to, and the opportunities to learn in, the specific learning area being investigated, as well as features of their educational experiences at school and home that support their learning. Teachers provide information about factors such as teachers' confidence in teaching the specific learning area under investigation, learning opportunities provided to students, and the professional and curriculum support provided to teachers.

Each year NMSSA focuses on two learning areas. During the course of a cycle, all learning areas of the curriculum, as well as cross-curriculum elements such as key competencies and literacy and mathematics across the curriculum, will be monitored. Annual reports of student achievement and factors associated with each learning area will be compiled. Trends and changes in student achievement within learning areas will be monitored through subsequent cycles. While aspects of student achievement on the key competencies and literacy and mathematics across the curriculum will be assessed each year, reports on these aspects will be produced at the end of each cycle rather than annually (see http://nmssa.otago.ac.nz/).

The project is supported by advisory panels of curriculum experts, reference groups for the priority population groups (Māori, Pasifika and special education needs), and a technical reference group.

2. The 2013 Study

In 2013, the dual focus for the NMSSA study was mathematics and statistics, and health and physical education. A nationally representative sample of approximately 2000 students at Year 4 and Year 8 took group-administered paper-and-pencil assessments in mathematics and statistics, and responded to questions about their attitudes, learning experiences and support for learning. A sub-sample of approximately 800 students at each of these year levels, also took part in individual assessments focussed on aspects of learning in mathematics and statistics.

The assessments were conducted by experienced, specially-trained classroom teachers during Term 3. Monitoring procedures ensured consistent and high quality administration of assessments and marking. The characteristics of the achieved samples are described in Appendix 1.

As well, at each year level, approximately 300 teachers from the schools involved in the study were invited to respond to a questionnaire that included sections about their confidence in teaching mathematics and statistics, learning opportunities in mathematics and statistics provided for students, and the professional support they received for teaching this learning area. Principals were invited to respond to a questionnaire about priority learning areas within the school, the arrangements for teaching the focus learning areas, and the professional development support provided for teachers in their schools.

3. Structure of the mathematics and statistics report

The report of student achievement in mathematics and statistics is set out in seven chapters:

- Chapter 1 provides a broad overview of the National Monitoring Study of Student Achievement programme.
- Chapter 2 sets out the development of the mathematics and statistics achievement measures and data collection instruments. The analytical and reporting approaches used to present the findings are also set out in this chapter.
- Chapter 3 presents the findings for Year 4 and Year 8 student achievement in mathematics and statistics and reports these against the levels of the mathematics and statistics curriculum using two scales: Knowledge and Application of Mathematical and Statistical Ideas, and Mathematical and Statistical Proficiencies. It also compares achievement between Year 4 and Year 8 students, and differences between sub-groups of gender, ethnicity, school decile and type of school.
- Chapter 4 examines factors that may be associated with student achievement in mathematics and statistics and draws on information collected from students about their attitudes to mathematics and statistics and their learning experiences in mathematics and statistics at school. This is examined alongside information collected from teachers about their confidence in teaching mathematics and statistics, the learning experiences they provide for students, professional support for teaching mathematics and statistics, and the school learning priorities.
- Chapter 5 reports the achievement of Māori students in mathematics and statistics on the two achievement measures. The characteristics of Māori students who achieve above the national average are examined in relation to gender, attitude to mathematics and statistics, and school decile.
- Chapter 6 presents the achievement of Pasifika students in mathematics and statistics in a parallel way to Māori students in Chapter 5.
- Chapter 7 reports the participation and achievement in mathematics and statistics of students who have high and moderate special education needs. Attitudes to mathematics and statistics, and opportunities to learn mathematics and statistics are also contrasted with those for students with no special education needs. The profile of students with moderate special education needs who score above the national average are examined in relation to gender, attitude to mathematics and statistics, and school decile.

2 The NMSSA Mathematics and Statistics Assessment Programme

This chapter provides an overview of the NMSSA assessment programme for mathematics and statistics. It includes seven parts:

- Part 1 discusses the mathematics and statistics learning area of the New Zealand Curriculum (NZC) and the assessment of mathematics and statistics in the New Zealand context.
- Part 2 sets out the overall mathematics and statistics assessment overview for NMSSA.
- Parts 3, 4, 5 and 6 describe the frameworks, assessment design processes, and reporting scales and methods for the four different components of the mathematics and statistics assessment programme.
- Part 7 provides more information about the scales and describes the graphs and statistics used to report the findings.

1. Assessing mathematics and statistics performance in New Zealand

The aim of the 2013 NMSSA mathematics and statistics study was to assess and begin to understand the achievement and progress of Year 4 and Year 8 students in the mathematics and statistics learning area of the NZC. The NZC describes mathematics as exploring and using patterns and relationships in quantities, space and time. Statistics is described as the exploration and use of patterns and relationships in data. According to the NZC, mathematics and statistics "… equip students with effective means for investigating, interpreting, explaining, and making sense of the world in which they live"[1].

The NZC presents achievement objectives for the mathematics and statistics learning area in three strands: number and algebra; geometry and measurement; and statistics. Eight levels of achievement objectives are described in each strand. The mathematical and statistical ideas covered by the achievement objectives are expected to be presented to students in meaningful contexts where students think mathematically and statistically to solve problems and model solutions. Students are also expected to make sense of the connections that exist between strands.

The NZC provides a framework rather than a detailed plan for teaching and learning. Schools are expected to determine the detail of their own school-based curriculum, while staying clearly aligned with the intent of the NZC document. According to the NZC document, the NZC

> … gives schools the scope, flexibility, and authority they need to design and shape their curriculum so that teaching and learning is meaningful and beneficial to their particular communities of students. In turn, the design of each school's curriculum should allow teachers the scope to make interpretations in response to the particular needs, interests, and talents of individuals and groups of students in their classes.[2]

[1] New Zealand Curriculum, page 26

[2] New Zealand Curriculum, page 37

The 2013 NMSSA mathematics and statistics study complements a number of system-wide assessments of mathematics achievement in New Zealand. These include studies carried out by the precursor to NMSSA, the National Education Monitoring Project (NEMP), and two international studies: the Trends in International Mathematics and Science Study (TIMSS), and the Programme for International Student Assessment (PISA).

The NEMP project was carried out by the University of Otago for the Ministry of Education. The project began in 1993 and assessed the achievement of New Zealand Year 4 and Year 8 students in all areas of the school curriculum. NEMP conducted monitoring in mathematics at four-yearly intervals commencing in 1997. NEMP's last report on mathematics (Crooks, Smith, & Flockton, 2010[3]) discussed data collected in the 2009 school year. The report noted that Year 8 students scored higher on tasks than those in Year 4, particularly in terms of the knowledge they could demonstrate and strategies they could apply. No overall improvement was noted between 2005 and 2009, although there were slight gains on tasks focused on geometry and statistics. NEMP reported differences between key population sub-groups in 2009 by averaging effect size differences across the series of tasks used to assess achievement in the study. Table 1 shows the average effect size differences reported for gender and ethnicity in 2009.

Table 2.1 Effect size differences between sub-groups reported by NEMP in 2009

	Year 4 Effect Size	Year 8 Effect Size
Gender		
Boys/Girls	0.14	0.03
Ethnicity		
Pākehā[4]/ Māori	0.42	0.38
Pākehā/Pasifika	0.50	0.53

The TIMSS project is run by the International Association for the Evaluation of Educational Achievement (IEA) and administered on a four year cycle. The first cycle was held in1994/5 and the country's most recent completed cycle was in 2010/11. The 2014/2015 cycle is currently underway. In New Zealand TIMSS focuses on Year 5 and Year 9 students, their teachers, and principals. In 2010/11 Year 5 performance on TIMSS dropped further below the international average compared with 2006/7 and 2002/3, but was still significantly higher than the first TIMSS cycle. New Zealand students in Year 5 showed relative strength on questions involving statistics (called data display in TIMSS), however performance in this area had dropped since 2006/7. In 2010/11 Year 9 students were also relatively strong on statistics questions and to a lesser extent number, but were very weak in algebra. Overall, Year 9 performance remained relatively stable between 2010/11 and the first cycle of TIMSS. At both year levels there were proportionally more Pakeha/European and Asian students represented in high achievement bands compared with Māori and Pasifika ethnic groups.

The PISA project is an initiative of the Organisation for Economic Co-operation and Development (OECD). It looks at the mathematical, reading, and scientific literacy of 15-year old students towards the end of compulsory education. PISA has been undertaken on a three-yearly cycle since 2003. New Zealand has traditionally performed well on PISA compared with other countries, but the latest results in mathematical literacy from 2012 showed a decline in terms of the average scale score. New Zealand students were relatively strong on questions involving statistical ideas, but achieved less well in the area of geometry.

[3] Crooks, T., Smith, J., Flockton, L. (2010). NEMP: Mathematics Assessment Results 2009. National Education Monitoring Report 52. Dunedin: University of Otago, Educational Research Unit.

[4] NEMP defined three ethnicity categories for use in the study: Māori, Pākehā and Pasifika. Pākehā was used for all students not defined as Māori or Pasifika

2. The NMSSA mathematics and statistics assessment overview

An advisory panel of mathematics education experts met with the NMSSA team to consider the mathematics and statistics learning area of the NZC. The panel identified key research questions to guide the study, including contextual questions to better understand students' achievement in mathematics and statistics. The discussion with the advisory panel formed the basis of the 'NMSSA mathematics and statistics assessment overview'.

Table 2.2 sets out the assessment overview for mathematics and statistics. Several 'big questions' identified the important or significant issues to explore. These led to a number of more 'specific questions' relating to (i) assessing achievement in mathematics and (ii) understanding achievement. The overview was used to guide and prioritise the development of the different components that made up the NMSSA mathematics and statistics assessment programme.

Table 2.2 The mathematics and statistics assessment overview

Big questions

- To what extent have students developed the knowledge, skills and understanding described by the New Zealand Curriculum for the learning area of mathematics and statistics?
- To what extent do students demonstrate the ability to work mathematically?
- To what extent do students demonstrate positive mathematical dispositions?
- To what extent do contextual factors influence learning in mathematics?
- To what extent do students demonstrate progress in mathematics between Year 4 and Year 8?

Assessing achievement: specific questions

- To what extent have students developed the knowledge, skills and understanding described by the three mathematics and statistics strands?
- To what extent are students able to demonstrate knowledge of efficient, accurate and flexible procedures in mathematics and statistics?
- To what extent are students able to communicate their thinking when they solve problems in mathematics and statistics?
- To what extent do students see mathematics and statistics as having a range of practical applications in learning areas and everyday life?

Understanding achievement: specific questions

Students

- To what extent do students demonstrate motivation, engagement and interest in learning mathematics and statistics?
- To what extent do students demonstrate self-regulation, perseverance, curiosity, interest and enjoyment of intellectual challenge as learners of mathematics and statistics?
- To what extent do students feel they have control over their learning in mathematics?
- What is the nature and range of learning experiences students have had in mathematics and statistics at school and out of school?

Teachers

- What interests, knowledge and experiences do teachers bring to their teaching of mathematics?
- How confident do teachers feel to teach mathematics?
- How is mathematics learning structured/organised in the class?
- To what extent do teachers consider they have control over the learning for their students in mathematics?
- What behaviours are important for students to have in order to be good at mathematics?
- How prepared do Year 8 teachers consider their students to be for Year 9?
- How able/confident are teachers in accommodating children with differentiated needs? How do they do this?
- What professional learning development have teachers had?

Principals

- How is mathematics learning structured at the school?
- What resources are available?
- What professional learning development opportunities has the school provided for teachers?
- How does the school engage with whānau/the wider community?

The components of the mathematics and statistics assessment programme

Four components related to assessing and understanding mathematics achievement were developed to address the overview. Two were focused directly on assessing student achievement: one of these was designed to be administered to groups of students (the group-administered approach) and the other involved an individual assessment approach where teacher assessors interacted with individual students (the individual-assessment approach). The two remaining components were focused on collecting contextual and attitudinal information from students, teachers and principals. Table 2.3 outlines each of the components.

Each component of the assessment programme is described in more depth in the following sections.

Table 2.3 The components of the 2012 NMSSA mathematics and statistics assessment programme

Component	Focus	Assessment Approach
1. Knowledge and Application of Mathematical and Statistical Ideas (KAMSI)	Understanding and using the ideas related to the mathematics and statistics achievement objectives described across the three content strands by the NZC.	Group-administered assessment: 40 minute paper-and-pencil assessment
2. Mathematical and Statistical Proficiencies (MSP)	Applying four broad and overlapping areas of mathematical and statistical proficiencies across the strands: understanding; reasoning strategies and mathematical procedures; and communication.	Individual assessments: one-to-one interview tasks, and individual performance activities
3. Student attitudes and learning opportunities in mathematics and statistics	Student attitude towards, and engagement with, mathematics and statistics Student views of opportunities and experiences for learning mathematics and statistics at school Student view of the nature of mathematical competence, learning strategies and self-efficacy	Paper-and-pencil questionnaire Short student interview
4. Teacher and principal perspectives on mathematics teaching and learning in the school	Teacher and principal views of mathematics and statistics learning in their school Teacher confidence as mathematics and statistics educators Professional support and learning related to teaching mathematics and statistics Curriculum priorities of the school	Paper-and-pencil questionnaires

3. The knowledge and application of mathematical and statistical ideas (KAMSI) assessment

The Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment was a group-administered paper-and-pencil assessment. All Year 4 and Year 8 students in the study (approximately 2,000 students at each level) completed the assessment, which covered the three strands of the mathematics and statistics learning area:

- number and algebra;
- geometry and measurement;
- statistics.

The assessment focused on the extent to which students could show understanding of, and apply the mathematical and statistical ideas covered in these strands.

Assessment framework

To guide the assessment development process, frameworks describing the knowledge and competencies to be assessed by KAMSI at each year level were developed. These were based on the mathematics and statistics learning objectives provided in the NZC. The frameworks informed assessment blueprints which outlined the relative proportion of items to be developed to represent each strand and the type of questions to be used. The frameworks are shown in Appendix 2.

A collection of assessment ‘items’ was developed based on the frameworks and blueprints. The items included a mix of selected response and constructed response (both short and longer answer) questions. The items were categorised according to their strand focus. Figure 2.1 shows an example of a KAMSI assessment item.

Two classes recorded the number of *kererū* and *tūī* in the trees around their school.

	Room 1	Room 2	TOTAL
Tūī	22	29	51
Kererū	7	2	9
TOTAL	29	31	60

What fraction of the birds that Room 2 recorded were *kererū*?

A. $\frac{2}{29}$

B. $\frac{2}{9}$

C. $\frac{2}{60}$

D. $\frac{2}{31}$

E. $\frac{2}{7}$

Figure 2.1 An example of a KAMSI item

Piloting and trialling items

All items were reviewed by the project team. Where relevant, this included a cultural review to make sure any stimulus material was used appropriately. The items were then piloted with several classes of students and the results used to select items to trial with larger numbers of students in several schools around New Zealand. For the trial, sets of items were organised into assessment booklets and trialled at the appropriate year levels with approximately 250 students each. To explore the development of a single reporting scale, a trial booklet containing a selection of Year 4 and Year 8 items was administered to approximately 250 Year 6 students.

Draft scoring guides were developed for each constructed response item. Student responses from the trial were marked, and the resulting response data analysed using an Item Response Theory (IRT) model — the Rasch model[5]. The results of the trial were used to make final decisions about each item’s suitability for inclusion in the 2013 NMSSA Mathematics and Statistics study and to refine scoring guides.

The 2013 NMSSA mathematics and statistics study

A pool of 60 Year 4 items and 82 Year 8 items was available for the main study. The items were used to construct three Year 4 and three Year 8 assessment booklets. Each Year 4 booklet contained 33 items, and each Year 8 booklet contained 40 items. At each separate year level the booklets contained a number of common items to ensure achievement could be linked across the year level. Teacher Assessors were trained how to administer the assessments during a training session prior to the main study. Approximately 25 students in each school completed one of the booklets each — just over 2000 students in total at each year level.

[5] More information about the IRT modelling used in the NMSSA mathematics and statistics study is included in Part 7 of this chapter.

Responses to seven of the 142 items used in the main study showed poor fit to the Rasch model and were not included in constructing the final reporting scale. Table 2.4 summarises the number of items that were included, broken down by year level and by strand. The table shows that the major emphasis was on Number and Algebra.

Table 2.4 Number of KAMSI items developed by strand

Strand	Year 4	Year 8	TOTAL
Number and Algebra	31	45	76
Geometry and Measurement	18	22	40
Statistics	8	11	19
Total	**57**	**78**	**135**

Linking Year 4 and Year 8 results

To enable student achievement to be linked between Year 4 and Year 8 and reported on the same scale, two additional booklets were constructed that contained a mix of Year 4 and Year 8 items. The linking booklets were administered to a sample of approximately 700 Year 6 students from a number of schools outside the NMSSA sample.

The use of Year 6 students meant that an appropriate group of students were administered both Year 4 and Year 8 questions, that is, the questions were appropriately targeted for the students. As the Year 6 sample was selected for the purposes of scale construction and was not necessarily nationally representative, no results for Year 6 are presented in this report.

Marking

A marking plan was developed and a group of markers employed to score the student booklets. Before marking each constructed response item, the marking team discussed the item's scoring guide and a sample of responses was marked together. Quality assurance was achieved by having members of the assessment development team on hand and the use of double marking. Regular checks were carried out to verify accuracy and consistency of marking.

The measurement scale

An IRT model (the Rasch model) was applied to all student responses including data from the linking study to construct a single measurement scale for the KAMSI assessment. The scale locates both student achievement and item difficulty on the same measurement continuum using scale scores. The scale has been constructed so that the average scale score for the combined sample of Year 4 and Year 8 students is 100 scale score units, and the approximate standard deviation for a year level is 20 scale score units. Scale scores range from approximately 20 to 180 scale score units.

Further details about the measurement scale and its construction can be found in Part 7 of this chapter.

Scale description

Figure 2.2 provides a description of the KAMSI scale. In the figure the scale has been divided into six broad bands. Each band is associated with a description that outlines the knowledge and competencies associated with questions located at that part of the scale. The descriptions have been written to cover the three strands: Number and Algebra, Geometry and Measurement, and Statistics.

To create the scale description, each item used in the KAMSI assessments was placed on the scale where the modelled probability of answering the item correctly was 70 percent. Each item was then examined to identify the mathematical and statistical skills and knowledge it required. This allowed the mathematics competencies associated with different regions on the scale to be described. The scale description is used to interpret findings in the data in subsequent chapters of the report.

Scale: Knowledge and Application of Mathematical and Statistical Ideas

Number and Algebra	Measurement and Geometry	Statistics
Solve a subtraction involving mixed length decimals; Work flexibly with problems involving decimals; Find an unknown in an equation involving order of operations; Write an algebraic expression to represent the nth term in a pattern; Continue non-linear spatial patterns.	Explain how to convert between grams and kilograms.	
Order non-unit fractions; Recognise equivalent fractions; Add and subtract fractions; Convert three-digit decimals to percentages; Understand the order of operations; Continue non-linear number patterns; Find the square root of a whole number; Recognise representations of decimals and of non-unit fractions.	Show a flexible understanding of perimeter, area and volume; Understand the effect of using a scale factor to enlarge a shape.	Recognise and make statements about the distribution of graphs; Interpret a 2 by 2 frequency table.
Recognise the number of 100s in a four-digit number; Convert between simple fractions, decimals and percentages; Add and multiply numbers involving one decimal place; Find a simple percentage of a number; Apply a word formula; Understand equality; Continue number and spatial patterns; Find fractions of amounts.	Rotate objects using turns expressed in degrees; Calculate the difference between two times several hours apart; Use measurements presented on a plan to find an unknown dimension; Use millilitres to estimate the capacity of a glass; Recognise properties of 2-D and 3-D shapes; Recognise invariant properties under transformation.	Calculate the number of possible combinations; Understand that probability is related to the relative frequency of an event; Describe a general trend in time-series data; Recognise incorrect statements about a data display; Interpret a pie graph.
Understand the effect of dividing by 1; Use simple ratios to solve problems; Find missing numbers in a simple multiplication; Estimate the product of one and two-digit numbers; Recognise the greatest decimal number in a list; Match a number sentence with a word story; Continue repeating spatial patterns with two variables.	Show a correct understanding of how to use a measurement scale; Use side by side scales to convert between inches and centimetres; Use grid references and compass directions to show location; Identify which net can be used to make a shown box; Recognise examples of different transformations.	Understand how changes to data affect the average; Interpret a pictograph where a symbol represents multiple objects and half units are used; Understand probabilities expressed as unit fractions or as simple ratios.
Recognise the number of tens in a three-digit number; Calculate the difference between two two-digit numbers; Complete simple multiplications; Add a sequence of two-digit numbers; Estimate the sum of two three-digit numbers; Recognise which negative number is the lowest; Complete simple divisions; Continue simple number and spatial patterns.	Select appropriate units to measure a heavy object; Convert digital to analogue time; Read a half way mark on a scale marked in 20's; Understand what two metres means in terms of length; Reflect a shape in a mirror line; Recognise a side view from an isometric representation.	Interpret information presented in a simple table or graph; Relate information presented in a table to a bar chart; Understand the idea of "most likely".
Understand the effects of adding 0; Write numerals as words; Add groups of 10; Demonstrate a sense of place value up to 3 digits.	Recognise that a container holds one litre; Count the number of cubes in a shape where part of each cube is visible.	

Scale axis marks (top to bottom): 145, 140, 135, 130, 125, 120, 115, 110, 105, 100, 95, 90, 85, 80, 75, 70, 65

Figure 2.2 The scale description for Knowledge and Application of Mathematical and Statistical Ideas

4. The mathematical and statistical proficiencies assessment

The second component of the NMSSA mathematics and statistics programme, the Mathematical and Statistical Proficiencies (MSP) assessment, was focussed on students' ability to work mathematically and demonstrate a range of proficiencies that underpin the mathematics and statistics learning area of the NZC. The assessment addressed three broad and overlapping areas of proficiency: understanding; reasoning strategies and mathematical procedures; and communication.

The MSP was made up of a set of tasks that included performance and interview tasks. Each task involved multiple parts that assessed one or more of the proficiencies. Many of the tasks asked students to explain their thinking using words and diagrams and were marked using task-specific rubrics. Students responded to several of the tasks orally and Teacher Assessors prompted students when necessary, for clarification.

Most tasks were used at both Year 4 and Year 8. Approximately 800 students at each year level, a subsample of the NMSSA sample, completed the MSP assessment.

Assessment framework

A framework describing each of the proficiency areas and a curriculum coverage map was written to guide task development. As part of the development process a task template was used to record task characteristics such as the proficiency and strand foci, the assessment approach, and the difficulty level. See Appendix 2 for the MSP framework, the coverage map, and the MSP task template.

Adventure (Y4)

SUPPLIES: problem card, recording book

Hand student problem card, recording book and pencil.

Once upon a time in a far off land the king asked a clever adventurer (that's you) to go on a journey.
The king said it could be dangerous and you should take arrows with you just in case.
He asks you to choose one of these options:

A) 40 arrows
B) 4 sets of 12 arrows
C) 60 arrows but over half of these are broken

1. You want the most arrows. Which option would you choose? A, B or C
You can use the paper to help you work out your answer.
2. You chose *(student response)*. Explain to me how you know this choice has the most arrows.

TA ensure reasoning for choice is clear e.g., value/number of each choice or why other two weren't chosen.

Figure 2.3 An example of a Year 4 Mathematical and Statistical Proficiencies task

King's Adventure (Y8)

SUPPLIES: problem card, recording book

Hand student problem card, recording book and pencil.

The King of a far off land is sending you on an adventure.
He says there is a $\frac{2}{10}$ chance of discovering a new animal, a $\frac{3}{5}$ chance of finding treasure and a $\frac{1}{2}$ chance of getting lost!

1. What does the king think is most likely to happen on your adventure; discovering a new animal, finding treasure, or getting lost?
You can use the paper to help you work out your answer.

Allow time.

2. You chose *(student response)*. Explain to me how you got that answer.

TA ensure reasoning for choice is clear e.g., value/number of each choice or why other two weren't chosen.

Figure 2.4 An example of a Year 8 Mathematical and Statistical Proficiencies task

Piloting and trialling

The MSP tasks were piloted in Dunedin schools before being used in a larger trial involving several schools around New Zealand. The student responses from the pilots and trial were used to refine the tasks and support the development of appropriate scoring guides. An IRT model was also applied to the data at this stage to explore the development of a reporting scale and inform the selection of tasks for the main study.

The 2013 NMSSA mathematics and statistics study

Teacher assessors were trained how to administer the MSP tasks during a five day training session prior to the main study. During the study a selection of tasks was administered to eight students in each school. Teacher assessors were carefully monitored and received feedback to ensure consistency of administration. Student responses were captured on video and stored electronically for marking. Each student completed a specific selection of tasks to ensure all tasks could be linked together across and between year levels. Table 2.5 describes the MSP tasks.

Table 2.5 List of Mathematical and Statistical Proficiencies tasks including focus and approach

Task	Focus	Overview of Task	Approach
Class Mat	Understanding; Reasoning, strategies and mathematical procedures; Communication	Solve a word problem to find the area of a rectangle	Paper-and-pencil
Watch the Words	Reasoning, strategies and mathematical procedures; Communication	Demonstrate understanding of everyday language in a mathematical context e.g. altogether, increased by	Paper-and-pencil
Fractions	Reasoning, strategies and mathematical procedures; Communication	Demonstrate different ways to express fractions	Paper-and-pencil
Adventure (Y4), King's Adventure (Y8)	Communication	Explain how to solve a word problem	Interview
Shapes	Reasoning, strategies and mathematical procedures	Find which shape has the bigger area and provide reasoning for a solution to a problem with diagonal and straight lines	Interview
Number Sentences	Communication	Demonstrate understanding of mathematical operations	Interview
Shopping	Reasoning, strategies and mathematical procedures	Demonstrate an effective strategy to solve a word problem	Computer
Maths Meaning	Communication	Demonstrate understanding of mathematical terms and symbols	Computer

Marking

Teacher markers, many of whom had been teacher assessors, were employed to mark the tasks. All markers were trained, and quality assurance procedures were used to ensure consistency of marking. The marking schedules were refined as necessary to ensure they reflected the range of responses found in the main study.

Creating the mathematical and statistical proficiencies scale

The Rasch model was applied to all student responses from the MSP assessment to construct a measurement scale. The MSP scale locates both student achievement and item difficulty on the same measurement continuum using scale scores.

Like the KAMSI scale, the MSP scale has been constructed so that the average scale score for the combined sample of Year 4 and Year 8 students is 100 scale score units, and the approximate standard deviation for a year level is 20 scale score units. Scale scores range from about 20 to 180 scale score units.

Further details about the measurement scale and its construction can be found in Part 7 of this chapter.

Scale description

Figure 2.5 describes the specific knowledge and competencies required to successfully complete the mathematics questions at different parts of the scale for the MSP assessment. The descriptions are provided in three broad bands.

To develop the description each scoring category associated with a question from the MSP was placed on the scale where the probability of scoring in that category reached a maximum. The descriptions of the scoring categories were examined and used to craft descriptions across three bands of the scale.

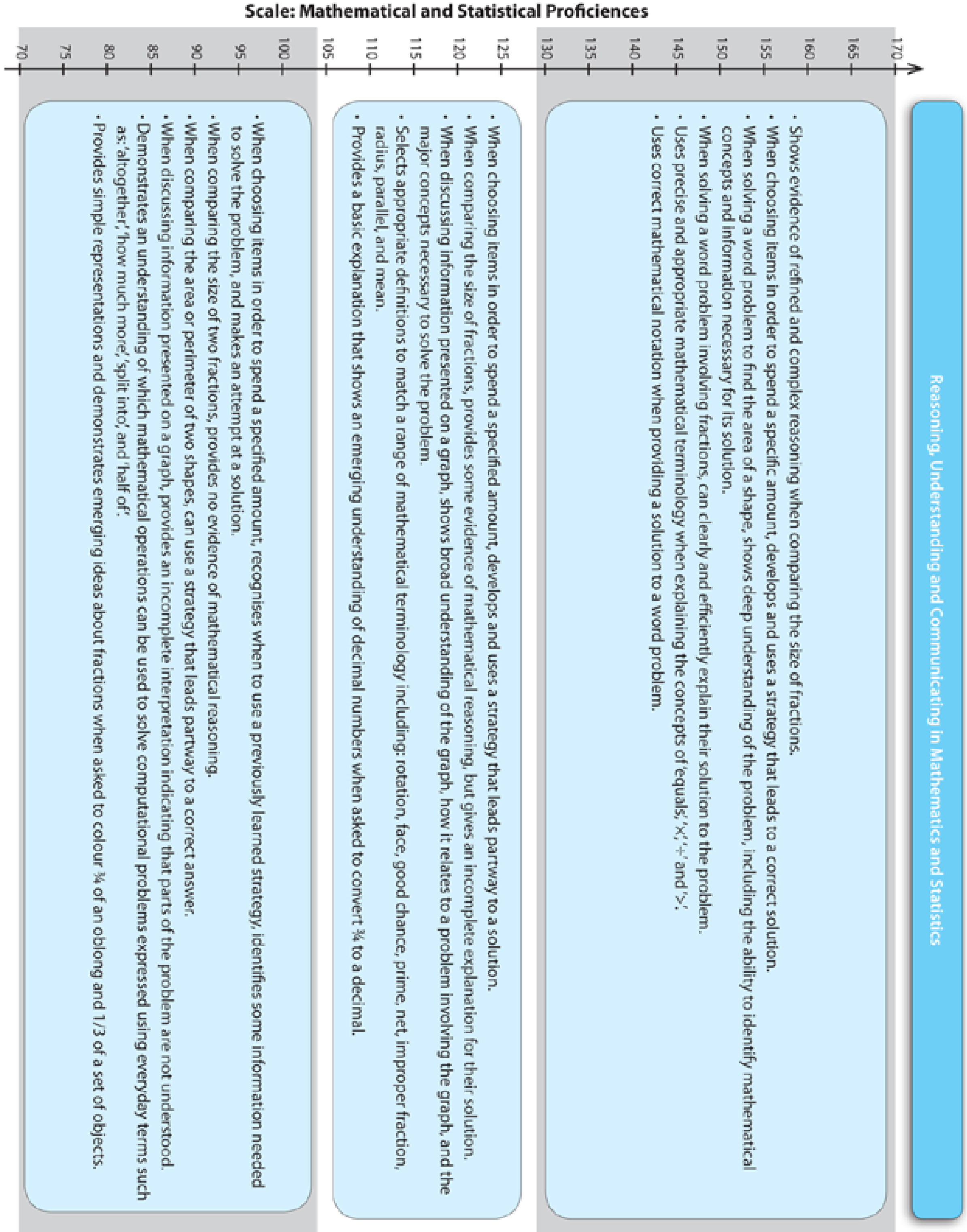

Figure 2.5 Scale Description for Mathematical and Statistical Proficiencies

5. Student attitudes, learning opportunities and perspectives on learning in mathematics

The third component of the NMSSA mathematics and statistics programme related to students' attitudes, their learning opportunities in mathematics, and their perspective on the nature of mathematics learning. Two methods were used to collect data. The first of these involved a student questionnaire, which was the same for Year 4 and Year 8 and was administered to all students in the 2013 NMSSA mathematics study. The second method involved a short one-to-one interview for students who were part of the individual study.

Attitudes to mathematics

One section of the student questionnaire asked students to show how much they agreed with a number of statements related to their general self-efficacy in mathematics and statistics and their level of engagement and interest in mathematics learning. Students used a four-point agreement scale to respond to each statement (Do not agree at all, Agree a little, Agree quite a lot and Agree heaps). The statements were sourced and/or adapted from a range of relevant studies, including NMSSA. The statements from the Attitudes to Mathematics section were:

- I usually do well in maths.
- I am good at maths.
- My teacher thinks I am good at maths.
- I think maths is interesting.
- I like doing maths at school.
- I would like to do more maths at school.
- I want to keep learning about maths when I grow up.
- I learn useful things in maths at school.

A draft version of the attitudes to mathematics section was piloted with small groups of students, before being used in a development trial with several hundred students at Year 4 and Year 8 in a range of schools. Responses from the trial were analysed using the Rasch model, and the results used to inform the selection of the final set of eight statements used in the 2013 NMSSA mathematics and statistics study.

The Rasch model was used to construct a reporting scale for the Attitudes to Mathematics section. The scale allowed the strength of each student's overall response to the set of statements to be located on a measurement continuum. Students who responded positively overall were given high scale scores. Students whose responses were more negative overall received lower scale scores. As with other NMSSA scales, the scale was set to have an average of 100 scale units and an approximate standard deviation of 20 scale units for a year level.

Opportunities to learn in mathematics

A second section of the student questionnaire asked students about the opportunities they had to learn mathematics. Students used a four-point response scale (Do not agree at all, Agree a little, Agree quite a lot, Agree heaps) to show how often they experienced different opportunities to be involved in mathematics learning activities. The learning opportunities statements were:

- Write about what I am learning in maths.
- Have a class or group discussion about a maths problem.
- Explain my way of solving a maths problem to other students or the teacher.
- Talk with the teacher about my maths learning and what my next learning steps might be.
- Learn about and use maths when doing work in other learning areas like in science or physical education or inquiry.
- I think about and do interesting maths problems.

A draft list of learning opportunities was piloted and trialled and a final list selected for use in the main study. Results from this section of the questionnaire have been reported item by item as the percentages of students selecting the different response categories for each learning opportunity.

Learning in mathematics interview

The one-to-one interview with individual students used a mixture of selected and open response questions to probe their perspectives on mathematics learning. The first section explored their beliefs about learning and was completed by all individual students. The second section was related to students' performance expectations and was completed by Year 8 students only. The interviews were videoed and a coding schedule developed to capture responses from the open-ended questions.

6. Teacher and principal perspectives on mathematics teaching and learning in the school

The final component of the assessment programme related to teacher and principal perspectives on mathematics teaching and learning in the school and involved teacher and principal questionnaires. The teacher questionnaire included questions related to their confidence as mathematics educators, their opportunities for professional development, and the types of mathematics learning activities and experiences that they provided for their students. The questionnaire was piloted with a teacher focus group and trialled with a small number of teachers from a range of schools, before being used in the main study. Teachers who taught mathematics to the students assessed in the mathematics study were asked to complete the questionnaire.

The principal questionnaire was developed to provide a school-wide perspective on mathematics and statistics teaching and learning in the school. It included questions related to curriculum priorities, resourcing, and professional learning.

7. Data analysis and reporting

In this section we provide some technical details around the scales developed to report the mathematics and statistics results, present the graphical formats used throughout the report, and provide some technical background and rationale for some of the statistics used.

IRT Scale construction

The scales used in this report have been developed using the Rasch Model. The family of Rasch measurement models are frequently used in studies such as this (for example PISA and TIMSS). The IRT software packages WINSTEPS[6] and RUMM[7] were used to develop the mathematics scales. Some advantages of applying the Rasch model are:

- both items and student achievement can be located independently on the constructed scale;
- unlike raw test scores, the measurement scale units represent the same amount of change in achievement across the whole scale;
- achievement for Year 4 and Year 8 students can be located on the same measurement scale;
- scales can be described to show what students typically understand and are able to do at different parts of the scale (for example, the scale descriptions in Part 3 and Part 4 of this chapter).

Standardising the scales

For ease of understanding, each of the scales developed using the Rasch model has been standardised so that:

- the mean of all students (Year 4 and Year 8 combined) is equal to 100 scale units;
- the average standard deviation for the two year levels is equal to 20 scale units.

The scores on each of the mathematics and statistics achievement scales range from around 20 to 180 scale units.

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6 Linacre, J. M. (2009). WINSTEPS Rasch measurement computer program. Chicago: Winsteps.com

7 Andrich, D., Sheridan, B.S., & Luo, G. (2012). Rumm 2030: Rasch Unidimensional Measurement Models (software). RUMM Laboratory Perth, Western Australia.

The association between the achievement measures

The two components of the assessment programme focussed on achievement (KAMSI and MSP) were centred on different, but overlapping aspects of mathematics and statistics in the NZC. They also used different assessment approaches to gather information: group-administered paper-and-pencil assessments compared with individual assessments using more open-ended performance tasks and student interviews. The correlation between the two measures was relatively high (.79 at Year 4 and .87 at Year 8) and indicates that they measure similar skills and competencies. Because of the differences in focus and approach the results from both assessments are reported separately.

Scale reliability

Table 2.6 provides reliability indices for each of the reporting scales developed for use in the assessment programme. These relate to the reliability of item locations and students' scale scores and have been calculated by the software used to construct the scales. The overall reliabilities are high and indicate that for each measure, both items and students' scores have been located on the respective scales with a very satisfactory level of precision.

Table 2.6 The reliability of the NMSSA scales

Measure	Item Reliability	Person Reliability
Knowledge and Application of Mathematics Ideas	1.00	0.92
Mathematical and Statistical Proficiencies	1.00	0.94
Attitude to Mathematics	0.99	0.86

Reporting achievement against curriculum levels

A curriculum alignment exercise using a bookmarking methodology was undertaken to link performance ranges on the KAMSI scale to the levels of the NZC. Creating this link allowed scale scores for the KAMSI assessment to be reported in terms of curriculum levels. The KAMSI scale was selected for alignment as it was completed by the larger sample of students.

In the NZC each of the first four curriculum levels has been designed to represent about two years of learning at school. In general, students are expected to be achieving firmly at Curriculum Level 2 by the end of Year 4 and firmly at Curriculum Level 4 by the end of Year 8.

The alignment exercise focused on defining scoring bands associated with performance at Level 2 and Level 4 of the curriculum. As noted, these are the expected scoring levels for student performance in Years 4 and 8 and were also associated with the greatest concentration of items written for the KAMSI assessment.

More information about the curriculum alignment procedures is provided in Appendix 3.

Use of graphs in the report

Box and whisker plots

Box and whisker plots are used extensively throughout this report. They are used to summarise groups of scores.

Scores are ordered from low to high and then divided into four equally sized groups, called quartile groups. These are displayed as shown in Figure 2.6.

Box: The box shows the middle 50 percent of the scores.

Whiskers: In this report, the whiskers of the box plot do not include outliers (scores that are rare and unusual) and have a maximum length of 1.5 × the inter-quartile range.

Colours: Box plots for reporting scales are coloured orange and teal. Two colours are used for the middle quartile groups to make it easier to distinguish between them. If printed in grey scale these colours still produce a contrast. Box plots relating to Attitudes to Mathematics are presented in a different pair of colours to distinguish them from those relating to achievement.

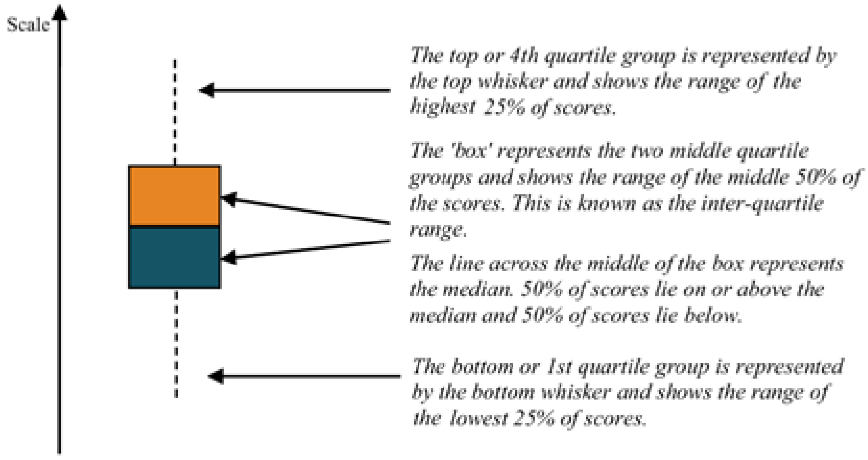

Figure 2.6 Understanding box plots

Grid lines: Grid lines are used on the box plots to make them easier to interpret. These are especially helpful in the graphs with many box plots side by side. The grid lines are placed at every 40 scale score units. They bear no relation to curriculum levels.

For plots involving the KAMSI assessment, the curriculum levels that correspond to scale score cut-offs are noted on the right of the graph and are indicated by the grey horozontal dotted lines across the graph (Figure 2.7).

Line graphs of score distributions

Another type of graphic used to display data in this report is the line graph (Figure 2.8). These are used to show how the distributions of scale scores for various groups compare with curriculum expectations.

Horizontal shaded lines are used to indicate the 'cut scores' used to separate one curriculum level from another. The shading around the lines provides a reminder that these lines represent the result of a judgment exercise.

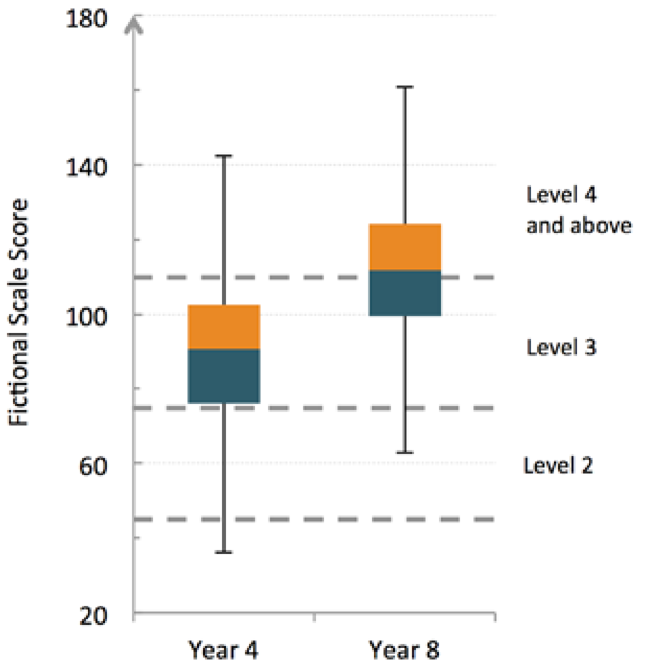

Figure 2.7 Interpreting box plots and NZC level bands

A detailed exercise was undertaken to establish the locations on the scales where one curriculum level merged into the next. Details of the standard setting exercise used to establish the curriculum bands can be found in Appendix 3. Curriculum levels are always labelled clearly when used, and should not be confused with grid lines in the box plots.

In graphs that display a scale, the scale is always placed on the vertical axis.

Graphs of sub-group differences

A graph called the scale score differences display has been developed to show the differences in scale score units between population sub-groups presented in pairs. An example is shown in Figure 2.9. The display shown provides comparisons for three pairs of Year 4 sub-groups on a fictional NMSSA scale: New Zealand European compared to non-New Zealand European, Māori compared to non-Māori and Pasifika compared to non-Pasifika. A blue bar is presented for each pair. The top of each bar marks the average score for the sub-group in each pair that scored higher. The bottom of the bar marks the average score for the sub-group in the pair that scored lower. The number above the bar indicates the difference between the two average scores in scale score units. The dotted red line shows the national average score for all students in Year 4.

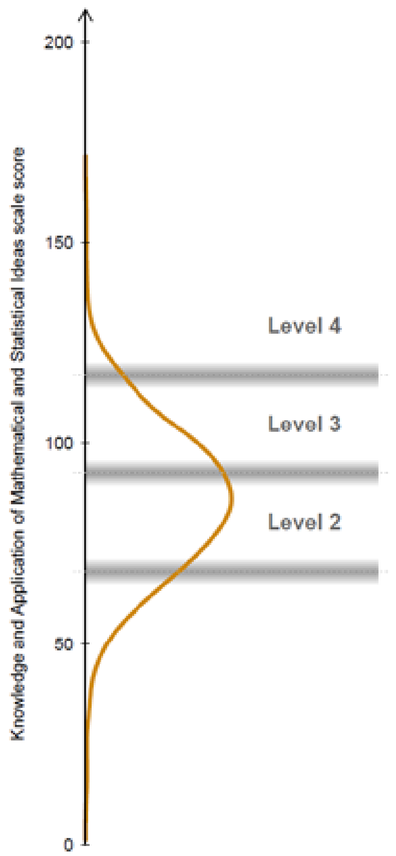

Figure 2.8 An example of a line graph display

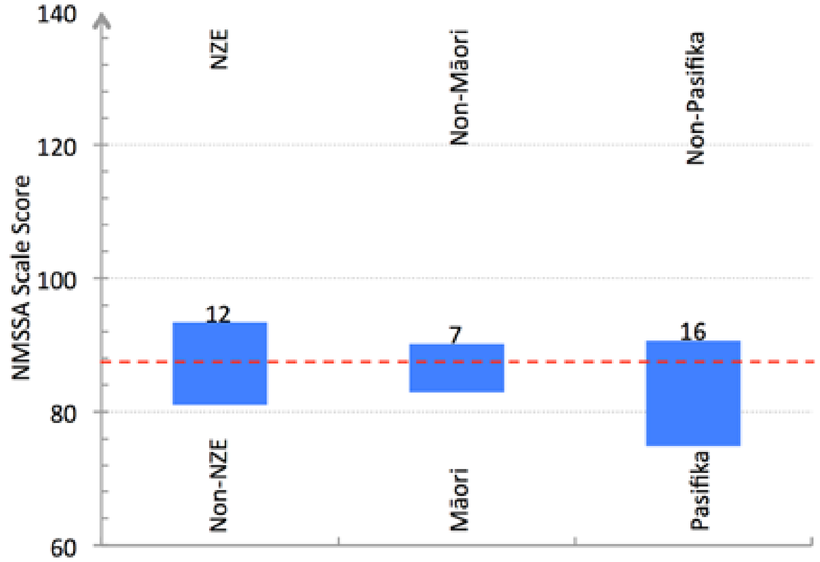

Figure 2.9 A scale score differences display for students on a fictional NMSSA scale

Interpreting score differences, effect size statistics and statistical significance

The two achievement measures developed for the NMSSA mathematics and statistics study quantify achievement differences in terms of scale score units. Because the same scales have been used at both Year 4 and Year 8 it is possible to estimate how much change on average occurs on an annual basis. Table 2.7 shows the differences in average scale scores on the KAMSI and MSP scales between Year 4 and Year 8, and how this relates to annualized change. As can be seen, on both measures students improved on average by about eight scale units per year. This figure is useful to keep in mind when interpreting scale score differences throughout the report.

Table 2.7 Average scale score differences between Year 4 and Year 8

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Year 4/Year 8 difference* (scale score units)	29	34
Average annual scale score change (scale score units)	7.25	8.5
Effect size	1.43	1.68
Average annual effect size	0.36	0.42

* Difference = Year 8 - Year 4

Table 2.6 also shows what the scale score differences between Year 4 and Year 8 equate to in terms of effect sizes. As can be seen, the average annual effect size is about 0.4 on each measure. Effect sizes have been used throughout the report to help interpret differences between groups. An effect size quantifies the difference between the average scores for two groups in terms of standard deviation units. The calculation of the effect sizes in this report weights the standard deviation for each group by its sample size[8]. Because the standard deviations for groups are often different, this can mean that the same difference in scale scores results in slightly different effect sizes for different pairs of groups. When comparing two effect sizes it is very important to refer back to the scale score differences.

Ninety-five percent confidence intervals have been calculated for each effect size reported and used to determine when an effect is statistically significant. A statistically-significant effect size means that the data support the hypothesis that the effect is real (non-zero). Statistically significant effect sizes are shown in bold text in the tables of findings. The confidence intervals have been adjusted to account for any design effect created through the sampling procedure (i.e. sampling schools and then sampling students).

As well as considering statistical significance, it is also important to consider the size of the effect. When groups are large (as for NMSSA), relatively small effects can be statistically significant.

Effect sizes have been used to examine:

- the difference in achievement between Year 4 and Year 8 students;
- the difference between sub-groups of students (girls/boys; NZ European/Non-NZ European, Māori/Non-Māori, Pasifika/Non-Pasifika students; schools of high, mid and low decile; and types of school (at Year 4 – full primary, and contributing; at Year 8 – composite, full primary, intermediate, and secondary).

Differences between the effect sizes for different pairs of comparisons were considered notable (significant) when the confidence intervals surrounding the respective effect sizes were non-overlapping. The average annual effect sizes between Year 4 and Year 8 student achievement (0.42 and 0.36 for KAMSI and MSP respectively) were used as guidelines to interpret sub-group differences in terms of years of progress.

The use of rounding

The average scores for each group and sub-group have been rounded to whole numbers. Some tables of findings report the difference between average scale score units for two groups or sub-groups. The scale score differences have been calculated using non-rounded numbers, and are numerically correct. In some cases the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

[8] The formula for the effect size calculation is: $\frac{M_1 - M_2}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}}$, where M_1 and M_2 represent the average scores for group 1 and group 2, s_1 and s_2 their standard deviations, and n_1 and n_2 the number in each group.

3 Student Achievement in Mathematics and Statistics

This chapter describes Year 4 and Year 8 student achievement in mathematics and statistics based on the two measures developed for the 2013 NMSSA mathematics and statistics assessment programme: Knowledge and Application of Mathematical and Statistical Ideas (KAMSI), and Mathematical and Statistical Proficiencies (MSP). The chapter examines how achievement varies within and between year levels, including variation by gender, ethnicity, school decile, and type of school. Achievement is also reported against the levels of the New Zealand Curriculum (NZC).

The chapter is organised into five parts. The first and second parts consider achievement for Year 4 and Year 8 students respectively. The third part examines achievement by decile and ethnicity, and the fourth part compares achievement between the two year levels. The fifth part presents a deeper look at student achievement by exploring performance on a selection of questions and tasks used in the KAMSI and MSP measures.

Tables and graphs are used throughout the chapter to display results. For many of the tables, particularly those associated with population sub-groups, fuller table of means, standard deviations, sample sizes, effect sizes and 95 percent confidence intervals can be found in Appendix 4.

Student achievement in mathematics and statistics – An overview

Student achievement in mathematics and statistics was assessed using two measures: Knowledge and Application of Mathematical Ideas (KAMSI); and Mathematical and Statistical Proficiencies (MSP).

Achievement against curriculum levels

The KAMSI scale was aligned to the curriculum levels in mathematics. Eighty one percent of Year 4 students scored within the performance band on the KAMSI measure associated with curriculum Level 2 or above. Forty one percent of Year 8 students scored within the performance band associated with curriculum Level 4 or above. Most Year 4 students were achieving in line with expectations expressed in the NZC. The majority of Year 8 students were achieving below curriculum expectations. There was a wide distribution of scores at both year levels on both achievement measures and some overlap in the achievement of Year 4 students and Year 8 students.

Achievement of sub-groups

Analysis of key population sub-groups showed average achievement varied by ethnicity and school decile. There were small, but statistically significant effects related to gender and school type. For both year levels, average scores on both measures were lower for Māori and Pasifika students than for non-Māori and non-Pasifika students respectively. Average scores were also lower for students from lower decile schools. These patterns are consistent with those observed over time in NEMP and TIMSS, as well as in NMSSA in Science and Writing from 2012.

When decile differences are accounted for, achievement on the KAMSI measure did differ according to ethnic group. This is similar to findings from NMSSA health and physical education (2013) where statistically significant ethnicity differences were also found after decile was taken into account.

'Progress' between Year 4 and Year 8

The difference in average scores between Year 4 and Year 8 students was used as a proxy for progress. The average annualised effect size over the two achievement measures was 0.39, greater than that found in NMSSA's 2013 health and physical education study (0.28) and the group administered 2012 NMSSA science measure (0.30), and similar to the effects found in the 2012 NMSSA writing study. There is some indication that Pasifika students made less 'progress' on average than non-Pasifika students and that Asian students made more 'progress' on average than other students.

Item analysis

Analysis of performance on different items used in the KAMSI assessment provide examples of the kinds of questions students found more or less difficult at each year level. An analysis of KAMSI items located at or around the Year 8 average indicates that in general, students are not having the success expected on items involving fractions, decimals, percentages and pro-numerals.

1. Year 4 achievement in mathematics and statistics

Overall Achievement

Table 3.1 provides the average scale scores, standard deviations, and sample sizes for Year 4 students on the two NMSSA mathematics and statistics achievement measures.

Table 3.1 Overall measures of mathematics and statistics achievement at Year 4

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Average (scale score units)	86	83
SD (scale score units)	19	17
N	2070	789

The scale description developed for the KAMSI measure indicates that the middle 50 percent of Year 4 students (those clustered around the average for Year 4) were typically able to answer questions related to Number and Algebra that asked them to:

- recognise the number of 10s in a three digit number;
- convert a 3-digit number written in words to numerals;
- calculate the difference between two 2-digit numbers;
- complete a simple multiplication involving numbers with one and two digits;
- regroup numbers and work with simple divisions;
- continue a simple additive sequence.

In questions about Geometry and Measurement these students were typically able to:

- select appropriate units to measure weight;
- convert time on a digital clock to an analogue clock;
- recognise that a container holds 1 litre;
- reflect a shape in a mirror line;
- identify the number of cubes in a simple 3-D shape;
- identify a shape is a square.

In questions related to the Statistics strand they were typically able to:

- interpret information presented in a simple table;
- relate information presented in a table to a bar chart;
- understand the idea of 'most likely'.

A curriculum alignment exercise (see Chapter 2 for details) was undertaken to link performance ranges on the KAMSI achievement scale to the curriculum levels of the NZC. Table 3.2 shows how Year 4 students' KAMSI scores were distributed across curriculum levels. A strong 'at Level 2' performance is the curriculum expectation for Year 4 students at the end of the year.

Table 3.2 Percentage of Year 4 students achieving across curriculum levels according to the Knowledge and Application of Mathematical and Statistical Ideas measure

	Knowledge and Application of Mathematical and Statistical Ideas (%)
Level 4 and above	5
Level 3	31
Level 2	45
Level 1	19

Figure 3.1 depicts a more generalised view where the whole distribution of Year 4 scores can be seen against the agreed alignment of curriculum levels 2, 3, and 4 with the KAMSI scale. The horizontal dotted lines represent the cut-scores for the performance bands associated with curriculum levels 2, 3 and 4.

Overall, 81 percent of Year 4 students were achieving in the performance range associated with curriculum level 2 or above.

Year 4 achievement by sub-group

Figures 3.2 and 3.3 display the level and spread of scores for key population sub-groups in Year 4 on the two mathematics and statistics achievement measures. Boxplots are used to show results by gender, ethnicity[9], school decile[10], and type of school[11]. The table of information that follows each figure (Table 3.3 and Table 3.4) provides the average, standard deviation and number of students for the distributions shown in the figures.

The pattern of achievement at Year 4 for these sub-groups was similar on both measures: gender differences were small, but some differences between ethnic groups and between school decile groups were notable.

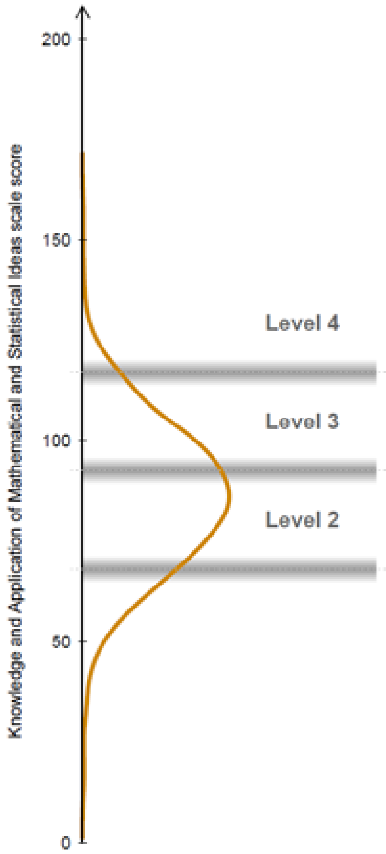

Figure 3.1 Distribution of Year 4 Knowledge and Application of Mathematical and Statistical Ideas scale scores aligned with curriculum levels.

9 Non-prioritised ethnicity was used where students could identify with up to three ethnicities. This meant they could be present in multiple ethnic groups. Student ethnicity data were obtained from student NSN information held on the Ministry of Education ENROL database. The ‘NZ European’ category included NZ Pakeha only. The 'Pasifika' category included Tokelauan, Fijian, Niuean, Tongan, Cook Islands Maori, Samoan and other Pacific peoples. The 'Asian' category included Filipino, Cambodian, Vietnamese, Other Southeast Asian, Indian, Chinese, Sri Lankan, Japanese, Korean, and other Asians. The 'Other' category included Australians, British/Irish, German, Dutch, Greek, Polish, South Slav, Italian and other Europeans, Middle Eastern, Latin American, African, and Not Stated.

10 Low decile schools (1–3); Mid decile schools (4–7); High decile schools (8–10)

11 Full Primary (Year 1–8); Contributing (Year 1–6); Intermediate (Year 7–8); Composite (Year 1–13); Secondary (Year 7–13)

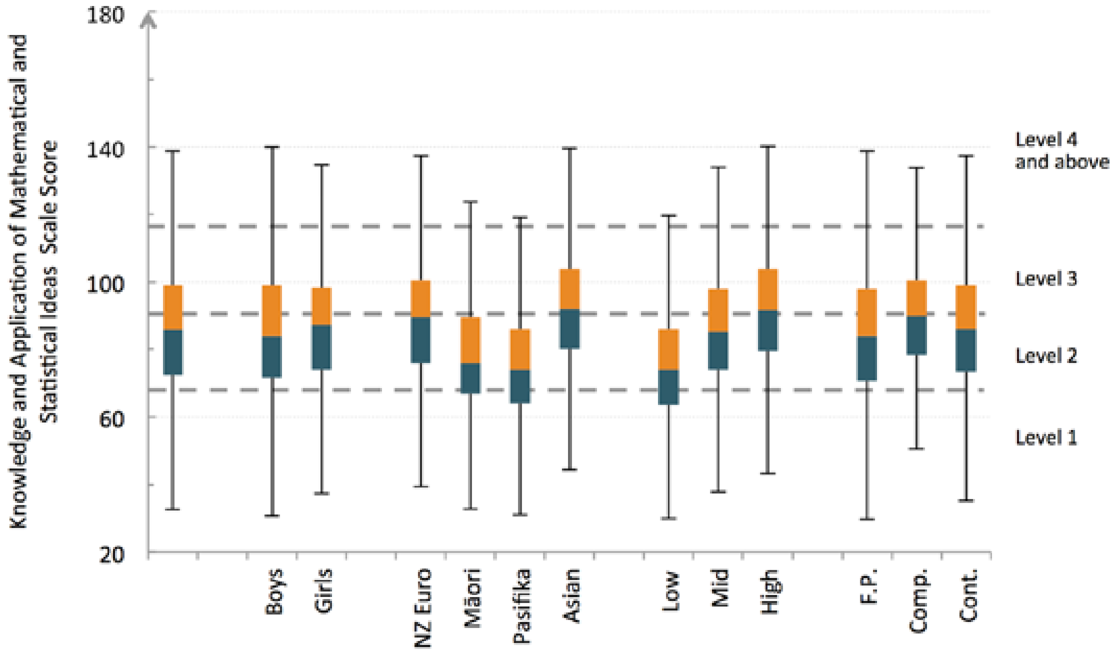

Figure 3.2 Year 4 student scores for Knowledge and Application of Mathematical and Statistical Ideas by gender, ethnicity, school decile and type (NZ Euro=NZ European, F.P.=Full Primary, Comp.=Composite, Cont.=Contributing)

Table 3.3 Year 4 student scores for Knowledge and Application of Mathematical and Statistical Ideas by gender, ethnicity, school decile and type

	Knowledge and Application of Mathematical and Statistical Ideas		
	Average (scale score units)	**SD** (scale score units)	**N**
Gender			
Boys	85	20	1050
Girls	87	19	1020
Ethnicity			
NZ European	89	19	1321
Māori	77	19	424
Pasifika	75	17	255
Asian	92	18	247
School Decile			
Low	74	18	463
Mid	86	19	707
High	92	18	900
School Type			
Full Primary	84	20	721
Composite	90	17	57
Contributing	86	19	1292

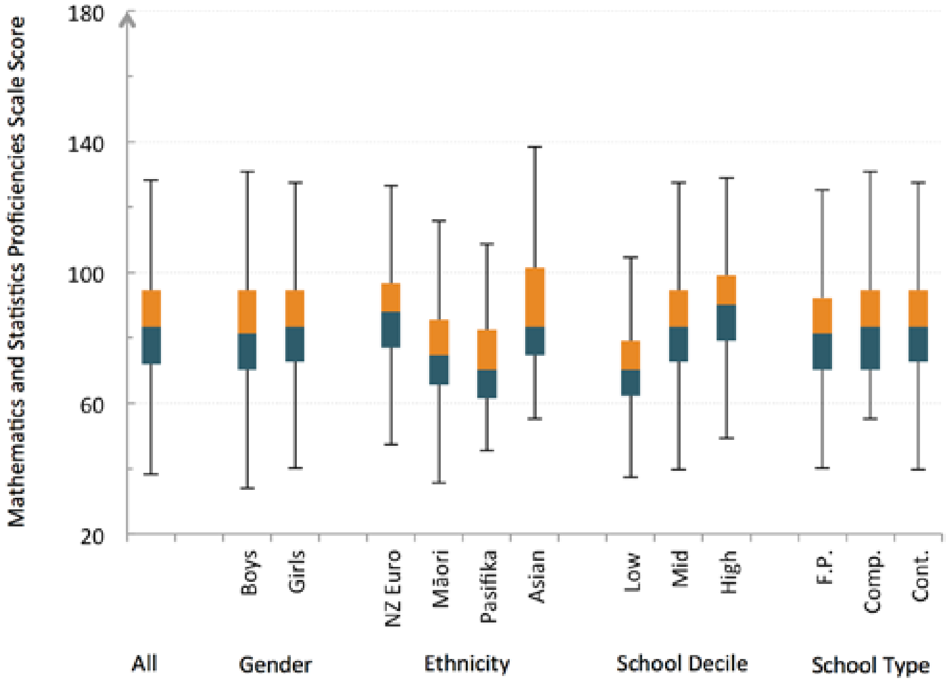

Figure 3.3 – Year 4 student scores for Mathematical and Statistical Proficiencies by gender, ethnicity, school decile and type (NZ Euro = NZ European, F.P. = Full Primary, Comp = Composite, Cont.= Contributing)

Table 3.4 Year 4 student scores for Mathematical and Statistical Proficiencies by gender, ethnicity, school decile and type

	Mathematical and Statistical Proficiencies		
	Average (scale score units)	**SD** (scale score units)	**N**
Gender			
Boys	83	18	419
Girls	84	16	370
Ethnicity			
NZ European	86	16	493
Māori	76	15	164
Pasifika	73	14	100
Asian	89	19	93
School Decile			
Low	72	14	189
Mid	84	16	281
High	90	17	319
School Type			
Full Primary	82	18	304
Composite	84	19	24
Contributing	84	17	461

Figures 3.4 and 3.5 display the differences in the average scale score for the sub-groups, illustrating their relative effect size on the two achievement measures.

Year 4 students from low decile schools scored on average, 17 scale points lower than their peers from high decile schools on the KAMSI scale and 18 scale points lower on the MSP scale. In both cases, the difference represents an effect size greater than 1.00. The difference between low and mid decile schools was smaller (an effect size of about 0.70) than the difference between mid and high decile schools (an effect size of about 0.35). These effect sizes were all statistically significant[12].

On both measures, Asian students on average, scored the highest. The difference in average scores between Asian and non-Asian students represented an effect size of about 0.40. The difference in average scale scores across ethnic groups at Year 4 was greatest between Pasifika and Non-Pasifika. On average, Non-Pasifika scored higher than Pasifika, represented by an effect size of about 0.68. Māori students on average performed similarly to Pasifika.

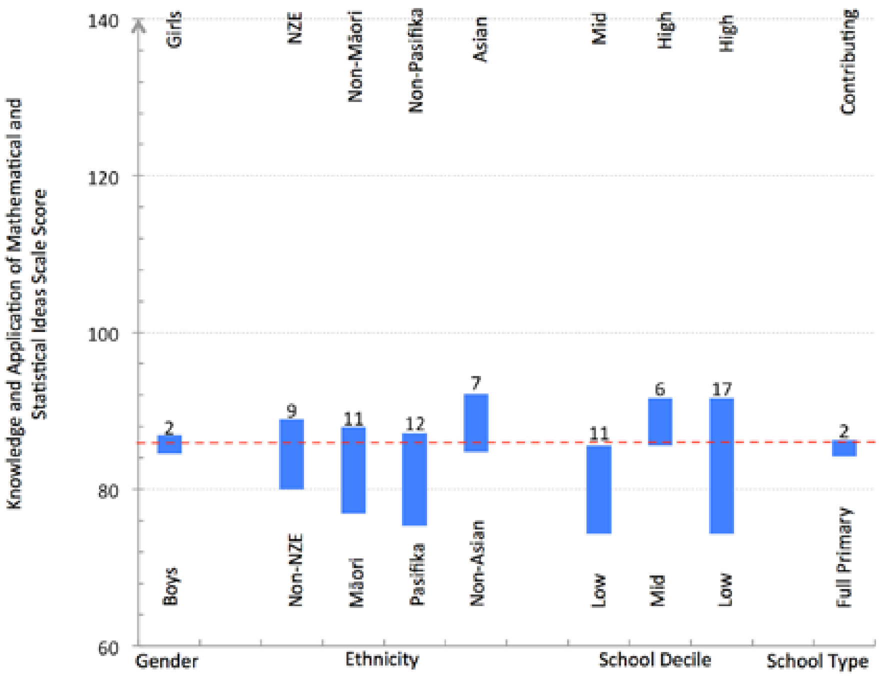

Figure 3.4 Year 4 students: Difference in average scores for Knowledge and Application of Mathematical and Statistical Ideas by sub-group (NZE=NZ European)

[12] i.e. data supports the hypothesis that the effect size is greater than zero

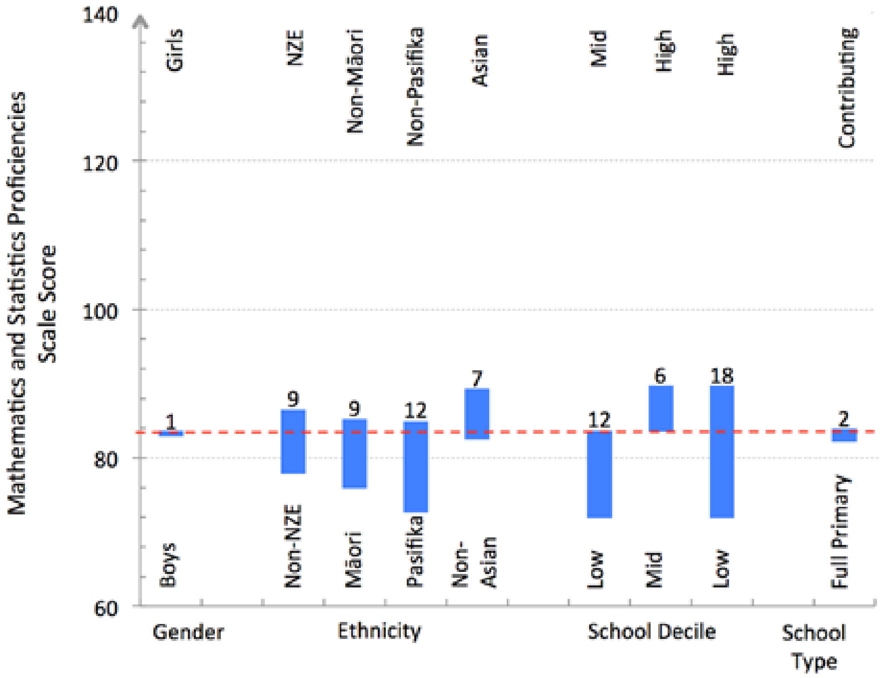

Figure 3.5 Year 4 students: Difference in average scores for Mathematical and Statistical Proficiencies by sub-group (NZE=NZ European)

Table 3.5 summarises average scale score differences and effect sizes between sub-groups on the two mathematics and statistics achievement measures.

Table 3.5 Year 4 sub-group differences on the two mathematical and statistical achievement scales

	Knowledge and Application of Mathematical and Statistical Ideas		Mathematical and Statistical Proficiencies	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Gender				
Boys/Girls	-2	**-0.11**	-1	-0.03
Ethnicity				
NZ European/Non-NZ European	9	**0.47**	9	**0.52**
Māori/Non-Māori	-11	**-0.58**	-9	**-0.56**
Pasifika/Non-Pasifika	-12	**-0.62**	-12	**-0.73**
Asian/Non-Asian	7	**0.39**	7	**0.40**
School Decile				
Low/Mid	-11	**-0.62**	-12	**-0.77**
Mid/High	-6	**-0.32**	-6	**-0.37**
Low/High	-17	**-1.09**	-18	**-1.27**
School Type				
Full Primary/Contributing	-2	**-0.12**	-2	-0.12

Effect sizes in bold are statistically significant (*p*<.05)

2. Year 8 achievement in mathematics and statistics

Overall achievement

Table 3.6 provides the average scale scores, standard deviations and sample sizes for Year 8 students on the two NMSSA mathematics and statistics achievement measures.

Table 3.6 Overall measures of mathematics and statistics achievement at Year 8

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Average (scale score units)	114	117
SD (scale score units)	21	23
N	2066	783

On the KAMSI assessment the middle 50 percent of the Year 8 students generally had little problem with questions involving the competencies previously described for Year 4 students. They also typically found questions associated with the Number and Algebra strand involving the following competencies well within their capabilities:

- recognise the greatest decimal;
- estimate the product of two two-digit numbers;
- recognise the sum of two numbers that include tenths;
- find a simple percentage of a whole number amount;
- recognise 1 as the multiplicative identity;
- give the sixteenth member of the spatial pattern 2, 4, 6, 8.

For questions associated with the Geometry and Measurement strand they could typically:

- use side by side scales to convert between inches and centimetres;
- estimate a distance on a map using a given scale;
- use grid references and compass directions to show location;
- show flexibility with isometric representations;
- recognise examples of transformations.

For questions associated with the Statistics strand they typically could:

- understand how changes to data affect the average;
- recognise the largest of three probabilities expressed as ratios.

Table 3.7 shows how Year 8 students' KAMSI scores were distributed across the curriculum levels. Forty one percent of Year 8 students scored in the performance band associated with Level 4 or above. At the end of Year 8 the curriculum expectation is for students to be achieving solidly at Level 4.

Table 3.7 Percentage of Year 8 students achieving across mathematics and statistics curriculum levels according to the Knowledge and Application of Mathematical and Statistical Ideas measure

	Knowledge and Application of Mathematical and Statistical Ideas (%)
Level 4 and above	41
Level 3	48
Level 2	10
Level 1	1

Figure 3.6 depicts a more generalized view where the whole distribution of Year 8 scores can be seen against the agreed alignment of curriculum levels 2, 3, and 4 with the KAMSI scale. The horizontal dotted lines represent the cut-scores for the performance bands associated with each curriculum level. The graphic shows that many Year 8 students performed within, or bordering on, curriculum Level 4 and above. However, the majority of students did not achieve at Level 4 or above.

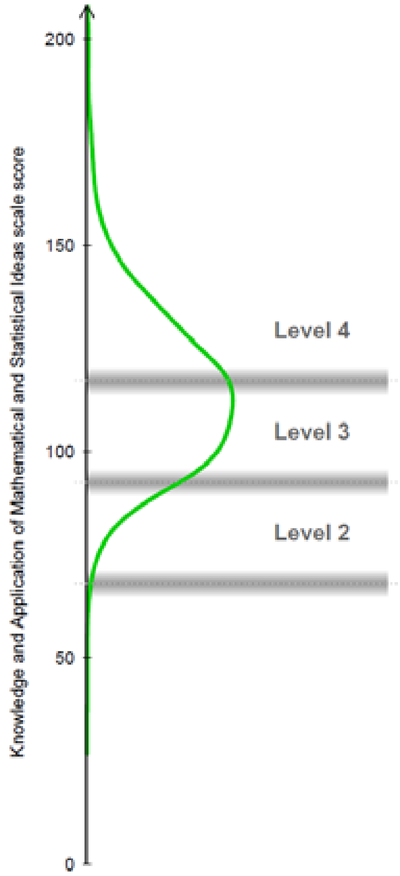

Figure 3.6 Distribution of Year 8 Knowledge and Application of Mathematical and Statistical Ideas scores aligned with curriculum levels.

Year 8 achievement by sub-group

Figures 3.7 and 3.8 display the achievement results for sub-groups in Year 8 on the two mathematics and statistics achievement measures. Boxplots are used to show results by gender, ethnicity, school decile, and type of school. The table of information that follows each figure (Table 3.8 and Table 3.9) provides the average, standard deviation and number of students for the distributions shown in the figures.

The pattern of achievement at Year 8 was similar for the different sub-groups across both measures. On average, boys scored higher than girls, although this difference was not statistically significant for the MSP measure.

Māori and Pasifika students scored lower than non-Māori and non-Pasifika students respectively, and students in the lowest decile schools scored lower, on average, than those from mid or high decile schools. Asian students scored higher than non-Asian students. The standard deviation for Asian students was greater on both measures than the standard deviation for other ethnic groups.

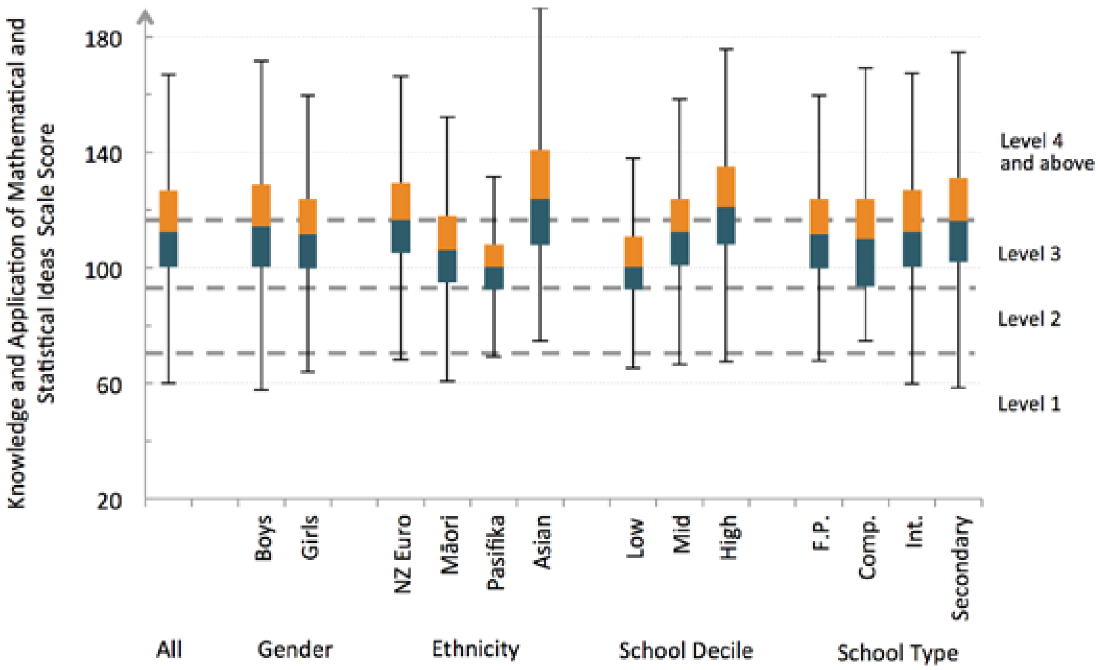

Figure 3.7 Year 8 student scores for Knowledge and Application of Mathematical and Statistical Ideas by gender, ethnicity, school decile and type (NZ Euro=NZ European, F.P.=Full Primary, Comp.=Composite, Cont.=Contributing, Int.=Intermediate)

Table 3.8 Year 8 student scores for KAMSI by gender, ethnicity, school decile and type

	Knowledge and Application of Mathematical and Statistical Ideas		
	Average (scale score units)	**SD** (scale score units)	**N**
Gender			
Boys	116	22	1053
Girls	113	19	1013
Ethnicity			
NZ European	118	19	1288
Māori	107	18	479
Pasifika	100	14	278
Asian	127	26	165
School Decile			
Low	102	16	405
Mid	114	19	989
High	123	22	672
School Type			
Full Primary	113	19	745
Composite	113	22	89
Intermediate	114	21	941
Secondary	118	23	291

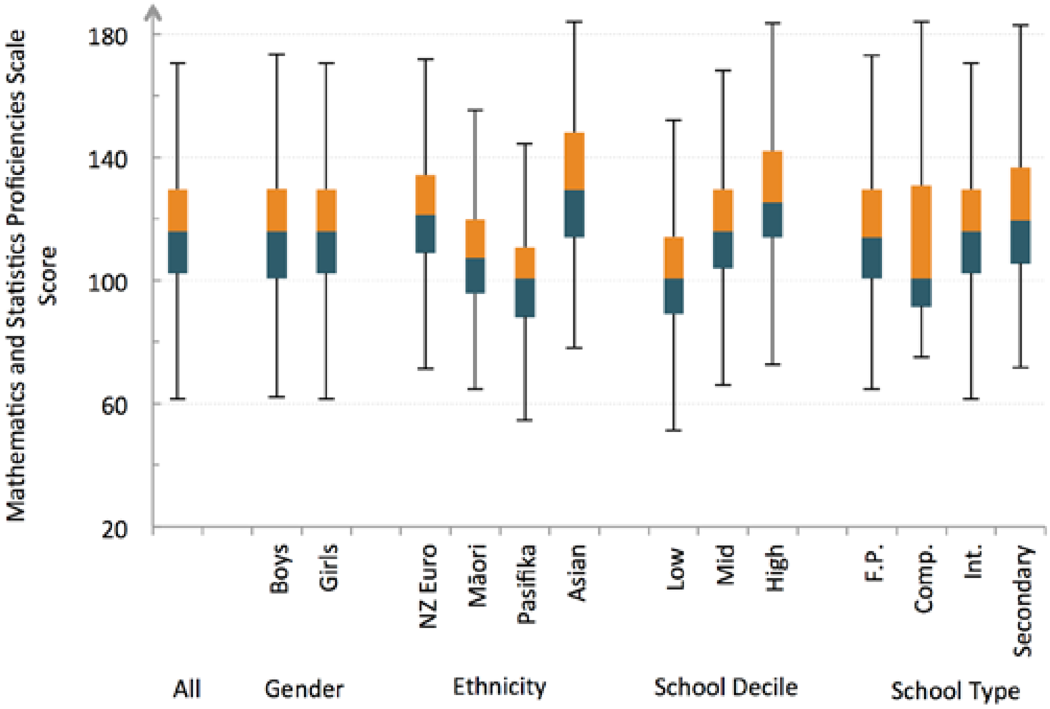

Figure 3.8 Year 8 student scores for Mathematical and Statistical Proficiencies by gender, ethnicity, school decile and type (NZ Euro=NZ European, F.P.=Full Primary, Comp.=Composite, Cont.=Contributing, Int.=Intermediate)

Table 3.9 Year 8 student scores for Mathematical and Statistical Proficiencies by gender, ethnicity, school decile and type

	Mathematical and Statistical Proficiencies		
	Average (scale score units)	**SD** (scale score units)	**N**
Gender			
Boys	118	23	388
Girls	116	22	395
Ethnicity			
NZ European	123	20	468
Māori	108	19	195
Pasifika	99	20	103
Asian	131	25	61
School Decile			
Low	101	19	168
Mid	117	20	371
High	128	22	244
School Type			
Full Primary	115	21	300
Composite	113	27	40
Intermediate	117	23	340
Secondary	121	21	103

Figures 3.9 and 3.10 display the differences in average scale scores between the sub-groups, illustrating their relative effect size on the two mathematics and statistics measures. Table 3.10 summarises the information presented in the two graphics showing differences in average scale scores between sub-groups and their effect sizes, on the two achievement measures.

Across both measures, Year 8 students from low decile schools scored, on average, more than 20 scale points lower than those from high decile schools. This difference is more marked for the MSP assessment than the KAMSI assessment, and in both cases the difference represents an effect size greater than 1.0. The difference between low and mid decile schools was also fairly large with an effect size of about 0.70, while the difference between mid decile and high decile schools was smaller with an effect size of about 0.50. The differences between the decile groups were greater at Year 8 than Year 4 on both measures.

On both measures the difference in average scale scores between Pasifika and non-Pasifika was the greatest across the ethnic groups, with an effect size of around 0.90. The differences in average scale scores between NZ European and non-NZ European, and between Māori and non-Māori were smaller, with an effect size of around 0.60 for both groups. On average, Asian students scored higher than non-Asian students on both measures with an effect size of around 0.70.

On both measures the difference in average scale scores between Pasifika and non-Pasifika students was greater at Year 8 than at Year 4. In addition, on average, Asian students had a greater score advantage over non-Asians at Year 8 than was recorded at Year 4.

On the KAMSI assessment boys on average scored higher at Year 8 than girls, reversing the achievement pattern recorded for Year 4s. At both year levels these gender differences were relatively small (effects sizes of around 0.10). The gender differences recorded for the MSP assessment at Year 4 and Year 8 were not statistically significant. On both measures and at both year levels the standard deviation of the boys' scores was greater than the standard deviation for the girls' scores.

On both measures, Year 8 students in secondary schools on average, outperformed Year 8 students at full primaries and intermediate schools. The result should be interpreted with care, as the relatively small number of secondary schools involved in the study was not necessarily representative of all secondary schools with Year 8 students.

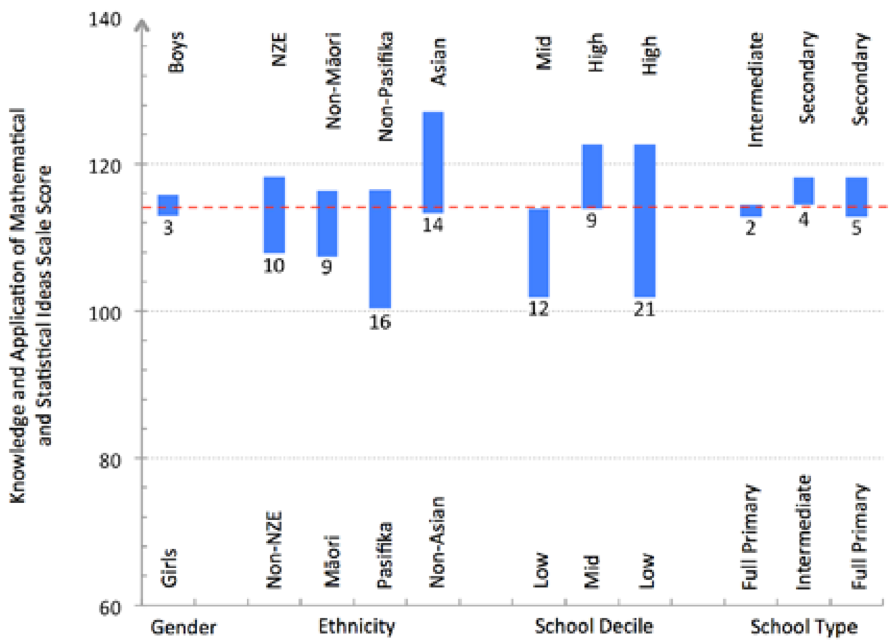

Figure 3.9 Year 8 students: Difference in average scores for Knowledge and Application of Mathematical and Statistical Ideas by sub-group (NZE=NZ European)

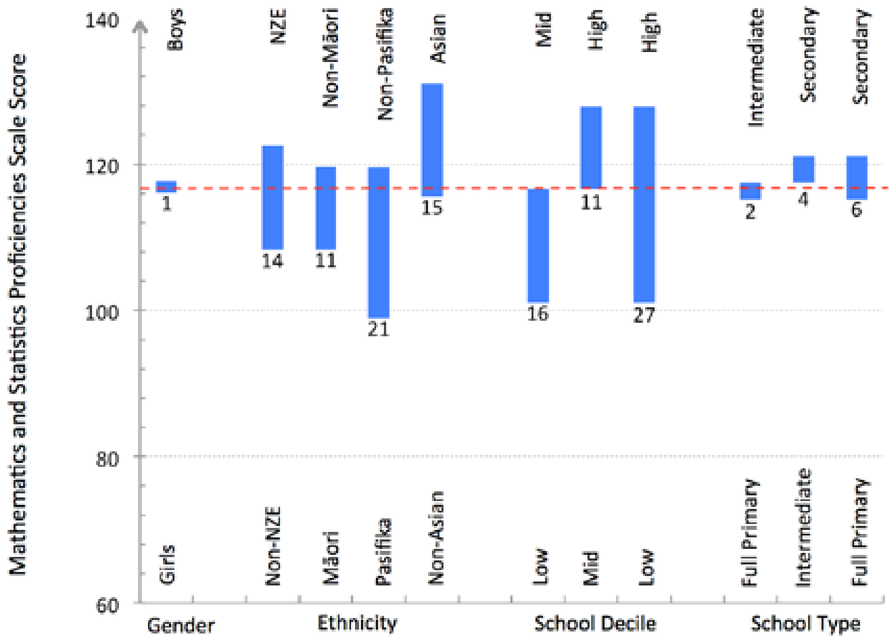

Figure 3.10 Year 8 students: Difference in average scores for Mathematical and Statistical Proficiencies by sub-group (NZE=NZ European)

Table 3.10 Year 8 sub-group differences on the two mathematics and statistics achievement scales

	Knowledge and Application of Mathematical and Statistical Ideas		Mathematical and Statistical Proficiencies	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Gender				
Boys/Girls	3	**0.14**	1	0.06
Ethnicity				
NZ European/ Non-NZ European	10	**0.52**	14	**0.66**
Māori/Non-Māori	-9	**-0.45**	-11	**-0.52**
Pasifika/Non-Pasifika	-16	**-0.82**	-21	**-0.97**
Asian/Non-Asian	14	**0.68**	15	**0.69**
School Decile				
Low/Mid	-12	**-0.67**	-16	**-0.79**
Mid/High	-9	**-0.45**	-11	**-0.55**
Low/High	-21	**-1.18**	-27	**-1.40**
School Type				
Full Primary/Intermediate	-2	-0.09	-2	-0.11
Intermediate/Secondary	-4	**-0.17**	-4	-0.15
Full Primary/Secondary	-5	**-0.20**	-6	-0.19

Effect sizes in bold are statistically significant (*p*<.05)

3. Achievement by decile and ethnicity

The previous sections have highlighted that school decile and student ethnicity are both important factors associated with mathematics achievement. It is important to note that any differences in average scores between ethnic groups may be confounded with decile differences. A regression analysis indicated that separate effects related to decile and to ethnicity could be identified. This means that when we account for decile differences, there are still differences in achievement in average scores in KAMSI between NZ European, Māori and Pasifika students. Further details of this analysis can be found in the chapters about Māori and Pasifika student achievement (Chapters 5 and 6) and in Appendix 5.

4. Comparison of Year 4 and Year 8 achievement

The use of reporting scales that are common to both Year 4 and Year 8 makes it possible to compare achievement between the two year levels. Figures 3.11 and 3.12 show the distribution of Year 4 and Year 8 students on the KAMSI and MSP scales respectively. As can be seen, there was a wide distribution of scores at both year levels and considerable overlap in the achievement of Year 4 students and Year 8 students.

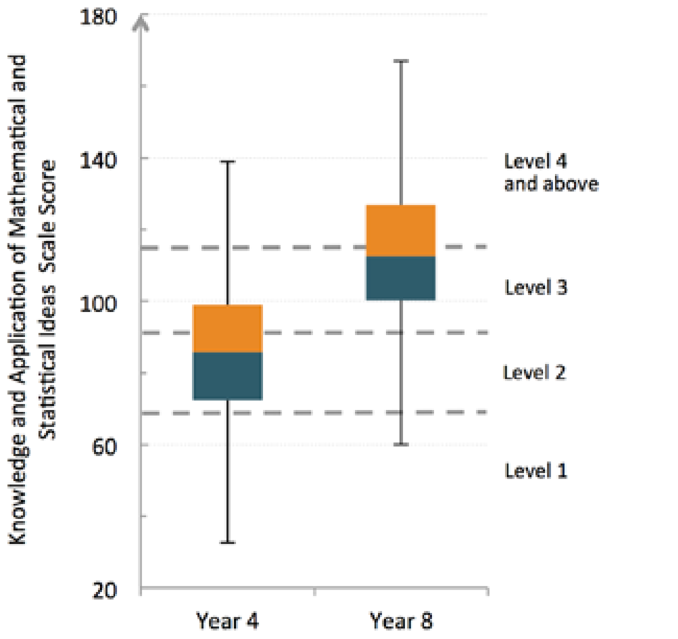

Figure 3.11 Student achievement for Knowledge and Application of Mathematical and Statistical Ideas

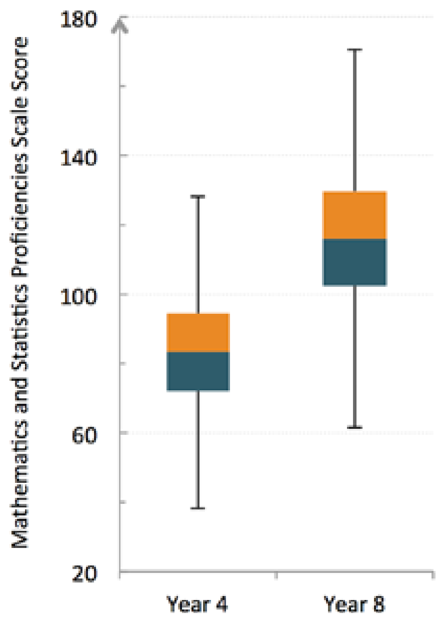

Figure 3.12 Student achievement for Mathematics and Statistics Proficiencies

Table 3.11 shows the averages and standard deviations for both achievement measures along with the differences in average scores between Year 4 and Year 8. The differences are expressed in scale score units and as effect sizes for the four year difference. The effect size is also stated as an average effect size per year (an annualized effect).

The differences between the average score for Year 4 and Year 8 students on both measures were similar: 29 scale points for KAMSI, and 34 scale points for MSP. These differences represent effect sizes between 1.40 and 1.70 over the four year period separating Year 4 and year 8, which equate to an average annual effect size of approximately 0.40. This is greater than the average annual effect size recorded by the NMSSA study for the group assessment in science in 2012, which was around 0.30.

Table 3.11 Overall measures of mathematics and statistics achievement and difference in achievement by year level

	Knowledge and Application of Mathematical and Statistical ideas		Mathematical and Statistical Proficiencies	
	Year 4	**Year 8**	**Year 4**	**Year 8**
Average (scale score units)	86	114	83	117
SD (scale score units)	19	21	17	23
N	2070	2066	789	783
Year 4/Year 8 difference (scale score units)*	29		34	
Effect Size	**1.43**		**1.68**	
Annual Average Effect Size	0.36		0.42	

* Difference = Year 8 - Year 4
Effect sizes in bold are statistically significant ($p<.05$)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

Sub-group achievement between Year 4 and Year 8

Table 3.12 displays gender, decile, and ethnic groups, the Year 4 and Year 8 average scores on KAMSI, the differences between them in scale score units, and the effect sizes related to the differences.

On average, the difference in scores for boys between Year 4 and Year 8 was greater than for girls. In Year 4, boys scored on average just below the girls, and in Year 8 this was reversed.

Asian students demonstrated the greatest difference in average scale scores between Year 4 and Year 8 (35 scale units), while Pasifika students demonstrated the smallest difference (25 scale units). NZ European and Māori recorded similar differences in average scale scores between the year levels (29 and 31 scale units respectively)[13].

Students from high decile schools made more ‘progress’ between Year 4 and Year 8 compared to students from mid and low decile schools. The difference in the amount of ‘progress’ is small (3 scale units in favour of students from high decile schools).

Table 3.12 Differences in achievement between Year 4 and Year 8 by sub-group

	Knowledge and Application of Mathematical and Statistical Ideas				
	Year 4 Average (scale score units)	**Year 8 Average** (scale score units)	**Score Difference*** (scale score units)	**Effect Size**	**Average Annual Effect Size**
Gender					
Boys	85	116	31	**1.49**	0.37
Girls	87	113	26	**1.38**	0.35
Ethnicity					
NZ European	89	118	29	**1.56**	0.39
Māori	77	107	31	**1.65**	0.41
Pasifika	75	100	25	**1.61**	0.40
Asian	92	127	35	**1.59**	0.40
School Decile					
Low	74	102	28	**1.60**	0.40
Mid	86	114	28	**1.53**	0.38
High	92	123	31	**1.57**	0.39

* Difference = Year 8 - Year 4,
Effect sizes in bold are statistically significant ($p<.05$)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

[13] 95 percent confidence intervals were calculated for the Year 4 to Year 8 ‘progress’ scores associated with each ethnic group. The intervals associated with Pasifika and Asian students were non-overlapping (25.0 ± 3.3 and 34.8 ± 5.3 scale score units respectively). The 95 percent confidence intervals for NZ European and Māori students were 29.4 ± 1.8 and 30.6 ± 3.0 scale score units respectively).

5. Exploring achievement in mathematics and statistics

The following section presents a more in-depth exploration of achievement on the KAMSI and MSP measures used to assess achievement in mathematics and statistics. The section explores performance on a range of questions and tasks used in the two assessments, including a selection of questions used in KAMSI that were originally part of the Trends in Mathematics and Science Study (TIMSS).

Exploring achievement on KAMSI questions

The KAMSI scale is based on a mathematical model (the Rasch model) that locates both student achievement and relative question difficulty on the same measurement continuum. The model makes it possible to estimate how probable it is for students achieving at particular locations on the scale to correctly answer any of the questions from the KAMSI assessment. In this section examples of questions are provided to exemplify the kinds of mathematical ideas students with average achievement for their year level were typically able to work with productively. Examples are also provided of questions that were generally difficult for students who achieved around their year level average.

Three sets of example questions are provided in the following tables. The first exemplifies the kinds of questions students with scores around the average scale score for Year 4 would regularly succeed on, that is they would be expected to answer these questions correctly about 70 percent of the time. The second set exemplifies the kinds of questions that students with scores around the average for Year 8 would be expected to answer correctly about 70 percent of the time. Because the average score for Year 4 was lower than the average score for Year 8, this second set also represents questions that students scoring around the Year 4 average would generally find more difficult[14]. That is, they would be expected to answer them correctly about 30 percent of the time.

The third set consists of questions that students with scores around the Year 8 average would be expected to find more difficult. That is, they would be expected to answer them correctly about 30 percent of the time.

Examination of the KAMSI item pool indicates that in general, Year 8 students did not have the success expected in terms of curriculum expectations, on items involving fractions, decimals and percentages, or that involved the use of pro-numerals. The third set of questions shown in Table 3.15 includes some examples of these kinds of items.

For each set, the KAMSI scale locations[15] of the questions, the modeled percentages of students at the relevant year level expected to answer the questions correctly[16], notes about the questions, and the visual representations of the questions themselves are presented[17].

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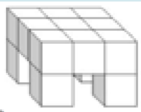
[14] These questions were located on the KAMSI scale, which is shared by Year 4 and Year 8 students. This makes it possible to predict how well the Year 4 cohort would do on Year 8 questions and vice versa. However, the questions were only done by one year level.

[15] Scale locations quoted for questions in the tables on the following pages represent the position on the scale where the expected probability of answering the question correctly is 0.5.

[16] The modelled, rather than actual percentage of students answering each question is provided in the following tables as each question was completed by a subsample of the full NMSSA sample. This ensures that the percentage correct figures are not influenced by any particular bias that might be present in the group of students who actually answered a question.

[17] Students were not permitted to use calculators during the KAMSI assessment.

Table 3.13 Set 1: Questions that students scoring around the Year 4 average score on KAMSI are expected to answer correctly about 70 percent of the time

Scale location and modelled percentage of Year 4 students answering correctly	Question notes and correct option	Question
77 scale units 61%	The student recognises that the pattern involves a common difference of 7 and is able to continue the pattern. Option B was a relatively popular distractor. Correct option: C	3, 10, 17, 24, ? **What is the next number in this pattern?** A. 25 B. 30 C. 31 D. 32 E. 48
70 scale units 69%	The student understands the effect of taking 100 from a number. Option A was a relatively popular distractor. Correct option: C	**Which number is 100 *less* than 538?** A. 428 B. 437 C. 438 D. 528 E. 537
66 scale units 73%	The student is able to construct a name for a given 3-digit numeral. B and C were relatively popular distractors. Correct option: E	**How do you write 604 in words?** A. Sixty four B. Six hundred and forty C. Six thousand and four D. Four hundred and six E. Six hundred and four
74 scale units 65%	The student is able to interpret a 3-D representation to count building blocks. E and C were popular distractors. Correct option: D	**2. How many cubes?**  Here is a model of a table made with cubes. **How many cubes are needed to build this table?** A. 4 B. 9 C. 12 D. 13 E. 18
76 scale units 62%	The student is able to estimate the capacity of a milk bottle. A and B were popular distracters. Correct option: C	**23. Milk bottle**  **About how much milk will this bottle hold when it is full?** A. 1 millilitre B. 10 millilitres C. 1 litre D. 10 litres E. 100 litres

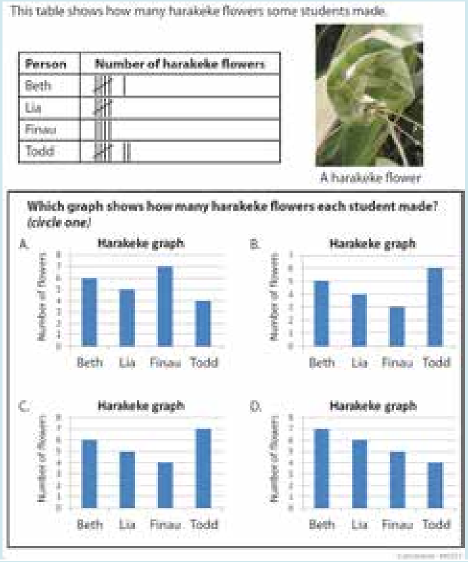
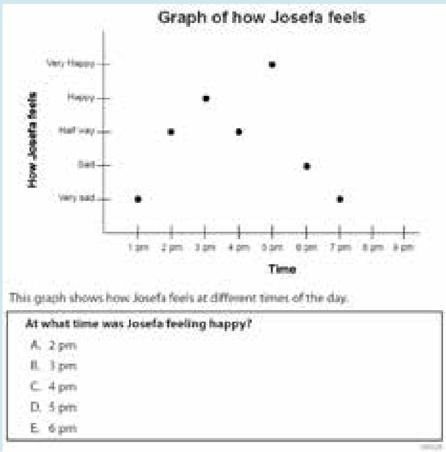
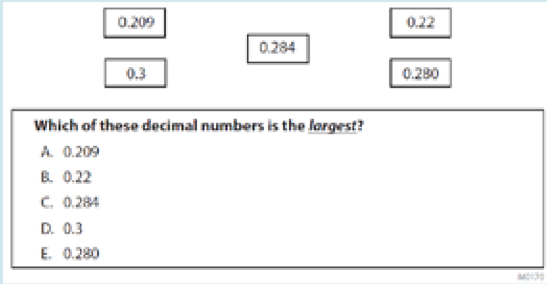
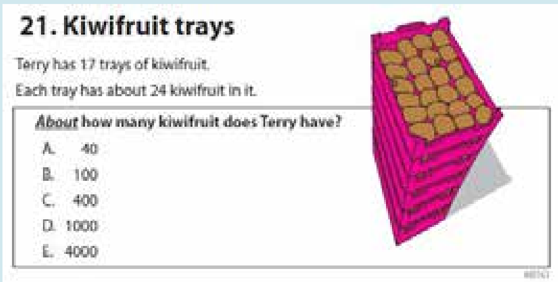
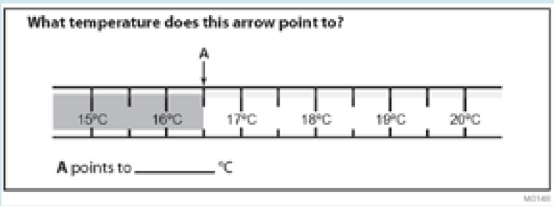
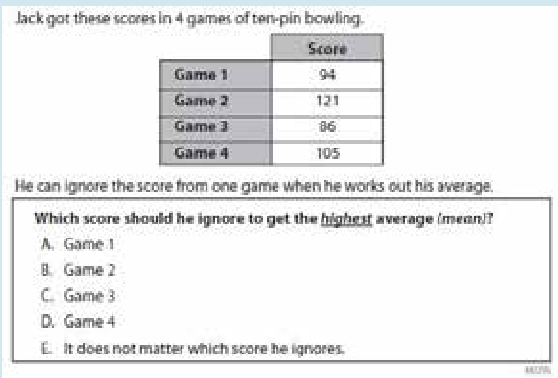
<table>
<tr><th>Scale location and modelled percentage of Year 4 students answering correctly</th><th>Question notes and correct option</th><th>Question</th></tr>
<tr><td>78 scale units
60%</td><td>The student is able to recognise the bar chart that best represents a given frequency table
A was a popular distractor.
Correct option: C</td><td>
</td></tr>
<tr><td>77 scale units
61%</td><td>The student is able to interpret a dot plot to find a given value.
D was a popular distractor.
Correct option: B</td><td>
</td></tr>
</table>

Table 3.14 Set 2: Questions that students scoring around the Year 8 average scores on KAMSI are expected to answer correctly about 70 percent of the time

Scale location and modelled percentage of Year 8 students answering correctly	Question notes and correct option	Question
103 scale units 63%	The student is able to name the greatest decimal number in a list of decimals. C was a popular distractor. Correct option: D	 0.209 0.284 0.22 0.3 0.280 Which of these decimal numbers is the *largest*? A. 0.209 B. 0.22 C. 0.284 D. 0.3 E. 0.280
98 scale units 70%	The student is able to estimate the result of a 2-digit by 2-digit multiplication. B and D were popular distractors. Correct option: C	 **21. Kiwifruit trays** Terry has 17 trays of kiwifruit. Each tray has about 24 kiwifruit in it. *About* how many kiwifruit does Terry have? A. 40 B. 100 C. 400 D. 1000 E. 4000
99 scale units 72%	The student is able to use whole number relationships to solve a proportional reasoning problem. D was a popular distractor. Correct option: B	 **21. Kūmara for hāngī** Temara is planning a hāngī for 30 people. She will need 6 kūmara for every 10 people. How many kūmara will she need to buy? A. 16 B. 18 C. 24 D. 26 E. 34
102 scale units 64%	The student is able to read a scale and recognise a half-way point between two whole numbers. Correct answer: 16.5	 What temperature does this arrow point to? A 15°C 16°C 17°C 18°C 19°C 20°C A points to ______ °C
96 scale units 72%	The student is able to understand how to maximise an average score by removing one data point. Correct option: C	 Jack got these scores in 4 games of ten-pin bowling. Score: Game 1 – 94; Game 2 – 121; Game 3 – 86; Game 4 – 105 He can ignore the score from one game when he works out his average. Which score should he ignore to get the *highest* average (mean)? A. Game 1 B. Game 2 C. Game 3 D. Game 4 E. It does not matter which score he ignores.

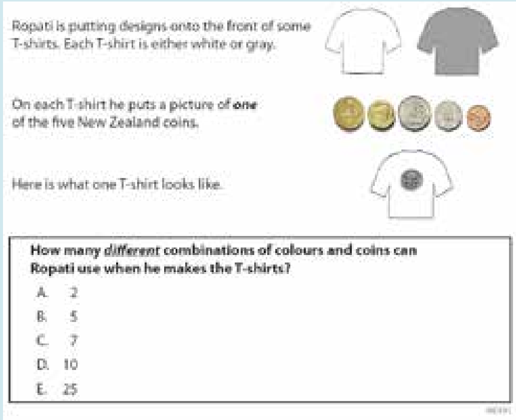
Scale location and modelled percentage of Year 8 students answering correctly	Question notes and correct option	Question
105 scale units 61%	The student is able to compute how many combinations are possible when two simple variables are combined. B was a popular distractor. Correct option: D	

Table 3.15 Set 3: Questions that students scoring around the Year 8 average score on KAMSI are expected to answer correctly about 30 percent of the time

Scale location and modelled percentage of Year 8 students answering correctly	Question notes and correct option	Question
128 scale units 33%	The student is able to convert between fractions and percentages and can exploit equivalent fractions. E and C were popular distractors. Correct option: D	Ariana got 60 out of 80 in a test. **What is this as a percentage?** A. 20% B. 30% C. 60% D. 75% E. 80%
126 scale units 36%	The student is able to apply a strong understanding of decimal notation and place value. B was a popular distractor. Correct option: E	4, 2, 1, 0.5, 0.25, 0.125, … **What is the next number in this halving pattern?** A. 0.62 B. 0.625 C. 0.65 D. 0.062 E. 0.0625 F. 0.065
126 scale units 36%	The student is able to convert between equivalent fractions. Option C was a very popular choice. Correct option: E	**Which fraction is *not* equivalent to $\frac{12}{16}$?** A. $\frac{3}{4}$ B. $\frac{6}{8}$ C. $\frac{15}{20}$ D. $\frac{18}{24}$ E. $\frac{24}{40}$
130 scale units 32%	The student knows how to calculate the area and perimeter of a square and can exploit the relationship between them to calculate a missing side. Correct option: B	 Aunty Nita has a **square** garden with an area of 36 square metres. **What is the length of one side of the garden?** A. 3 metres B. 6 metres C. 9 metres D. 18 metres E. 36 metres
129 scale units 33%	The student is able to interpret a 2 by 2 table and use the correct cells to form an appropriate fraction. B was a popular answer. Correct option: D	 Two classes recorded the number of kereru and tui in the trees around their school. (table) Room 1 / Room 2 / TOTAL — Tui: 22 / 29 / 51; Kereru: 7 / 2 / 9; TOTAL: 29 / 31 / 60 **What fraction of the birds that Room 2 recorded were kereru?** A. $\frac{2}{29}$ B. $\frac{2}{9}$ C. $\frac{2}{60}$ D. $\frac{2}{31}$ E. $\frac{2}{7}$

KAMSI items and curriculum alignment

Each of the KAMSI items was examined and assigned to the curriculum level most closely associated with the knowledge and skills assessed by the item. Table 3.16 compares the curriculum levels assigned to the items with their KAMSI scale locations.

Table 3.16 Scale location of items on the KAMSI scale by curriculum level

Scale location (scale score units)	Level 1	Level 2	Level 3	Level 4	TOTAL
49 - 76	2	6			**8**
77 - 91	1	28	4		**33**
92 - 106		8	14	8	**30**
107 - 120		1	10	23	**34**
121 - 134			3	20	**23**
135 +				7	**7**
TOTAL	**3**	**43**	**31**	**58**	**135**

As was expected, items assigned to higher curriculum levels were generally located higher on the scale. There was some overlap in where items from different levels were located.

The curriculum levels assigned to the items and their location on the scale support the decisions made during the standard setting exercise. For instance, it does indicate that the average Year 8 score of 114 scale units is somewhat low, when the expectation is that Year 8 students will successfully deal with questions involving Level 4 concepts.

Misfit between student performance and item curriculum level

Some items were located much higher or lower on the KAMSI scale than might have been expected given their curriculum level designation. Sometimes this will reflect the difficulty of categorising a mathematical idea in terms of a set level. How accessible an idea is will depend on how the idea is expected to be used and the context it is set in. At other times it could promote discussion about the levelling of the idea in the curriculum. The following describes some of these items.

Curriculum Level 2

The following descriptions represent items that were judged to represent Level 2 achievement objectives, but which were located higher on the KAMSI scale than expected. The first three of these items involved aspects of proportional reasoning.

- Recognise that a third of a square is shaded when it is divided unequally.
- Interpret a pictograph where a symbol represents more than one object, and half symbols are used.
- Recognise that spinners have equal probabilities when the ratio of their areas is constant.
- Obtain the length of an object when the item being measured is offset (i.e., does not align with zero on a ruler).

Curriculum Level 3

The following descriptions represent items that were judged to be Level 3, but which were located significantly lower on the KAMSI scale than curriculum expectations would suggest.

- Write a four-digit number in words.
- Recognise regrouping in a division problem.
- Compute the number of 20s in 200.
- Read the midpoint between 20 and 40 on a scale.

The following descriptions represent items that were judged to be Level 3, but which were located significantly higher on the KAMSI scale than curriculum expectations would suggest.

- Recognise what a shape looks like when it is enlarged by a scale factor of 3.
- Recognise the number of non-unit squares needed to fill an area.
- Reason with a word problem.

Curriculum Level 4

The following descriptions represent items that were judged to be Level 4, but were significantly lower on the KAMSI scale than curriculum expectations would suggest.

- Recognise the smallest number in a list that includes negative numbers.
- Find x where 6:10 = x:30 in a word problem.
- Recognise the multiplicative identity.
- Understand how changes to data affect the mean.
- Estimate the product of two two-digit numbers.

The following descriptions represent items that were judged to be Level 4, but which were located significantly higher on the KAMSI scale than curriculum expectations would suggest.

- Write an algebraic expression that gives the nth term in a pattern.
- Find x where $2 \times (x + 6) = 20$.

Exploring achievement on the mathematical and statistical proficiencies scale

The MSP measure assessed students' communication, reasoning and understanding in mathematics and statistics. The following discusses achievement on two MSP tasks that focussed on communication: Watch the Words and Maths Meaning.

Watch the words

How a number problem is expressed is intricately bound up with its difficulty. Solving a number problem requires being able to identify the actors and objects within the problem and interpret how they are related to each other and the numbers given, in order to create a mathematical view of the problem. Once an appropriate representation has been established the problem solver has to take advantage of the relationships they have identified, and work strategically with the numbers involved (for instance, cross a ten boundary) to find an unknown.

Watch the Words explored students' ability to use key phrases and words associated with problems involving addition and subtraction, multiplication and division, and proportions and ratios. The problems were designed to minimise the complexity of any computation that might be involved. Rather, the emphasis was on the student using the language the problem was couched in to identify and make use of the mathematical relationships within the problem.

During the task Teacher Assessors presented the students with a range of questions printed on a task sheet and asked them to record their answers. If necessary, the Teacher Assessor would read the question to the student and help record their response. Some of the questions were answered by students at both year levels. Year 8 students were asked a wider range of questions, including questions involving proportional reasoning.

Table 3.17 describes a selection of the questions used in Watch the Words that involved additive thinking. The table provides a description of the language load and gives a symbolic representation of each question. The percentage of students who were able to answer each question correctly at Year 4 and Year 8 is also reported.

As can be seen, the percentage correct, especially for Year 4 students, varied across the problems. Questions where the relationships between the numbers were less straightforward, or involved an increased numeric demand, such as crossing a 10 boundary, were generally more difficult.

The two questions set in a temperature context (examples 5 and 6), which involve a more detailed context and use the phrases 'increase to' and 'increased from' to frame the relationships between the quantities involved, were much harder for Year 4 students than Year 8 students. Examples 4 and 6 are very similar mathematically, but Year 4 students found example 6 (which uses 'increased by') substantially harder, reinforcing that the use of 'increase' is a barrier for Year 4 students.

The three questions that used 'more' or 'left over' (examples 2, 3, and 4) were of roughly equal difficulty, indicating that these terms may be processed by students in a similar way.

Table 3.17 Understanding language for addition and subtraction: Percentage of students answering each question correctly by year level

Example	Question Text	Language and Context Considerations	Symbolic Representation	Year 4 (%)	Year 8 (%)
1	There were 5 oranges and 4 apples, how many pieces of fruit is that altogether?	Solving this problem involves understanding the amount of each fruit is to be combined to form a total amount.	5+4=?	94	95
2	There were 12 sausages, 8 of them were eaten at a party. How many were left over?	Students need to understand that an original amount has been decreased (signalled by 'eaten') and the objective is to find how many 'were left over'.	12-8=?	87	-
3	8 and 4 more is what number?'	This question is presented in a mathematical context. The term '4 more' is used to indicate an additional amount added to a starting amount. The student needs to realise that 8 is the starting amount and that the phrase 'is what number' signals that a new total is required. The student also has to cross a ten boundary when calculating the new total.	8+4=?	85	89
4	11 is how many more than 7?	Like Example 4 the context involves numbers only, and the term 'more' indicates a combination. However, this time an addend (the part added on), rather than the total is the unknown quantity in the problem. The student needs to have a strategy that will successfully cross the 10 boundary.	11 = 7+?	80	93
5	The temperature was 18°C and increased by 5°C in the afternoon. What was the afternoon temperature?	Students need to understand that the 5°C represents an 'increase' and that the increase will result in a new total.	18+5=?	57	92
6	During the day the chilly bin temperature increased from 5°C to 12°C. How much did the temperature increase by?	This question involves the student working with temperature measurements. They need to recognise an increase has taken place (signalled by 'increased from / to') and that the 'increase by' amount is what is required. They have to apply a strategy that can successfully cross the 10 boundary to find the 'increase by' amount (the difference between 12 and 5).	5+?=12	48	81

Table 3.18 reports on questions involving multiplication, division, and proportional reasoning. Fifty seven percent of Year 4 students correctly answered a question that required multiplication using the expression ‘5 teams of 5 … how many altogether’ (example 2 from Table 3.17). The corresponding number at Year 8 was about 90 percent. Performance at both year levels was more similar when students were asked to split 10 people into 2 teams, where over 80 percent of Year 4 and 95 percent of Year 8 students correctly performed the calculation required. Most Year 8 students were able to work successfully with the idea of a half (see examples 1 and 3, where about 95 percent of Year 8 students gave a correct response). However, the difficulty of the question for Year 8 students changed markedly to about 70 percent when the half was given and students were expected to find the whole (example 4).

A more complex example of this type of problem asked Year 8 students to work out an original amount that had been reduced by 25 percent to a given final price (example 5). In this case, just over 20 percent of students correctly answered the question. This type of question is typically hard even for more senior students, as it requires more than a single operation. There is a subtle language difference between the wording '25 percent **off'** and '25 percent **of**', each leading to quite different answers (for example 25 percent **off** 40 = 30, whereas 25 percent **of** 40 = 10). Examples 3 and 4 use 'of' rather than 'off', and both are substantially easier.

Table 3.18 Understanding language for multiplication, division and proportions: Percentage of students answering each question correctly by year

Example	Question Text	Language and Context Considerations	Symbolic Representation	Year 4 (%)	Year 8 (%)
1	10 children were split into 2 teams. How many children were in each team?	Students need to interpret ‘split’ in order to share 10 objects equally into 2 groups; or to recognise that this involves division by 2, or halving 10.	$10 \div 2 = ?$	82	96
2	There were 5 teams of 5 children. How many children is that altogether?	This word problem requires multiplying two amounts to obtain a total, which is indicated by the word 'altogether'. The word team indicates a grouping unit of 5 students.	$5 \times 5 = ?$	57	88
3	What is half of 100?	The question is posed in a mathematical context. Students need to recognise that it involves division by 2, or halving 100.	$100 \times 1/2 = ?$ or $100 \div 2 = ?$	-	95
4	20 is half of what number?	In this question the result of a division (the quotient) is given, and student needs to find the number (the dividend) that is being halved to give that quotient.	$20 = 1/2 \times ?$ or $20 = ? \div 2$	-	71
5	The sale price is $30 for the top. It is in a 25% off sale. What was the original price?	This question uses the word 'off' to denote reducing an original unknown amount by a percentage, so it equals a given amount.	$30 = (100–25)/100 \times ?$ or $30 = 0.75 \times ?$ or $30 = ? – 0.25 \times ?$	-	22

Maths Meaning

The Maths Meaning task was focused on students' understanding of mathematical terminology. The task presented students with a series of symbols and words on a computer screen and asked them to click on the description that best matched each word or symbol. Some questions were asked to students in both year levels and some to students in Year 8 only. Figure 3.13 presents screenshots of the questions in the task.

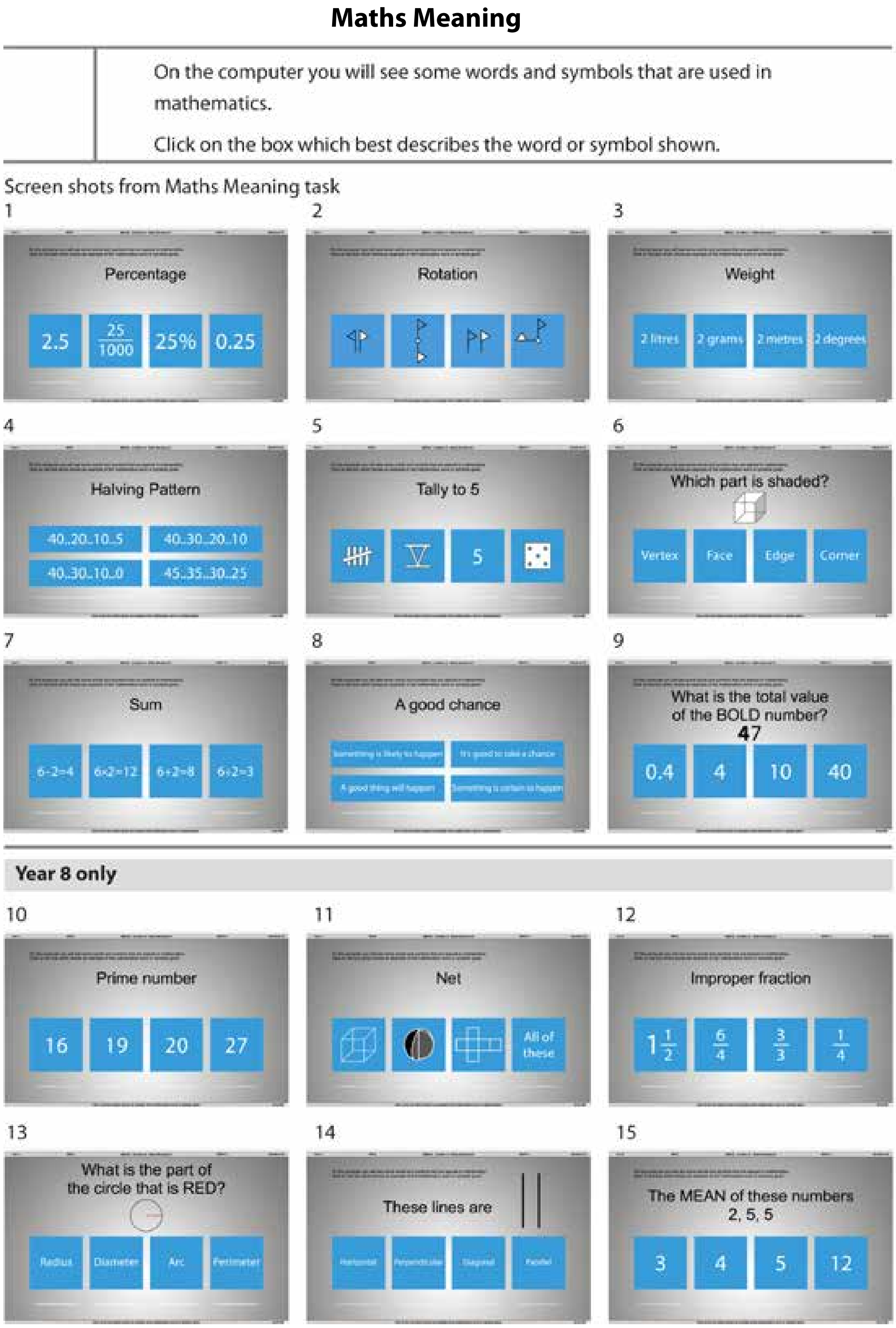


Figure 3.13 Screen shots of the Maths Meaning task

Figures 3.14 and 3.15 show how students performed on the questions. Year 8 students consistently out-performed Year 4 students. However, there were large proportions of students at both year levels who were unable to select an appropriate definition for many of the terms. 'Percentage', 'Tally' and 'Measure of weight' were the most commonly understood symbols at both year levels.

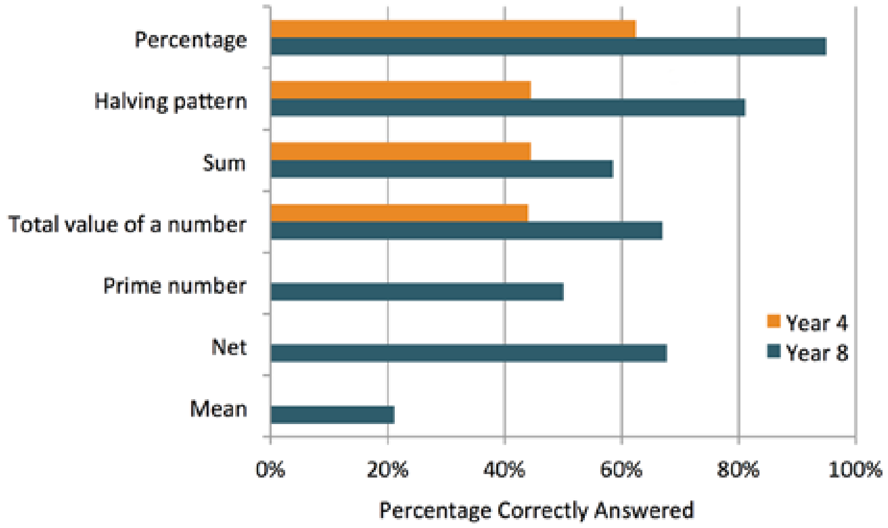


Figure 3.14 Understanding terminology and representations related to Number and Algebra: Percentage of students answering each question correctly by year

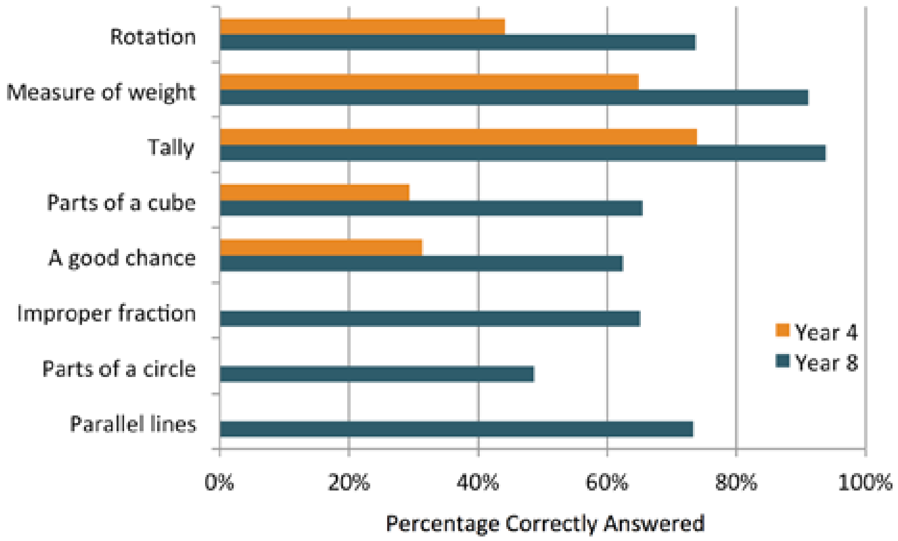


Figure 3.15 Understanding terminology and representations related to Statistics, Geometry and Measurement: Percentage of students answering each question correctly by year

Achievement on TIMSS items

A small number of questions (items) from the 2010/11 Trends in International Mathematics and Science Study (TIMSS)[18] were included in the KAMSI assessment. Permission was granted to use these items, and they were displayed and marked using the protocols developed for the TIMSS study. Responses to the TIMSS items were included in the construction of the KAMSI scale and the items located on the scale with the other items.

[18] SOURCE: TIMSS 2011 Assessment. Copyright © 2013 International Association for the Evaluation of Educational Achievement (IEA). Publisher: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College, Chestnut Hill, MA and International Association for the Evaluation of Educational Achievement (IEA), IEA Secretariat, Amsterdam, the Netherlands

Including TIMSS items had a two-fold benefit. Firstly, it allowed linkages between NMSSA mathematics tasks and an important international study. Secondly, the TIMSS items selected were typically of a more open-ended nature than the other items, which were predominantly selected response items.

Table 3.19 shows how students in the NMSSA study performed on the TIMSS items and provides comparisons with how New Zealand students and students internationally performed on the items. To make the comparisons the percentage of students answering the question correctly is provided. Since not all students in the NMSSA sample did every TIMSS item, a modelled percentage correct across the appropriate year level sample has been calculated based on the location of the item on the KAMSI scale.

When using the table to make comparisons it is important to remember that the TIMSS study was carried out with Year 5 and Year 9 students in New Zealand. In one year we would expect the percentage correct on each KAMSI item to increase by about 6-9 percentage points. This figure is based on the growth of the average KAMSI score of 28 scale score units between Year 4 and Year 8 — an average of 7 scale score units per year. This translates to an increase of about 6 - 9 percentage points in the percentage of students answering the item correctly.

Once a year of growth is taken into account the students involved in the NMSSA study have achieved at similar levels on many of the TIMSS items compared to the older students who participated in TIMSS. Some items stand out as exceptions, for instance item M042270 where students are asked to draw an isosceles triangle.

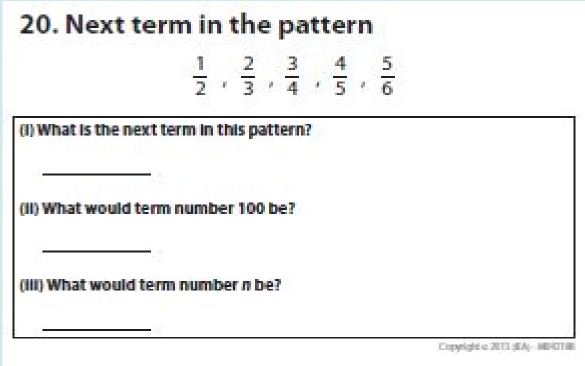
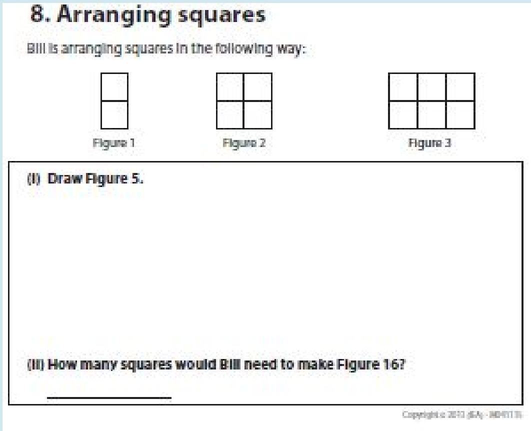
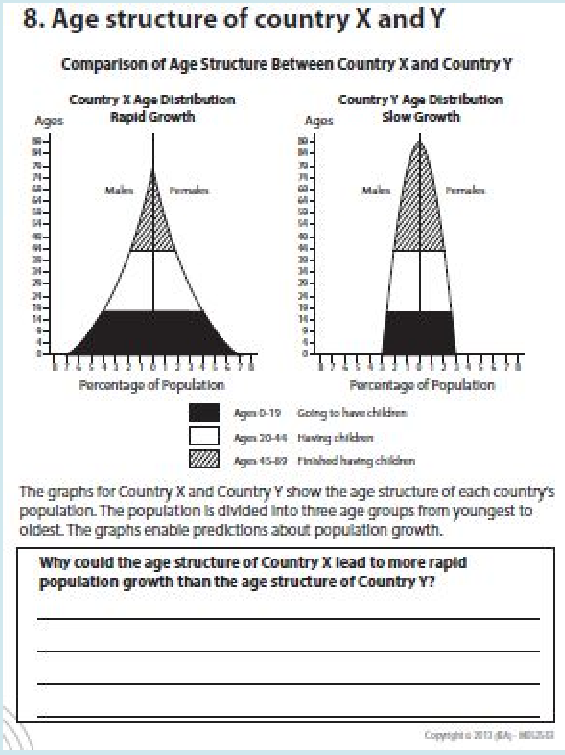
Table 3.19 Performance of TIMSS items on KAMSI scale

TIMSS item name [TIMSS number]	Year Level Used	KAMSI Scale Location (scale score units)	KAMSI NZ Percentage Correct (modelled%)	TIMSS NZ Percentage Correct (%)	TIMSS International Percentage Correct (%)
Next term in the pattern (i) [M042198A]	8	82.5	84	89^	70
Draw a reflection [M041328]	4	86.8	49	60^	53
Arranging squares (i) [M041115A]	4	90.0	44	59	58
Arranging squares (ii) [M041115B]	4	105.7	26	43	45
Statements about figures [M041148]	4	113.5	19	32	32
Next term in the pattern (ii) [M042198B]	8	115.4	49	56^	41
Make a pie chart [M042207]	8	116.7	47	59^	51
Soccer tournament [M051001]	4	120.9	14	26	27
Red and black tiles [M032757]	8	132.4	43	58^	54
Age structure of country X and Y [M052503]	8	135.1	25	17	21
Draw an isosceles triangle [M042270]	8	155.0	19	46	48
Next term in the pattern (iii) [M042198C]	8	196.1	2	11v	18

Λ NZ percentage significantly above International average
V NZ percentage significantly below International average

Table 3.20 displays three of the TIMSS items used in the study and provides some commentary on how New Zealand students did on the items. These items were chosen to provide examples of the TIMSS items and the patterns of responses recorded.

Table 3.20 Examples of TIMSS items used in KAMSI

New Zealand Year 8 students performed higher than the eighth grade TIMSS international percentages for parts (i) and (ii). Most students were able to generalise this relationship. However, Year 8 students scored particularly low on part (iii), struggling to express the relationship using pro-numerals.	
Year 8 students in the NMSSA study did less well than Year 9 New Zealand students who were involved in the TIMSS study, even after adjusting for the difference in year level. Year 9 New Zealand students had performed at the international average.	
Year 8 students in the NMSSA study performed above the international level for this item, even though the Year 9 New Zealand students in TIMSS performed close to the international level. This is consistent with the suggestion that New Zealand students perform well in the Statistics strand[19].	

19 Kirkham, Sarah. (2013). *TIMSS 2010/11: New Zealand Year 9 students' strengths and weaknesses in mathematics*. Downloaded on May 12th 2014 from http://www.educationcounts.govt.nz/__data/assets/pdf_file/0003/146514/TIMSS-2010-11-NZ-Year-9-Maths-Strengths-and-Weaknesses.pdf

4 Understanding Achievement in Mathematics and Statistics

As described in Chapter 2, the NMSSA mathematics and statistics assessment programme used student interviews and student, teacher and principal questionnaires to collect data focused on a number of contextual factors associated with understanding achievement in mathematics and statistics. This included data related to:

- student attitudes to mathematics and statistics;
- students' sense of efficacy as learners of mathematics and statistics;
- students' beliefs related to learning mathematics and statistics;
- opportunities to learn mathematics and statistics at school;
- the organisation of mathematics and statistics teaching in the school;
- teachers' attitudes and confidence regarding the teaching of mathematics and statistics;
- professional support and development for teachers in mathematics and statistics;
- school priorities for learning.

This chapter describes how students, teachers, and principals responded to the interviews and questionnaires, and relates the responses back to patterns in achievement. Year 4 and Year 8 results are reported together so that comparisons between year levels can be easily made.

For many of the tables used in this chapter, particularly those associated with population sub-groups, fuller tables of means, standard deviations, sample sizes, effect sizes, and 95 percent confidence intervals can be found in Appendix 4.

Understanding achievement in mathematics and statistics – An overview

Students' attitude to mathematics and opportunities to learn

An Attitude to Mathematics scale was developed to measure the students' responses to questions about their attitudes to mathematics and statistics. Students in Year 4 responded more positively to these questions than students in Year 8. Boys were slightly more positive on average than girls, and Asian and Pasifika students reported more positive attitudes on average than students from other ethnic groups.

Scale scores on the Attitude to Mathematics measure showed some association with achievement scores on the KAMSI and MSP scale. The correlation between attitude scores and achievement was greater for students from high decile schools than for students from mid or low decile schools.

Students reported involvement in a range of activities that provided opportunities to learn mathematics and statistics. Having class/group discussions about maths problems and explaining ways of solving problems to other students or the teacher were rated as highly frequent by both Year 4 and 8 students. Analysis was not able to identify a strong association between any of the opportunities to learn mathematics questionnaire items and achievement scores.

Teachers' views of teaching mathematics and confidence in their teaching

Teachers reported that group discussions and peer sharing happened frequently during mathematics learning. They also indicated that playing maths games that assist learning and using special maths equipment occurred frequently. On questions that mirrored the students' questionnaire items regarding learning opportunities, teachers generally reported that the learning activities occurred more frequently than did students.

Teachers reported frequently grouping students for instruction, using whole class teaching, and providing individual assistance. Remedial and extension opportunities that occurred outside of the classroom were reported by about 35 percent of teachers.

A high proportion of teachers at both year levels indicated that they felt confident in their teaching, and that they were able to engage and meet the needs of their students. Very few teachers reported that they didn't enjoy maths or like teaching it.

Principals' view of the mathematics and statistics learning area

Principals ranked mathematics and statistics as a high priority learning area. The average rank out of 17 areas of learning was only slightly lower than the average rank for reading and writing at both year levels.

Students' views of learning and performance expectations

Students in the individual assessment part of NMSSA were asked questions about their learning in mathematics and at Year 8, their performance expectations on a mathematics test during a one-to-one interview with a teacher assessor. Most students selected responses to questions about learning in mathematics that indicated mathematics ability could be developed through effort and engagement in learning (an incremental view of learning). On average, students in Year 8 who chose more incremental responses scored higher on the KAMSI achievement measure.

On average, boys, Pasifika students and Asian students had higher performance expectations on mathematics tests than other students. The correlation between students' performance expectations and their actual scores on the KAMSI measure was greatest for students from higher decile schools.

1. Year 4 and Year 8 attitude to mathematics and statistics

Students develop important attitudes and beliefs about mathematics and statistics, including their own ability as learners during their time at school. One section of the NMSSA student questionnaire focused on students' attitudes and beliefs related to learning mathematics and statistics at school.

A scale based on the Rasch model was developed to measure the overall strength of each student's response to the section on attitudes[20]. Chapter 2 describes this section of the questionnaire and the Attitude to Mathematics scale in more detail.

Figure 4.1 displays the distributions of scale scores on the Attitude to Mathematics measure for Year 4 and Year 8 students. Scores, on average, were less positive for Year 8 students than for Year 4 students. This is similar to what has been observed in other learning areas assessed by NMSSA[21] and mirrors results on attitude questions and scales used in the NEMP and TIMSS studies. The variation in scores is similar at each year level, although a longer lower tail is evident in the Year 4 distribution.

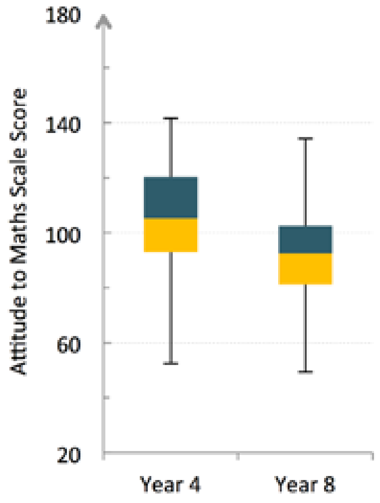


Figure 4.1 Year 4 and Year 8 student scale scores for Attitude to Mathematics

Table 4.1 shows the average Attitude to Mathematics scale score and standard deviation for each year level. The average scale score is 14 scale score units lower in Year 8 than in Year 4. This difference represents an effect size of –0.68.

Table 4.1 Year 4 and Year 8 Attitude to Mathematics and difference by year level

	Year 4	Year 8
Average (scale score units)	107	93
SD (scale score units)	20	20
N	2048	2037
Effect size	**-0.68**	

Effect sizes in bold are statistically significant (*p*<.05)

Table 4.2 breaks down the results for girls and boys at both year levels. Boys and girls had similar average scores in Year 4. However, the girls' average attitude score was five scale score units lower than the boys' at Year 8 (an effect size of approximately 0.25). For both girls and boys the difference between the Year 4 and Year 8 average scores was statistically significant. Girls and boys scored 15 and 12 points scale score units lower respectively at Year 8 compared with Year 4.

Table 4.2 Year 4 and Year 8 Attitude to Mathematics for boys and girls

	Boys		Girls	
	Year 4	**Year 8**	**Year 4**	**Year 8**
Average (scale score units)	108	96	106	91
SD (scale score units)	21	20	20	19
N	1033	1040	1015	997
Effect size	**-0.60**		**-0.78**	

Effect sizes in bold are statistically significant (*p*<.05)

[20] The attitude scales for different areas of learning involve different questions and raw score transformations. The scale values cannot be compared directly.
[21] An exception to this is Physical Education where boys in Year 8 generally sustained the positive attitudes observed in Year 4.

Figure 4.2 and Figure 4.3 display the distributions of Attitude to Mathematics scale scores for population sub-groups for Year 4 and Year 8 respectively. The sub-groups shown relate to gender, ethnicity[22], school decile[23] and type of school[24]. At Year 4, the score distributions were fairly similar for each of the sub-groups. In Year 8, students in low decile schools recorded a higher average Attitude to Mathematics score than students in mid or high decile schools.

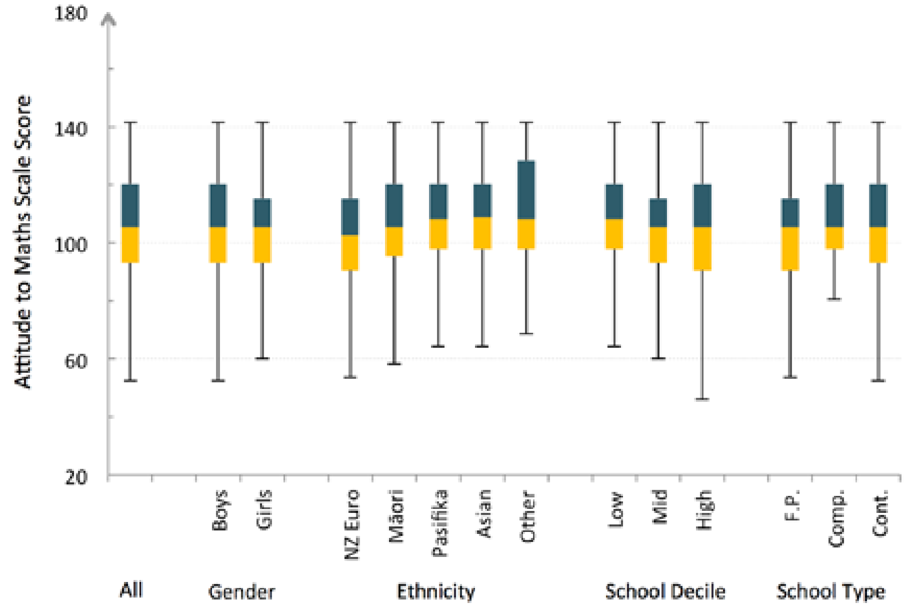


Figure 4.2 Year 4 student Attitude to Mathematics scores by gender, ethnicity, school decile and type (NZ Euro = NZ European, F.P. = Full Primary, Comp. = Composite, Cont. = Contributing)

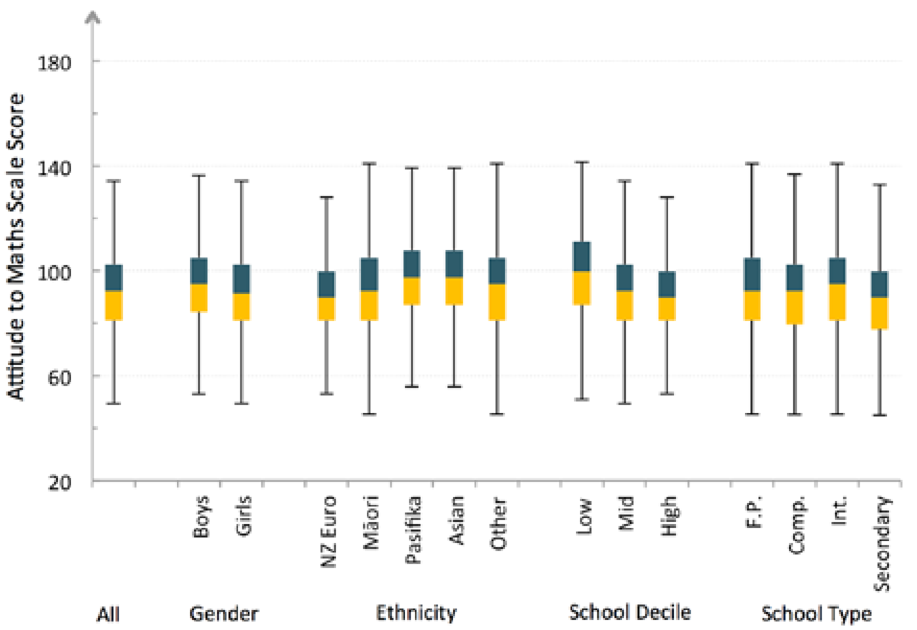


Figure 4.3 Year 8 student Attitude to Mathematics scores by gender, ethnicity, school decile and type (NZ Euro =NZ European, F.P. = Full Primary, Comp. = Composite, Int. = Intermediate)

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22 Non-prioritised ethnicity was used where students could identify with up to three ethnicities. This meant they could be present in multiple ethnic groups. Student ethnicity data were obtained from student NSN information held on the Ministry of Education ENROL database. The 'NZ European' category included NZ Pakeha only. The 'Pasifika'category included Tokelauan, Fijian, Niuean, Tongan, Cook Islands Maori, Samoan and other Pacific peoples. The 'Asian' category included Filipino, Cambodian, Vietnamese, Other Southeast Asian, Indian, Chinese, Sri Lankan, Japanese, Korean, and other Asians. The 'Other' category included Australians, British/Irish, German, Dutch, Greek, Polish, South Slav, Italian and other Europeans, Middle Eastern, Latin American, African, and Not Stated.

23 Low decile schools (1–3); Mid decile schools (4–7); High decile schools (8–10) (http://www.minedu.govt.nz/NZEducation/EducationPolicies/Schools/SchoolOperations/Resourcing/OperationalFunding/Deciles.aspx)

24 Full Primary (Year 1–8); Contributing (Year 1–6); Intermediate (Year 7–8); Composite (Year 1–13); Secondary (Year 7–13)

Relationship between attitude to mathematics and statistics, and achievement

Table 4.3 shows the correlation between Attitude to Mathematics and achievement on the two mathematics and statistics achievement measures using the Pearson product-moment correlation coefficient (*r*). The linear relationship between attitude to mathematics and mathematics achievement was weak overall at both year levels, but was slightly stronger at Year 8 than at Year 4. Interestingly, these correlations show differences by decile groups, with stronger correlations in higher decile schools. Table 4.4 shows these correlations for the KAMSI scale.

Table 4.3 Correlation (*r*) between Attitude to Mathematics and mathematics achievement at Year 4 and Year 8

	Knowledge and Application of Mathematical and Statistical Ideas (r)	Mathematical and Statistical Proficiencies (r)
Year 4	0.18	0.15
Year 8	0.28	0.21

Table 4.4 Correlation (*r*) between Attitude to Mathematics and mathematics achievement at Year 4 and Year 8 by decile group

	Knowledge and Application of Mathematical and Statistical Ideas (r)		
	Low Decile	**Mid decile**	**High decile**
Year 4	0.13	0.17	0.30
Year 8	0.21	0.37	0.45

Figure 4.4 and Figure 4.5 show how groups of students with different scores on the attitude measure achieved on the two mathematics achievement measures (KAMSI and MSP) at Year 4 and Year 8. To construct this graph, three reporting groups were defined on the basis of the Attitudes to Mathematics scale scores: the lowest group of students was made up of students scoring below the bottom quartile of the Attitude to Mathematics scores; the middle group represented the students who scored between the 25th and 75th percentile; and the highest group represented the students who scored at or above the upper quartile of the distribution. The distribution of achievement for each of these groups is displayed.

On both KAMSI and MSP, and at both year levels, students who reported a more positive attitude to mathematics, on average, gained higher achievement scores. As noted above in Table 4.3 this relationship is more readily observable at Year 8.

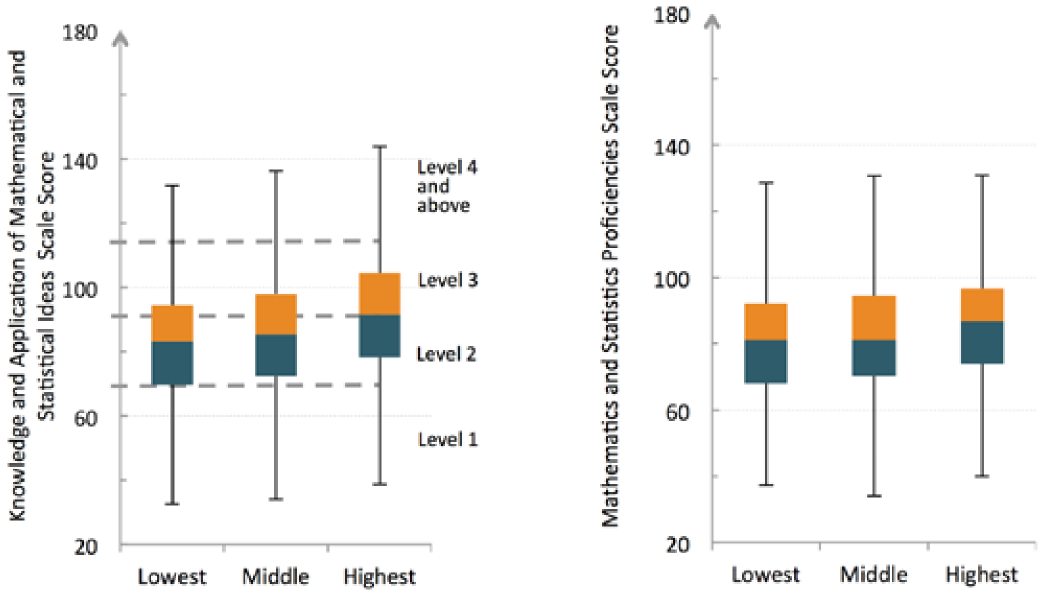

Figure 4.4 Year 4 student mathematics achievement scores by level of Attitude to Mathematics

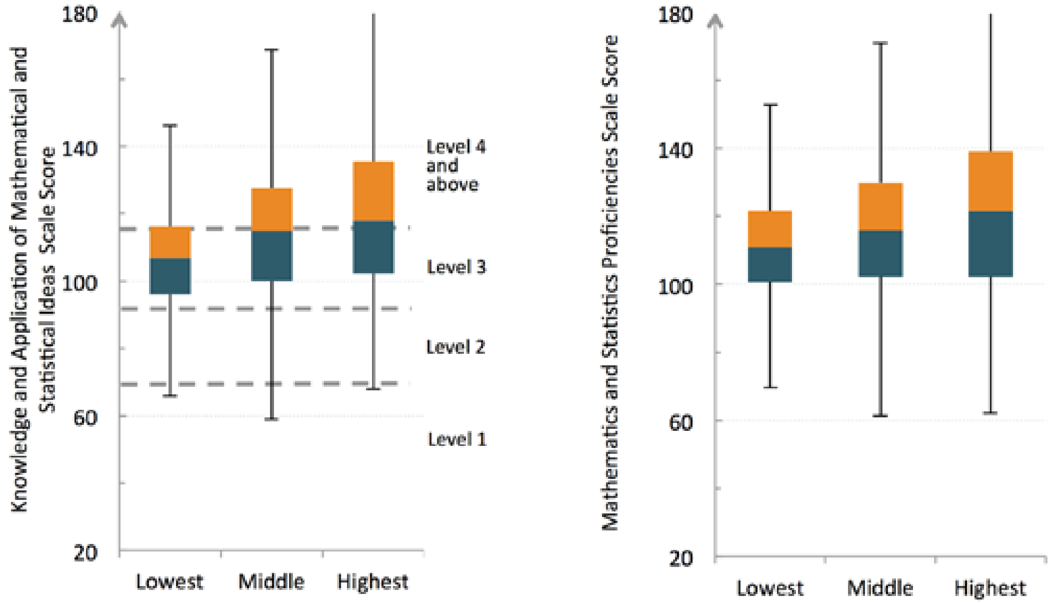

Figure 4.5 Year 8 student mathematics achievement scores by level of Attitude to Mathematics

Table 4.5Effect sizes in bold are statistically significant (p<.05)

Table 4.6 show how average achievement on the KAMSI and MSP scales compared for the three Attitude to Mathematics score groups. An effect size related to each difference is also reported. For the most part these effect sizes were statistically significant.

Table 4.5 Year 4 students: Differences in mathematics achievement by level of Attitude to Mathematics

	Knowledge and Application of Mathematical and Statistical Ideas		Mathematics and Statistics Proficiencies	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Lowest/Middle	2	**0.13**	1	0.06
Middle/Highest	6	**0.30**	5	**0.29**
Lowest/Highest	8	**0.44**	6	**0.36**

Effect sizes in bold are statistically significant (p<.05)

Table 4.6 Year 8 students: Differences in mathematics achievement by level of Attitude to Mathematics

	Knowledge and Application of Mathematical and Statistical Ideas		Mathematics and Statistics Proficiencies	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Lowest/Middle	8	**0.45**	7	**0.32**
Middle/Highest	5	**0.24**	3	0.14
Lowest/Highest	13	**0.66**	10	**0.46**

Effect sizes in bold are statistically significant (p<.05)

2. Opportunities to learn mathematics and statistics at school

Another set of items in the student questionnaire asked students to rate how frequently they were involved in a range of learning experiences related to mathematics and statistics at school. It should be noted that the numbers and frequencies reported here are the result of recording students' own perceptions about their opportunities for learning in mathematics. How this relates to teachers' view of learning opportunities is discussed later in this chapter.

Figure 4.6 and Figure 4.7 show how students in Year 4 and Year 8 responded to the questions. Overall, Year 4 students reported more frequent involvement in the range of activities than Year 8 students. The activities most often rated as highly frequent (over 60 percent of responses in the two categories reporting the highest frequency of involvement) at Year 4 were:

- thinking about and doing interesting maths problems;
- explaining ways of solving problems to a teacher or peers;
- having class/group discussions about maths problems.

At Year 8 activities most often rated as highly frequent were:

- having class/group discussions about maths problems;
- explaining ways of solving problems to a teacher or peers.

The item which showed the most difference between Year 4 and Year 8 responses was ‘I think about and do interesting maths problems’. Year 8 students reported this as a less frequent occurrence that Year 4 students. It may be that the perceived drop in interesting problems reflects the drop in engagement seen between Year 4 and Year 8.

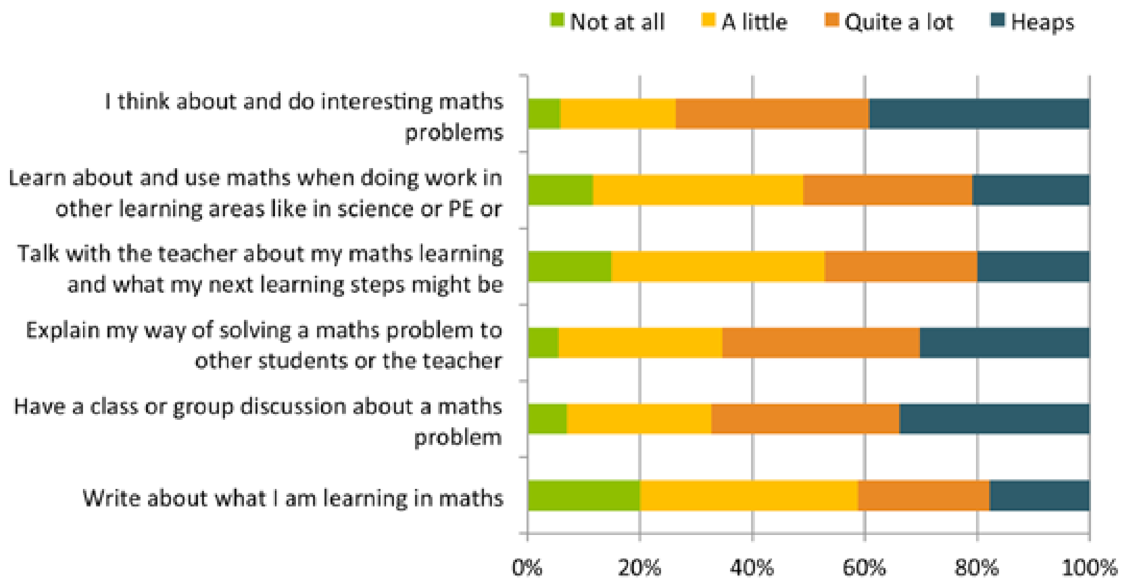

Figure 4.6 Frequency of mathematics-related activities reported by Year 4 students

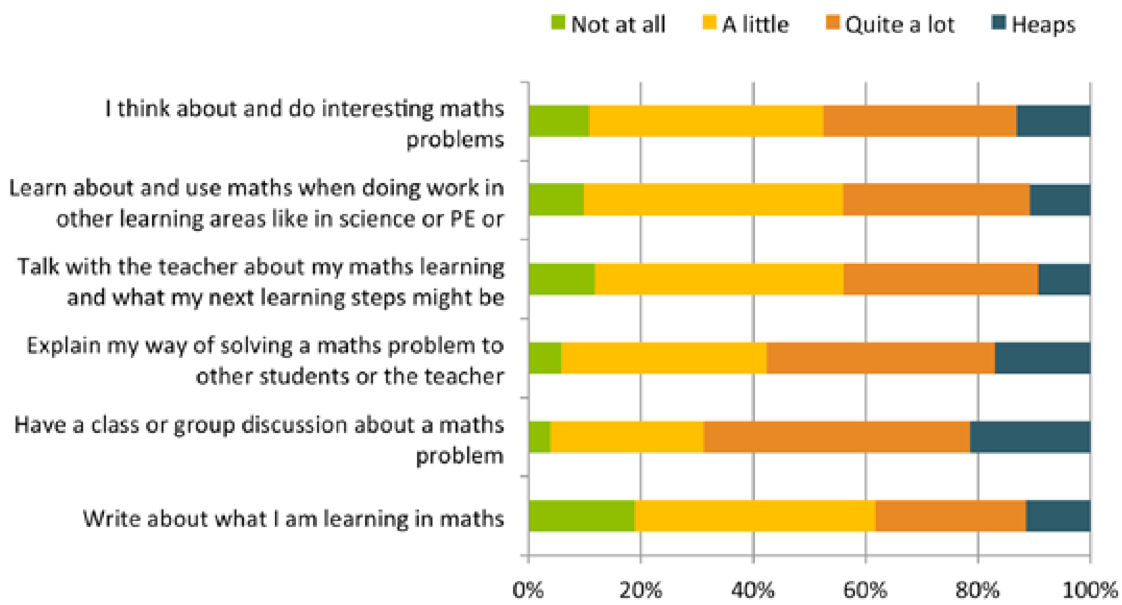

Figure 4.7 Frequency of mathematics-related activities reported by Year 8 students

Relationship between opportunities to learn and achievement in mathematics

Analyses were undertaken to explore the relationship between students' responses to the questionnaire items about opportunities for learning in mathematics and their mathematics achievement as measured by the two NMSSA mathematics scales, KAMSI and MSP. Simple linear regression models were run for each item separately to identify any associations between students' responses to the items, and achievement.

Two items showed a weak, but statistically significant linear relationship to the mathematics achievement scores at Year 8. These were:

- Explain my way of solving a maths problem to other students or the teacher
- I think about and do interesting maths problems.

At Year 4 just one item was observed to have a linear relationship with mathematics achievement scores:

- I think about and do interesting maths problems.

Cluster analysis

A series of analyses were carried out to explore patterns in student responses to the six opportunities to learn questionnaire items. The analyses identified a number of student clusters with similar response patterns. As students in a school are exposed to similar opportunities for learning we might expect to see clusters of similar response patterns within schools. However, tables of school by cluster membership showed that students within schools were scattered liberally across the response pattern clusters, indicating students within the same school do not particularly perceive their opportunities to learn in a similar way to each other. These differences may be attributed to differences in classroom practices that can occur within a school (a variable NMSSA does not collect), or varying perceptions of students within the school.

Overall, we did not observe any consistent relationship between the Opportunities for Learning responses and mathematics achievement scores. Given that we might expect to observe some association between opportunities for learning and achievement scores, some possibilities for the lack of this observation could be:

- students' perception of their opportunities for learning may vary amongst students who have the same opportunities;
- the general nature of the questions in the student questionnaire may not encapsulate ‘opportunities for learning in mathematics’ concisely enough to render an observable result;
- the relationship may exist, but be indirect, or involve a lag. That is, this year's opportunity for learning in the classroom may affect next year's achievement, but not this year's.

3. Teaching mathematics and statistics at Year 4 and Year 8

Up to three teachers in each school were asked to complete a questionnaire about the teaching of mathematics and statistics at Year 4 or Year 8. Where there was a specialist mathematics teacher this person responded to the teacher questionnaire.

Teachers' attitudes to and confidence in teaching mathematics and statistics

A section of the teachers' questionnaire asked about their attitude to, and confidence in, teaching mathematics and statistics. Figure 4.8 and Figure 4.9 show how teachers responded to the items in this section. Overall, at both year levels, teachers responded positively to items regarding their enjoyment of mathematics and statistics and how much they liked teaching it. At both year levels a high proportion of teachers indicated that they feel confident in their teaching, and that they were able to engage and meet the needs of the students they teach.

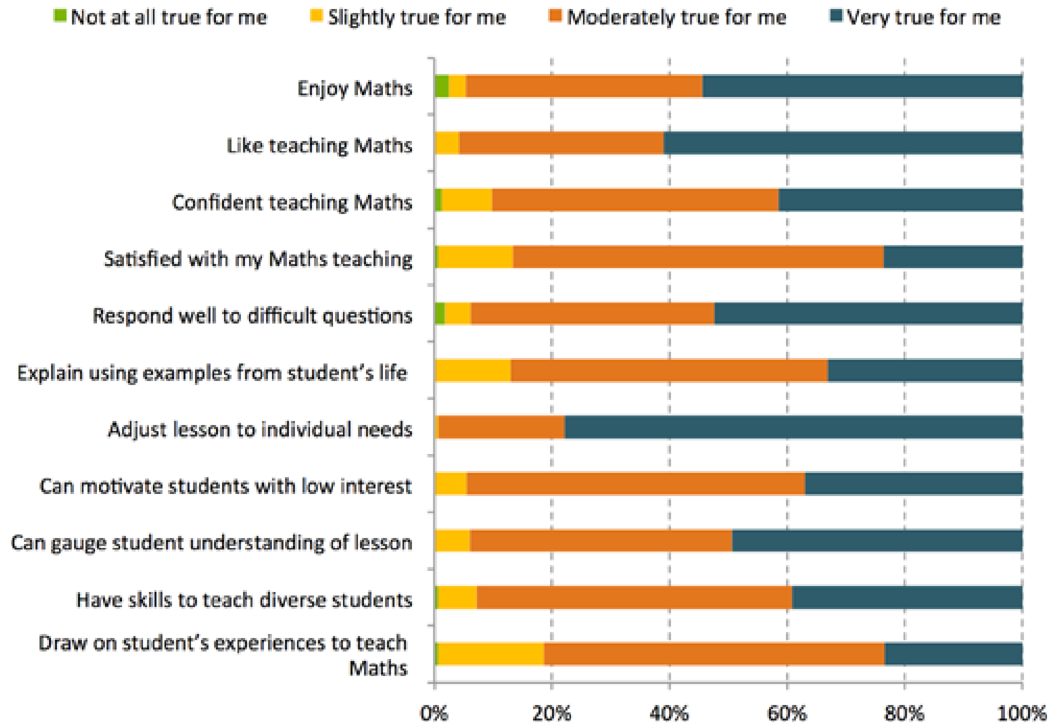

Figure 4.8 Year 4 Teachers' Attitudes to Teaching Mathematics and Statistics

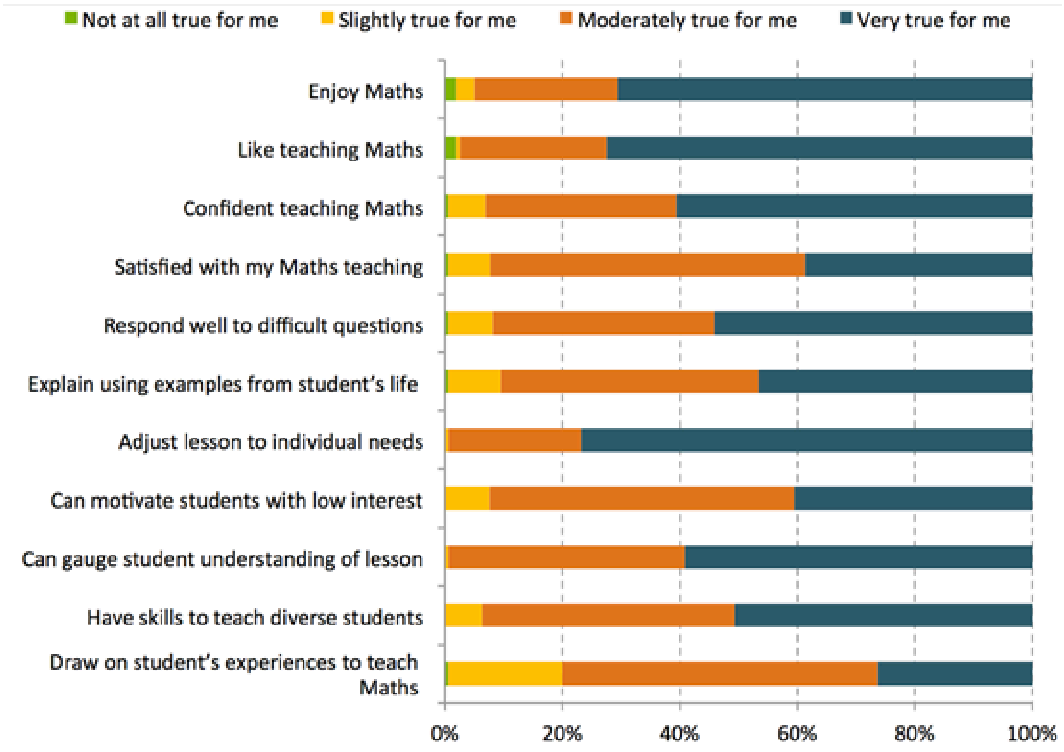

Figure 4.9 Year 8 Teachers' Attitudes to Teaching Mathematics and Statistics

Mathematics activities provided by teachers in the classroom

Teachers were also asked to report how frequently students in their class were involved in a range of opportunities to learn mathematics and statistics. Figure 4.10 and Figure 4.11 present the teachers' responses.

At both year levels, the activities least likely to occur were:

- Take part in Maths competitions
- Students suggest maths problems or ideas.

The activities most likely to occur on an almost daily basis at both year levels were:

- Group discussions on maths problems
- Share maths problems with peers.

Year 4 teachers also reported very frequent practice of:

- Playing maths games that assist learning
- Using special maths equipment.

Patterns of response across the questions are generally very similar for Year 4 and Year 8 teachers.

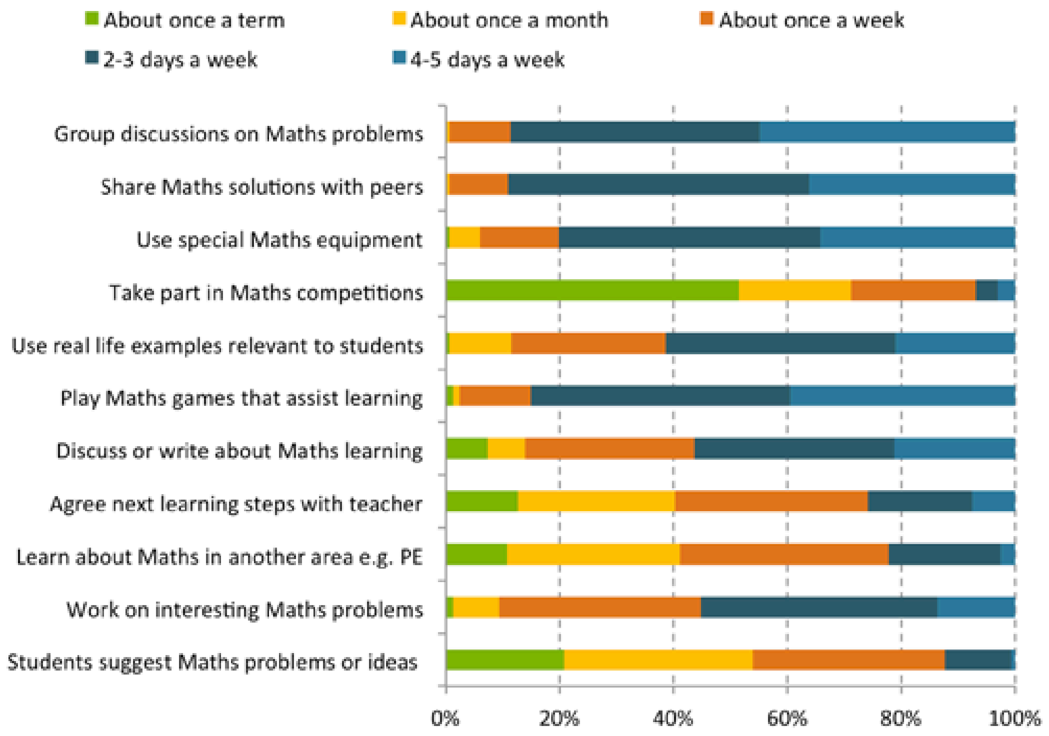

Figure 4.10 Year 4 Teachers' responses to statements about Opportunities to Learn Mathematics

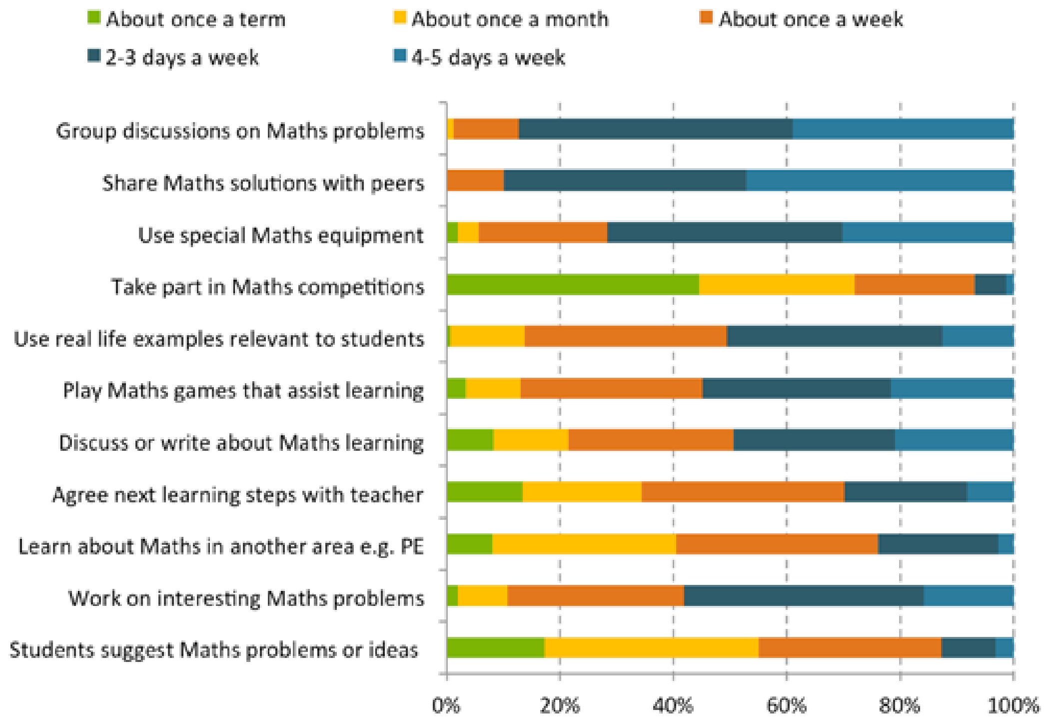

Figure 4.11 Year 8 Teachers' responses to statements about Opportunities to Learn Mathematics

Comparing student and teacher perceptions of opportunities to learn

Students and teachers were asked some parallel questions about the frequency of some classroom activities related to mathematics, although the wording was slightly different in the two questionnaires. Table 4.7 shows the percentages of students and teachers who reported high frequency (once a week or more) of activities listed in the parallel questions. On the whole, teachers reported higher frequencies of these activities than students.

Table 4.7 Students' and teachers' perceptions of frequent activities in the classroom

Students			**Teachers**		
Statement	**Year**	**(%)**		**Year**	**(%)**
I think about and do interesting maths problems	4	74	Work on interesting maths problems	4	91
	8	47		8	89
Learn about and use maths when doing work in other learning areas like science or PE	4	51	Learn about maths in another area e.g PE	4	59
	8	44		8	60
Talk with the teacher about my maths learning and what my next learning steps may be	4	47	Agree next learning steps with teacher	4	60
	8	44		8	66
Explain my way of solving a maths problem to other students or the teacher	4	65	Share maths solutions with peers	4	99
	8	58		8	100
Have a class or group discussion about a maths problem	4	67	Group discussions on maths problems	4	99
	8	69		8	99
Write about what I am learning in maths	4	41	Discuss or write about maths learning	4	86
	8	38		8	78

Meeting the differentiated needs of students in mathematics

Teachers were asked about the strategies they use to meet the differentiated needs of their students in mathematics. Figure 4.12 displays the results in graphical form. The pattern of responses was similar at Year 4 and Year 8. Maths groups within the classroom, whole class activities, providing extra individual assistance within the classroom were the most commonly used strategy (about 80 percent). Activities outside the classroom (extension and remedial activities, using community events for learning) were less commonly used strategies (around 30 to 40 percent). Using specialist advice to adapt the NZC for learners with special education needs was the least frequently mentioned strategy.

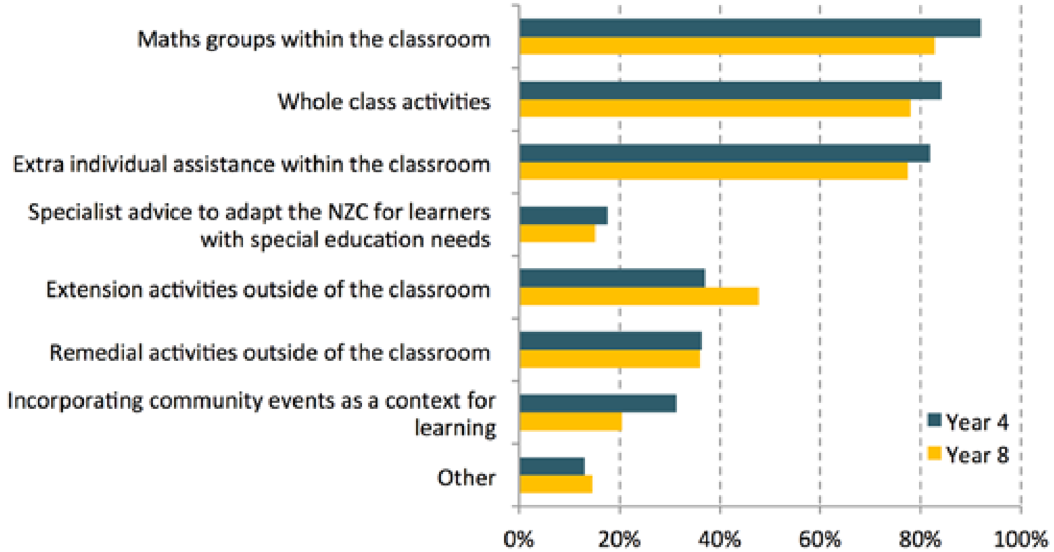

Figure 4.12 Percentage of Year 4 and Year 8 teachers using strategies to meet the differentiated needs of students for mathematics

Professional support and development for teachers in mathematics and statistics

Teachers of participating schools were asked in what ways teachers of Year 4 and Year 8 students were supported in their teaching of mathematics. They responded by selecting the categories of support that were available from a given list. Figure 4.13 shows their responses of teachers for each type of support. For both Year 4 and Year 8 the most common types of support was teacher aides. Teacher reports of support from other teachers were made by less than 20 percent of teachers. Less than 20 percent of teachers mentioned parent helpers, community or cultural advisors.

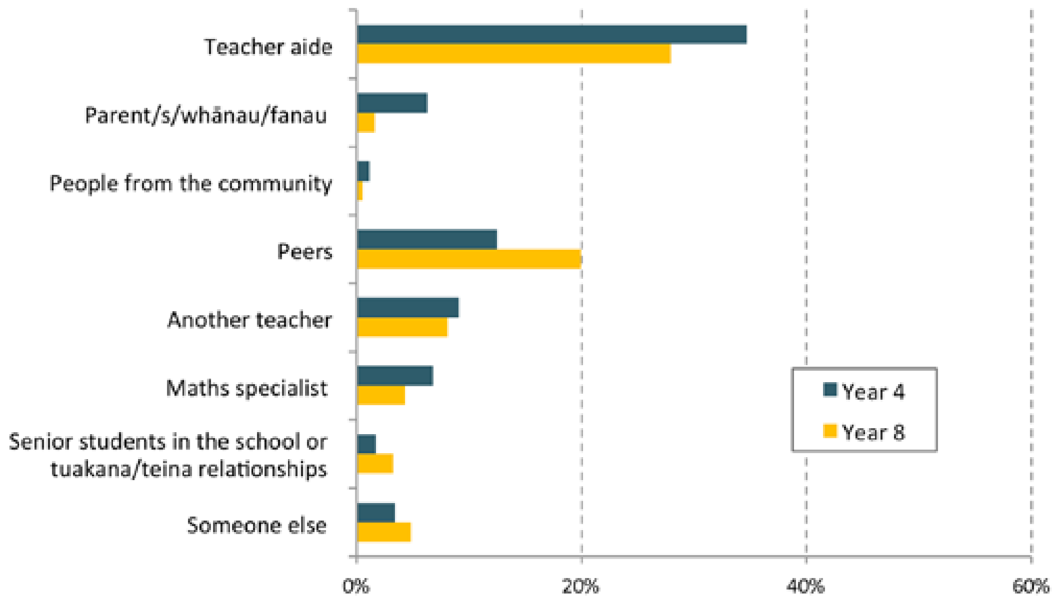

Figure 4.13 Percentage of teachers reporting help available to them as they teach maths in the classroom

Teachers were asked to give an overall rating of their level of support in the classroom with respect to the teaching of mathematics (Figure 4.14). Around 60 percent of teachers at both year levels rated their support as excellent or very good. Approximately 10 percent rated the support provided as poor or very poor.

The timing of their most recent experience of professional development in mathematics teaching is displayed in Figure 4.15. Most teachers (around 70 percent) said they had had professional development opportunities within the last year. Almost all said they had had opportunities within the previous five years.

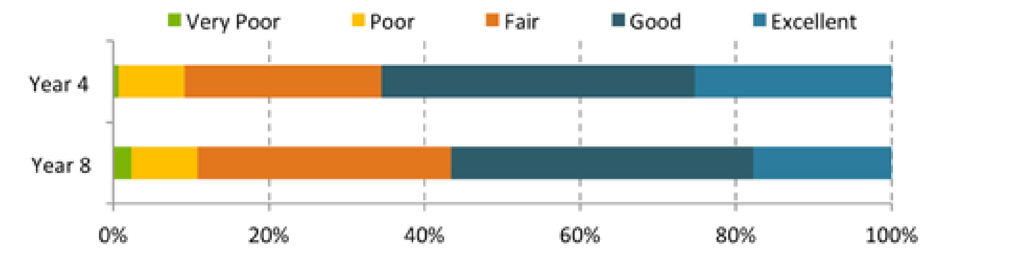

Figure 4.14 Teachers' perspective of overall level of support in the classroom

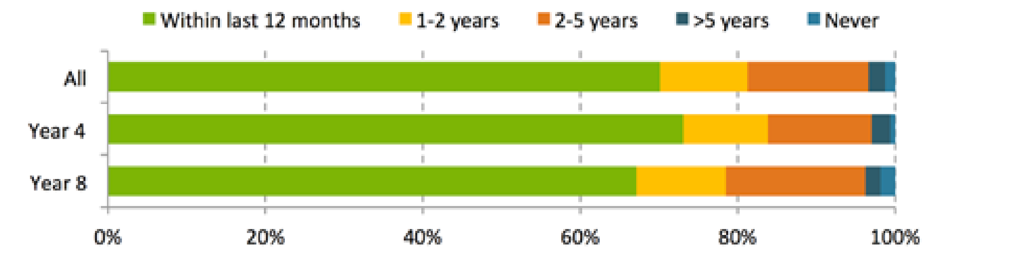

Figure 4.15 Teachers' most recent opportunity for professional development in mathematics teaching

4. The place of mathematics and statistics in the overall teaching programme

Principals were asked to rank the following 17 areas of learning according to the order of priority they take in their school:

- English (Listening, Presenting, Reading, Speaking, Viewing, Writing)
- arts (Dance, Drama, Music, Visual Arts)
- health
- languages
- maths
- physical education
- science
- social sciences
- technology

Year 4 principals' average ranking for mathematics was 2.1, with maths ranked 3rd overall after reading and writing. Year 8 principals' average ranking for mathematics was 2.2, again with maths ranked 3rd overall after writing and reading.

At Year 4, mathematics was ranked in the top 5 (out of 17) priority subject areas by 97 percent of principals and at Year 8 by 94 percent of principals.

Table 4.8 Year 4 students: Top 5 priority areas of learning (out of 17) ranked by principals

Rank	Subject	Number of responses	Minimum Rank	Maximum Rank	Mean Rank
1	Reading	79	1	5	1.7
2	Writing	78	1	6	1.7
3	Maths	79	1	11	2.1
4	Speaking	76	1	15	4.7
5	Listening	75	1	16	5.6

Table 4.9 Year 8: Top 5 priority areas of learning (out of 17) ranked by principals

Rank	Subject	N	Minimum Rank	Maximum Rank	Mean Rank
1	Writing	69	1	7	1.5
2	Reading	67	1	13	1.9
3	Maths	71	1	7	2.2
4	Speaking	67	1	16	5.4
5	Listening	68	1	16	5.9

Principals were also asked to identify people or groups of people who were responsible for setting curriculum priorities in their schools. Principals could indicate as many groups as applied. Figure 4.16 shows the responses by year level. At both year levels most principals indicated that the principal (95-100 percent) and syndicate/curriculum committees (about 80 percent) were involved in setting curriculum priorities. About half of the responding principals indicated that the Board of Trustees had input. The community, students, and other experts were less likely to be involved.

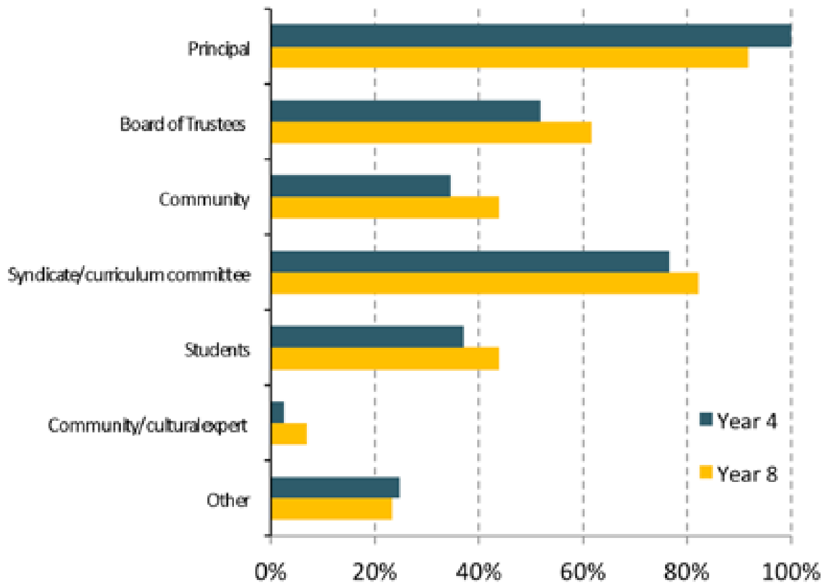

Figure 4.16 Principals' reports of groups involved in setting curriculum priorities

5. Learning in mathematics

Students involved in the Individual Assessment part of the NMSSA study were asked a number of questions about their learning in mathematics during a one-to-one interview with a teacher assessor. The questions focused on students' beliefs about mathematics learning and their performance expectations in regards to mathematics assessments.

Students' beliefs about learning

Three questions probed students' belief that they had some control over their performance in mathematics and whether they thought their mathematics ability was fixed or malleable. The questions were modelled on items developed by Carol Dweck and colleagues[25] to explore students' beliefs about the malleability of intelligence, more generally. Dweck and Leggett[26] described those who believe intelligence is fixed as 'entity theorists'. In contrast, they referred to those who believe they can increase their intelligence as 'incremental theorists', and suggested that each belief was associated with particular achievement behaviours, and goal orientations. In 2007, Blackwell, Trzesniewski and Dweck[27] reported the success of an intervention that focused on strengthening students' incremental theory of intelligence, which they also claimed had a positive effect on students' achievement in mathematics. However, investigations of a causal link between an incremental belief and higher achievement than those with an entity belief have had mixed results.

Perceived control and change in mathematics learning

Each of the first two questions asked students how much they agreed with a statement about learning in mathematics. They were asked to respond using a four-point scale (Totally agree, Agree quite a lot, Agree a little, Do not agree at all). Students also had the option not to answer, or to state they were unsure. Nearly all students provided a response using the agreement scale. The statements associated with these two questions and the percentage of students choosing the different response categories are shown in and Table 4.11.

Table 4.10 Student responses to statement 1: Whether or not I do well in maths is completely up to me

	No Response (%)	Unsure/ Don't Know (%)	Totally Agree (%)	Agree Quite a Lot (%)	Agree a Little (%)	Do Not Agree at All (%)
Year 4	0	0	32	36	28	4
Year 8	<1	<1	28	42	26	4

Table 4.11 Student responses to statement 2: You are either good or bad at maths and you can't do much to change it

	No Response (%)	Unsure/ Don't Know (%)	Totally Agree (%)	Agree Quite a Lot (%)	Agree a Little (%)	Do Not Agree at All (%)
Year 4	0	<1	20	27	28	26
Year 8	0	<1	4	14	31	51

For the purpose of analysis, responses to each question were scored from 1 to 4. Responses that promoted a more incremental-oriented view of learning were given the higher scores. For question one this meant that the 'Totally agree' response was scored as a four. For question two it meant that the 'Do not agree at all' response was scored as a four.

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25 Dweck, C. S. (2000). Self-theories: Their role in motivation, personality, and development. New York: Psychology Press.

26 Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. Psychological Review, 95(2), 256-273. doi: 10.1037//0033-295X.95.2.256

27 Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across adolescent transition: A longitudinal study and an intervention. Child Development, 78(1), 246-263. doi: 10.1111/j.1467-8624.2007.00995.x

Table 4.12 and 4.13 show the average response scores for key population sub-groups on the two questions.

For both questions, students on average, tended towards an incremental-oriented response. While the average response to question 1 was similar at both year levels, students in Year 8 took a stronger incremental position on Question 2 than those in Year 4.

At each year level, the average scores across the sub-groups were relatively similar on both questions. On both questions, the Pasifika sub-group tended to have a weaker incremental view on average, than students in other sub-groups, with the exception of Year 4 Pasifika students' responses to Question 2.

Table 4.12 Average response score by sub-group for question 1: Whether or not I do well in maths is completely up to me.

	Year 4	Year 8
All Students	2.95	2.96
Gender		
Boys	2.99	3.00
Girls	2.93	2.90
Ethnicity		
NZ European	2.95	3.02
Māori	2.95	2.93
Pasifika	2.78	2.69
Asian	2.99	2.92

Table 4.13 Average response score by sub-group for question 2: You are either good or bad at maths and you can't do much to change it.

	Year 4	Year 8
All Students	2.59	3.29
Gender		
Boys	2.63	3.29
Girls	2.53	3.29
Ethnicity		
NZ European	2.57	3.43
Māori	2.53	3.43
Pasifika	2.53	3.00
Asian	2.73	3.30

Relationship between beliefs about learning and achievement

Students' responses to these two questions were compared with their scores on the KAMSI achievement measure. To make the comparison, students who selected the two more-incremental oriented response categories (scoring categories 3 and 4) were compared with students who selected the two less-incremental oriented categories (scoring categories 1 and 2). Table 4.14 and Table 4.15 show for each year level, the average KAMSI scale score and standard deviation for students in each merged category, the difference between the average scores, and the effect size represented by the difference.

On both questions and at both year levels the average KAMSI score was greatest for students with the more incremental-oriented responses. The effect was statistically significant at Year 8 on both questions with an average effect size of about 0.64, roughly equivalent to a year and a half of progress. At Year 4 the effect size was smaller and only statistically significant for Question 1. Figure 4.17 shows the distributions of KAMSI scores associated with the merged categories for question 2. As can be seen, there is a difference in terms of average student achievement. However, it is important to also note the overlap between the score distributions.

Overall the finding indicates that at least for Year 8 students, not only does a student believing they have some control over their learning arguably give them a more positive view of learning, their mind-set can be associated with their performance in mathematics.

Table 4.14 Average scale score on KAMSI for combined response categories on question 1

	Knowledge and Application of Mathematical and Statistical Ideas			
	Year 4		Year 8	
	Less-incremental Responses	More-incremental Responses	Less-incremental Responses	More-incremental Responses
Average (scale score units)	81	86	107	118
SD (scale score units)	19	19	18	21
N	248	523	224	532
Difference (scale score units)	5		11	
Effect size	**0.27**		**0.53**	

Effect sizes in bold are statistically significant (*p*<.05)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

Table 4.15 Average scale score on KAMSI for combined response categories on question 2

	Knowledge and Application of Mathematical and Statistical Ideas			
	Year 4		Year 8	
	Less-incremental Responses	More-incremental Responses	Less-incremental Responses	More-incremental Responses
Average (scale score units)	84	85	103	118
SD (scale score units)	19	19	16	21
N	359	411	135	623
Difference (scale score units)	2		15	
Effect size	0.08		**0.74**	

Effect sizes in bold are statistically significant (*p*<.05)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

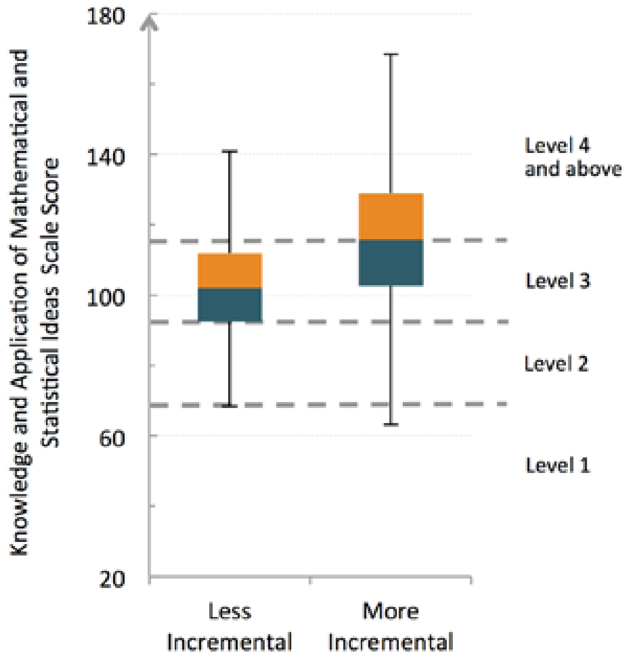


Figure 4.17 Year 8 score distributions for combined response categories on question 2

Perceived influences on mathematics learning

Adding to the picture of students' beliefs were their responses to the third question, 'What do you think is most important when it comes to learning maths?' For this question students were asked to choose from six response categories (unsure/don't know, a good teacher, how clever you are, a home and family that supports you, working hard at your learning and something else). Most Year 8 students (71 percent) tended to think that working hard at their learning is most important when it came to learning maths. A smaller proportion of Year 4 students (56 percent) chose the 'working hard at your learning' category. Only small percentages of both year groups thought that how clever you are was the most important factor (seven percent of Year 4s and two percent of Year 8s). A slightly greater proportion of Year 4s (18 percent) than Year 8s (10 percent) chose 'a home and family that supports you' as most important.

Looking at the data according to students' ethnicities (see Table 4.16) showed that Māori and Pasifika students were slightly more likely to choose 'a home and family that supports you' is most important when it comes to learning maths, and were slightly less likely than other groups to select 'working hard at your learning'. For Pasifika students, this idea that responsibility for their learning is a collective concern seems to be consistent with their lower average score on Question 1, 'Whether or not I do well in maths is completely up to me'. Students of all ethnicities were more likely to rate effort as the most important factor. No more than five percent of students in each group thought that how clever you are was the most important factor.

Table 4.16 Students' views of what is most important when it comes to learning maths, by ethnicity

	N	Unsure/ Don't know (%)	A good teacher (%)	How clever you are (%)	A home and family that supports you (%)	Working hard at your learning (%)	Something else (%)
NZ European	856	1	15	4	13	64	3
Māori	348	0	14	4	17	62	3
Pasifika	199	0	17	5	16	62	1
Asian	154	0	13	3	9	70	5
Other	132	2	11	2	17	64	3

Asian students' beliefs about what was most important tended to have a slightly different emphasis. They were more likely than students of other ethnicities to think that effort was most important, and less likely to think a supportive family was important. New Zealand European students' thoughts fell somewhere between Asian students and students of either Māori or Pasifika ethnicity.

Some of these results run counter to findings of a number of previous studies of children and young people's beliefs about being able to improve their academic outcomes[28], which identified young students as being more likely to believe they can increase their ability than older students, who tended to believe their ability was fairly stable. Much of the research literature builds a picture of students beginning school believing they can increase their ability through applying effort, moving towards a belief that ability is fixed as they get older.

However, more recent research[29] has found the ability-related beliefs of Year 4 and 5 students in New Zealand to be more complex than is reflected by their responses to the types of item used by Dweck and colleagues. What Bonne and Johnston's work shows is that some students believed some aspects of

[28] Ablard, K. E., & Mills, C. J. (1996). Implicit theories of intelligence and self-perceptions of academically talented adolescents and children. *Journal of Youth and Adolescence, 25*(2), 137-148. doi: 10.1007/BF01537340

Kärkkäinen, R., Räty, H., & Kasanen, K. (2008). Children's notions of the malleability of their academic competencies. *Social Psychology of Education, 11*(4), 445-458.

Kurtz-Costes, B., McCall, R. J., Kinlaw, C. R., Wiesen, C. A., & Joyner, M. H. (2005). What does it mean to be smart? The development of children's beliefs about intelligence in Germany and the United States. *Applied Developmental Psychology, 26*, 217-233.

Leonardi, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. *Psychology in the Schools, 39*(3).

[29] Bonne, L., & Johnston, M. (submitted, Feb 2014). The relationship between primary students' beliefs about intelligence, mathematics self-efficacy and achievement.

their intelligence were stable and others malleable, with their responses to Likert-scale type statements representing an amalgamation of these two beliefs.

A Western viewpoint has shaped much of the theorizing of children's thinking and beliefs about their ability and intelligence – theorizing that has not accounted for the perspectives of Māori and Pasifika students, and Asian students. Comparative studies, such as that of Stevenson and Stigler[30] (1992) that investigated cultural differences in how East Asian and American children and their parents and teachers perceived ability and effort, have found that academic excellence was the goal of education in the Asian countries, while the development of children's self-esteem was more important to many Americans.

Students' performance expectations

Two questions focused on students' performance expectations on tests were adapted from a study by Randel, Stevenson and Witruk[31] for use in the interview with Year 8 students only. The first asked students to estimate what score they would expect to attain in a test if the average score for their class was 70 percent. The second followed up the first by asking what score out of 100 they would be happy with.Table 4.17 shows the average and standard deviation associated with the students' expected scores for the first question by sub-group. Overall, the average of the students' estimates was 70.2 percent (almost exactly the average score assumed in the question). Boys on average expected to get slightly higher scores than girls, and Asian students expected higher scores on average than students in other ethnic groups. Score estimates varied the most for Pasifika students and students from quintile 1 schools (deciles 1 and 2)[32].

Table 4.17 Year 8 student responses by sub-group to: 'If the average score on a maths test for your class was 70 out of 100, what score would you expect to get?'

	Average (%)	SD (%)	N	Standard Error (%)	Minimum (%)	Maximum (%)
All Students	70	16	740	0.74	5	100
Gender						
Boys	72	16	366	1.06	5	100
Girls	69	16	374	1.03	9	100
Ethnicity						
NZ European	69	15	405	0.93	5	100
Māori	69	17	181	1.53	9	100
Pasifika	70	21	96	2.60	10	100
Asian	75	15	59	2.34	18	100
Quintile						
1	70	20	118	2.26	10	100
2	68	17	118	2.00	9	100
3	71	16	204	1.38	5	100
4	71	16	117	1.87	15	100
5	71	13	183	1.18	40	100

30 Stevenson, H. W., & Stigler, J. (1992). The learning gap: Why our schools are failing and what we can learn from Japanese and Chinese Education. New York: Summit Books.

31 Randel, B., Stevenson, H.W., Witruk, E. (2000). Attitudes, beliefs, and mathematics achievement of German and Japanese high school students. *International Journal of Behavioral Development, 24* (2), 190-198.

32 A quintile represents a pairing of deciles. For instance, quintile 1 represents students from a combination of decile 1 and decile 2 schools. Quintile is used in this analysis rather than the low, mid and high categories used elsewhere to provide more levels of differentiation.

The students' expected classroom test scores and the scores they actually achieved on the KAMSI assessments were compared. The correlation between the two sets of scores for all students was 0.30. When the data for this item were disaggregated by ethnicity and gender, it was the correlation between the expected scores and actual KAMSI scores for Pasifika boys that were lowest at r = .09, while the correlation for NZ European boys was the highest at r =.41 (see Table 4.18).

Table 4.18 Year 8 correlation between expected scores on a classroom test and scores on the KAMSI assessment, by gender and ethnicity (combined)

Group	Correlation Between Expected and NMSSA Scores (r)
NZ European	
Boys	0.41
Girls	0.32
Māori	
Boys	0.25
Girls	0.16
Pasifika	
Boys	0.09
Girls	0.19
Asian	
Boys	0.30
Girls	0.38

The correlation between students' expected and actual scores also varied by decile. Figure 4.18 provides a series of graphics that plot the expected scores on the classroom test against actual KAMSI scores for students in different quintiles. As can be seen, there is a greater association between students' estimated classroom scores and their KAMSI scores for students from quintile 5 (decile 9 and 10) schools than for students from quintile 1 schools.

Some of the differences between quintiles may be attributable to a reduction in the range of KAMSI scores for students in lower quintiles. However, it could also suggest that students in higher quintiles are more aware of their scoring potential in test-type assessments. Whether this might be associated with the clarity and accuracy of the feedback students received about their learning from their teachers and their families, or one of many other factors, can only be speculated.

Students' responses to the second question about their expected scores, 'Which score out of 100 would you be happy with?' showed some important differences by gender and ethnicity. Table 4.19 shows the mean and standard deviation for the students' responses by sub-group.

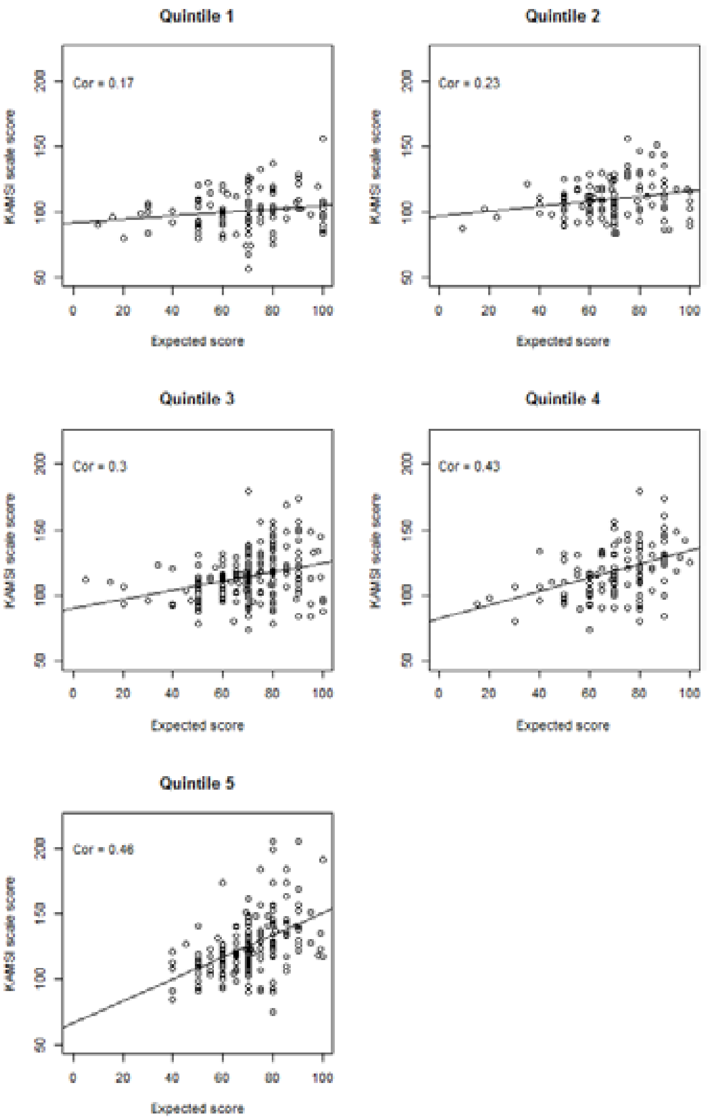


Figure 4.18 Correlation between expected scores on a classroom test and scores on the KAMSI assessment, by school quintile

Table 4.19 Year 8 student responses by sub-group to: 'What score out of 100 would you be happy with?'

	Average (%)	SD (%)	N	Standard Error (%)	Minimum (%)	Maximum (%)
All Students	79	16	740	0.74	5	100
Gender						
Boys	81	15	372	0.97	25	100
Girls	77	17	377	1.07	5	100
Ethnicity						
NZ European	78	15	369	0.96	40	100
Māori	78	17	185	1.54	5	100
Pasifika	82	19	101	2.30	18	100
Asian	83	16	61	2.49	20	100
Quintile						
1	81	18	122	2.03	18	100
2	78	19	121	2.10	5	100
3	81	15	204	1.27	49	100
4	78	17	121	1.93	40	100
5	77	13	181	1.24	25	100

On average, boys responded that they would be happy with scores that were nearly five percentage points higher than girls (81.4 compared with 76.7 percent). Moreover, as shown in Figure 4.19, given that the median scores for boys and girls were almost equivalent, it was the group of boys with the highest expectations that made the difference in terms of the expected average score.

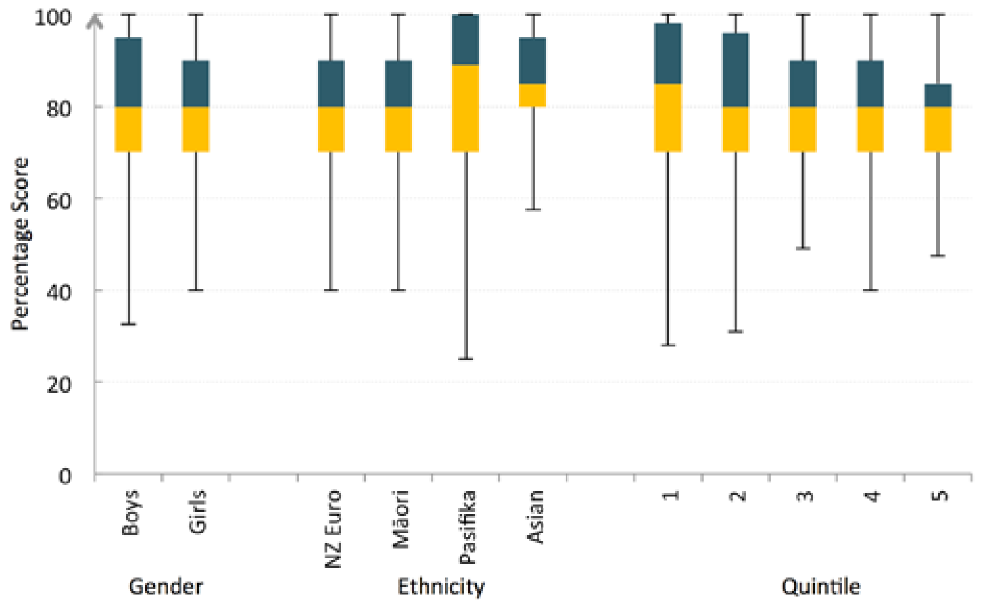


Figure 4.19 Year 8 distribution of scores by sub-group for 'What score would you be happy with'

Students from lower quintile schools, Pasifika students, and Asian students also nominated higher 'happy-with scores' on average than did other groups of students. In Figure 4.20, the narrower range of 'happy-with scores' indicated by students from quintile 5 schools was consistent with these students also having a narrower range of expected scores (see Table 4.17).

In Figure 4.19, the pattern of responses for Māori students and NZ European students are similar.

Overall the findings reported here suggest that high performance expectations, at least by themselves, are not sufficient to promote high scoring. They also suggest a mismatch between students' expectations and actual scoring on an assessment like KAMSI for some priority learners.

5 Māori Student Achievement in Mathematics and Statistics

This chapter presents the findings for Māori[33] student achievement in mathematics and statistics at Year 4 and Year 8. It looks at the variation of achievement within each year level and presents results against the levels of the NZ Mathematics curriculum. It examines the difference in achievement between Year 4 and Year 8, and differences among sub-groups by gender, school decile and type of school. The chapter presents a profile of Māori students who scored above the national average at Year 4 and Year 8 with respect to gender, school decile, and students' attitudes and opportunities to learn mathematics.

In this chapter, we compare the key population sub-group of Māori students to all students in the national sample. When making these comparisons the national sample will be referred to as 'All Students'.

For some of the tables used in this chapter, particularly those associated with population sub-groups, fuller tables of averages, standard deviations, sample sizes, effect sizes, and 95 percent confidence intervals can be found in Appendix 4.

[33] Students could identify with up to three ethnic groups. All students who identified as Māori were included in these analyses.

Success and achievement of Māori students in mathematics and statistics – An overview

Achievement in mathematics and statistics

At Year 4, the average score for Māori students on the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment was 77 scale score units and on the Mathematical and Statistical Proficiencies (MSP) assessment, 76 scale score units. These scores were lower than the national sample (All Students) average scores of 86 and 83 scale score units respectively. The average achievement for Year 8 Māori students on the KAMSI was 107 scale score units and on the MSP was 108 scale score units. The average scores for the All Students group on the two measures were 114, and 117 scale score units respectively. At both Year 4 and Year 8 the average scale score difference between Māori students and the All Students group equates to about a year's worth of progress.

The average achievement on the KAMSI and the Mathematical and Statistical Proficiencies (MSP) scales was lower for Māori students from low decile schools compared to Māori students from high decile schools at both year levels. This is similar to the finding for the All Students group. There was a small difference between Māori girls' and Māori boys' achievement on the KAMSI scale at Year 4 with girls scoring higher than boys, but apart from this and the decile differences, there were no statistically significant sub-group differences by gender or by school type.

The difference between the average scores of Māori students in Year 4 and those in Year 8 was similar to the equivalent difference observed for All Students.

Achievement against curriculum levels

Two-thirds of Year 4 Māori students achieved in the NZC Level 2 performance band or above.on the KAMSI scale – a smaller proportion than for All Students (81 percent). At Year 8, 26 percent of Māori students were achieving at Level 4 or above – also a smaller proportion than for All Students (41 percent). The performance at Year 8 is below curriculum expectations for both groups.

Benchmarking Māori success

The characteristics of Māori students at each year level who scored above the national sample average for their year level were explored. Thirty two percent of Māori students achieved at this level in both year levels compared to about 50 percent of All Students. At both year levels the ratio of boys to girls in the group scoring above the national sample average was similar for both Māori and All Students. The profile of Attitude to Maths scores were also similar for both groups at each year level.

Māori students who scored above the national average on the KAMSI scale were compared to a similar sized group of Māori students who scored lowest on the KAMSI scale in terms of their responses to questions about opportunities to learn mathematics. The analysis showed generally similar response patterns for the two groups. However, at Year 4 the highest scoring group reported a higher frequency of thinking about and doing interesting problems. At Year 8 the opportunity to discuss maths problems with others stood out as a more frequently experienced activity for the highest scoring group.

The interaction between decile and ethnicity

At each year level, a greater proportion of Māori students at high decile schools achieved above the national average than Māori students from mid and low decile schools. A study of how decile and ethnicity related to achievement on KAMSI indicated that decile is strongly associated with achievement on this scale. Average KAMSI scores increased with decile. In addition, there was an effect due to ethnicity which remained after accounting for the decile effect. At both year levels Māori students scored lower on average than their New Zealand European peers. The difference between these groups of students was constant across all deciles.

1. Year 4 Māori student achievement in mathematics and statistics

Table 5.1 shows how Māori students in Year 4 performed on the two NMSSA mathematics and statistics assessments. It provides the average scale scores for each assessment along with standard deviations and sample sizes.

Table 5.1 Overall measures of mathematics and statistics achievement for Māori students at Year 4

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Average (scale score units)	77	76
SD (scale score units)	19	15
N	424	164

At Year 4, the average score for Māori students on the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) scale was 77 scale score units and on the Mathematical and Statistical Proficiencies (MSP) scale, 76 scale score units. These scores are lower than the national sample average scores of 86 and 83 scale score units respectively. The variation in scores for Māori students was similar to the national sample. As with the national sample, Year 4 Māori student scores vary slightly less on the MSP scale than on the KAMSI scale. The differences in average scores between Māori students and All Students is equivalent to approximately a year's progress.

The curriculum alignment exercise described in chapter 2 enabled achievement on the KAMSI scale to be reported in terms of curriculum expectations. Table 5.2 sets out the percentage of Year 4 Māori students in each curriculum band for the KAMSI measure. Sixty eight percent of Māori students were achieving in the Level 2 band or above. At the end of Year 4 students are expected to be achieving strongly at curriculum level 2.

Table 5.2 Percentage of Year 4 Māori students achieving across curriculum levels compared to the All Students group

	Knowledge and Application of Mathematical and Statistical Ideas	
	Māori Students (%)	**All Students (%)**
Level 4 and above	1	5
Level 3	19	31
Level 2	48	45
Level 1	32	19

2. Year 8 Māori student achievement in mathematics and statistics

Table 5.3 shows how Māori students in Year 8 performed on the two NMSSA mathematics and statistics assessments. The table provides average scale scores for each assessment along with standard deviations and sample sizes.

Table 5.3 Overall measures of mathematics and statistics achievement for Māori students at Year 8

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Average (scale score units)	107	108
SD (scale score units)	18	19
N	479	195

The average achievement for Year 8 Māori students on the KAMSI measure was 107 scale score units and for the MSP measure it was 108 scale score units. These average scores were lower than for All Students (114, and 117 scale score units respectively), and the scores varied a little less for Māori students than for All Students. As with the Year 4 cohort, these differences in average scores equate to approximately a year's progress on the mathematics scales.

Table 5.4 shows how Year 8 Māori students performed against the curriculum on the KAMSI assessment. 26 percent of Māori students achieved at Level 4 or above. At the end of Year 8, students are expected to achieve a strong 'at Level 4' performance.

Table 5.4 Percentage of Year 8 Māori students achieving across curriculum levels compared to the All Students group

	Knowledge and Application of Mathematical and Statistical Ideas	
	Māori Students (%)	**All Students (%)**
Level 4 and above	26	41
Level 3	57	48
Level 2	16	10
Level 1	1	1

3. Comparison of Year 4 and Year 8 Māori student achievement

Figures 5.1 and 5.2 show the distribution of Year 4 and Year 8 Māori students on the KAMSI and MSP scales respectively. As expected, Māori students in Year 8 achieved, on average, higher scores than Year 4 Māori students. As with the full national sample, there was a wide variation in scores at each year level, and some overlap in the achievement of Year 4 and Year 8 Māori students.

Figures 5.3 and 5.4 illustrate the spread of achievement across the curriculum levels for Year 4 and Year 8 Māori students on the KAMSI measure. In both graphs the grey dashed line is used to show the score distribution for All Students. The graphs confirm the extent of the overlap between the year levels, and the fact that Māori students are scoring lower than the All Students group on average.

Table 5.5 shows the differences in average scores between Year 4 and Year 8 Māori students expressed in scale score units and as effect sizes, and the averages and standard deviations for both mathematics and statistics measures. The differences between the average score for Year 4 and Year 8 students was 31 scale points on the KAMSI measure and 32 scale points on the MSP measure. These differences represent an average annual effect size of 0.41 - 0.47. The differences in scale score units on both measures between Year 4 and Year 8 for Māori students was similar to the differences observed for the All Students group. This indicates that although Māori students score lower than the All Students group on average on both scales, progress (as indicated by differences in average scores) between Year 4 and Year 8 is similar.

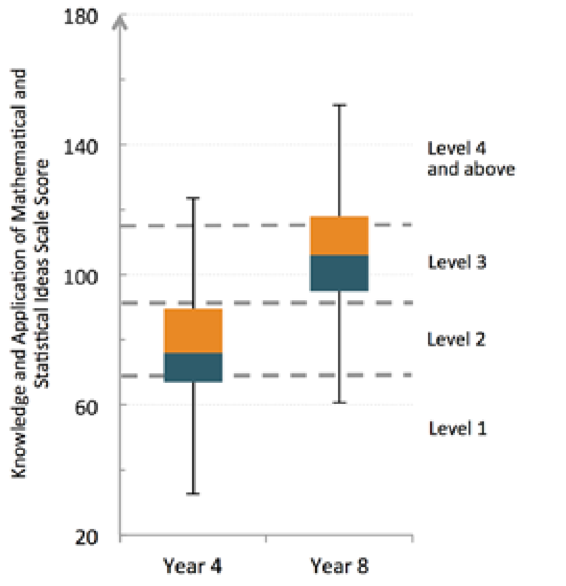


Figure 5.1 Māori student achievement for Knowledge and Application of Mathematical and Statistical Ideas

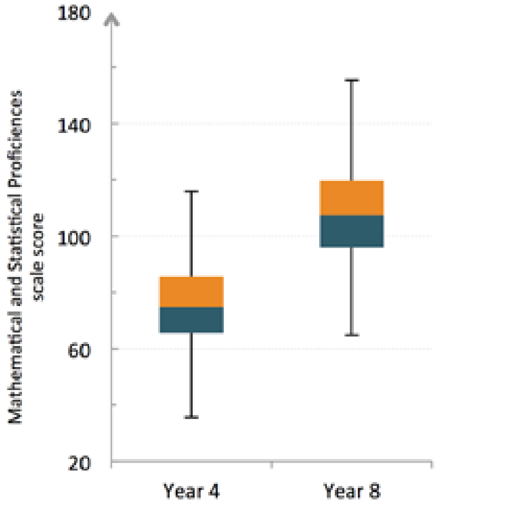


Figure 5.2 Māori student achievement for Mathematical and Statistical Proficiencies

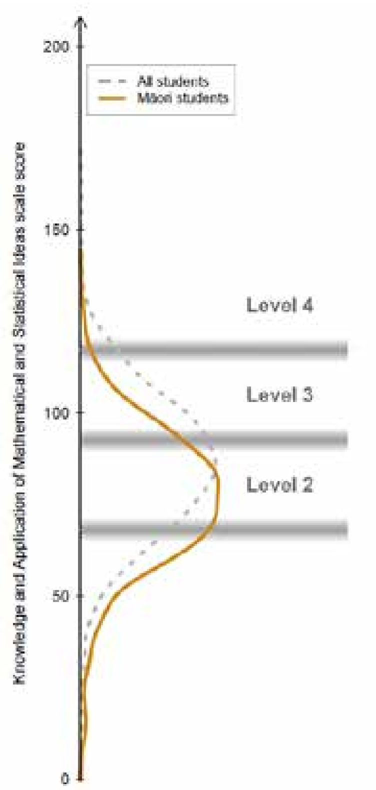


Figure 5.3 Distribution of Year 4 Māori student achievement on the KAMSI scale against levels of the NZ maths curriculum

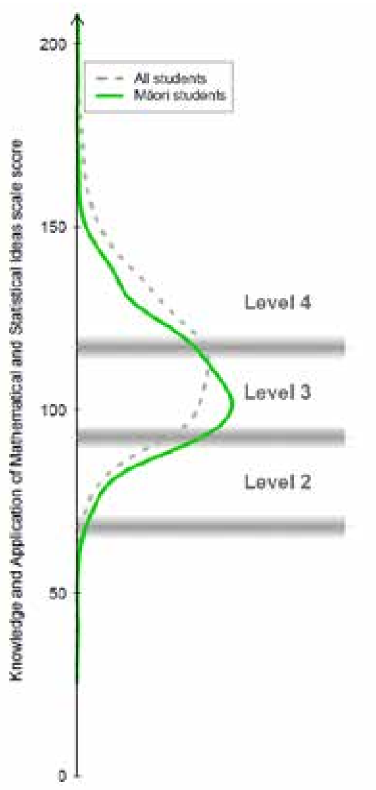


Figure 5.4 Distribution of Year 8 Māori student achievement on the KAMSI scale against levels of the NZ maths curriculum

Table 5.5 Māori student achievement on the Knowledge and Application of Mathematical and Statistical Ideas and Mathematical and Statistical Proficiencies scales in Year 4 and Year 8

	Knowledge and Application of Mathematical and Statistical Ideas		Mathematical and Statistical Proficiencies	
	Year 4	**Year 8**	**Year 4**	**Year 8**
Average (scale score units)	77	107	76	108
SD (scale score units)	19	18	15	19
N	424	479	164	195
Year 4/Year 8 difference (scale score units)*	31		32	
Effect size	**1.65**		**1.87**	
Annual average effect size	0.41		0.47	

* Difference = Year 8 - Year 4
Effect sizes in bold are statistically significant (*p*<.05)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

Sub-group comparisons

Figures 5.5 and 5.6 display the level and spread of scores for the KAMSI and MSP scales for Year 4 Māori students. Distributions are shown for gender, school decile, and type of school. The overall pattern of results was the same for both scales.

Figures 5.7 and 5.8 show comparative sub-group results for Year 8 Māori students. As with Year 4 there is a distinctive pattern on both scales across decile groups where Year 8 Māori students in high decile schools scored higher, on average, than Year 8 Māori students in mid and low decile schools.

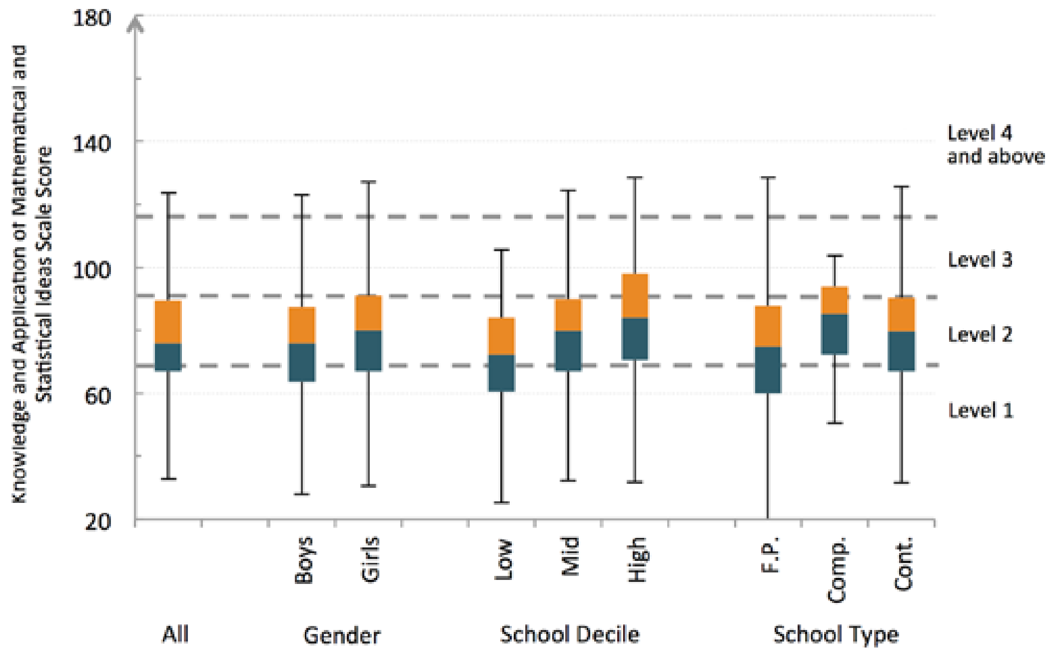


Figure 5.5 Year 4 Māori student scores on the Knowledge and Application of Mathematical and Statistical Ideas scale by gender, school decile and type (F.P.=Full Primary, Cont.=Contributing, Comp=Composite)

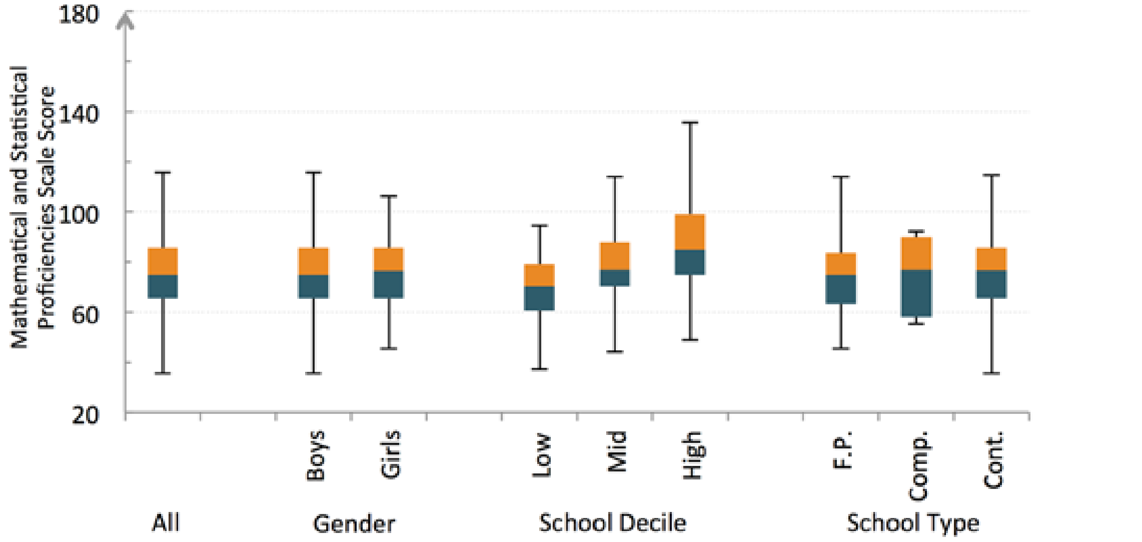


Figure 5.6 Year 4 Māori student scores on the Mathematical and Statistical Proficiencies scale by gender, school decile and type (F.P.=Full Primary, Cont.=Contributing, Comp=Composite)

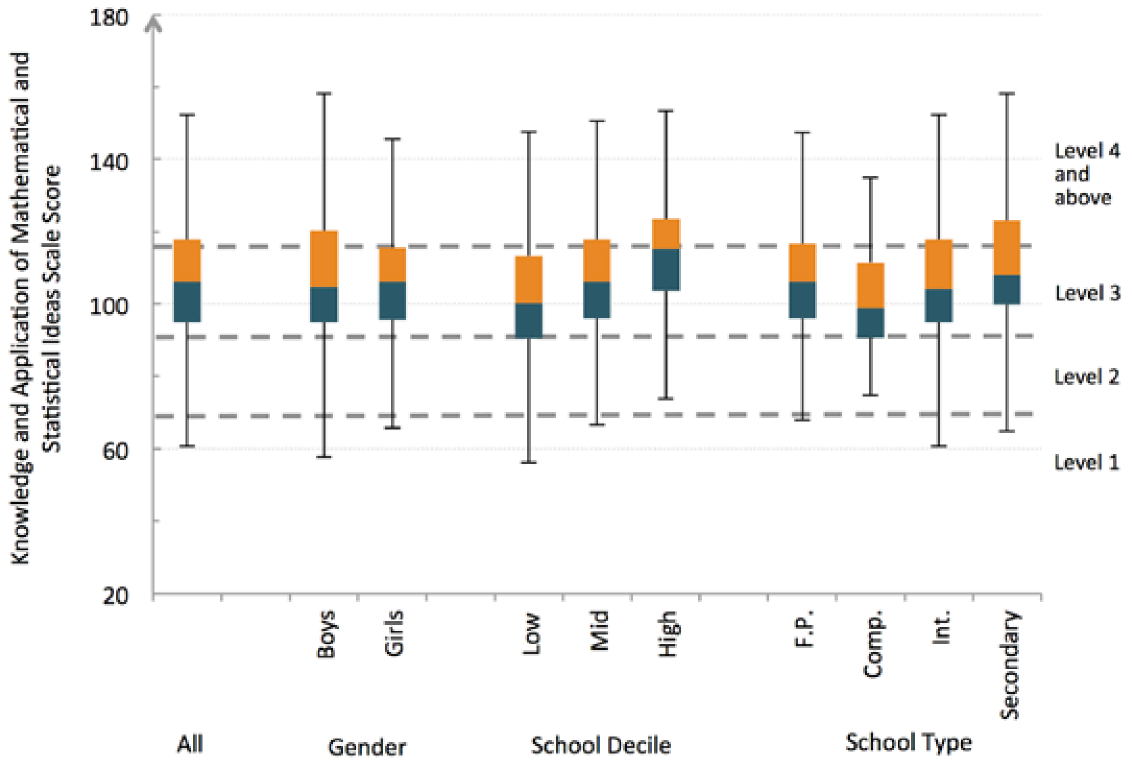


Figure 5.7 Year 8 Māori student scores on the Knowledge and Application of Mathematical and Statistical Ideas scale by gender, school decile, and type of school (F.P.=Full Primary, Comp=Composite)

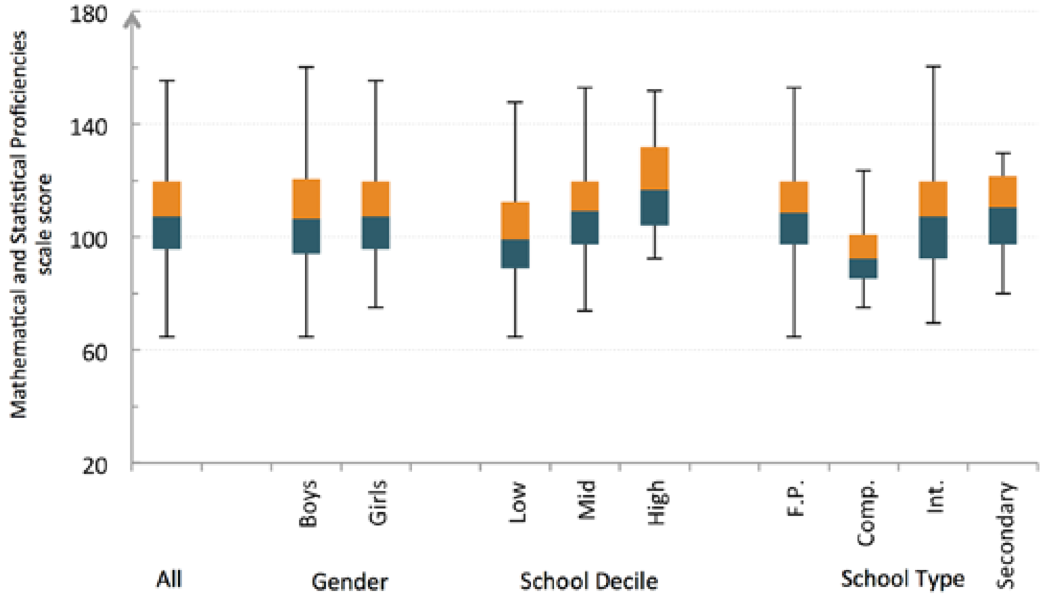


Figure 5.8 Year 8 Māori student scores on the Mathematical and Statistical Proficiencies scale by gender, school decile, and type of school (F.P.=Full Primary, Comp.=Composite)

Tables 5.6 and 5.7 set out the average scale score differences between sub-groups on the two mathematics and statistics measures and the corresponding effect sizes these represent at Year 4 and Year 8.

The most notable difference at both year levels and for both scales was between students from low and high decile schools. The effect size of the difference between the average scores of these two groups was between 0.70 (14 scale score units difference) and 0.80 (14 scale score units difference) on the KAMSI scale at Year 4 and Year 8 respectively. On the MSP scale the effect size was around 1.0 for both year levels (ssud=15 at Year 4, and ssud=17 at Year 8). These effect sizes are equivalent to about half of the effect observed between Year 4 and Year 8 students overall. On the KAMSI scale there was a statistically significant difference between the average score for boys and girls at Year 4.

Table 5.6 Year 4 and Year 8 Māori students: Sub-group differences on the Knowledge and Application of Mathematical and Statistical Ideas scale

	Knowledge and Application of Mathematical and Statistical Ideas			
	Year 4		Year 8	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Gender				
Boys/Girls	4	**0.19**	-1	-0.05
School Decile				
Low/Mid	9	**0.49**	7	**0.41**
Mid/High	5	**0.27**	7	**0.41**
Low/High	14	**0.73**	14	**0.79**
School Type				
Full Primary/Contributing	8	0.41	-	-
Full Primary/Intermediate	-	-	-1	-0.08
Intermediate/Secondary	-	-	6	0.30
Full Primary/Secondary	-	-	5	0.25

Effect sizes in bold are statistically significant (*p*<.05)

Table 5.7 Year 4 and Year 8 Māori students: Sub-group differences on the Mathematical and Statistical Proficiencies scale

	Mathematical and Statistical Proficiencies			
	Year 4		Year 8	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Gender				
Boys/Girls	1	0.04	0	0.01
School Decile				
Low/Mid	8	**0.61**	10	**0.53**
Mid/High	7	0.44	7	0.40
Low/High	15	**1.04**	17	**0.97**
School Type				
Full Primary/Contributing	0	0.03	-	-
Full Primary/Intermediate	-	-	-2	-0.08
Intermediate/Secondary	-	-	1	0.04
Full Primary/Secondary	-	-	-1	-0.04

Effect sizes in bold are statistically significant (*p*<.05)

Table 5.8 compares the differences between Year 4 and Year 8 students for each sub-group. The average annual effect size for each group ranged from 0.37 to 0.44 (scale score unit differences ranged from 23 to 27). The average annual effect size for All Students was 0.36 (scale score unit differences ranged from 26 to 31).

Table 5.8 Differences in Knowledge and Application of Mathematical and Statistical Ideas scale between Year 4 and Year 8 Māori students by sub-group

	Knowledge and Application of Mathematical and Statistical Ideas				
	Year 4 Average (scale score units)	**Year 8 Average** (scale score units)	**Difference*** (scale score units)	**Effect Size**	**Average Annual Effect Size**
Gender					
Boys	75	101	27	**1.71**	0.43
Girls	76	99	23	**1.49**	0.37
School Decile					
Low	72	98	26	**1.75**	0.44
Mid	78	102	24	**1.58**	0.40
High	88	111	23	**1.54**	0.39

* Difference = Year 8 – Year 4

Effect sizes in bold are statistically significant (*p*<.05)

The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

4. Benchmarking Māori success

This section contrasts the profiles of Year 4 and Year 8 Māori students who scored above the national average for their year level with the students from All Students group who also scored above the national averages for Year 4 and Year 8 respectively. The 2013 national averages serve as benchmark scores to compare mathematics and statistics results for different groups this year. This benchmark may also be used to compare mathematics results across future cycles of NMSSA Mathematics.

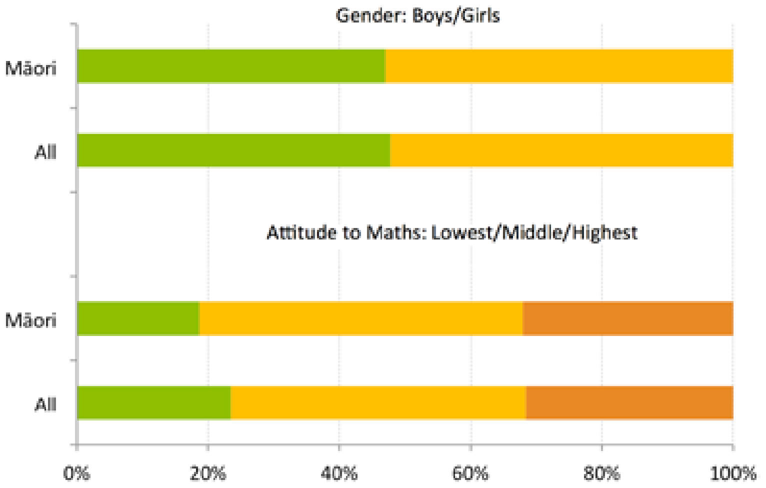
In this section we examine the KAMSI scale benchmark only. Numbers are too small in the relevant sub-groups on the MSP measure to make reliable statements about differences.

Table 5.9 shows the number (and percentage) of Year 4 and Year 8 Māori students who scored above the benchmark for their year level. At Year 4, 32 percent of Māori students scored above the benchmark compared with 50 percent of All Students. At Year 8, the same percentage (32 percent) of Māori students scored above the benchmark compared with 47 percent of All Students.

Table 5.9 Year 4 and Year 8: Summary statistics for students scoring above the benchmarks for their year

	Knowledge and Application of Mathematical and Statistical Ideas			
	Year 4 students scoring above the national Year 4 average		Year 8 students scoring above the national Year 8 average	
	Māori Students	All Students	Māori Students	All Students
Number above benchmark (of total group)	134 (424)	1045 (2070)	152 (479)	964 (2066)
Percentage of respective group (%)	32	50	32	47
Average (scale score units)	97	101	128	131
SD (scale score units)	9	12	13	15

Figures 5.9 and 5.10 contrast the group of Māori students who achieved above the benchmark with the All Students group who scored above the benchmark at Year 4 and Year 8 respectively in relation to gender, and Attitude to Mathematics. There are no notable differences between these groups at either year level.



igure 5.9 Year 4: Percent of Māori students scoring above the benchmark compared to All Students with respect to gender and Attitude to Mathematics

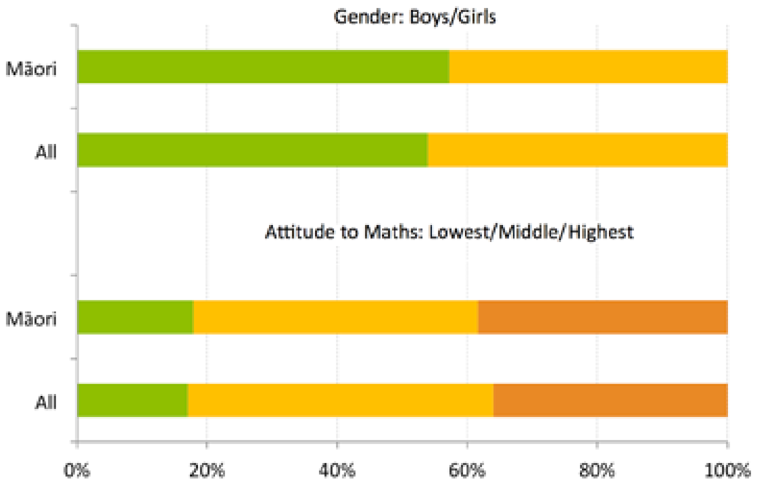


Figure 5.10 Year 8: Percent of Māori students scoring above the benchmark compared to All Students with respect to gender and Attitude to Mathematics

Māori students and opportunities to learn mathematics and statistics

When a particular group of students is achieving at a high level, it is informative to try and determine factors which are associated with their success, but which are not present for less successful groups.

This section compares Māori students who scored above the benchmark to a similar sized group of Māori students who gained the lowest scores on the KAMSI scale with respect to opportunities to learn mathematics. To make comparisons more straightforward the two low frequency categories – 'Not at all' and 'A little' are combined, and compared with the two high frequency categories – 'Quite a lot' and 'Heaps'.

Table 5.10 looks at the six items from the 'opportunities to learn' section in the Student Survey separately for these two groups at Year 4. The high achieving group reported that writing about what they learn in maths happens less frequently than was reported by the low scoring group, but reported that they think about and do interesting maths problems more frequently. The responses to other items did not show large differences.

Table 5.10 Year 4 Māori: Opportunities to Learn Mathematics by high/low achievement

	Year 4 Māori students scoring above benchmark (N=134)		Comparison group of Year 4 Māori students with lowest achievement (N = 134)	
How often you do these things when learning or using maths at school?	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**
Write about what I am learning in maths	54	46	38	62
Have a class or group discussion about a maths problem	34	66	40	60
Explain my way of solving a maths problem to other students or the teacher	29	71	32	68
Talk with the teacher about my maths learning and what my next learning steps might be	45	56	46	54
Learn about and use maths when doing work in other learning areas like in science or PE or inquiry	41	59	32	68
I think about and do interesting maths problems	18	82	34	66

Table 5.11 gives the same breakdown for Year 8 Māori students. The high achieving group reported more class discussions about maths problems, and providing explanations of their own solutions to maths problems more frequently than the low achieving group. The low achieving group report a higher frequency of learning about maths when doing work in other learning areas than the high achieving group.

Table 5.11 Year 8 Māori: Opportunities to Learn Mathematics by high/low achievement

	Year 8 Māori students scoring above benchmark (N=152)		Comparison group of Year 8 Māori students with lowest achievement (N = 152)	
How often you do these things when learning or using maths at school?	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**
Write about what I am learning in maths	54	46	55	45
Have a class or group discussion about a maths problem	24	76	40	60
Explain my way of solving a maths problem to other students or the teacher	31	69	44	56
Talk with the teacher about my maths learning and what my next learning steps might be	54	47	51	49
Learn about and use maths when doing work in other learning areas like in science or PE or inquiry	57	43	47	53
I think about and do interesting maths problems	47	53	42	58

Māori student achievement by decile

Tables 5.12 and 5.13 show the total number of Māori students assessed in mathematics and statistics and the number of Māori students who achieved above the benchmark for their year, broken down by school decile. The tables also provide a breakdown of NZ European students across the deciles – an entirely different distribution pattern – with whom the Māori students will be compared in this section.

At Year 4 and Year 8, 78 percent and 86 percent respectively of Māori students came from low and mid decile schools. This contrasts with 45 percent and 58 percent of NZ European students attending low and mid decile schools in Year 4 and Year 8 respectively.

In a similar way to the full national sample, a greater proportion of Māori students at high decile schools achieved above the benchmark than Māori students from mid and low decile schools (see Chapter 3).

Table 5.12 Year 4: Number and Percentage of Māori and NZ European students by school decile who participated in KAMSI and achieved above the benchmark

	All Māori Students		Māori students who achieved above the national average as a percentage of all Māori students in that decile group	
School Decile	**N**	**%**	**N**	**%**
Low	170	40	34	20
Mid	163	38	55	34
High	93	22	45	48
Total	426	100	134	-
	All NZ European Students		**NZ European students who achieved above the national average as a percentage of all NZ European students in that decile group**	
School Decile	**N**	**%**	**N**	**%**
Low	133	10	54	41
Mid	461	35	242	52
High	727	55	462	64
Total	1321	100	758	-

Table 5.13 Year 8: Number and Percent of Māori and NZ European students by school decile who participated in KAMSI and achieved above the benchmark

	All Māori Students		Māori students who achieved above the national average as a percentage of all Māori in that decile group	
School Decile	**N**	**%**	**N**	**%**
Low	160	33	36	23
Mid	256	53	81	32
High	68	14	35	51
Total	484	100	152	-
	All NZ European Students		**NZ European students who achieved above the national average as a percentage of all NZ European students in that decile group**	
School Decile	**N**	**%**	**N**	**%**
Low	81	6	29	36
Mid	667	52	346	52
High	540	42	348	64
Total	1288	100	723	-

The interaction between decile and ethnicity

Reporting on differences between groups of students in New Zealand by ethnicity is a complex matter. Analysis is complicated on two counts. First, as already reported, ethnic groups (Māori and NZ European) are disproportionately represented across deciles, with a high proportion of Māori students and small proportion of NZ European students attending lower decile schools (Tables 5.12 and 5.13). Secondly, students may identify with more than one ethnic group. It is difficult to make useful, robust statistical statements about these two groups when there is substantial 'blurring' with regard to group membership.

To attempt to extrapolate an accurate picture, the dataset for this analysis has been reduced to those who identify with Māori, New Zealand European, or both ethnic groups. Decile has been grouped by quintile[34].

Separate models for each year were run to examine effects on performance outcomes due to quintile and ethnicity. In this case, the models showed that there was an effect due to ethnicity which remained after accounting for the quintile effect. That is, there is a difference in average maths scores between Māori and NZ European students over and above the difference accounted for by quintile. This difference is constant (as far as the model can determine) across all quintiles.

At Year 4 there is a difference of 10 scale score units on average between Māori and NZ European performance on the KAMSI scale after quintile has been taken into account. This equates to an effect size of about 0.5. At Year 8, the equivalent difference is slightly smaller – about 9 scale score units, with Māori students scoring lower than NZ European on average – an effect size of about 0.4.

These results should be interpreted with caution. The model's ability to precisely assess how Māori students are performing in higher decile schools (and how NZ European students are performing in lower decile schools) is compromised by the disproportionate numbers of students in those deciles with respect to their ethnicity. Details of this analysis can be found in Appendix 5 along with graphics giving an overall representation of the results. The graphics display important information about the distribution of ethnic groups across quintiles, and the variability of scores within quintile.

[34] Decile 1-2 à Quintile 1, Decile 3-4 à Quintile 2, … , Decile 9-10 à Quintile 5

6 Pasifika Student Achievement in Mathematics and Statistics

This chapter presents the findings for Pasifika[35] student achievement in mathematics and statistics at Year 4 and Year 8. It looks at the variation of achievement within year levels and presents results against the levels of the NZ Mathematics curriculum. It examines the difference in achievement between Year 4 and Year 8, and differences among sub-groups by gender, school decile and type of school. The chapter presents a profile of Pasifika students who scored above the national average at Year 4 and Year 8 with respect to gender, school decile, and students' attitudes and opportunities to learn mathematics.

In this chapter, we compare the Pasifika students' sub-group to all students in the national sample. When making these comparisons the national sample will be referred to as 'All Students'.

For some of the tables used in this chapter, particularly those associated with population sub-groups, fuller tables of averages, standard deviations, sample sizes, effect sizes, and 95 percent confidence intervals can be found in Appendix 4.

[35] Students could identify with up to three ethnic groups. All students who identified as Pasifika were included in these analyses.

Success and achievement of Pasifika students in mathematics and statistics – An overview

Achievement in mathematics and statistics

At Year 4, the average score for Pasifika students on the Knowledge and Application of Mathematical Ideas (KAMSI) assessment was 75 scale score units and on the Mathematical and Statistical Proficiencies (MSP) assessment, 73 scale score units. These scores were lower than the national sample average (All Students) scores of 86 and 83 scale score units respectively. The average achievement for Year 8 Pasifika students on the KAMSI was 100 scale score units and on the MSP was 99 scale score units. The average scores for the All Students group on the two measures were 114 and 117 scale score units respectively. At both Year 4 and Year 8 the average scale score difference between Pasifika students and the All Students group equates to about a year and a half of progress.

The average achievement on the KAMSI scale was lower for Pasifika students from low decile schools compared to Pasifika students from high decile schools at both year levels. This is similar to the finding for the All Students group.

The difference between the average scores of Pasifika students in Year 4 and those in Year 8 was similar to the equivalent difference observed in the national sample.

Many features of Pasifika student achievement followed similar patterns to the national samples (see Chapter 3). Apart from decile differences, there were no statistically significant sub-group differences for Pasifika students by gender or by school type.

Achievement against curriculum levels

Two-thirds of Year 4 Pasifika students were achieving at Level 2 or above of the NZC according to the KAMSI measure – a smaller proportion than for All Students (81 percent). Eleven percent of Year 8 Pasifika students were achieving at Level 4 or above – also a smaller proportion than for All Students (41 percent). The performance at Year 8 is below curriculum expectations for both groups.

Benchmarking Pasifika success

The characteristics of Pasifika students at each year level who scored above the national average for their year level were explored. At Year 4, 27 percent and at Year 8, 14 percent of Pasifika students were in this group compared to about 50 percent of All Students. Pasifika students who scored above the national average shared similar attitudes to mathematics to the group of All Students who scored above the national average although the Pasifika students tended to be a little more positive. This characteristic is also generally true of the whole Pasifika sample (See chapter 3).

The group of Pasifika students who scored above the national average on the KAMSI scale were compared to a similar sized group of Pasifika students who scored lowest on the KAMSI scale in terms of responses to questions asked about opportunities to learn mathematics. The analysis showed generally similar response patterns for the two groups. At both Year 4 and Year 8 the highest scoring groups reported a greater frequency of group discussions about maths problems than their lower scoring peers.

The interaction between decile and ethnicity

At each year level, a greater proportion of Pasifika students at high decile schools achieved above the national average than Pasifika students from mid and low decile schools. A study of how decile and ethnicity related to achievement on KAMSI indicated that decile is strongly associated with achievement on this scale. At both year levels average KAMSI scores increased with decile. In addition, there was an effect due to ethnicity, which remained after accounting for the decile effect.

1. Year 4 Pasifika student achievement in mathematics and statistics

Table 6.1 shows how Year 4 Pasifika students performed on the two mathematics and statistics assessments. It provides the average scale scores, standard deviations, and sample sizes.

Table 6.1 Overall measures of mathematics achievement for Pasifika students at Year 4

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Average (scale score units)	75	73
SD (scale score units)	17	14
N	255	100

At Year 4, the average score for Pasifika students on the Knowledge and Application of Mathematical Ideas (KAMSI) scale was 75 scale score units and on the Mathematical and Statistical Proficiencies (MSP) scale, 73 scale score units. These scores are lower than the national sample average scores of 86 and 83 scale score units respectively. The variation in scores for Pasifika students was a little less than the national sample on both scales. As with the national sample, Year 4 Pasifika student scores varied slightly less on the MSP scale than on the KAMSI scale.

The alignment of the KAMSI scale to the NZC described in chapter 2 enables Pasifika achievement to be reported in terms of curriculum expectations. Table 6.2 sets out the percentage of Year 4 Pasifika students in each curriculum band for the KAMSI measure. At the end of Year 4 students are expect to achieve a strong 'at Level 2' performance.

Table 6.2 Percentage of Year 4 Pasifika students achieving across the mathematics curriculum levels compared to All Students group

	Knowledge and Application of Mathematical and Statistical Ideas	
	Pasifika Students (%)	All Students (%)
Level 4 and Above	0	5
Level 3	14	31
Level 2	51	45
Level 1	34	19

2. Year 8 Pasifika student achievement in mathematics and statistics

Table 6.3 provides the average scale scores, standard deviations and sample sizes for Year 8 Pasifika students on the two measures of mathematics and statistics.

Table 6.3 Overall measures of mathematics achievement for Pasifika students at Year 8

	Knowledge and Application of Mathematical and Statistical Ideas	Mathematical and Statistical Proficiencies
Average (scale score units)	100	99
SD (scale score units)	14	20
N	278	103

At Year 8, the average score for Pasifika students on the KAMSI scale was 100 scale score units and for the MSP scale 99 scale score units. These average scores are lower than for All Students (114, and 117 scale score units respectively), and the scores vary less for Year 8 Pasifika students on the KAMSI scale than for All Students. For the MSP scale the variability is about the same for both Pasifika and All Students.

Table 6.4 shows how Year 8 Pasifika students performed against the curriculum on the KAMSI assessment. At the end of Year 8 students are expected to achieve a strong 'at Level 4' performance. Most Pasifika students and the majority of the All Students group did not meet this expectation.

Table 6.4 Percentage of Year 8 Pasifika students achieving across the mathematics curriculum levels compared to All Students group

	Knowledge and Application of Mathematical and Statistical Ideas	
	Pasifika Students (%)	All Students (%)
Level 4 and Above	11	41
Level 3	65	48
Level 2	23	10
Level 1	1	1

3. Comparison of Year 4 and Year 8 Pasifika student achievement

Figures 6.1 and 6.2 show the distribution of Year 4 and Year 8 Pasifika students on the KAMSI and MSP scales respectively. As expected, Year 8 Pasifika students achieved, on average, higher scores than Year 4 students. As with the full national sample, there is a wide variation in scores at each year level, and some overlap in the achievement of Year 4 and Year 8 Pasifika students.

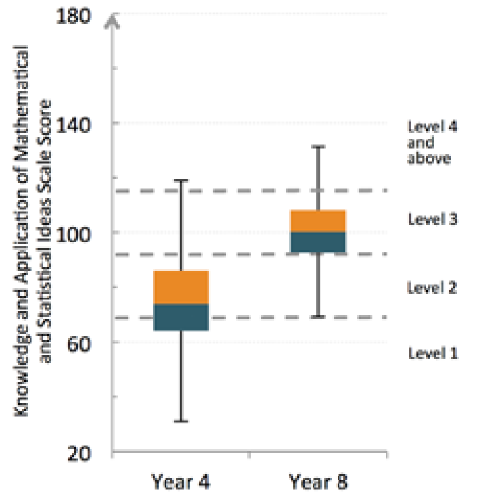


Figure 6.1 Pasifika student achievement for Knowledge and Application of Mathematical and Statistical Ideas

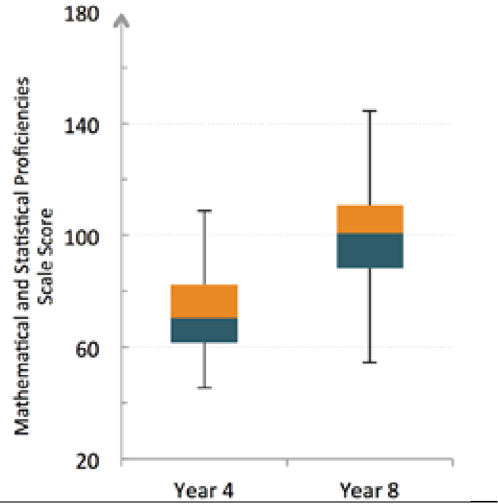


Figure 6.2 Pasifika student achievement for Mathematical and Statistical Proficiencies

Figures 6.3 and 6.4 illustrate the spread of achievement across the curriculum levels for Year 4 and Year 8 Pasifika students on the KAMSI measure. The dashed grey lines are used to show the score distributions for the All Students group. The graphs confirm the extent of the overlap between the year levels, and show that Pasifika students are scoring lower than the All Students group on average.

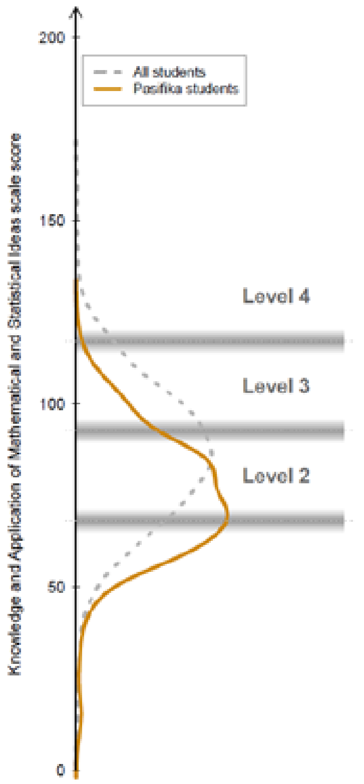


Figure 6.3 Distribution of Year 4 Pasifika and All Students achievement on the KAMSI scale against levels of the mathematics curriculum

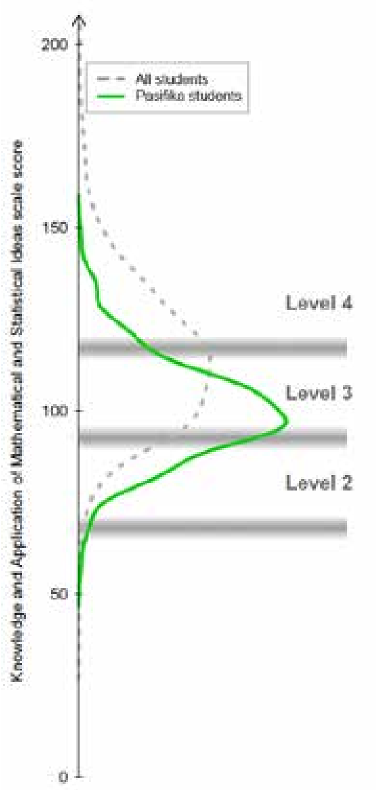


Figure 6.4 Distribution of Year 8 Pasifika and All Students achievement on the KAMSI scale against levels of the mathematics curriculum

Table 6.5 shows, for both mathematics and statistics measures, the differences in average scores between Year 4 and Year 8 Pasifika students, along with the averages and standard deviations at both year levels. The differences between the average score for Year 4 and Year 8 students was 25 scale points on the KAMSI measure and 26 scale points on the MSP measure. These differences represent effect sizes of about 1.6, which in turn represent an average annual growth effect of around 0.40. The differences between Year 4 and Year 8 for Pasifika students are very similar to those observed in the All Students group, indicating that the amount of progress being made by Pasifika students is the same as for other groups, although the actual level is lower.

Table 6.5 Pasifika student achievement on the Knowledge and Application of Mathematical and Statistical Ideas and Mathematical and Statistical Proficiencies scales in Year 4 and Year 8

	Knowledge and Application of Mathematical and Statistical Ideas		Mathematical and Statistical Proficiencies	
	Year 4	**Year 8**	**Year 4**	**Year 8**
Average (scale score units)	75	100	73	99
SD (scale score units)	17	14	14	20
N	255	278	100	103
Year 4/Year 8 difference*	25		26	
Effect size	**1.61**		**1.56**	
Annual average effect size	0.40		0.39	

* Difference = Year 8 - Year 4
Effect sizes in bold are statistically significant (*p*<.05)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

Sub-group comparisons

This section reports on sub-group achievement levels for the KAMSI scale only. The number of Pasifika students assessed using the MSP measure in both Year 4 and Year 8 was smaller and not able to generate as robust a sub-group analysis as the KAMSI scale.

Figure 6.5 displays the level and spread of scores for the KAMSI scale for Year 4 Pasifika students. Distributions are shown for gender, school decile[36], and type of school. There is a pattern of increasing average scores for Year 4 Pasifika students attending low, mid and high decile schools. Pasifika girls and boys are achieving at the same level at Year 4, and there are no differences with respect to school type.

Figure 6.6 shows comparative sub-group results for Year 8 Pasifika students. As with Year 4 there was a distinctive pattern of achievement across decile groups, where Year 8 Pasifika students in high decile schools scored higher, on average, than Year 8 Pasifika students in mid and low decile schools. At Year 8 the difference between Pasifika boys' and girls' average scores was not statistically significant. This is also the case with differences between average scores by school type.

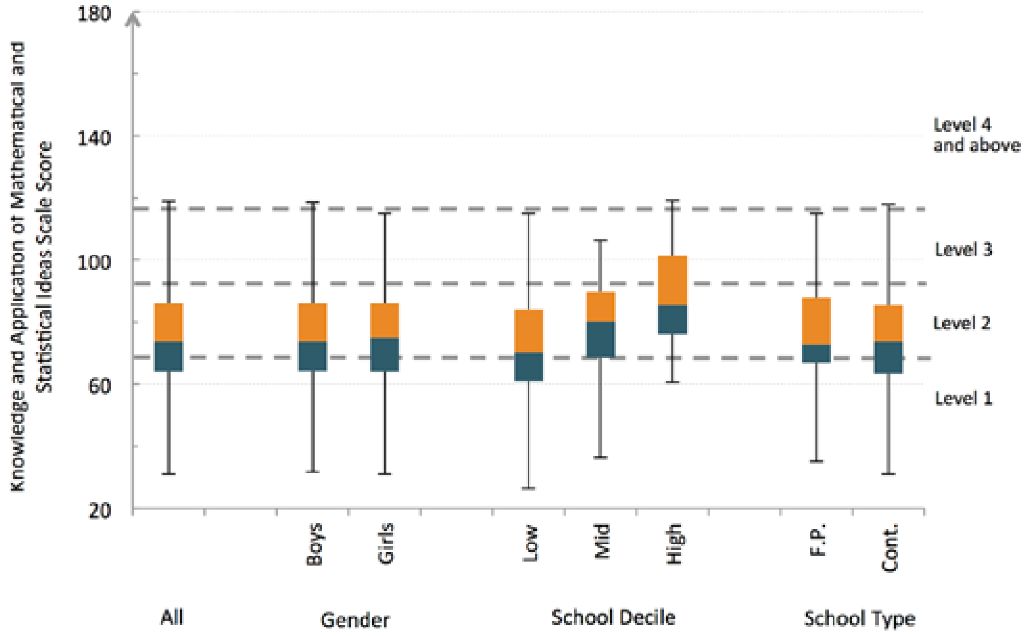


Figure 6.5 Year 4 Pasifika student scores on the Knowledge and Application of Mathematical and Statistical Ideas scale by gender, school decile and type (F.P.=Full Primary, Cont.=Contributing)

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36 Low decile schools (1–3); Mid decile schools (4–7); High decile schools (8–10)

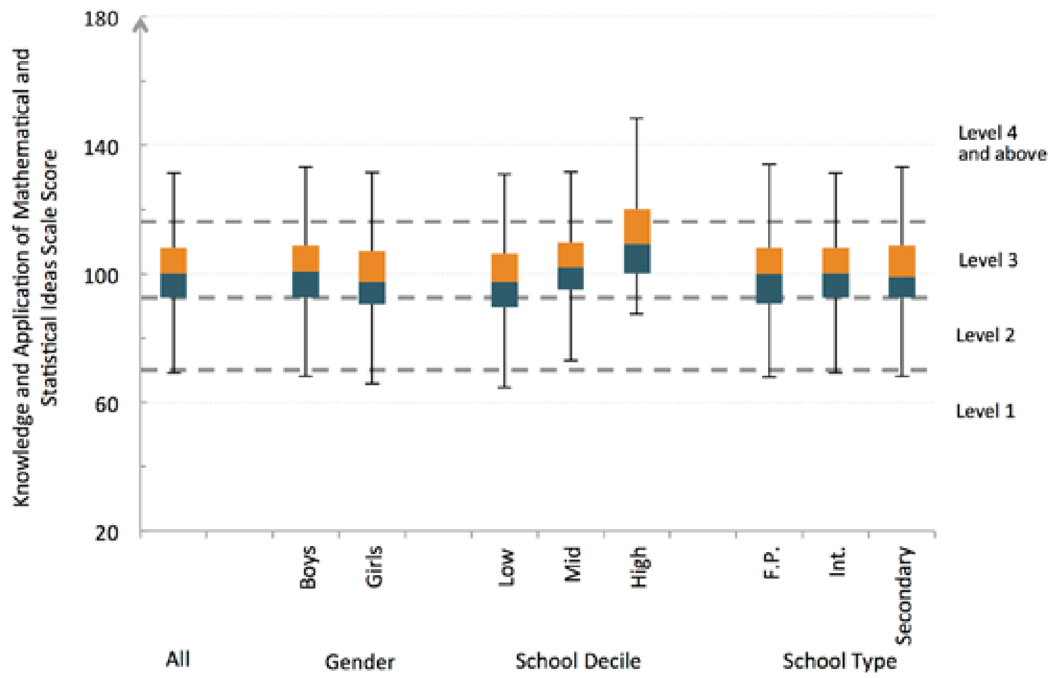

Figure 6.6 Year 8 Pasifika student scores on the Knowledge and Application of Mathematical and Statistical Ideas scale by gender, school decile, and type of school (F.P.=Full Primary, Int.=Intermediate)

Table 6.6 sets out the average scale score differences between sub-groups and corresponding effect sizes at Year 4 and Year 8. The sub-group analysis shows that, on average, achievement of Pasifika students at both year levels showed significant differences by school decile, but not by gender or school type.

The most notable difference at both year levels and for both scales was between students from low and high decile schools. The effect size related to the difference between the average scores of these two groups was about 1.0 at both Year 4 and Year 8 (16 scale score units at Year 4, and 13 scale score units at Year 8). The difference between low and high decile averages for Pasifika students is similar to the equivalent difference for All Students. To understand the magnitude of the difference between average scores for low and high decile students we can compare it to the difference between the average scores for Year 4 and Year 8 students. The difference between low and high decile Pasifika students on average equates to nearly half of the difference in average scale scores observed between Year 4 and Year 8 students.

Table 6.6 Year 4 and Year 8 Pasifika students: Sub-group differences on the Knowledge and Application of Mathematical and Statistical Ideas scale

	Knowledge and Application of Mathematical and Statistical Ideas			
	Year 4		Year 8	
	Difference (scale score units)	**Effect Size**	**Difference** (scale score units)	**Effect Size**
Gender				
Boys/Girls	1	0.08	-2	-0.14
School Decile				
Low/Mid	6	**0.37**	4	**0.30**
Mid/High	10	**0.60**	9	**0.66**
Low/High	16	**0.98**	13	**0.98**
School Type				
Full Primary/Contributing	-1	-0.09	-	-
Full Primary/Intermediate	-	-	0	-0.01
Intermediate/Secondary	-	-	2	0.12
Full Primary/Secondary	-	-	2	0.11

Effect sizes in bold are statistically significant (p<.05)

Table 6.7 compares the differences between Year 4 and Year 8 students for each sub-group. The average annual effect size for each group ranged from 0.37 to 0.44 (the scale score unit difference ranged from 23 to 27). The average annual effect size for All Students was 0.36 (the scale score unit difference ranged from 26 to 31).

Table 6.7 Differences in Knowledge and Application of Mathematical and Statistical Ideas scale between Year 4 and Year 8 Pasifika students by sub-group

	Knowledge and Application of Mathematical and Statistical Ideas				
	Year 4 Average (scale score units)	**Year 8 Average** (scale score units)	**Difference*** (scale score units)	**Effect Size**	**Average Annual Effect Size**
Gender					
Boys	75	101	27	**1.71**	0.43
Girls	76	99	23	**1.49**	0.37
School Decile					
Low	72	98	26	**1.75**	0.44
Mid	78	102	24	**1.58**	0.40
High	88	111	23	**1.54**	0.39

* Difference = Year 8 - Year 4
Effect sizes in bold are statistically significant ($p<.05$)
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

4. Benchmarking Pasifika success

This section contrasts the profiles of Year 4 and Year 8 Pasifika students who scored above the national average at their year level with the students from the national sample (All Students) who also scored above the national averages for Year 4 and Year 8 respectively. The 2013 national averages serve as benchmark scores with which to compare mathematics and statistics results for different groups this year. These benchmarks may also be used to compare mathematics results across future cycles of NMSSA Mathematics.

In this section we examine the KAMSI scale benchmark only where sample numbers are large enough to allow reliable statements about differences to be made.

Table 6.8 shows the number (and percentage) of Year 4 and Year 8 Pasifika students who scored above the benchmark for their year level. At Year 4, 27 percent of Pasifika students scored above the benchmark compared with 50 percent of All Students. At Year 8, 14 percent of Pasifika students scored above the benchmark compared with 47 percent of All Students.

Table 6.8 Year 4 and Year 8: Summary statistics for students scoring above the benchmarks for their year

	Knowledge and Application of Mathematical and Statistical Ideas			
	Year 4 students scoring above the national Year 4 average		**Year 8 students scoring above the national Year 8 average**	
	Pasifika Students	**All Students**	**Pasifika Students**	**All Students**
Number above benchmark (of total group)	70 (255)	1045 (2070)	40 (278)	964 (2066)
Percentage of respective group (%)	27	50	14	47
Average (scale score units)	95	101	124	131
SD (scale score units)	8	12	8	15

Figures 6.7 and 6.8 contrast the group of Pasifika students scoring above the benchmark with the group of All Students who scored above the benchmark at Year 4 and Year 8 respectively in relation to gender and attitudes to mathematics. There are no notable gender differences, but a suggestion that the above-benchmark Pasifika group are a little more positive in their attitude towards mathematics than the All Students group who scored above the benchmark. This pattern is in line with observations made about the complete samples (see Chapter 4).

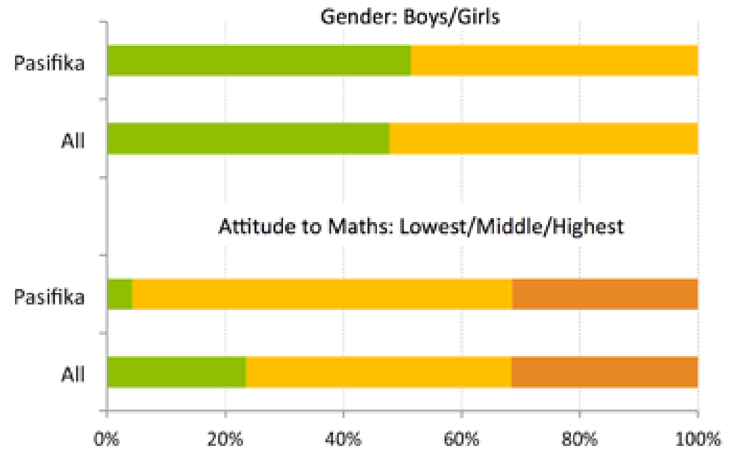

Figure 6.7 Year 4: Pasifika students scoring above the benchmark compared to All Students with respect to gender and Attitude to Mathematics

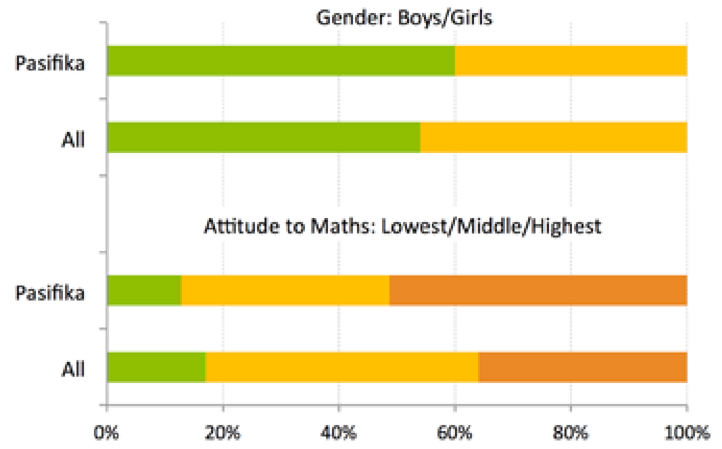

Figure 6.8 Year 8: Pasifika students scoring above the benchmark compared to All Students with respect to gender and Attitude to Mathematics

Pasifika students and opportunities to learn mathematics and statistics

When a particular group of students is achieving at a high level, it is informative to try and determine factors which are associated with their success, but which are not present for less successful groups.

This section compares Pasifika students who scored above the benchmark to a similar sized group of Pasifika students who gained the lowest scores on the KAMSI scale with respect to opportunities to learn mathematics. To make comparisons easily the two low frequency categories – ‘Not at all’ and ‘A little’ are combined, and compared with the two high frequency categories – ‘Quite a lot’ and ‘Heaps’.

Table 6.9 looks at each item (from the 'opportunities to learn' section in the NMSSA student questionnaire) separately for these two groups at Year 4. The high achieving group report they have class discussions about maths problems more frequently than those in the low achieving group. They also report they think about and do interesting maths problems more frequently than their low achieving peers.

Table 6.9 Year 4 Pasifika: opportunities to learn mathematics by high/low achievement

	Year 4 Pasifika students scoring above benchmark (N=134)		Comparison group of Year 4 Pasifika students with lowest achievement (N = 134)	
How often you do these things when learning or using maths at school?	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**
Write about what I am learning in maths	47	53	38	61
Have a class or group discussion about a maths problem	28	72	44	57
Explain my way of solving a maths problem to other students or the teacher	30	70	20	80
Talk with the teacher about my maths learning and what my next learning steps might be	32	69	40	60
Learn about and use maths when doing work in other learning areas like in science or PE or inquiry	38	61	29	71
I think about and do interesting maths problems	14	86	35	66

Table 6.10 gives the same breakdown for Year 8 Pasifika students. The low achieving group perceive that they have more frequent opportunities than the high achieving group to write about what they are learning in maths; to talk with the teacher about their maths learning and what their next learning steps might be; and to think about and do interesting maths problems.

Conversely the high achieving group report that they have class or group discussions about maths problems more frequently than the low achieving group.

Table 6.10 Year 8 Pasifika opportunities to learn mathematics by high/low achievement

	Year 8 Pasifika students scoring above benchmark (N=?)		Comparison group of Year 8 Pasifika students with lowest achievement (N = ?)	
How often you do these things when learning or using maths at school?	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**	**Not at All/ A Little (%)**	**Quite a Lot/ Heaps (%)**
Write about what I am learning in maths	48	53	31	70
Have a class or group discussion about a maths problem	23	76	36	65
Explain my way of solving a maths problem to other students or the teacher	27	73	28	72
Talk with the teacher about my maths learning and what my next learning steps might be	44	56	24	77
Learn about and use maths when doing work in other learning areas like in science or PE or inquiry	47	52	41	59
I think about and do interesting maths problems	35	65	21	79

Pasifika student achievement by decile

Tables 6.11 and 6.12 show the total number of Pasifika students assessed in mathematics and statistics and the number of Pasifika students who achieved above the benchmark for their year, broken down by school decile. It should be noted that numbers are extremely small, and results should be interpreted with caution. However, the patterns observed at a national level do persist in the Pasifika student sub-group. The tables also provide a breakdown of NZ European students across the deciles – an entirely different distribution pattern – with whom the Pasifika students will be compared in this section.

At Year 4 and Year 8, 88 percent and 90 percent respectively of Pasifika students came from low and mid decile schools. This contrasts with 45 percent and 58 percent of NZ European students attending low and mid decile schools in Year 4 and Year 8 respectively.

In a similar way to the All Students group, a greater proportion of Pasifika students at high decile schools achieved above the national benchmark than Pasifika students from mid and low decile schools (see Chapter 3).

Table 6.11 Year 4: Number and percentage of Pasifika students and NZ European student by school decile who participated in KAMSI and achieved above the benchmark

	All Pasifika Students		Pasifika students who achieved above the national average as a percentage of all Pasifika in that decile group	
School Decile	**N**	**%**	**N**	**%**
Low	171	66	38	22
Mid	58	22	18	31
High	29	11	14	48
Total	258	100	70	-
	All NZ European Students		**NZ European students who achieved above the national average as a percentage of all NZ European students in that decile group**	
School Decile	**N**	**%**	**N**	**%**
Low	133	10	54	41
Mid	461	35	242	52
High	727	55	462	64
Total	1321	100	758	-

Table 6.12 Year 8: Number and percentage of Pasifika students and NZ European students by school decile who participated in KAMSI and achieved above the benchmark

	All Pasifika Students		Pasifika students who achieved above the national average as a percentage of all Pasifika in that decile group	
School Decile	N	%	N	%
Low	182	65	19	10
Mid	71	25	12	17
High	26	9	9	35
Total	279	100	40	-
	All NZ European Students		**NZ European students who achieved above the national average as a percentage of all NZ European students in that decile group**	
School Decile	**N**	**%**	**N**	**%**
Low	81	6	29	36
Mid	667	52	346	52
High	540	42	348	64
Total	1288	100	723	-

The interaction between decile and ethnicity

Reporting on differences between groups of students in New Zealand by ethnicity is a complex matter. Analysis is complicated on two counts. First, as already reported, ethnic groups (Pasifika and NZ European) are disproportionately represented across deciles, with a high proportion of Pasifika students and small proportion of NZ European students attending lower decile schools. Secondly, students may identify with more than one ethnic group. It is difficult to make useful, robust statistical statements about these two groups when there is substantial 'blurring' with regard to group membership. A further obstacle in this analysis is the small sample numbers of Pasifika students in the national sample.

To attempt to extrapolate an accurate picture, the dataset for this analysis has been reduced to those who identify with Pasifika, New Zealand European, or both ethnic groups. Decile has been grouped by quintile[37].

Separate models were run for each year level to examine effects on performance outcomes due to quintile and ethnicity. In this case, the models showed that there was an effect due to ethnicity which remained after accounting for the quintile effect. That is, there is a difference in average mathematics and statistics scores between Pasifika and NZ European students over and above the difference accounted for by quintile. This difference is constant (as far as the model can determine) across all quintiles.

At Year 4 there is a difference of eight scale score units on average between Pasifika and NZ European performance on the KAMSI scale after quintile has been taken into account. This equates to an effect size of about 0.4. At Year 8, the equivalent difference is larger – about 13 scale score units, with Pasifika students scoring lower than NZ European on average – an effect size of about 0.6.

These results should be interpreted with caution. The model's ability to precisely assess how Pasifika students are performing in higher decile schools (and how NZ European students are performing in lower decile schools) is compromised by the disproportionate numbers of students in those deciles with respect to their ethnicity. Details of this analysis can be found in Appendix 5 along with graphics giving an overall representation of the results. The graphics display important information about the distribution of ethnic groups across quintiles, and the variability of scores within quintile

[37] Decile 1-2 à Quintile 1, Decile 3-4 à Quintile 2, … , Decile 9-10 à Quintile 5

7 Achievement of Students with Special Education Needs in Mathematics and Statistics

The NMSSA includes students with special education needs in the assessment programme. We have information about the students in the study with special education needs and are able to describe those students' achievement. We are also able to report on their views of school and their perceptions regarding their learning.

In the NMSSA study, the group of students with moderate special education needs was large enough to make some comparisons with other groups of interest. The group of students with high special education needs, and the group of students 'on referral' were too small to make statistically robust comparisons. However, where appropriate, descriptive reporting of these two very small groups has been included in the report. In future rounds of NMSSA it is the intention that with suitable accommodations available, these students will be increasingly encouraged to take part in the study.

Some tables in this chapter contain asterisks. Asterisks are used to indicate that where there are very small sample numbers it is impossible to report percentages or other statistics meaningfully. All statistical details about sample sizes, sub-groups average scale scores, standard deviations, effect sizes and confidence intervals and contained in Appendix 4.

Success and achievement of students with special education needs in mathematics and statistics – An overview

Participation of students with special education needs

Students with special education needs were included in NMSSA. Students with high needs made up approximately 0.5 percent of the sample at each year level. Students with moderate needs made up 5-6 percent of the sample at each year level. The number of students in the 'on referral' category was smaller than in 2012. This is likely due to differences in the timing of data collection. The small number of students with special education needs in the sample means that overall, the findings in this chapter should be interpreted with caution.

Achievement in mathematics and statistics

At both year levels, students with high or moderate special education needs tended to achieve at a lower level on the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment than those with no special education needs. However, the overlap between the groups indicated that there were students, particularly those with moderate special education needs, who were achieving at the same level as students with no special education needs.

The difference between average scores at Year 4 and Year 8 for students with moderate special education needs was similar to the equivalent difference for all students in the national sample (the All Students group).

At Year 4, 44 percent of students with moderate needs achieved at Level 2 of the NZC or above, and at Year 8, eight percent of students with moderate needs achieved at Level 4 or above.

Attitude to mathematics and opportunities to learn

The decrease in Attitude to Mathematics from Year 4 to Year 8 was similar for students with high and moderate needs, and in both cases was less than the decrease for students with no special education needs.

Students with special education needs reported having a similar range of opportunities to learn mathematics and statistics as students with no special education needs.

Benchmarking success for students with special education needs

At Year 4, 11 percent of students with moderate needs and at Year 8, 12 percent of students with moderate needs scored above the national average on the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) scale, compared to approximately 50 percent of All Students.

The profile of the group of students with special education needs who scored above the national average at each year level was broadly similar to the group of All Students who scored above the average across decile and Attitude to Mathematics. The groups of students with special education needs who scored above the average included a higher proportion of boys than the above-average corresponding All Students groups.

Inclusion of students with special education needs in mathematics and statistics

Almost all principals at both year levels rated their school's inclusion of students with special education needs in the mathematics and statistics programme as good, very good or excellent.

1. Students with special education needs in NMSSA

The NMSSA includes students with special education needs in the assessment programme. Participating schools identified students' special education needs[38] using the following categories:

- High special education needs: for example, ORS funded, Supplementary Learning Support (SLS), severe behaviour or communication assistance from Special Education
- Moderate special education needs: for example, provided with a teacher aide from school funds, on the case load for Resource Teachers: Learning and Behaviour (RTLB), or Child Youth and Family Services (CYFS)
- On referral: for example, referred to Special Education or CYFS with action pending.

Students who did not fall into these categories were assigned to the 'no special education needs' group.

Students with special education needs were encouraged to participate in the study using the level of assistance normally provided to them. Schools and parents were able to withdraw any students whom they believed participating in NMSSA would be inappropriate. For example, a child may have been withdrawn if they had very high special education needs that could not be accommodated, anxiety, or behaviour issues. Students withdrawn for reasons of special education needs numbered 37 at Year 4, and 35 at Year 8. These figures represent a high level of withdrawal in this group of students.

The small number of students with special education needs in the sample means that overall, the findings in this chapter should be interpreted with caution. This is particularly true with regard to the high special education needs group from which many of the special education needs student withdrawals are likely to have come, and the on referral group. The two groups cannot be considered as statistically representative samples. The number in the on referral group is lower than the 2012 NMSSA study, for which on referral students made up four percent of the sample at both year levels. The lower number of students falling within the on referral category for the mathematics and statistics assessment programme was likely due to the timing and manner of collecting the information from schools.[39]

When reporting achievement this chapter focuses on the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment, which was completed by the larger numbers of students.

Tables 7.1 and 7.2 use the special needs classification system to break down the number of Year 4 and Year 8 students who completed the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment by gender and decile[40]. Although the number of students with high special education needs was very small at both year levels, the number with moderate special education needs was larger and allowed analysis of achievement and some comparison with the national sample. Students with moderate special needs made up 6 percent of the national sample at Year 4, and 5 percent at Year 8.

There were approximately twice as many boys than girls with special education needs at both year levels. The gender split for the 'no special education needs' group was more even at both year levels. At both year levels, similar proportions of students with special education needs attended schools from the three decile groups.

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[38] The categories of special education needs were those common in schools and therefore easy for schools to respond to. Schools were asked to describe the funding supports in place for children with special education needs to access the curriculum, through ORS, SLS, RTLB, MoE specialist staff, and school funds. To capture any unmet needs they were also asked to note students who were on referral to MoE specialist staff, RTLB etc. These categories were discussed and endorsed by the NMSSA special education needs reference group.

[39] In 2012 and 2013 schools were asked to identify any students for whom participating in NMSSA would not be appropriate due to high special education needs (ORS funded), ESOL, Māori Immersion, or for whom the experience would be anxiety provoking. In 2012 after the school visits to collect data, schools were asked to identify students who were 'on referral'. In 2013 schools were asked to identify students who were on referral when students to be included in the study were initially selected, that is before data were collected. There was also a change in the method of returning this information to NMSSA: in 2012 it was by email; in 2013 it was by email or online.

[40] KAMSI, which was completed by all students in the national sample is used for reporting in this chapter. Because of the low numbers of students with special needs, reporting on the Mathematical and Statistical Proficiencies (MSP) assessment is omitted.

Table 7.1 Breakdown of Year 4 students with special education needs and no special education needs participating in the KAMSI assessment by gender and decile group

	All		Gender		Decile		
	N	%	Boys (N)	Girls (N)	Low (N)	Mid (N)	High (N)
High special education needs	10	0	6	4	6	3	1
Moderate special education needs	129	6	86	43	46	37	46
On referral	6	0	4	2	3	1	2
No special education needs	1925	93	954	971	408	666	851
Total	2070	100	1050	1020	463	707	900

Table 7.2 Breakdown of Year 8 students with special education needs and no special education needs participating in the KAMSI assessment by gender and decile group

	All		Gender		Decile		
	N	%	Boys (N)	Girls (N)	Low (N)	Mid (N)	High (N)
High special education needs	13	1	9	4	5	7	1
Moderate special education needs	108	5	74	34	38	40	30
On referral	7	0	6	1	2	4	1
No special education needs	1938	94	964	974	360	938	640
Total	2066	100	1053	1013	405	989	672

2. Year 4 achievement in mathematics and statistics for students with special education needs

Table 7.3 shows the average scale score and standard deviation on the KAMSI assessment for Year 4 students according to special education category.

Table 7.3 Achievement of Year 4 students with special education needs on the KAMSI assessment

	Knowledge and Application of Mathematical and Statistical Ideas			
	High Special Education Needs	Moderate Special Education Needs	On Referral	No Special Education Needs
Average (scale score units)	63	66	59	87
SD (scale score units)	20	18	11	19
N	10	129	6	1925

The average score for Year 4 students with high special education needs on the KAMSI assessment was 63 scale score units, 66 for students with moderate special education needs, and 59 for those who were on referral. These compared with an average of 87 scale score units for students classified with no special education needs. Drawing on the description of the KAMSI scale provided in Chapter 2, the Year 4 students with moderate special education needs whose scores were clustered around their group's average score (the middle 50 percent) typically were able to:

- understand the effect of adding 0;
- write numerals as words;
- demonstrate a sense of place value up to 3-digits.

The small size of the high special education needs group and on referral group made it inappropriate to describe typical performance for these groups.

Table 7.4 links the KAMSI scale scores to curriculum expectations (see Appendix 3 for details of the curriculum alignment exercise carried out to link performance ranges on the KAMSI scale to curriculum expectations). Forty-four percent of students with moderate special education needs scored in curriculum Level 2 and above compared to 84 percent of students with no special education needs.

Table 7.4 Percentage of Year 4 students with different categories of special education needs achieving across the mathematics curriculum levels

	Knowledge and Application of Mathematical and Statistical Ideas			
	High Special Education Needs	**Moderate Special Education Needs**	**On Referral**	**No Special Education Needs**
Level 4 and above (%)	*	1	*	5
Level 3 (%)	*	5	*	33
Level 2 (%)	*	38	*	46
Level 1 (%)	*	56	*	16
N	10	129	6	1925

Table 7.5 displays the average differences in scale scores at Year 4 between the three groups of students with special education needs and the group of students categorised as having no special education needs.

Table 7.5 Year 4 difference in mathematics achievement between categories of special education needs and no special education needs

	Knowledge and Application of Mathematical and Statistical Ideas	
	Average Score Difference (scale score units)	**Effect Size**
High/No special education needs	-24	*
Moderate/No special education needs	-21	**-1.13**
On Referral/No special education needs	-28	*

Bold indicates the effect size is statistically significant ($p<.05$)

3. Year 8 achievement in mathematics and statistics for students with special education needs

Table 7.6 shows the average scale score and standard deviation on the KAMSI assessment for Year 8 students according to special education category.

Table 7.6 Achievement of Year 8 students with special education needs on the KAMSI assessment

	Knowledge and Application of Mathematical and Statistical Ideas			
	High Special Education Needs	**Moderate Special Education Needs**	**On Referral**	**No Special Education Needs**
Average (scale score units)	94	97	100	116
SD (scale score units)	11	15	16	20
N	13	108	7	1938

The average score for Year 8 students on the KAMSI assessment was 94 scale score units for students with high special education needs, 97 for students with moderate special education needs, and 100 for those who were on referral. These compared with an average scale score of 116 for students classified with no special education needs. Drawing on the description of the KAMSI scale provided in chapter 2, the Year 8 students with moderate special education needs whose scores were clustered around their group's average score (the middle 50 percent) could typically work successfully with the following ideas.

In number and algebra they could:

- calculate the difference between two, two-digit numbers;
- complete simple multiplications;
- add a sequence of two-digit numbers;
- add two three-digit numbers;
- recognise which negative number is the lowest.

In measurement and geometry they typically could:

- select appropriate units to measure a heavy object;
- convert digital to analogue time;
- read a half way mark on a scale marked in 20's;
- understand what two metres means in terms of length;
- reflect a shape in a mirror line;
- recognise a side view from an isometric representation;
- use informal units to measure length to a half unit.

In statistics they could:

- interpret information presented in a simple table;
- relate information presented in a table to a bar chart;
- understand the idea of 'most likely'.

As with Year 4, the small sizes of the Year 8 high special education needs and on referral groups made it inappropriate to describe typical performance for either group.

Table 7.7 shows how Year 8 students with special education needs performed on the KAMSI measure in terms of curriculum expectations. Most Year 8 special education needs students were not yet at Level 4.

Table 7.8 displays the average differences in scale scores at Year 8 between the three groups of students with special education needs and the group of students categorised as having no special education needs.

Table 7.7 Percentage of Year 8 students with different categories of special education needs achieving across curriculum levels

	Knowledge and Application of Mathematical and Statistical Ideas			
	High Special Education Needs	**Moderate Special Education Needs**	**On Referral**	**No Special Education Needs**
Level 4 and above (%)	*	8	*	43
Level 3 (%)	*	55	*	48
Level 2 (%)	*	36	*	8
Level 1 (%)	*	1	*	1
N	13	108	7	1938

Table 7.8 Year 8 difference in mathematics achievement between categories of special education needs and no special education needs

	Knowledge and Application of Mathematical and Statistical Ideas	
	Average Score Difference (scale score units)	**Effect Size**
High/No special education needs	-22	*
Moderate/No special education needs	-19	**-0.92**
On Referral/No special education needs	-16	*

Bold indicates the effect size is statistically significant (p<.05)

4. Comparison of Year 4 and Year 8 student achievement in mathematics and statistics for students with special education needs

Figures 7.1 and 7.2 show the distribution of Year 4 and Year 8 students with special education needs on the KAMSI scale. On average, Year 8 students with special education needs had higher achievement scores than Year 4 students. There was less overlap in the achievement of Year 4 and Year 8 special education needs students compared to the no special education needs group.

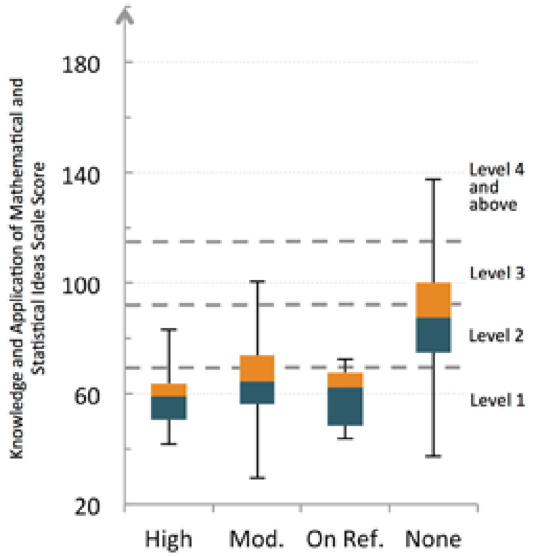

Figure 7.1 Achievement of Year 4 students with special education needs for mathematics and statistics (Mod.=Moderate, Ref.=Referral)

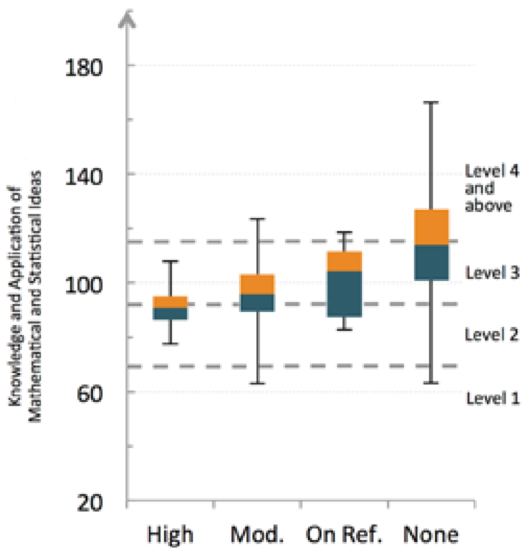

Figure 7.2 Achievement of Year 8 students with special education needs for mathematics and statistics (Mod.=Moderate, Ref.=Referral)

Table 7.9 displays, for the different categories of special education needs, the differences between Year 4 and Year 8 students in scale score units and as effect sizes where appropriate. This table details the difference in average scores between one cohort of students at Year 4 and another at Year 8. We use this difference to provide an estimate of progress between these year levels. It must be noted that this is not a measure of actual progress by a particular group of students.

Table 7.9 Difference in mathematics achievement by category of special education needs and no special education needs

	Difference between Year 4 and Year 8 on Knowledge and Application of Mathematical and Statistical Ideas	
	Difference (scale score units)	**Effect Size**
High special education needs	31	*
Moderate special education needs	31	**1.88**
On Referral	40	*
No special education needs	28	**1.45**

Bold indicates the effect size is statistically significant

Difference = Year 8 – Year 4

5. Year 4 and Year 8 student attitude to mathematics and statistics

Figure 7.3 displays the Year 4 and Year 8 scores on the Attitude to Mathematics measure described in Chapter 2 according to special education need category.

Table 7.10 provides summary statistics including the differences in average attitude scores between the year levels. The average Attitude to Mathematics score declined overall from Year 4 to Year 8 for all groups, including the special education needs group. At both Year 4 and Year 8 the moderate special education needs and no special education needs groups had comparable attitude score distributions. The moderate needs group scored slightly lower on average than the no needs group at Year 4[41].

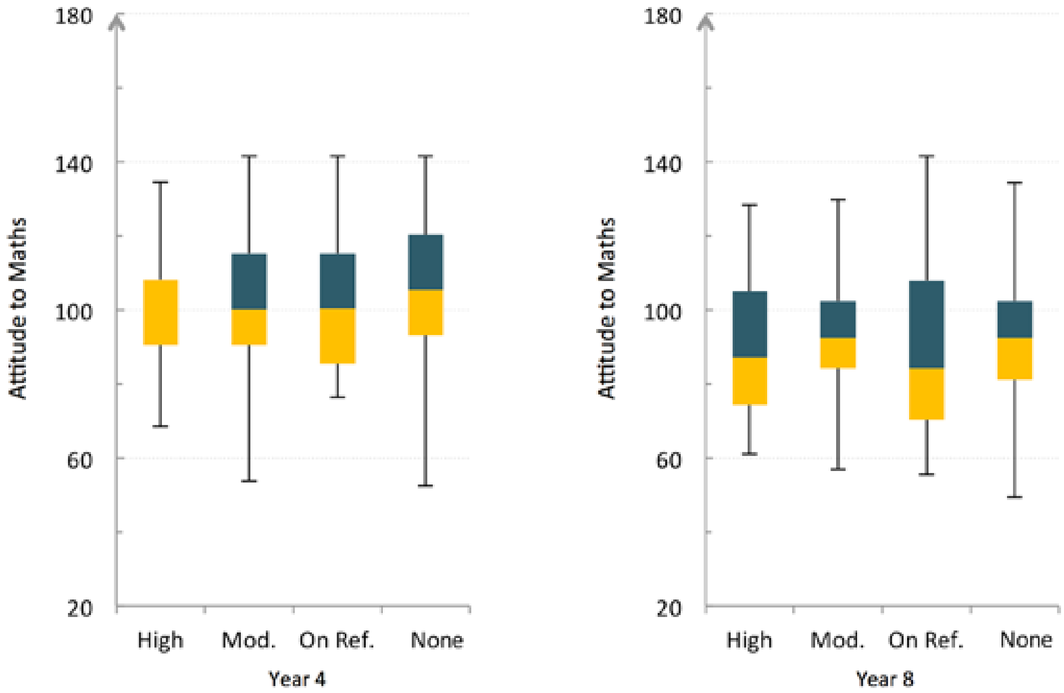

Figure 7.3 Year 4 and Year 8 student scores on Attitude to Maths for different categories of special education needs (Mod.=Moderate, Ref.=Referral)

Table 7.10 Year 4 and Year 8 student difference in Attitude to Mathematics for different categories of education needs and no special education needs

		Difference between Year 4 and Year 8 on Attitude to Mathematics				
		Average (scale score units)	**SD** (scale score units)	**N**	**Difference** (scale score units)	**Effect Size**
High special education needs	Year 4	103	20	9	-12	*
	Year 8	91	21	13		
Moderate special education needs	Year 4	103	19	126	-11	-0.59
	Year 8	92	19	107		
On referral	Year 4	103	25	6	-12	*
	Year 8	91	28	7		
No special education needs	Year 4	107	21	1907	-14	**-0.69**
	Year 8	93	20	1910		

Bold indicates the effect size is statistically significant
The scale score differences were calculated using non-rounded numbers and are numerically correct. In some cases, the scale score difference may not be the same as the simple difference in the pair of averages reported in the table.

41 When sample numbers are very small, box plots are difficult to display meaningfully. Quartile groups can become 'lost' in the calculation of group boundaries, as is the case with the Year 4 box plot for students with high special education needs.

6. Opportunities to learn mathematics and statistics

Students were asked to identify how often they were involved in a range of mathematics learning activities at school. Appendix 6 shows the distribution of responses for students with moderate and no special education needs. The pattern and frequency of learning experiences reported by students with moderate special education needs was similar overall to those with no special education needs. The groups of students with high special education needs at Year 4 and Year 8 are too small to present realistically as percentages.

At Year 4, the most frequently reported (over 60 percent in the 'heaps' and 'quite a lot' categories) opportunities to learn by students with moderate special education needs were 'thinking about and doing interesting maths problems' and 'having a class or group discussion about a maths problem'. At Year 8, the most frequently reported (over 60 percent in the 'heaps' and 'quite a lot' categories) opportunity to learn mentioned by students with moderate special education needs was 'explaining my way of solving a maths problem to other students or a teacher'.

7. Benchmarking success for students with special education needs

This section contrasts the profiles of Year 4 and Year 8 students with special education needs who scored above the national average for their year level on the KAMSI assessment. As for Māori and Pasifika students, they are compared with the group of students from the All Students at the same year level who also scored above the national average. The 2013 national average serves as a benchmark to compare results for different groups in this year’s assessment of mathematics and statistics. It may also be used to compare mathematics and statistics results from future cycles of NMSSA assessment.

Tables 7.11 and 7.12 show the number and percentage of Year 4 and Year 8 students with special education needs who scored above the benchmarks for their year level, and the average and standard deviation of their scores. For example, at Year 4, 11 percent of students with moderate special education needs scored above the benchmark (the Year 4 average for All Students). This contrasts with 54 percent of the no special education needs group scoring above the benchmark.

At Year 8, the corresponding figures were 12 percent for students with moderate special education needs and 49 percent for students with no special education needs.

Table 7.11 Summary statistics for Year 4 students by categories of special education needs and All Students scoring above the Year 4 benchmark

	Year 4 students scoring above the Year 4 benchmark			
	Number Above Benchmark (total group)	**Percentage of Respective Group** (%)	**Average** (scale score units)	**SD** (scale score units)
High special education needs	1 (10)	*	*	*
Moderate special education needs	14 (129)	11	97	9
On referral	0 (6)	*	*	*
No special education needs	1030 (1925)	54	101	12

Table 7.12 Summary statistics for Year 8 students by categories of special education needs and All Students scoring above the Year 8 benchmark

	Year 8 students scoring above the Year 8 benchmark			
	Number Above Benchmark (total group)	**Percentage of Respective Group** (%)	**Average** (scale score units)	**SD** (scale score units)
High special education needs	0 (13)	*	*	*
Moderate special education needs	13 (108)	12	125	12
On referral	1 (7)	*	*	*
No special education needs	950 (1938)	49	132	15

Figures 7.4 and 7.5 contrast the profiles of students with special education needs who scored above the national average (the national benchmark score) with the profiles of all students who scored above the national average, according to gender, Attitude to Mathematics score category, and school decile. The profiles of students with special education needs shown here were created by combining the three needs groups into one larger group at each year level. This was because of the small numbers in the individual categories.

There are several observations that can be made. First, at both year levels there were proportionately more boys than girls in the above benchmark special education needs group compared with All Students. Second, at both year levels the above benchmark group of students with special education needs showed similar patterns with respect to Attitude to Mathematics as the All Students group. Finally, at Year 4 and Year 8 the vast majority of special education needs students performing above the benchmark came from either mid or high decile schools.

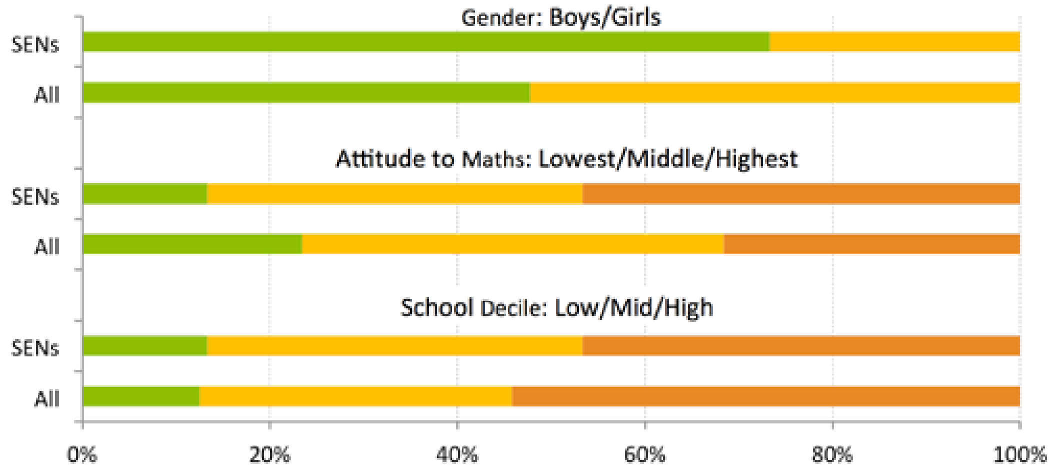

Figure 7.4 Percentage of Year 4 students with special education needs and All Students scoring above the national mean in mathematics by gender, Attitude to Mathematics and school decile

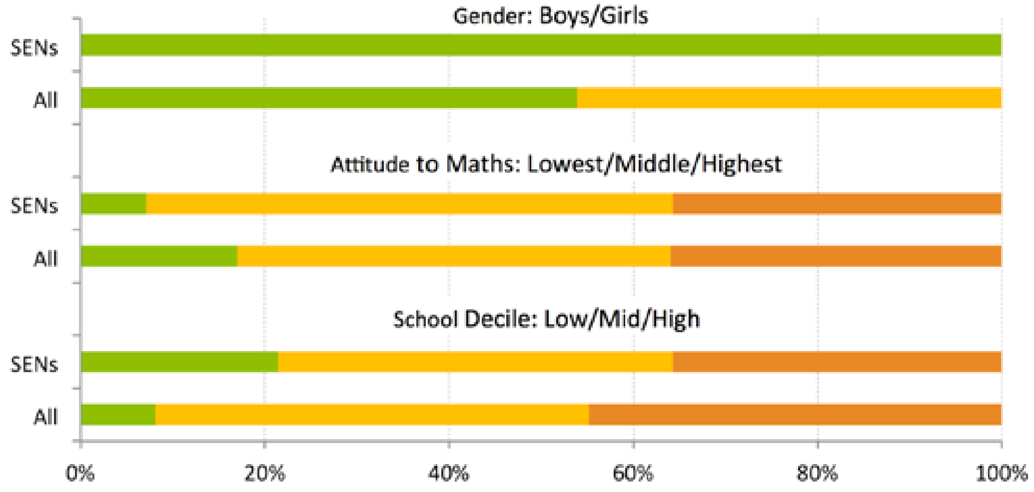

Figure 7.5 Percentage of Year 8 students with special education needs and All Students scoring above the national mean in mathematics by gender, Attitude to Mathematics and school decile

8. Inclusion of students with special education needs in mathematics and statistics

Principals of the NMSSA sample schools were asked how they rated their school's inclusion of students with special education needs in the school's mathematics programme. Most were able to report in the 'very good' or 'excellent' categories (about 68 percent for both year levels). Nearly all the rest gave a rating of 'good', with a very small minority saying 'fair'. There were no responses of 'poor'.

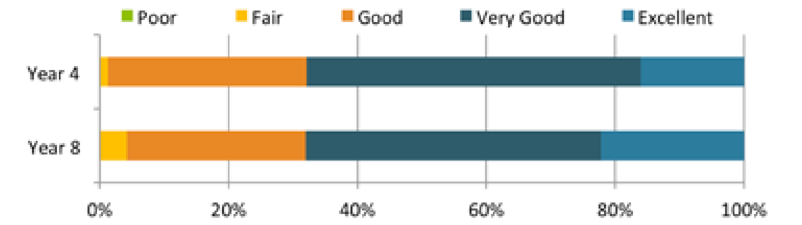

Figure 7.6 Principals' rating of their school's inclusion of students with special education needs in the mathematics programme by year level

Appendix 1: National Monitoring Study of Student Achievement 2013

1. Samples for 2013

A two-stage sampling design was used to select nationally representative samples of students at Year 4 and at Year 8. The first stage involved sampling schools, and the second step involved sampling students within schools.

A stratified random sampling approach was taken with the intention of selecting 100 schools at Year 4 and 100 schools at Year 8. Twenty-eight students were randomly selected from each school with three being available as reserves. From that list 25 students made up a sample of approximately 2000 students at Year 4 and 2000 students at Year 8.

To select the Year 4 and Year 8 students for 2013, the MoE 2012 school returns for Year 3 and Year 7 respectively were used.

2. Sampling of schools

Sampling algorithm

From the complete list of NZ schools select two datasets – one for Year 3 students and the other for Year 7 students.

For the Year 3 sample:

- Exclude:
    - Schools which have fewer than 8 Year 3 students
    - Private schools
    - Special schools
    - Correspondence School
    - Kura Kaupapa Māori.
- Stratify the sampling frame by region and quintile.[42]
- Within each region-by-quintile stratum, order the schools by Year 3 roll size.[43]
- Arrange the strata alternately in increasing and decreasing order of roll size.[44]
- Select a random starting point.
- From the random starting point, cumulate the Year 3 roll.
- Because 100 schools are required in the sample, the sampling interval is calculated as
    - Total number of Year 3 students / 100
- Assign each school to a "selection group" using this calculation:
    - Selection group = ceiling (cumulative roll/sampling interval).
- Select the first school in each selection group to form the final sample.

Follow the same process for the Year 7 sample.

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42 Decile 1 and 2 comprises Quintile 1; Decile 3 and 4 comprises Quintile 2; Decile 5 and 6 comprises Quintile 3; Decile 7 and 8 comprises Quintile 4; and Decile 9 and 10 comprises Quintile 5.

43 Roll size refers to the year level in question e.g. roll size for Year 3 students

44 This is done so that when replacements are made across stratum boundaries the replacement school is of a similar size to the one it is replacing.

If a school is selected in both the Year 3 and Year 7 samples, randomly assign it to one of the two samples. Locate the school in the unassigned sample and select a replacement school (next on list). Repeat the process for each school selected in both samples.

The 2013 NMSSA sample

The sample frames constituted 1476 schools for Year 3 and 946 schools for Year 7 after exclusions had been applied. No schools were listed in both samples.

Selected schools were invited to participate. Those that declined to participate were substituted using the following procedure:

- From overall school sample frame, select school one row below the school withdrawn.
- Verify that the substitute school is of similar type, decile, size.
- If this school is not available, re-select by going to one row above the school withdrawn.
  Verify profile.
- If this school is not available, select school two rows below the school withdrawn. Continue in this sequence until a substitute is found.

In total, 61 schools (21 at Year 4 and 40 at Year 8) declined to participate. Replacement schools were found for all. One Year 8 school withdrew two days prior to their visit date due to school merger issues.

The achieved samples of schools

The participation rate of schools before substitution was 83 percent at Year 4 and 71 percent at Year 8. After substitution, the achieved sample of 100 schools at Year 4 represented a participation rate[45] of 85 percent; and the achieved sample of 99 schools at Year 8 represented a response rate of 83 percent[46].

3. Sampling of students

After schools agreed to participate in the programme, they were asked to provide a list of all Year 4 (or Year 8) students, identifying any students for whom the experience would be inappropriate (e.g. high special needs (ORS), very limited English language (ESOL), Māori Immersion Level 1, would be absent during the visit, had left the school, other health or behavioural issues, e.g. anxiety). The procedure for selecting students for the group-administered sample and the individual sample was as follows:

- Each school provided a list of all students in their school at Year 4 or Year 8 in 2013. The lists were arranged in the order as provided by the school (that is alphabetically by last name). A computer-generated random number between 1 and 1,000,000 was assigned to each student. Students were ranked by their random number from highest to lowest.
- The first 28 non-excluded students in the ordered list were identified as belonging to the group-administered sample. The first eight students were identified as also belonging to the individual sample. Where there were more than 25 students in a year level, up to three students next on the list were selected as 'reserves' for potential replacements if required.
- The draft school lists of selected students were returned to schools for approval. Principals and teachers identified inappropriate students if they had omitted to do so at the first stage. These students were replaced with students up to number 28 from the initial rankings, resulting in a confirmed list. Letters of consent were sent to these students' parents.
- The children of parents who declined to have their child participate were withdrawn from the list.

[45] School participation rate is defined as the number of schools that participated (the achieved sample) as a percentage of the number of schools required (those invited plus replacements).

- Prior to the start of school visits, withdrawn students were not replaced unless they had been omitted to be identified at the first stage, in which case the student with the next rank on the school's student sample list was included. Students continued to be replaced (only if an originally selected student was withdrawn) up until two weeks prior to teacher assessors (TAs) arriving in schools to conduct the assessments. This time schedule was put in place as any later withdrawals meant we would not have had sufficient time to advise parents of substitute students.
- On the day before arrival in each school, TAs checked the final student list.
- On-site replacements of students by TAs were made if:
    - Any of students 1 – 8 (the individual sample) were absent or withdrawn (e.g. by principal) on the first day, prior to the start of assessments. They were replaced according to ethnicity / gender criteria.
    - All other students (up to 28) participated in group-administered assessments. However, a maximum of 25 booklets from each school was included in the results.
    - If students were absent or withdrawn (e.g. by principal) after the start of the assessment programme, no replacements were made.

The achieved samples of students at Year 4

Table A1.1 shows that at Year 4 the intended sample was 2173 randomly selected students. Principals identified 122 students for whom the experience would be unsuitable. The 'eligible' sample was reduced to 2051. Substitutions were selected for 63 students, and 164 students either withdrew late, were absent or made non-responses during the assessment period. The achieved group-administered sample included 2087 students representing a participation rate of 88 percent.

The achieved individual sample included 790 students representing a participation rate of 98 percent.

The combined school and student participation rates for the two samples were 74 percent and 83 percent respectively.

Table A1.2 contrasts the characteristics of the samples with the population.

Table A1.1 Selection of Year 4 students for the group-administered (GAP) and individual samples

	GAP - N	Individual - N
Intended sample of students	2173	800
Students withdrawn by principal before sample selected	122	5
Eligible sample	2051	795
Students withdrawn by parents or principal after sampling	103	5
Supplement students used	63	5
Students for whom there were no substitutes	0	-
Late withdrawals	1	-
Absences/non responses during assessment period	163	-
Achieved sample	2087	790

Table A1.2 Comparison of group-administered (GAP) and individual samples with population characteristics at Year 4

	Population (%)	Group-administered Sample n = 2087* (%)	Individual Sample n = 790* (%)
Gender			
Boys	51	51	53
Girls	49	49	47
Ethnicity**			
European	63	64	62
Māori	23	20	21
Pasifika	12	12	13
Asian	11	12	13
Other	3	3	3
School Quintile			
1-2	17	14	15
3-4	16	17	18
5-6	18	17	17
7-8	20	18	20
9-10	29	34	30
School Type			
Contributing (Year 1-6)	61	62	59
Full Primary (Year 1-8)	36	35	38
Composite (Year 1-13)	3	3	3
MOE Region			
Central North	21	22	23
Central South	18	19	19
Northern	40	39	37
Southern	21	20	21

(Note that rounding to integers means that percentages do not always add up to 100 percent)

* Some students responses were excluded because their assessment data was not able to be used (e.g. too few questions were attempted to be able to be a reliable estimate of their achievement, or the video taped response was inaudible).

** Percentages for ethnic groupings do not add to 100%. Non-prioritised ethnicity data is used throughout the NMSSA reports. Non-prioritised ethnicity data is sourced from the Ministry of Education's live enrolments database ENROL, rather than School Roll Returns

The achieved samples of students at Year 8

Table A1.3 shows that at Year 8 the intended sample was 2500. Principals identified 165 students for whom the experience would be unsuitable. The 'eligible' sample was reduced to 2099. Substitutions were selected for 71 students, and 139 students either withdrew late, were absent or made non-responses during the period of assessment. The achieved group-administered sample included 2088 students representing a participation rate of 82 percent.

The achieved individual sample included 787 students representing a participation rate of 98 percent.

The combined school and student participation rates for the two samples were 69 percent and 81 percent respectively.

Table A1.3 Selection of Year 8 students for the group-administered (GAP) and the individual samples.

	GAP - N	Individual - N
Intended sample of students	2264	800
Students withdrawn by principal before sample selected	165	5
Eligible sample	2099	795
Students withdrawn by parents or principal after sampling	118	
Supplement students used	71	
Students for whom there were no substitutes	25*	8
Late withdrawals	5	-
Absences/non responses during assessment period	211	-
Achieved sample	2088	787

* Late withdrawal of one school

Table A1.4 contrasts the characteristics of the samples with the population.

Table A1.4 Comparison of group-administered and individual samples with population characteristics at Year 8

	Population (%)	Group-administered Sample n = 2088* (%)	Individual Sample n = 787* (%)
Gender			
Boys	51	51	50
Girls	49	49	50
Ethnicity**			
European	61	62	60
Māori	22	23	25
Pasifika	12	13	13
Asian	10	8	13
Other	3	2	3
School Quintile			
1-2	14	15	16
3-4	16	16	16
5-6	24	28	27
7-8	21	16	16
9-10	24	26	24
School Type			
Full Primary (Year 1-8)	34	36	38
Intermediate	47	46	44
Secondary (Year 7-13)	13	14	13
Composite (Year 1-13 & 7-10)	5	4	5
MOE Region			
Central North	22	22	23
Central South	18	16	16
Northern	38	38	37
Southern	22	24	23

(Note that rounding to integers means that percentages do not always add up to 100 percent)

* Some student responses were excluded because their assessment data was not able to be used (e.g. too few questions were attempted to be able to be a reliable estimate of their achievement, or the video taped response was inaudible).

** Percentages for ethnic groupings do not add to 100%. Non-prioritised ethnicity data is used throughout the NMSSA reports. Non-prioritised ethnicity data is sourced from the Ministry of Education's live enrolments database ENROL, rather than School Roll Returns.

4. Investigating weighting the NMSSA 2013 sample

A post-hoc investigation was carried out to determine whether or not weights should be applied to the NMSSA 2013 sample.

Sample weights can be used to correct for misrepresentation in the sample. In NMSSA 2013 weights were calculated with respect to gender, decile (represented by quintile), and ethnicity. Non-prioritised ethnicity variables were used. That is, each sample member's ethnicity was denoted by five binary variables, with the possibility of identifying with multiple groups.

For each sample member five weights (one for each possible ethnic identification) were calculated as:

- P_N(gender) * P_N(quintile) * P_N(ethnic group) / P_S(gender) * P_S(quintile) * P_S(ethnic group)
- where ethnic group could be one of NZ European, Māori, Pasifika, Asian, and Other

The subscripts 'N' and 'S' denote national level probabilities and sample probabilities respectively.

A final weight, taking the average of the five weights was applied.

Distribution of final weights

Table A1.5 shows the distribution of final weights for each sample.

Table A1.5 - Distribution of final weights for each sample

	Final weights	
	Year 4	**Year 8**
Average	1.00	1.00
Minimum	0.86	0.82
25th percentile	0.89	0.88
50th percentile	0.96	0.92
75th percentile	1.09	1.09
Maximum	1.23	1.43

There were no extreme weights, and the distributions for both year level samples are reasonably closely clustered around 1.00. This indicates that in general the selected sample was representative of the national population. A decision was taken not to apply weights to these samples.

Appendix 2: Assessment Frameworks for the NMSSA Mathematics and Statistics Programme

1. Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment framework

According to the New Zealand Curriculum (NZC) document, mathematics is the exploration and use of patterns and relationships in quantities, space, and time. Statistics is the exploration and use of patterns and relationships in data. In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations.

By studying mathematics and statistics, students develop the ability to:

- think creatively, critically, strategically, and logically;
- structure, organise, and carry out procedures flexibly and accurately;
- process and communicate information;
- enjoy intellectual challenge;
- create models;
- conjecture, predict outcomes, justify, and verify;
- seek patterns and relationships;
- calculate with precision;
- estimate with reasonableness;
- understand when results are precise and when to interpret them with uncertainty;
- understand that mathematics and statistics have a broad range of practical applications in everyday life, in other learning areas, and in workplaces.

The Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) assessment assesses students' knowledge and application of the mathematical and statistical ideas described by the mathematics and statistics achievement objectives in the NZC. Tables A2.1 to A2.4 outline the validity claims and achievement objectives covered by the assessment.

Table A2.1 Validity claims for the Knowledge and Application of Mathematical and Statistical Ideas assessment: Year 4

	Sub claims	Students will be able to:	Students will know:
NUMBER	Students can calculate and estimate, using appropriate mental, written, or machine calculation methods in flexible ways. Students also know when it is appropriate to use estimation and are able to discern whether results are reasonable.	Use a range of additive strategies with whole numbers, fractions, and decimals, including counting on, combining and partitioning. Use simple multiplicative strategies with whole numbers and fractions, including equal sharing, skip counting, repeated addition, combining and partitioning. Make sensible estimates when using additive strategies or simple multiplicative strategies with whole numbers and fractions.	Forward and backward counting sequences with whole numbers to at least 1000 How many tenths, ones, tens, and hundreds are in whole numbers to at least 1000 Fractions in everyday use. Groupings to 10 Multiples of 10 and 100 that add to 100 and 1000 How to use written recording using equations The order of whole numbers, unit fractions, and equivalent fractions.
ALGEBRA	Students can generalise and represent the patterns and relationships found in numbers, shapes, and measures.	Interpret additive and simple multiplicative strategies, using, words, diagrams, and symbols, with an understanding of equality Create and continue sequential patterns and repeating patterns with one or two variables by identifying the unit of repeat Continue sequential patterns and use tables and diagrams to find rules for the next element in the pattern Generalise the properties of addition and subtraction with whole numbers.	The conventions for >, <, and =.
GEOMETRY	Shape Students can recognise and use the properties of shapes.	Identify the plane shapes found in objects. Recognise drawings and models of simple objects.	The names of simple two-dimensional shapes.
	Position and orientation Students can describe position and movement.	Use simple maps to show position and direction Describe different views and pathways from locations on a map using grid references, turns, and points of the compass.	The language for turns (clockwise and anticlockwise, right and left), and the main compass points.
	Transformation Students can recognise and use the symmetries of shapes.	Predict and describe the transformations (reflection, rotation, translation) that have mapped one object onto another, and the symmetry of shapes.	The language of transformation.

	Sub claims	Students will be able to:	Students will know:
MEASUREMENT	Students can quantify the attributes of objects, using appropriate units and instruments.	Use appropriate units and devices, including linear scales, to measure units of length, area, volume and capacity, weight (mass), turn (angle), temperature, and time.	The standard units of length, area, volume and capacity, weight (mass), turn (angle), temperature, and time
STATISTICS	Statistical investigations Students can identify problems that can be explored by the use of appropriate data, design investigations, collect data, exploring and use patterns and relationships in data, solve problems, and communicate findings.	Identify patterns and trends in context, within and between data sets.	
	Statistical literacy Students can interpret statistical information and evaluate data-based arguments.	Compare statements with the features of simple data displays from statistical investigations or probability activities undertaken by others.	
	Probability Students can deal with uncertainty and variation.	Investigate simple situations that involve elements of chance, recognising equal and different likelihoods and acknowledging uncertainty.	the terms for subjective probability.

Table A2.2 Knowledge and Application of Mathematical and Statistical Ideas Curriculum Achievement Objective Coverage: Year 4*

	Level 1	Level 2	Level 3	Specific contexts
NUMBER **Knowledge**	Know the forward and backward counting sequences of whole numbers to 100. Know groupings with five, within ten, and with ten.	Know forward and backward counting sequences with whole numbers to at least 1000. Know the basic addition and subtraction facts. Know how many ones, tens, and hundreds are in whole numbers to at least 1000. Know simple fractions in everyday use.	Know basic multiplication and division facts. Know counting sequences for whole numbers. Know how many tenths, tens, hundreds, and thousands are in whole numbers. Know fractions and percentages in everyday use.	Place value – whole numbers to 1000 Place value – simple decimals (not ordering) FNS, BNS – whole numbers Simple fractions
NUMBER **Strategies**	Use a range of counting, grouping, and equal-sharing strategies with whole numbers and fractions.	Use simple additive strategies with whole numbers and fractions.	Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages.	Addition – whole number, decimal, simple fractions Subtraction – whole number, decimal Multiplication – whole number, fraction of whole number
ALGEBRA **Equations and expressions**	Communicate and explain counting, grouping, and equal-sharing strategies, using words, numbers, and pictures.	Communicate and interpret simple additive strategies, using words, diagrams (pictures), and symbols.	Record and interpret additive and simple multiplicative strategies, using, words, diagrams, and symbols, with an understanding of equality.	Simple linear equations Meaning of equals
ALGEBRA **Patterns and relations**	Generalise that the next counting number gives the result of adding one object to a set and that counting the number of objects in a set tells how many. Create and continue sequential patterns.	Generalise that whole numbers can be partitioned in many ways. Find rules for the next member in a sequential pattern.	Generalise the properties of addition and subtraction with whole numbers. Connect members of sequential patterns with their ordinal position and use tables, graphs, and diagrams to find relationships between successive elements of number and spatial patterns.	Number sequences Spatial patterns Repeating patterns Additive identity
MEASUREMENT	Order and compare objects or events by length, area, volume and capacity, weight (mass), turn (angle), temperature, and time by direct comparison and/or counting whole numbers of units.	Create and use appropriate units and devices to measure length, area, volume and capacity, weight (mass), turn (angle), temperature, and time. Partition and/or combine like measures and communicate them, using numbers and units.	Use linear scales and whole numbers of metric units for length, area, volume and capacity, weight (mass), angle, temperature, and time. Find areas of rectangles and volumes of cuboids by applying multiplication.	Informal units and Formal units of: length, area, volume and capacity, weight (mass), turn (angle), temperature, and time Area and volume calculations (whole units) Reading scales, Scale maps (whole units)

	Level 1	Level 2	Level 3	Specific contexts
GEOMETRY **Shape**	Sort objects by their appearance.	Sort objects by their spatial features, with justification. Identify and describe the plane shapes found in objects.	Classify plane shapes and prisms by their spatial features. Represent objects with drawings and models.	3-D views of shapes Nets
GEOMETRY **Position and orientation**	Give and follow instructions for movement that involve distances, directions, and half or quarter turns. Describe their position relative to a person or object.	Create and use simple maps to show position and direction. Describe different views and pathways from locations on a map.	Use a co-ordinate system or the language of direction and distance to specify locations and describe paths.	Simple co-ordinate plots Map reading and interpretation
GEOMETRY **Transformation**	Communicate and record the results of translations, reflections, and rotations on plane shapes.	Predict and communicate the results of translations, reflections, and rotations on plane shapes.	Describe the transformations (reflection, rotation, translation, or enlargement) that have mapped one object onto another.	Reflection Rotation Translation
STATISTICS **Investigations** **Conduct investigations using the statistical enquiry cycle:**	Posing and answering questions. Gathering, sorting and counting, and displaying category data. Discussing the results.	Posing and answering questions. Gathering, sorting, and displaying category and whole-number data. Communicating findings based on the data.	Gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions. Identifying patterns and trends in context, within and between data sets. Communicating findings, using data displays.	
STATISTICS **Statistical literacy**	Interpret statements made by others from statistical investigations and probability activities.	Compare statements with the features of simple data displays from statistical investigations or probability activities undertaken by others.	Evaluate the effectiveness of different displays in representing the findings of a statistical investigation or probability activity undertaken by others.	Graph interpretation Table interpretation
STATISTICS **Probability**	Investigate situations that involve elements of chance, acknowledging and anticipating possible outcomes.	Investigate simple situations that involve elements of chance, recognising equal and different likelihoods and acknowledging uncertainty.	Investigate simple situations that involve elements of chance by comparing experimental results with expectations from models of all the outcomes, acknowledging that samples vary.	Subjective probability Ordering probabilities Simple fractional probabilities

* Highlighted objectives are particularly amenable to assessment in a group administered format. The majority of tasks came from Level 2 objectives, with some accessible Level 1 and 3 objectives included (also highlighted).

Table A2.3 Validity claims for the Knowledge and Application of Mathematical and Statistical Ideas assessment: Year 8

	Sub claims	Students will be able to:	Students will know:
NUMBER	Students can calculate and estimate, using appropriate mental, written, or machine calculation methods in flexible ways. Students also know when it is appropriate to use estimation and are able to discern whether results are reasonable.	Use a range of multiplicative strategies flexibly when operating on whole numbers, fractions, decimals, and percentages Use a range of addition and subtraction strategies flexibly on whole numbers, decimals, equivalent fractions, and integers Find fractions, decimals, and percentages of amounts expressed as whole numbers, simple fractions, and decimals Apply linear proportions, including ordering fractions Use prime numbers, common factors and multiples, and powers Make sensible estimates when using strategies with whole numbers, decimals and fractions.	Equivalent decimal and percentage forms for everyday fractions The relative size and place value structure of positive and negative integers and decimals to three places Fractions and percentages in everyday use Commonly used fraction, decimal, and percentage conversions The order of simple fractions and decimals. Square numbers to 100 Simple equivalent fractions.
ALGEBRA	Students can generalise and represent the patterns and relationships found in numbers, shapes, and measures.	Generalise the properties of operations with whole numbers. Use graphs, tables, and rules to describe and continue linear relationships found in number and spatial patterns and simple non-linear relationships. Rules may be recursive for the next member, or functional to connect members of sequential patterns with their ordinal position Form linear equations and simple quadratic equations and solve simple linear equations, including using inverse operations.	The meaning of equality.
GEOMETRY	Shape Students can recognise and use the properties of shapes.	Identify classes of two- and three-dimensional shapes by their geometric properties Relate three-dimensional models to two-dimensional representations, and vice versa.	The names of simple two- and three-dimensional shapes.
	Position and orientation Students can describe position and movement.	Interpret locations and directions, using compass directions, distances, and grid references Interpret points and lines on co-ordinate planes, including simple scales.	The language for direction.
	Transformation Students can recognise and use the symmetries of shapes.	Predict and describe the transformations (reflection, rotation, translation) that have mapped one object onto another Use the invariant properties of figures and objects under transformations.	The language of transformation.

	Sub claims	Students will be able to:	Students will know:
MEASUREMENT	Students can quantify the attributes of objects, using appropriate units and instruments.	Use appropriate scales, devices, and metric units for length, area, volume and capacity, weight (mass), temperature, angle, and time with awareness that measurements are approximate Convert between metric units, using whole numbers and commonly used decimals Use side or edge lengths to find the perimeters and areas of rectangles, parallelograms, and triangles and the volumes of cuboids.	The standard units of length, area, volume and capacity, weight (mass), turn (angle), temperature, and time The appropriate language of measurement.
STATISTICS	Statistical investigations Students can identify problems that can be explored by the use of appropriate data, design investigations, collect data, explore and use patterns and relationships in data, solve problems, and communicate findings.	Identify and detect patterns, variations, relationships, and trends in context Compare distributions visually, and using measures of centre and spread.	The appropriate language of statistics, including mean (average), median, and mode.
	Statistical literacy Students can interpret statistical information and evaluate data-based arguments.	Evaluate statements made by others about the findings of statistical investigations and probability activities.	
	Probability Students can deal with uncertainty and variation.	Investigate situations that involve elements of chance by comparing experimental distributions with expectations from models of the possible outcomes, acknowledging variation and independence Use simple fractions and percentages to describe probabilities.	

Table A2.4 Knowledge and Application of Mathematical and Statistical Ideas Curriculum Achievement Objectives Coverage: Year 8*

	Level 3	Level 4	Level 5	Specific contexts
NUMBER **Knowledge**	Know basic multiplication and division facts. Know counting sequences for whole numbers. Know how many tenths, tens, hundreds, and thousands are in whole numbers. Know fractions and percentages in everyday use.	Know the equivalent decimal and percentage forms for everyday fractions. Know the relative size and place value structure of positive and negative integers and decimals to three places.	Know commonly used fraction, decimal, and percentage conversions. Know and apply standard form, significant figures, rounding, and decimal place value.	Place value – whole numbers to 1000 Place value – decimals, ordering decimals
NUMBER **Strategies**	Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages.	Use a range of multiplicative strategies when operating on whole numbers. Understand addition and subtraction of fractions, decimals, and integers. Find fractions, decimals, and percentages of amounts expressed as whole numbers, simple fractions, and decimals. Apply simple linear proportions, including ordering fractions.	Reason with linear proportions. Use prime numbers, common factors and multiples, and powers (including square roots). Understand operations on fractions, decimals, percentages, and integers. Use rates and ratios.	Addition – whole number, decimal, fractions Subtraction – whole number, decimal Multiplication – whole number, fraction of whole number or fraction Division
ALGEBRA **Equations and expressions**	Record and interpret additive and simple multiplicative strategies, using, words, diagrams, and symbols, with an understanding of equality.	Form and solve simple linear equations.	Form and solve linear and simple quadratic equations.	Linear equations Simple quadratic equations Meaning of equals
ALGEBRA **Patterns and relations**	Generalise the properties of addition and subtraction with whole numbers. Connect members of sequential patterns with their ordinal position and use tables, graphs, and diagrams to find relationships between successive elements of number and spatial patterns.	Generalise properties of multiplication and division with whole numbers. Use graphs, tables, and rules to describe linear relationships found in number and spatial patterns.	Generalise the properties of operations with fractional numbers and integers. Relate tables, graphs, and equations to linear and simple quadratic relationships found in number and spatial patterns.	Number sequences Spatial patterns Multiplicative identity Interpreting graphs Functional rules

	Level 3	Level 4	Level 5	Specific contexts
MEASUREMENT	Use linear scales and whole numbers of metric units for length, area, volume and capacity, weight (mass), angle, temperature, and time. Find areas of rectangles and volumes of cuboids by applying multiplication.	Use appropriate scales, devices, and metric units for length, area, volume and capacity, weight (mass), temperature, angle, and time. Convert between metric units, using whole numbers and commonly used decimals. Use side or edge lengths to find the perimeters and areas of rectangles, parallelograms, and triangles and the volumes of cuboids. Interpret and use scales, timetables, and charts.	Select and use appropriate metric units for length, area, volume and capacity, weight (mass), temperature, angle, and time, with awareness that measurements are approximate. Convert between metric units, using decimals. Deduce and use formulae to find the perimeters and areas of polygons and the volumes of prisms. Find the perimeters and areas of circles and composite shapes and the volumes of prisms, including cylinders.	Formal units of: length, area, volume and capacity, weight (mass), turn (angle), temperature, and time Conversion of units Area, perimeter, and volume calculations (fractional or decimal units) Reading scales, timetables and charts. Scale maps (units)
GEOMETRY **Shape**	Classify plane shapes and prisms by their spatial features. Represent objects with drawings and models.	Identify classes of two- and three-dimensional shapes by their geometric properties. Relate three-dimensional models to two-dimensional representations, and vice versa.	Deduce the angle properties of intersecting and parallel lines and the angle properties of polygons and apply these properties. Create accurate nets for simple polyhedra and connect three-dimensional solids with different two-dimensional representations.	3-D views of shapes Nets
GEOMETRY **Position and orientation**	Use a co-ordinate system or the language of direction and distance to specify locations and describe paths.	Communicate and interpret locations and directions, using compass directions, distances, and grid references.	Construct and describe simple loci. Interpret points and lines on co-ordinate planes, including scales and bearings on maps.	Co-ordinate plots and Grids Map reading and interpretation
GEOMETRY **Transformation**	Describe the transformations (reflection, rotation, translation, or enlargement) that have mapped one object onto another.	Use the invariant properties of figures and objects under transformations (reflection, rotation, translation, or enlargement).	Define and use transformations and describe the invariant properties of figures and objects under these transformations. Apply trigonometric ratios and Pythagoras' theorem in two dimensions.	Reflection Rotation Translation Invariant properties Enlargement

	Level 3	Level 4	Level 5	Specific contexts
STATISTICS **Investigations** **Conduct investigations using the statistical enquiry cycle:**	Gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions Identifying patterns and trends in context, within and between data sets Communicating findings, using data displays.	Determining appropriate variables and data collection methods gathering, sorting, and displaying multivariate category, measurement, and time-series data to detect patterns, variations, relationships, and trends comparing distributions visually communicating findings, using appropriate displays.	Determining appropriate variables and measures considering sources of variation gathering and cleaning data using multiple displays, and re-categorising data to find patterns, variations, relationships, and trends in multivariate data sets comparing sample distributions visually, using measures of centre, spread, and proportion presenting a report of findings.	Multivariate data (Bi-variate) Distributions Variability Trends (Time series)
STATISTICS **Statistical literacy**	Evaluate the effectiveness of different displays in representing the findings of a statistical investigation or probability activity undertaken by others.	Evaluate statements made by others about the findings of statistical investigations and probability activities.	Evaluate statistical investigations or probability activities undertaken by others, including data collection methods, choice of measures, and validity of findings.	Graph interpretation Table interpretation Measures
STATISTICS **Probability**	Investigate simple situations that involve elements of chance by comparing experimental results with expectations from models of all the outcomes, acknowledging that samples vary.	Investigate situations that involve elements of chance by comparing experimental distributions with expectations from models of the possible outcomes, acknowledging variation and independence. Use simple fractions and percentages to describe probabilities.	Compare and describe the variation between theoretical and experimental distributions in situations that involve elements of chance. Calculate probabilities, using fractions, percentages, and ratios.	Ordering probabilities Fractional probabilities Variability

* Highlighted objectives are particularly amenable to assessment in a group administered format. The majority of tasks came from Level 4 objectives, with some accessible Level 3 and 5 objectives included (also highlighted).

Mathematical and Statistical Proficiencies (MSP) assessment framework

The Mathematical and Statistical Proficiencies (MSP) assessment focusses on students' understanding, reasoning, strategies and mathematical procedures, and ability to communicate mathematically across the strands of the mathematics and statistics learning area.

Construct definition

a) Understanding

- Understands the question(s) the problem poses.
- Chooses information that is relevant to solving the problem.
- When student uses graphs, tables or pictorial representations they show an accurate interpretation of the problem.
- Can restate the problem in their own words.

b) Reasoning, strategies and mathematical procedures

(Devising a problem solving strategy; Procedural fluency; Reasoning)

- Chooses an appropriate mathematical procedure to solve the problem.
- Chooses an appropriate and applicable strategy (e.g. breaking complex problems into simpler parts) to solve the problem.
- Strategy presented communicates reasoning process that is logical and sequential.
- Strategy draws from past knowledge and experience – making connections.
- Uses a system to check accuracy and precision, and the reasonableness of answers and conclusions.
- Evaluates mathematical arguments and claims.
- Moves from the specific situation towards generalisation.
- Perseverance in problem solving.

c) Communication

(Using mathematical representations; Mathematical terminology and notation; Orally explaining a solution; Communicating in a group)

- Results are presented clearly, coherently and accurately.
- Uses mathematical tools to communicate. These tools include, but are not limited to, words, phrases and sentences, labels, mathematical symbols and notations, equations, graphs, tables and pictures.
- Shows correct use of mathematical terms and uses them whenever appropriate.
- Explains the mathematics that leads to a solution.
- Works in groups to share ideas, to develop and coordinate approaches to problems and to communicate findings.
- Analyses and evaluates mathematical thinking and strategies of others.

Table 2.5 outlines the focus of each of the MSP tasks.

Table A2.5 Coverage map for the Mathematical and Statistical Proficiencies assessment

TASK	Strand	Proficiency area						
		Understanding	Reasoning, strategies and mathematical procedures			Communication		
			Devising a problem solving strategy	Procedural fluency	Reasoning	Use maths representations	Maths terminology /notation	Explaining a solution
Class Mat	Measurement	*	*	*		*	*	
Fractions Y8/4	Number				*	*		
Number Sentences	Algebra						*	*
Shapes Y8/4	Geometry		*		*			*
Shopping	Number		*	*				
Maths Meaning						*		
Watch the Words	Number			*			*	
Why is it Bigger?	Number				*			
Adventure (Y4) **King's Adventure (Y8)**	Number							*

Figure A2.1 displays an example of a task template used to guide the development of a proposed MSP task.

MSP TASK TITLE:

STRAND:	Number & Algebra		Geometry & Measurement		Statistics
KEY LEARNING AREA	• Number Strategies • Number Knowledge • Equations & Expressions • Patterns & Relationships		• Measurement • Shape • Position & Orientation • Transformation		• Statistical Investigation • Statistical Literacy • Probability
CONSTRUCTS:		MATHEMATICAL PROFICIENCES			
	KNOWLEDGE	UNDERSTANDING	REASONING, STRATEGIES & MATHEMATICAL PROCEDURES	COMMUNICATION	CONTEXTUAL
			• Devise problem solving strategies • Procedural fluency • Reasoning	• Mathematical representations • Terminology & notation • Explaining • Communicating in a group	
KEY COMPETENCIES:	• Relating to others • Managing self • Thinking • Using language, symbols, text • Participating & Contributing				

Figure A2.1 – An example of a task template for MSP tasks

Appendix 3: Curriculum Alignment of the Knowledge and Application of Mathematical and Statistical Ideas Scale

A curriculum alignment exercise was carried out for the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) scale.

The KAMSI scale was constructed using students' responses to mathematics questions in a paper-and-pencil assessment. About 2000 students at each of Year 4 and Year 8, and another 700 students at Year 6 contributed information used to construct the KAMSI achievement scale.

A panel of subject matter experts came together for a day to complete the curriculum alignment exercise. Panel members were chosen for their experience and familiarity with:

- mathematics and statistics in the New Zealand Curriculum (NZC);
- the National Standards in Mathematics for Years 1 to 8;
- the nature of students and their mathematics and statistics learning at Year 4 and Year 8.

A thorough discussion was held about the KAMSI assessment framework, and its relationship to the NZC. Panel members were presented with a detailed description of the KAMSI scale and its construction. They were shown how assessment items and students are both located on the same scale, and that an item's difficulty and a student's achievement level are related through a mathematical model expressing the probability that a student (with a particular achievement level) will answer an item (of particular difficulty) correctly.

The goal was to identify cut-points on the KAMSI scale to delineate curriculum levels 1 to 4. For example, the cut-point for Level 2 would define the lowest location on the KAMSI scale where a student could be considered to be achieving at Level 2 of the curriculum.

Panel members familiarised themselves with the KAMSI assessment items by completing a specially compiled form designed to represent the range of questions that students had attempted in the NMSSA study. As panel members worked on each question, they were asked to think about and discuss in small groups:

- how a Year 4 or Year 8 student thinks and processes information;
- what common misconceptions students have;
- what students might get tripped up by;
- whether the questions contain contexts that are likely to be familiar to students;
- the extent to which the structure of the question (for instance, selected or open response) affects the difficulty;
- the processing load of the item;
- the reading load of the item.

The bookmark method

The bookmark method[47] was used for the alignment. The method involves arranging items in order from easiest to most difficult into an ordered item booklet. The KAMSI ordered item booklet contained a selection of items spanning the range of content, contexts, curriculum strands, and difficulty from the complete NMSSA mathematics and statistics item bank.

The first cut-point discussed was curriculum Level 4. Panel members were asked to think about, discuss, and come to a common understanding of, the description of the National Standards in Mathematics for the end of Year 7. This level is designed to align with early level 4 of the curriculum. The panel was then asked to imagine a group of 100 students just at the entry point into Level 4. That is, each of the 100 imaginary students would be achieving at the same level – just higher than Level 3, but only just. The group of imaginary students is said to be 'minimally competent at level 4'.

Individually, the panel members worked their way through the ordered item booklet, and for each successive item asked the following question:

Would 70 percent or more of the minimally competent group give a correct answer to this question?

If the answer was 'yes' each panel member carried on to the next item (next page) and repeated the process. If the answer was no, the page would be bookmarked.

The idea is that the concepts and competencies assessed in items before the bookmarked page would be considered ‘mastered’ (i.e. minimally competent students would be able to answer these sorts of questions correctly at least 70% of the time), but that the items on the bookmarked page and beyond were yet to be mastered.

Panel members were given an opportunity to discuss and justify variations in their collective bookmark placing. Consensus was not required, but the opportunity to update the bookmark placing in light of the subsequent discussions was offered.

Each bookmark placing was converted to a scale location, and the average over all locations was taken to be the cut-point required for the curriculum level under discussion.

A similar approach was taken to find a cut-point for the entry point into Level 2. The description of the National Standards in Mathematics for the end of Year 3 was considered in this case.

The Level 3 cut-point was set to be half way between Level 2 and Level 4.

The final curriculum alignment locations on the KAMSI scale are shown in Table 1.

Table A3.1 Final curriculum cut-points on the Knowledge and Application of Mathematical and Statistical Ideas scale

	Knowledge and Application of Mathematical and Statistical Ideas scale location (scale score units)
Level 4 entry point	117.0
Level 3 entry point	92.5
Level 2 entry point	68.0

47 Mitzel, H. C., Lewis, D. M., Patz, R. J., and Green, D. R. (2001). The bookmark procedure: Psychological perspectives. In Cizek, G. J. (Ed.), Setting performance standards: Concepts, methods and perspectives. Mahwah, NJ: Lawrence Erlbaum Associates Publishers, pp. 249-281.

Appendix 4
Sub-group Analyses Summary

Note: Effect sizes and the confidence intervals are directional; that is, they are either negative or positive. The direction of the effect sizes reported in this appendix may differ from what is reported in the tables in the body of the report. In the body of the report and in the appendices, the sign of any effect size can be interpreted by using the contextual information provided with it. For example, in Table 1.2 of this appendix, the effect size for the difference in Year 4 average scale scores for students in low vs mid decile groups (Low/Mid) is reported as 0.60. Students in low decile schools scored lower than students in mid decile schools (77 vs 89). The effect size reported in Table 3.4 of Chapter 3 reports it as -.60The following tables provide a range of statistics across the year levels and measures.

Effect sizes analyses

1. All Students
    - 1.1 Year 4 All Students: Sub-group means, standards deviations and sample sizes.
    - 1.2 Year 4 All Students: Sub-group effect sizes and confidence intervals
    - 1.3 Year 8 All Students: Sub-group means, standards deviations and sample sizes
    - 1.4 Year 8 All Students: Sub-group effect sizes and confidence intervals
    - 1.5. Year 8/Year 4 All students: Sub-group means, standards deviations and sample sizes
    - 1.6. Year 8/Year 4 All Students: Differences, effect sizes and confidence intervals
2. Māori Students
    - 2.1. Year 4 Māori Students: Sub-group means, standards deviations and sample sizes
    - 2.2. Year 4 Māori Students: Sub-group effect sizes and confidence intervals
    - 2.3. Year 8 Māori Students: Sub-group means, standards deviations and sample sizes
    - 2.4. Year 8 Māori Students: Sub-group effect sizes and confidence intervals
    - 2.5. Year 8/Year 4 Māori Students: Sub-group means, standards deviations and sample sizes
    - 2.6. Year 8/Year 4 Māori Students: Differences, effect sizes and confidence intervals
3. Pasifika Students
    - 3.1. Year 4 Pasifika Students: Sub-group means, standards deviations and sample sizes
    - 3.2. Year 4 Pasifika Students: Sub-group effect sizes and confidence intervals
    - 3.3. Year 8 Pasifika Students: Sub-group means, standards deviations and sample sizes
    - 3.4. Year 8 Pasifika Students: Sub-group effect sizes and confidence intervals
    - 3.5. Year 8/Year 4 Pasifika Students: Sub-group means, standards deviations and sample sizes
    - 3.6. Year 8/Year 4 Pasifika Students: Differences, effect sizes and confidence intervals
4. Special Education Needs (SEN) Students
    - 4.1. Year 4 Special Education Needs Students: means, standards deviations and sample sizes.
    - 4.2. Year 4 Special Education Needs Students: Sub-group effect sizes and confidence intervals.
    - 4.3. Year 8 Special Education Needs Students: Means, standards deviations and sample sizes
    - 4.4. Year 8 Special Education Needs Students: Sub-group effect sizes and confidence intervals
    - 4.5. Year 8/Year 4 Special Education Needs Students: Differences, effect sizes and confidence intervals

1. All Students

Table A4.1.1 Year 4 All Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score				Attitude to Maths			
Variable		Boys	Girls			Boys	Girls			Boys	Girls		
Gender	Mean	85	87			83	84			108	106		
	SD	20	19			18	16			21	20		
	N	1050	1020			419	370			1033	1015		
		NZ Euro	Māori	Pasifika	Asian	NZ Euro	Māori	Pasifika	Asian	NZ Euro	Māori	Pasifika	Asian
Ethnicity	Mean	89	77	75	92	86	76	73	89	105	108	110	111
	SD	19	19	17	18	16	15	14	19	21	20	19	19
	N	1321	424	255	247	493	164	100	93	1306	421	254	246
		Non-NZ Euro	Non-Māori	Non-Pasifika	Non-Asian	Non-NZ Euro	Non-Māori	Non-Pasifika	Non-Asian				
Ethnicity	Mean	80	88	87	85	78	85	85	82				
	SD	20	19	19	19	18	17	17	17				
	N	749	1646	1815	1823	296	625	689	696				
		Low	Mid	High		Low	Mid	High		Low	Mid	High	
School Decile	Mean	74	86	92		72	84	90		110	106	106	
	SD	18	19	18		14	16	17		19	20	21	
	N	463	707	900		189	281	319		461	698	889	
		Contributing	Full Primary			Contributing	Full Primary			Contributing	Full Primary		
School Type	Mean	86	84			84	82			107	106		
	SD	19	20			17	18			21	20		
	N	1292	721			461	304			1275	716		
		Lowest	Middle	Highest		Lowest	Middle	Highest					
Attitude to Maths	Mean	82	85	91		81	82	87					
	SD	18	19	21		16	17	18					
	N	544	977	524		206	357	206					

Table A4.1.2 Year 4 All Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score			
Variable	Comparison	Boys/Girls				Boys/Girls			
Gender	Upper	0.22				0.20			
	Effect Size	0.11				0.03			
	Lower	0.01				-0.14			
	Comparison	NZE/ Non-NZ Euro	Māori/ Non-Māori	Pasifika/ Non-Pasifika	Asian/ Non-Asian	NZE/ Non-NZE	Māori/ Non-Māori	Pasifika/ Non-Pasifika	Asian/ Non-Asian
Ethnicity	Upper	-0.35	0.72	0.78	-0.22	-0.33	0.77	1.00	-0.13
	Effect Size	-0.47	0.58	0.62	-0.39	-0.52	0.56	0.73	-0.40
	Lower	-0.58	0.45	0.46	-0.55	-0.70	0.34	0.47	-0.67
	Comparison	Low/Mid	Mid/High	Low/High		Low/Mid	Mid/High	Low/High	
School Decile	Upper	0.76	0.45	1.09		1.01	0.57	1.51	
	Effect Size	0.62	0.32	0.95		0.77	0.37	1.27	
	Lower	0.47	0.20	0.80		0.53	0.17	1.02	
	Comparison	Contributing/ Full Primary				Contributing/ Full Primary			
School Type	Upper	0.22				0.30			
	Effect Size	0.11				0.12			
	Lower	0.00				-0.06			
	Comparison	Lowest/Middle	Middle/Highest	Lowest/Highest		Lowest/Middle	Middle/Highest	Lowest/Highest	
Attitude to Maths	Upper	0.26	0.43	0.59		0.27	0.51	0.60	
	Effect Size	0.13	0.30	0.44		0.06	0.29	0.36	
	Lower	0.00	0.17	0.29		-0.16	0.08	0.12	

Table A4.1.3 Year 8 All Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score				Attitude to Maths			
Variable		Boys	Girls			Boys	Girls			Boys	Girls		
Gender	Mean	116	113			118	116			96	91		
	SD	22	19			23	22			20	19		
	N	1053	1013			388	395			1040	997		
		NZ Euro	Māori	Pasifika	Asian	NZ Euro	Māori	Pasifika	Asian	NZ Euro	Māori	Pasifika	Asian
Ethnicity	Mean	118	107	100	127	123	108	99	131	91	94	98	99
	SD	19	18	14	26	20	19	20	25	19	19	19	20
	N	1288	479	278	165	468	195	103	61	1265	474	274	164
		Non-NZ Euro	Non-Māori	Non-Pasifika	Non-Asian	Non-NZ Euro	Non-Māori	Non-Pasifika	Non-Asian				
Ethnicity	Mean	108	116	117	113	108	120	120	116				
	SD	21	21	21	20	23	23	22	22				
	N	778	1587	1788	1901	315	588	680	722				
		Low	Mid	High		Low	Mid	High		Low	Mid	High	
School Decile	Mean	102	114	123		101	117	128		100	92	91	
	SD	16	19	22		19	20	22		19	20	19	
	N	405	989	672		168	371	244		400	975	662	
		Full Primary	Composite			Full Primary	Composite			Full Primary	Composite		
School Type	Mean	113	113			115	113			93	93		
	SD	19	22			21	27			20	21		
	N	745	89			300	40			735	88		
		Intermediate	Secondary			Intermediate	Secondary			Intermediate	Secondary		
	Mean	114	118			117	121			94	90		
	SD	21	23			23	21			20	18		
	N	941	291			340	103			931	283		
		Lowest	Middle	Highest		Lowest	Middle	Highest					
Attitude to Maths	Mean	107	115	120		111	117	121					
	SD	14	20	24		16	23	26					
	N	541	888	601		204	336	216					

Table A4.1.4 Year 8 All Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score			
Variable	Comparison	Boys/Girls				Boys/Girls			
Gender	Upper	-0.03				0.11			
	Effect Size	-0.14				-0.06			
	Lower	-0.25				-0.24			
	Comparison	NZE/Non-NZE	Māori/Non-Māori	Pasifika/Non-Pasifika	Asian/Non-Asian	NZE/Non-NZE	Māori/Non-Māori	Pasifika/Non-Pasifika	Asian/Non-Asian
Ethnicity	Upper	-0.41	0.58	0.98	-0.48	-0.48	0.72	1.23	-0.37
	Effect Size	-0.52	0.45	0.82	-0.68	-0.66	0.52	0.97	-0.69
	Lower	-0.63	0.32	0.66	-0.88	-0.85	0.31	0.70	-1.02
	Comparison	Low/Mid	Mid/High	Low/High		Low/Mid	Mid/High	Low/High	
School Decile	Upper	0.82	0.57	1.22		1.02	0.75	1.55	
	Effect Size	0.67	0.45	1.05		0.79	0.55	1.28	
	Lower	0.53	0.32	0.89		0.56	0.34	1.02	
	Comparison	Full Prim./Int.	Int./Secondary	Full Prim./Secondary		Full Prim./Int.	Int./Secondary	Full Prim./Secondary	
School Type	Upper	0.20	0.34	0.44		0.30	0.43	0.55	
	Effect Size	0.08	0.17	0.27		0.10	0.15	0.27	
	Lower	-0.04	0.01	0.10		-0.09	-0.12	-0.01	
	Comparison	Lowest/Middle	Middle/Highest	Lowest/Highest		Lowest/Middle	Middle/Highest	Lowest/Highest	
Attitude to Maths	Upper	0.58	0.37	0.80		0.54	0.36	0.70	
	Effect Size	0.45	0.24	0.66		0.32	0.14	0.46	
	Lower	0.32	0.12	0.51		0.10	-0.07	0.22	

Table A4.1.5 Year 8/Year 4 All students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score		Mathematical and Statistical Proficiencies Scale Score		Attitude to Maths	
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
All Students	Mean	86	114	83	117	107	93
	SD	19	21	17	23	20	20
	N	2070	2066	789	783	2048	2037
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Gender - Boys	Mean	85	116	83	118	108	96
	SD	20	22	18	23	21	20
	N	1050	1053	419	388	1033	1040
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Gender - Girls	Mean	87	113	84	116	106	91
	SD	19	19	16	22	20	19
	N	1020	1013	370	395	1015	997
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Ethnicity - European	Mean	89	118	86	123	105	91
	SD	19	19	16	20	21	19
	N	1321	1288	493	468	1306	1265
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Ethnicity - Māori	Mean	77	107	76	108	108	94
	SD	19	18	15	19	20	19
	N	424	479	164	195	421	474
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Ethnicity - Pasifika	Mean	75	100	73	99	110	98
	SD	17	14	14	20	19	19
	N	255	278	100	103	254	274
		Year 4	**Year 8**				
Ethnicity - Asian	Mean	92	127				
	SD	18	26				
	N	247	165				

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score		Mathematical and Statistical Proficiencies Scale Score		Attitude to Maths	
		Year 4	Year 8	Year 4	Year 8	Year 4	Year 8
Decile - Low	Mean	74	102	72	101	110	100
	SD	18	16	14	19	19	19
	N	463	405	189	168	461	400
		Year 4	Year 8	Year 4	Year 8	Year 4	Year 8
Decile - Mid	Mean	86	114	84	117	106	92
	SD	19	19	16	20	20	20
	N	707	989	281	371	698	975
		Year 4	Year 8	Year 4	Year 8	Year 4	Year 8
Decile - High	Mean	92	123	90	128	106	91
	SD	18	22	17	22	21	19
	N	900	672	319	244	889	662

Table A4.1.6 Year 8/Year 4 All Students: Differences, effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score		Attitude to Maths	
Comparison		**All**			**All**		**All**	
All Students	Upper	1.50			1.80		-0.60	
	Effect Size	1.43			1.68		-0.68	
	Lower	1.37			1.57		-0.76	
Comparison		**Boys**	**Girls**				**Boys**	**Girls**
Gender	Upper	1.61	1.50				-0.49	-0.66
	Effect Size	1.49	1.38				-0.60	-0.78
	Lower	1.37	1.26				-0.71	-0.89
Comparison		**NZ European**	**Māori**	**Pasifika**				
Ethnicity	Upper	1.66	1.84	1.85				
	Effect Size	1.56	1.65	1.61				
	Lower	1.45	1.47	1.37				
Comparison		**Asian**						
Ethnicity	Upper	1.87						
	Effect Size	1.59						
	Lower	1.31						
Comparison		**Low**	**Mid**	**High**				
Decile	Upper	1.79	1.66	1.71				
	Effect Size	1.60	1.53	1.57				
	Lower	1.41	1.39	1.43				

2. Māori Students

Table A4.2.1 Year 4 Māori Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score			Attitude to Maths		
Variable		**Boys**	**Girls**		**Boys**	**Girls**		**Boys**	**Girls**	
Gender	Mean	75	79		76	76		109	106	
	SD	19	18		17	13		21	19	
	N	224	200		87	77		220	201	
		Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
School Decile	Mean	70	79	84	70	78	85	112	104	107
	SD	19	17	18	13	14	18	19	18	23
	N	169	162	93	75	58	31	167	162	92
		Contributing	**Full Primary**		**Contributing**	**Full Primary**		**Contributing**	**Full Primary**	
School Type	Mean	78	74		77	74		108	107	
	SD	18	20		15	16		20	19	
	N	274	140		99	59		270	141	
		Lowest	**Middle**	**Highest**	**Lowest**	**Middle**	**Highest**			
Attitude to Maths	Mean	75	77	79	82	83	83			
	SD	17	19	19	18	21	20			
	N	90	221	109	36	82	42			

Table A4.2.2 Year 4 Māori Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			**Mathematical and Statistical Proficiencies Scale Score**		
Variable	**Comparison**	**Boys/Girls**			**Boys/Girls**		
Gender	Upper	0.43			0.42		
	Effect Size	0.19			0.04		
	Lower	-0.04			-0.35		
	Comparison	**Low/Mid**	**Mid/High**	**Low/High**	**Low/Mid**	**Mid/High**	**Low/High**
School Decile	Upper	0.77	0.58	1.06	1.05	0.99	1.60
	Effect Size	0.49	0.27	0.73	0.61	0.44	1.04
	Lower	0.22	-0.05	0.41	0.17	-0.12	0.48
	Comparison	**Contributing/Full**			**Contributing/Full**		
School Type	Upper	0.45			0.56		
	Effect Size	0.20			0.16		
	Lower	-0.05			-0.25		
	Comparison	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**
Attitude to Maths	Upper	0.43	0.40	0.61	0.52	0.49	0.62
	Effect Size	0.13	0.12	0.26	0.03	0.02	0.05
	Lower	-0.18	-0.17	-0.09	-0.46	-0.45	-0.51

Table A4.2.3 Year 8 Māori Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score			Attitude to Maths		
Variable		**Boys**	**Girls**		**Boys**	**Girls**		**Boys**	**Girls**	
Gender	Mean	108	107		108	108		95	93	
	SD	19	18		19	19		19	19	
	N	254	225		104	91		255	219	
		Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
School Decile	Mean	102	109	116	101	111	118	99	92	87
	SD	17	17	21	17	19	17	20	19	17
	N	157	254	68	70	97	28	155	252	67
		Full Primary	**Composite**		**Full Primary**	**Composite**		**Full Primary**	**Composite**	
School Type	Mean	108	101		110	96		95	95	
	SD	16	14		17	15		20	21	
	N	162	38		75	18		161	38	
		Intermediate	**Secondary**		**Intermediate**	**Secondary**		**Intermediate**	**Secondary**	
	Mean	107	113		109	110		94	89	
	SD	18	30		20	15		18	19	
	N	242	37		89	13		239	36	
		Lowest	**Middle**	**Highest**	**Lowest**	**Middle**	**Highest**			
Attitude to Maths	Mean	104	107	112	106	109	107			
	SD	14	17	21	19	16	17			
	N	119	206	148	49	79	57			

Table A4.2.4 Year 8 Māori Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score		
Variable	**Comparison**	**Boys/Girls**			**Boys/Girls**		
Gender	Upper	0.18			0.36		
	Effect Size	-0.05			0.01		
	Lower	-0.27			-0.34		
	Comparison	**Low/Mid**	**Mid/High**	**Low/High**	**Low/Mid**	**Mid/High**	**Low/High**
School Decile	Upper	0.66	0.75	1.16	0.92	0.93	1.55
	Effect Size	0.41	0.41	0.79	0.53	0.39	0.97
	Lower	0.16	0.08	0.43	0.14	-0.14	0.39
	Comparison	**Full Prim./Int.**	**Int./Secondary**	**Full Prim./Secondary**	**Full Prim./Int.**	**Int./Secondary**	**Full Prim./Secondary**
School Type	Upper	0.17	0.73	0.70	0.30	0.77	0.70
	Effect Size	-0.08	0.30	0.25	-0.08	0.04	-0.04
	Lower	-0.32	-0.13	-0.20	-0.47	-0.69	-0.79
	Comparison	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**
Attitude to Maths	Upper	0.47	0.52	0.72	0.63	0.30	0.53
	Effect Size	0.18	0.26	0.42	0.18	-0.13	0.05
	Lower	-0.10	0.00	0.11	-0.27	-0.56	-0.43

Table A4.2.5 Year 8/Year 4 Māori Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score		Mathematical and Statistical Proficiencies Scale Score		Attitude to Maths	
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
All Students	Mean	77	107	76	108	108	94
	SD	19	18	15	19	20	19
	N	424	479	164	195	421	474
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Gender - Boys	Mean	75	108	76	108	109	95
	SD	19	19	17	19	21	19
	N	224	254	87	104	220	255
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Gender - Girls	Mean	79	107	76	108	106	93
	SD	18	18	13	19	19	19
	N	200	225	77	91	201	219
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Decile - Low	Mean	70	102	70	101	112	99
	SD	19	17	13	17	19	20
	N	169	157	75	70	167	155
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Decile - Mid	Mean	79	109	78	111	104	92
	SD	17	17	14	19	18	19
	N	162	254	58	97	162	252
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Decile - High	Mean	84	116	85	118	107	87
	SD	18	21	18	17	23	17
	N	93	68	31	28	92	67

Table A4.2.6 Year 8/Year 4 Māori Students: Differences, effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score			Attitude to Maths	
Comparison		**All**			**All**			**All**	
All Students	Upper	1.81			2.12			-0.55	
	Effect Size	1.65			1.87			-0.72	
	Lower	1.50			1.62			-0.89	
Comparison		**Boys**	**Girls**					**Boys**	**Girls**
Gender	Upper	2.00	1.84					-0.48	-0.49
	Effect Size	1.73	1.57					-0.71	-0.73
	Lower	1.47	1.30					-0.94	-0.98
Comparison		**Low**	**Mid**	**High**					
Decile	Upper	2.08	1.99	2.09					
	Effect Size	1.76	1.71	1.64					
	Lower	1.44	1.42	1.19					

3. Pasifika Students

Table A4.3.1 Year 4 Pasifika Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			**Mathematical and Statistical Proficiencies Scale Score**			**Attitude to Maths**		
Variable		**Boys**	**Girls**		**Boys**	**Girls**		**Boys**	**Girls**	
Gender	Mean	75	76		74	71		109	110	
	SD	17	17		15	12		20	19	
	N	142	113		57	43		142	112	
		Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
School Decile	Mean	72	78	88	69	76	86	109	109	113
	SD	16	17	15	12	14	15	19	18	21
	N	170	56	29	65	26	9	170	56	28
		Contributing	**Full Primary**		**Contributing**	**Full Primary**		**Contributing**	**Full Primary**	
School Type	Mean	**74**	**76**		**73**	**72**		**110**	**108**	
	SD	17	16		14	13		19	20	
	N	146	106		55	45		145	106	
		Lowest	**Middle**	**Highest**	**Lowest**	**Middle**	**Highest**			
Attitude to Maths	Mean	70	76	78	66	72	77			
	SD	12	16	21	12	14	12			
	N	44	144	66	15	53	29			

Table A4.3.2 Year 4 Pasifika Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score		
Variable	**Comparison**	**Boys/Girls**			**Boys/Girls**		
Gender	Upper	0.39			0.35		
	Effect Size	0.08			-0.15		
	Lower	-0.23			-0.65		
	Comparison	**Low/Mid**	**Mid/High**	**Low/High**	**Low/Mid**	**Mid/High**	**Low/High**
School Decile	Upper	0.75	1.17	1.49	1.09	1.75	2.33
	Effect Size	0.37	0.60	0.98	0.51	0.74	1.40
	Lower	-0.01	0.02	0.47	-0.07	-0.28	0.47
	Comparison	**Contributing/Full Primary**			**Contributing/Full Primary**		
School Type	Upper	0.23			0.59		
	Effect Size	-0.09			0.09		
	Lower	-0.40			-0.40		
	Comparison	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**
Attitude to Maths	Upper	0.83	0.47	0.94	1.17	0.94	1.73
	Effect Size	0.41	0.10	0.46	0.43	0.37	0.89
	Lower	-0.02	-0.26	-0.03	-0.30	-0.21	0.05

Table A4.3.3 Year 8 Pasifika Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score			Attitude to Maths		
Variable		**Boys**	**Girls**		**Boys**	**Girls**		**Boys**	**Girls**	
Gender	Mean	101	99		100	98		101	95	
	SD	14	14		20	19		19	18	
	N	147	131		47	56		145	129	
		Low	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
School Decile	Mean	98	102	111	95	102	123	101	94	91
	SD	13	13	15	18	18	27	19	18	14
	N	181	71	26	66	31	6	179	71	24
		Full Primary	**Composite**		**Full Primary**	**Composite**		**Full Primary**	**Composite**	
School Type	Mean	100	-		100	-		99	-	
	SD	13	-		18	-		20	-	
	N	139	-		56	-		137	-	
		Intermediate	**Secondary**		**Intermediate**	**Secondary**		**Intermediate**	**Secondary**	
	Mean	100	102		99	96		99	91	
	SD	14	16		22	15		18	14	
	N	111	26		38	8		109	26	
		Lowest	**Middle**	**Highest**	**Lowest**	**Middle**	**Highest**			
Attitude to Maths	Mean	100	100	100	101	97	100			
	SD	12	14	15	17	19	19			
	N	41	125	108	11	50	40			

Table A4.3.4 Year 8 Pasifika Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score		
Variable	**Comparison**	**Boys/Girls**			**Boys/Girls**		
Gender	Upper	0.16			0.38		
	Effect Size	-0.14			-0.11		
	Lower	-0.43			-0.60		
	Comparison	**Low/Mid**	**Mid/High**	**Low/High**	**Low/Mid**	**Mid/High**	**Low/High**
School Decile	Upper	0.65	1.24	1.51	0.94	2.24	2.58
	Effect Size	0.30	0.66	0.98	0.40	1.06	1.47
	Lower	-0.04	0.08	0.45	-0.15	-0.12	0.37
	Comparison	**Full Prim./Int.**	**Int./Secondary**	**Full Prim./Secondary**	**Full Prim./Int.**	**Int./Secondary**	**Full Prim./Secondary**
School Type	Upper	0.30	0.65	0.64	0.46	0.84	0.71
	Effect Size	-0.01	0.12	0.11	-0.06	-0.14	-0.23
	Lower	-0.32	-0.42	-0.41	-0.57	-1.12	-1.17
	Comparison	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**	**Lowest/Middle**	**Middle/Highest**	**Lowest/Highest**
Attitude to Maths	Upper	0.48	0.31	0.48	0.61	0.68	0.79
	Effect Size	0.04	-0.01	0.03	-0.22	0.15	-0.06
	Lower	-0.40	-0.33	-0.42	-1.05	-0.37	-0.92

Table A4.3.5 Year 8/Year 4 Pasifika Students: Sub-group means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score		Mathematical and Statistical Proficiencies Scale Score		Attitude to Maths	
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
All Students	Mean	75	100	73	99	110	98
	SD	17	14	14	20	19	19
	N	255	278	100	103	254	274
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Gender - Boys	Mean	75	101	74	100	109	101
	SD	17	14	15	20	20	19
	N	142	147	57	47	142	145
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Gender - Girls	Mean	76	99	71	98	110	95
	SD	17	14	12	19	19	18
	N	113	131	43	56	112	129
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Decile - Low	Mean	72	98	69	95	109	101
	SD	16	13	12	18	19	19
	N	170	181	65	66	170	179
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Decile - Mid	Mean	78	102	76	102	109	94
	SD	17	13	14	18	18	18
	N	56	71	26	31	56	71
		Year 4	**Year 8**	**Year 4**	**Year 8**	**Year 4**	**Year 8**
Decile - High	Mean	88	111	86	123	113	91
	SD	15	15	15	27	21	14
	N	29	26	9	6	28	24

Table A4.3.6 Year 8/Year 4 Pasifika Students: Differences, effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score			Attitude to Maths	
Comparison		**All**			**All**			**All**	
All Students	Upper	1.81			1.87			-0.39	
	Effect Size	1.61			1.56			-0.61	
	Lower	1.41			1.24			-0.83	
Comparison		**Boys**	**Girls**					**Boys**	**Girls**
Gender	Upper	2.05	1.85					-0.15	-0.50
	Effect Size	1.71	1.49					-0.44	-0.83
	Lower	1.38	1.14					-0.73	-1.16
Comparison		**Low**	**Mid**	**High**					
Decile	Upper	2.06	2.09	2.32					
	Effect Size	1.75	1.58	1.54					
	Lower	1.44	1.08	0.77					

4. Special education needs (SEN) students

Table A4.4.1 Year 4 Special Education Needs Students: Means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score				Attitude to Maths			
Variable		**High**	**Mod.**	**On Ref.**	**No**	**High**	**Mod.**	**On Ref.**	**No**	**High**	**Mod.**	**On Ref.**	**No**
SENS Level	Mean	63	66	59	87	50	68	-	85	103	103	103	107
	SD	20	18	11	19	10	15	-	17	20	19	25	21
	N	10	129	6	1925	3	56	0	730	9	126	6	1907

Table A4.4.2 Year 4 Special Education Needs Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score		
Variable	**Comparison**	**High/No**	**Mod./No**	**On Ref./No**	**High/No**	**Mod./No**	**On Ref./No**
SENS Level	Upper	2.07	1.36	2.48	3.51	1.35	-
	Effect Size	1.30	1.13	1.48	2.10	1.01	-
	Lower	0.53	0.91	0.49	0.68	0.66	-

Table A4.4.3 Year 8 Special Education Needs Students: Means, standards deviations and sample sizes

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score				Attitude to Maths			
Variable		**High**	**Mod.**	**On Ref.**	**No**	**High**	**Mod.**	**On Ref.**	**No**	**High**	**Mod.**	**On Ref.**	**No**
SENS Level	Mean	94	97	100	116	90	97	85	118	91	92	91	93
	SD	11	15	16	20	19	17	13	22	21	19	28	20
	N	13	108	7	1938	5	39	2	737	13	107	7	1910

Table A4.4.4 Year 8 Special Education Needs Students: Sub-group effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score			Mathematical and Statistical Proficiencies Scale Score		
Variable	**Comparison**	**High/No**	**Mod./No**	**On Ref./No**	**High/No**	**Mod./No**	**On Ref./No**
SENS Level	Upper	1.76	1.17	1.70	2.38	1.35	3.24
	Effect Size	1.08	0.92	0.78	1.29	0.95	1.51
	Lower	0.41	0.68	-0.14	0.19	0.55	-0.22

Table A4.4.5 Year 8/Year 4 Special Education Needs Students: Differences, effect sizes and confidence intervals

		Knowledge and Application of Mathematical and Statistical Ideas Scale Score				Mathematical and Statistical Proficiencies Scale Score				Attitude to Maths			
Variable		**High**	**Mod.**	**On Ref.**	**No**	**High**	**Mod.**	**On Ref.**	**No**	**High**	**Mod.**	**On Ref.**	**No**
Gender	Upper	3.32	2.27	5.26	1.54	5.66	2.49	-	1.86	0.57	-0.26	1.12	-0.61
	Effect Size	1.96	1.88	2.89	1.45	2.39	1.87	-	1.71	-0.59	-0.59	-0.45	-0.69
	Lower	0.59	1.50	0.51	1.36	-0.88	1.26	-	1.57	-1.75	-0.92	-2.03	-0.77

Appendix 5: The Interaction Between Ethnicity and Decile: Regression Analysis

Reporting on differences between groups of students in New Zealand by ethnicity is a complex matter. Analysis is complicated on two counts. First, as mentioned in the main part of the report, a high proportion of Māori and Pasifika students attend lower decile schools, and a much lower proportion attend high decile schools. This situation inflicts a skew on the distribution of all ethnic sub-groups with respect to decile. An added problem resulting from this skew is that there are very small sample numbers for ethnic sub-groups in some deciles which makes it difficult to estimate model parameters precisely.

The second complication is that students may identify with more than one ethnic group. It is difficult to make useful, robust statistical statements with respect to performance in ethnicity sub-groups when there is substantial 'blurring' with regard to group membership.

To explore the performance of ethnic groups across deciles the following regression analyses were carried out:

- a comparison of Māori and NZ European student mathematics outcomes on the Knowledge and Application of Mathematical and Statistical Ideas (KAMSI) scale;
- a comparison of Pasifika and NZ European student mathematics outcomes on the KAMSI scale.

For the purposes of the analysis decile was coded to quintile[48].

In all cases there was a strong (statistically significant) quintile effect. Average scores increased consistently with quintile.

For each year level and for both Māori and Pasifika sub-groups, separate models were run to examine the effect on performance outcomes due to quintile and ethnicity.

Final Māori model:

At each of Year 4 and Year 8, the following model was found to be the most parsimonious in the context of the variables of interest.

For student *i*

$$\text{KAMSI score}_i \; F = a + b1_i\text{*quintile} + b2_i\text{*Māori} + b3_i\text{*NZE} + \text{error}_i$$

where quintile, Māori, and NZE are all classification ('dummy') variables.

Students with dual ethnicity were identified under both 'Māori' and 'NZE' classifications.

The R^2 statistic, indicating the proportion of variance in the KAMSI scores accounted for by the model was 0.13 at both Year 4 and Year 8. That is, 13 percent of the variance in the KAMSI scores for Māori and NZ European students could be accounted for by quintile and ethnicity.

[48] Decile 1-2 à Quintile 1, Decile 3-4 à Quintile 2, … , Decile 9-10 à Quintile 5

Models with additional interaction terms were considered, but showed no significant improvement over the main effects model specified above. Models were compared using the usual F-test where the hypotheses are:

- H_0: reduced model is adequate
- H_A: full model is better

Then $F = \frac{\left(\frac{Drop\ in\ SSE}{Number\ of\ added\ terms}\right)}{S^2\ for\ the\ full\ model}$, where SSE = Sum of the squared residuals in the respective model

Final Pasifika model:

At each of Year 4 and Year 8, the following model was found to be the most parsimonious in the context of the variables of interest.

For student *i*

$$\text{KAMSI score}_i\ F = a + b1_i\text{*quintile} + b2_i\text{*Pasifika} + b3_i\text{*NZE} + \text{error}_i$$

where quintile, Pasifika, and NZE are all classification ('dummy') variables.

Similarly to the Māori model, students with both Pasifika and NZ European ethnicity were identified under both classifications in the model.

The R^2 statistic, indicating the proportion of variance in the KAMSI scores accounted for by the model was 0.12 at Year 4 and 0.17 at Year 8.

As with the Māori models, no improvement was made at either Year level when interaction terms were added to the Pasifika models.

Summary

In all cases, the models showed that there was an effect due to ethnicity which remained after accounting for the quintile effect. That is, there was a difference in average KAMSI scores between each ethnic sub-group and NZ European students over and above the difference accounted for by quintile. This difference was constant (as far as the model could determine) across all quintiles.

Figures A5.1 to A5.4 show KAMSI scores by quintile. Ethnic group membership is shown by using different symbols. Average scores for each group are shown using dotted lines and symbols. The variation in scores at each quintile is considerable. It should be noted however, that despite there being differences, on average, between the Māori and Pasifika groups and the NZ European groups, there are many students in low decile schools scoring higher on the KAMSI scale than students in high decile schools.

The results from this analysis need to be interpreted with caution. The model's ability to assess precisely how Māori or Pasifika students are performing, on average, in higher decile schools (and how NZ European students are performing in lower decile schools) is compromised by the disproportionate numbers of students in those deciles in the national sample with respect to their ethnicity.

At Year 4, the modelled scale scores show that on average Māori students scored 10 scale score units lower than NZ European students (Table A5.1 and Figure A5.1), and at Year 8, eight scale score units lower (Table A5.2 and Figure A5.2). Rounding of scale scores to the nearest integer may cause some differences to appear slightly more or less than this in the tables.

Table A5.1 Year 4: Modelled averages on the KAMSI scale by quintile and ethnicity

Quintile	NZE	Māori
1	78	67
2	85	75
3	86	76
4	89	79
5	93	83

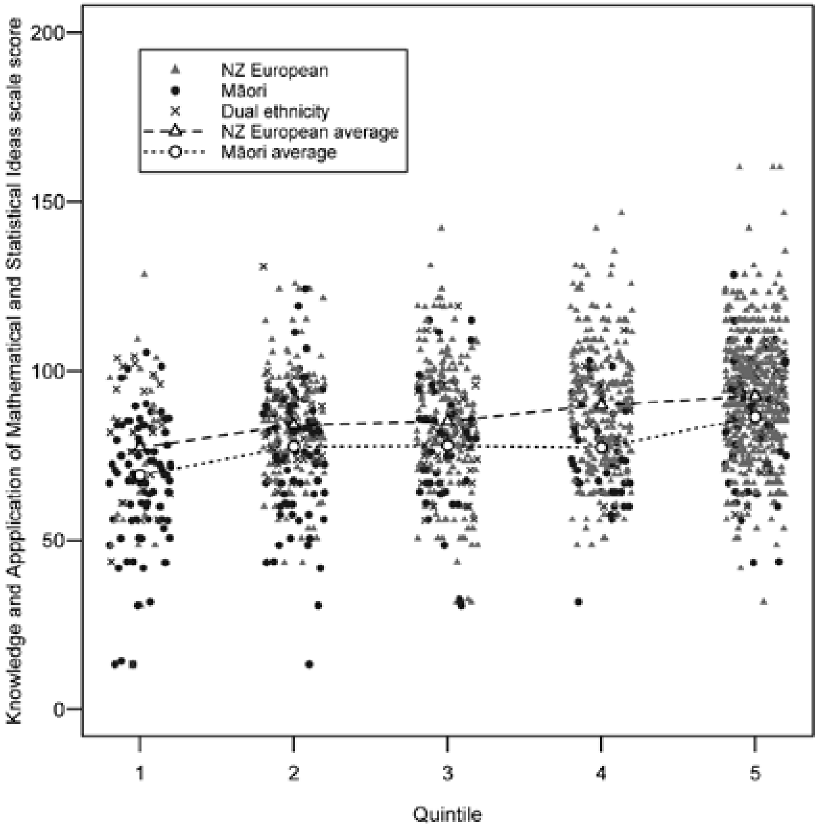

Figure A5.1 Year 4 NZ European and Māori students' KAMSI scores by quintile

Table A5.2 Year 8: Modelled averages on the KAMSI scale by quintile and ethnicity

Quintile	NZE	Māori
1	108	100
2	112	104
3	116	108
4	119	110
5	124	115

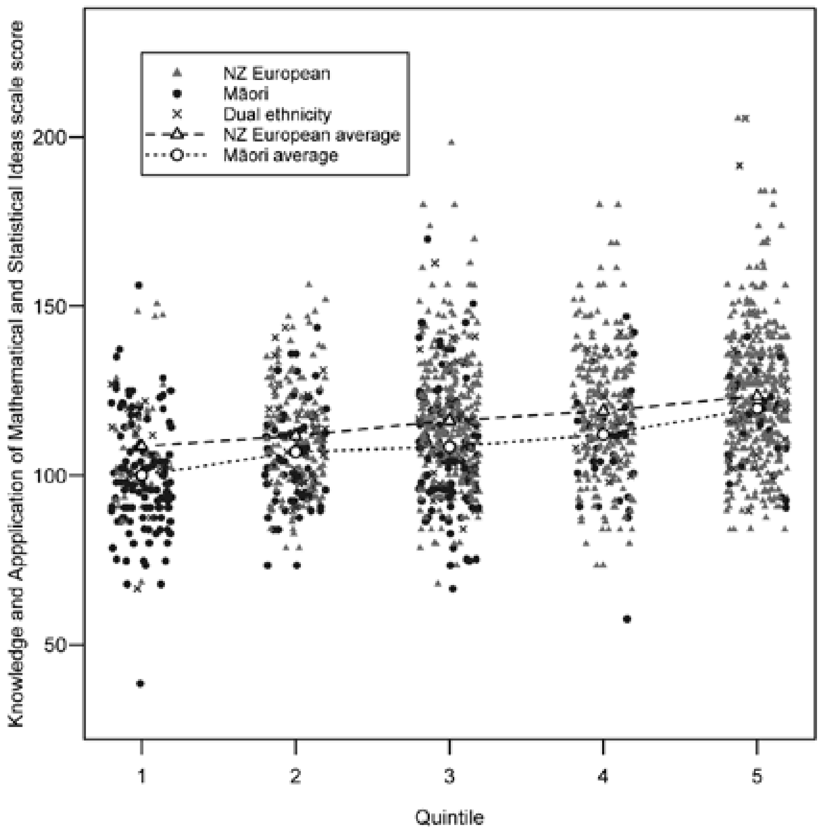

Figure A5.2 Year 8 NZ European and Māori students' KAMSI scores by quintile

At Year 4, the modelled scale scores show that on average Pasifika students scored 8 scale score units lower than NZ European students (Table A5.3 and Figure A5.3), and at Year 8, 13 scale score units lower (Table A5.4 and Figure A5.4). Rounding of scale scores to the nearest integer may cause some differences to appear slightly more or less than this in the tables.

Table A5.3 Year 4: Modelled averages on the KAMSI scale by quintile and ethnicity

Quintile	NZE	Pasifika
1	80	72
2	84	75
3	85	77
4	90	81
5	93	84

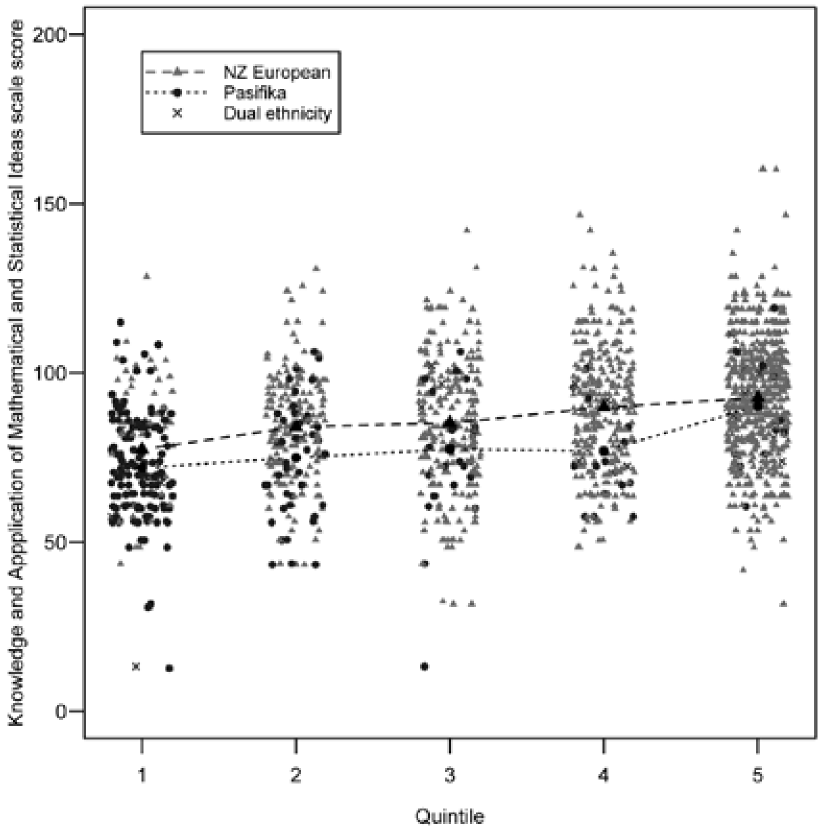

Figure A5.3 Year 4 NZ European and Pasifika students' KAMSI scores by quintile

Table A5.4 Year 8: Modelled averages on the KAMSI scale by quintile and ethnicity

Quintile	NZE	Pasifika
1	110	97
2	112	99
3	116	103
4	119	106
5	124	111

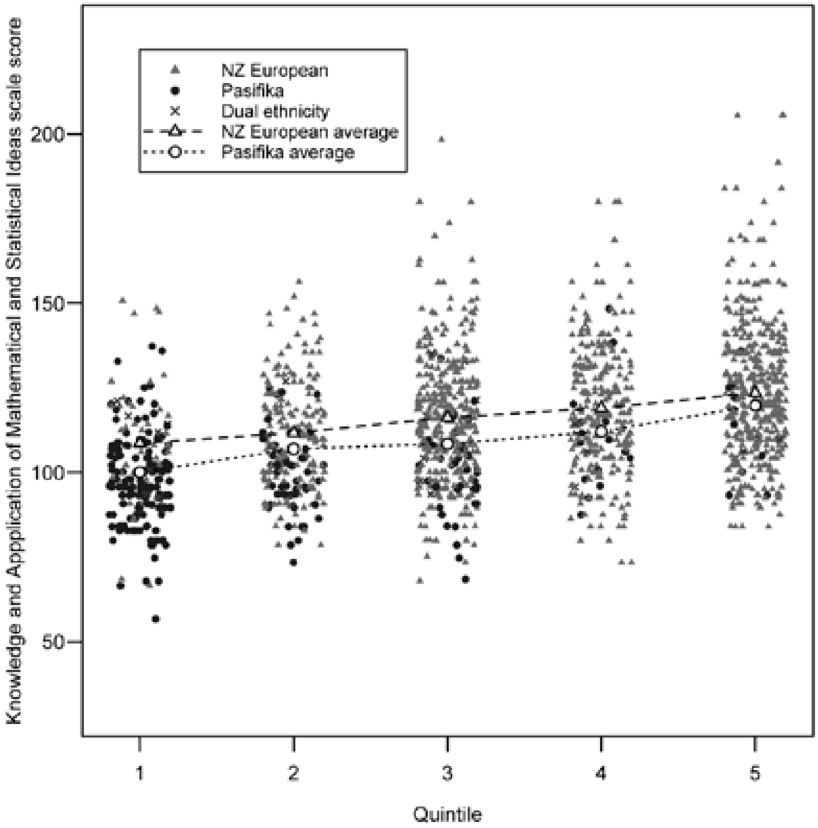

Figure A5.4 Year 8 NZ European and Pasifika students' KAMSI scores by quintile

Appendix 6:
Opportunities to Learn Mathematics and Statistics for Students at Year 4 and Year 8 with Moderate and No Special Education Needs

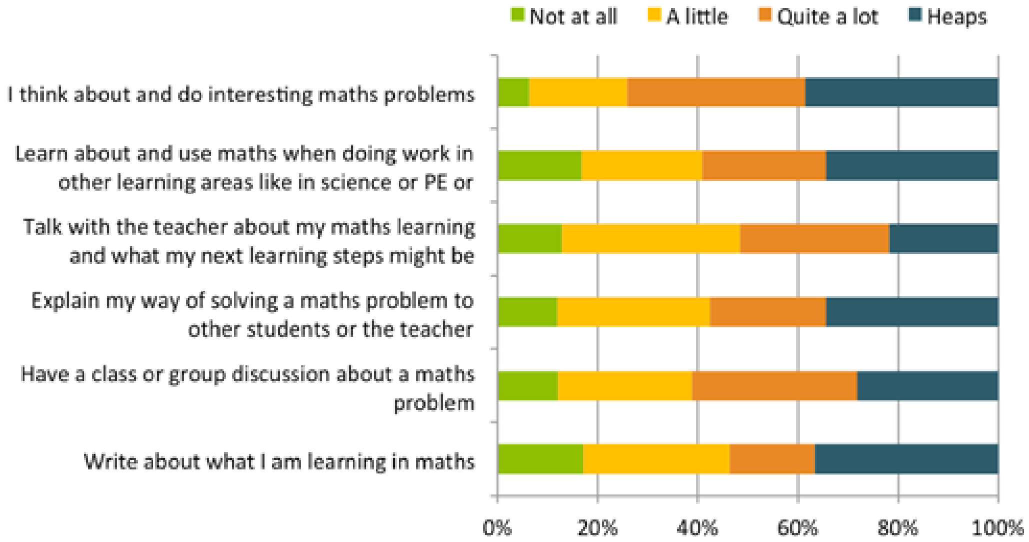

Figure A6.1 Year 4: Moderate special education needs: Opportunities to learn mathematics

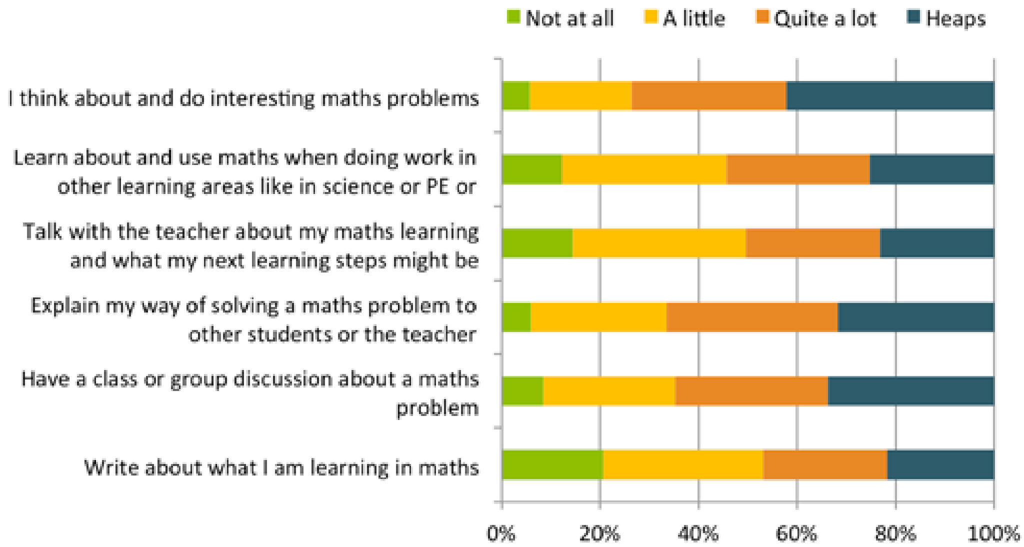

Figure A6.2 Year 4: No special education needs: Opportunities to learn mathematics

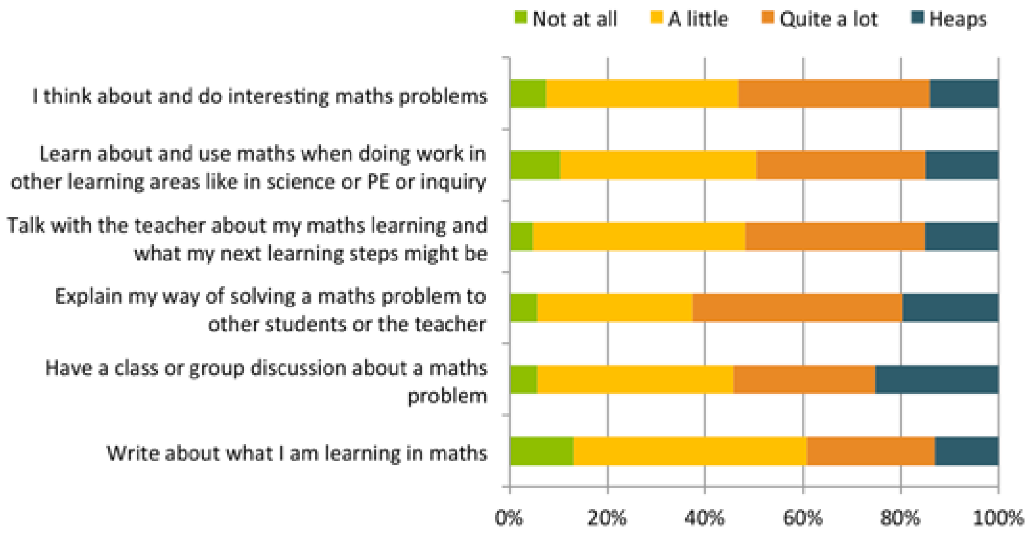

Figure A6.3 Year 8: Moderate special education needs: Opportunities to learn mathematics

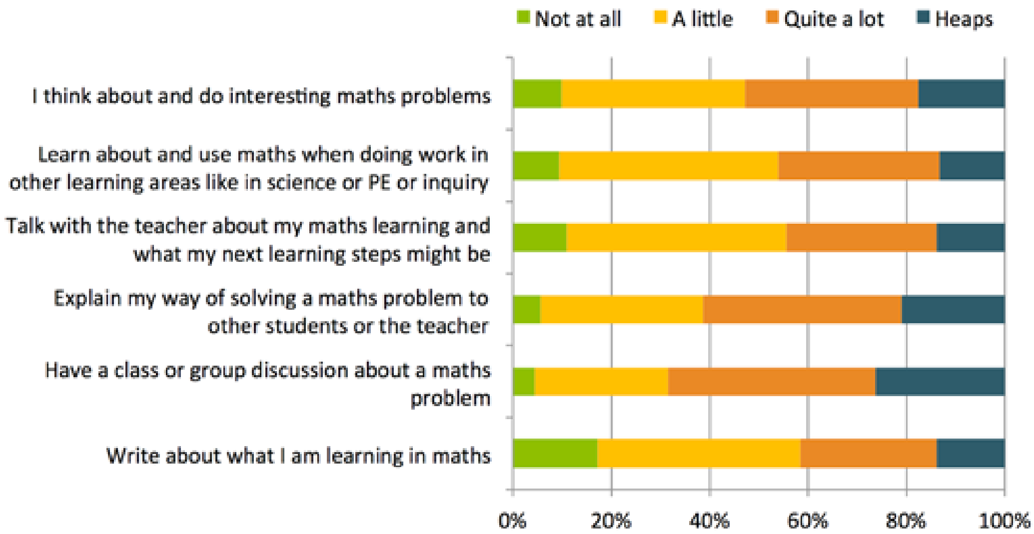

Figure A6.4 Year 8: No special education needs: Opportunities to learn mathematics