Wānangatia te Putanga Tauira
National Monitoring Study of Student Achievement

Science

2012

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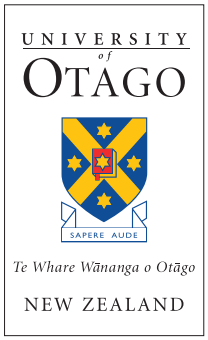
Educational Assessment Research Unit
and
New Zealand Council for Educational Research

NMSSA Report 1



Report 1
National Monitoring Study of Student Achievement, Science 2012

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National Monitoring Study of Student Achievement
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- Members of the reference groups: Technical, Maori, Pasifika, and Special Education
- Members of the curriculum advisory panels in Science and Writing
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- Principals, teachers and Board of Trustees members of the 235 schools who participated in the 2012 main study including the linking study
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- The more than 30 teachers who administered the assessments to the children
- The nearly 60 teachers and senior initial teacher education students who undertook the marking
- The Ministry of Education Research Team and Steering Committee

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The name

The Māori phrase, Wānangatia te putanga tauira, is derived from the karakia, Mānawatia te putanga tauira, which is about celebrating student success. Wānangatia te putanga tauira is about studying, considering, analysing student success and achievement.

The National Monitoring Study of Student Achievement (NMSSA) is a collaboration between the Educational Assessment Research Unit (EARU) team at the University of Otago and the New Zealand Council for Educational Research (NZCER). We work in partnership with the Ministry of Education (MoE) to maximise the potential of national monitoring and maintain the independence of the programme to ensure the trust of the community, educators and policy makers.

Executive summary

The National Monitoring Study of Student Achievement (NMSSA) – Wānangatia Te Putanga Tauira is designed to assess and understand student achievement across the curriculum at the primary level in New Zealand's English-medium state schools.

The main purposes of NMSSA are to provide a snapshot of Year 4 and Year 8 student achievement and factors that are associated with achievement; to assess strengths and weaknesses across the curriculum; and to monitor change over time. NMSSA also has a specific focus on Māori and Pasifika students and students with special education needs.

NMSSA is a long-term project that commenced in 2012. In this first year of NMSSA it is possible to provide a baseline or snapshot of student achievement in two learning areas of the New Zealand Curriculum (NZC) – science and writing. Data in subsequent years will provide information about student achievement and strengths and weaknesses across the whole curriculum including key competencies. It will also provide information about literacy and mathematics across the curriculum. In subsequent cycles, when NMSSA repeats its focus on each learning area, NMSSA will be able to report on any changes in achievement and monitor trends over a longer term. Thus, NMSSA is a national monitoring programme that will evolve and develop over time to assess and understand student achievement in New Zealand.

NMSSA follows on from the National Education Monitoring Project (NEMP) that was conducted between 1995 and 2010. NMSSA has built on and extended the design of NEMP to make use of more advanced psychometrics for reporting student achievement and exploring factors associated with that achievement. Thus, NMSSA is able to draw on findings from four cycles of NEMP assessments to retain continuity in monitoring national achievement and trends.

A focus on science

Science in the NZC is about exploring how the natural world, the physical world and science itself works so that students can participate as critical, informed and responsible citizens in a society in which science plays a significant role. The NZC provides a framework for schools to develop their own science curriculum. It does not prescribe what should be taught, except at a high level. The Nature of Science is the core strand in the NZC science curriculum, and is explored through four contextual strands - Living World, Planet Earth and Beyond, Physical World and Material World. Unlike other learning areas in the NZC, the achievement objectives for Levels 1 and 2 are the same, and Levels 3 and 4 are almost the same.

This report presents the findings about the achievement and attitudes of Year 4 and Year 8 students in science and factors that are associated with that achievement. The components of the 2012 science assessment programme include:

i. Knowledge and Communication of Science Ideas – a measure of students' knowledge, understanding and communication of ideas across the four content strands of the science curriculum. This was a paper-and-pencil assessment completed by approximately 2000 students at each year level.

ii. Nature of Science – a measure of students' understanding of scientific thinking as applied to the content and competencies specified in the Nature of Science themes in the NZC. This measure was derived from a series of individual assessments using one-to-one interviews and performance activities completed by approximately 700 students at each year level.

iii. Student attitudes and learning opportunities in science including a measure of their self-efficacy and engagement with science.

iv. Teacher perspectives on science teaching and learning in the school including their confidence as science educators and professional support for teaching science.

Several of the science measures including both achievement measures were developed using Item Response Theory to report on a scale common to Year 4 and Year 8 students. This allowed comparisons to be made between the two year levels.

The report also describes the achievement of subgroups of students (by gender, ethnicity, school decile and type of school), the achievement of the key population groups (Māori, Pasifika and students with special education needs).

Key findings from the report

National student achievement

For each science achievement scale a set of descriptors was developed that described the knowledge and competencies associated with three broad bands in the scale. The descriptors provide an indication of the progression of science knowledge and competencies found between Year 4 and Year 8. These descriptors provide valuable information not previously available about how students may be expected to progress through the science curriculum. As such, they are likely to be a valuable resource for the sector.

The NMSSA science achievement scores were also aligned with the science curriculum by a panel of New Zealand science education experts. The panel identified a series of cut-off scores on the Knowledge and Communication of Science Ideas scale that defined a series of boundaries (cut-off scores) where one curriculum level progressed into the next. The panel was able to make confident distinctions between scores associated with Emerging (entry) Curriculum Level 1 and 2 and Developed (advanced) Curriculum Level 1 and 2. A similar distinction was made between score levels associated with Emerging Level 3 and 4, and Developed Level 3 and 4.

- For both science measures, the average achievement of Year 4 students was within the Developed Curriculum Level 1 and 2 band, while for Year 8 students the average achievement was within the Emerging Curriculum Level 3 and 4 band. The average results for Year 4 students aligned with the expected level described in the NZC, while the average Year 8 results did not reach the expected curriculum level (Developed Curriculum Level 3 and 4).
- The results show that the middle 50 percent of Year 4 students drew on everyday experiences and observations rather than specific science knowledge to answer questions, were beginning to develop scientific vocabulary and recognise how scientists find things out. They knew how to carry out scientific investigations and could offer their own explanations for the outcomes observed.
- The middle 50 percent of Year 8 students were able to use basic knowledge of more abstract science, notice simple patterns in data and make basic inferences from these. They demonstrated a developing understanding of scientific thinking, process and vocabulary.
- As expected, Year 8 students achieved higher scores, on average, than Year 4 students with an average annual effect size of about 0.30. This level of growth is similar to that found for other curriculum areas (Hattie, 2009)[1].
- The progress between Year 4 and Year 8 was similar for all but one set of subgroups (e.g. boys and girls; types of school). Students in high decile schools showed greater progress than those in low decile schools.
- However, there was a wide distribution of scores at both year levels and some overlap in the achievement of Year 4 students and Year 8 students.
- The results showed that, on average, achievement varied by ethnicity and school decile. For both year levels and both measures of science, average scores 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. Achievement in science was similar for boys and girls.
- The disparity between school decile and ethnicity subgroups found in NEMP from1999 to 2007 continued to be present in 2012. The decreasing disparity between boys and girls found in NEMP over the same period has reversed at Year 4 with there being a greater discrepancy between boys and girls than in 2007, but a decline in the disparity at Year 8.
- Apart from absence of gender difference at Year 8 the pattern of results for these subgroups is generally consistent with the TIMSS 2010/2011 Year 9 science results.

Factors associated with achievement

A number of factors associated with achievement were examined. These included a measure of student attitude to science, the amount of English spoken at home, science learning opportunities at school reported by students and teachers, teachers' confidence as science educators, and the level of professional and curriculum support provided within school and by professional learning and development (PLD) programmes.

- Overall, students at Year 4 reported a more positive attitude to science than at Year 8, which is consistent with the findings from TIMSS and has been a persistent finding from NEMP since 1995.
- Attitude to science was related to achievement particularly for students with low Attitude to Science scores and the relationship between attitudes to science and science achievement was stronger at Year 8 than Year 4.

[1] Hattie, J. (2009) Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement, London & New York: Routledge, Taylor& Francis

- Students who always spoke English at home were more likely to achieve at a higher level at both Year 4 and Year 8 than students who spoke English sometimes or never. This difference held for both group-administered and individual assessments.
- There appear to be very few opportunities for hands-on science activities such as doing science experiments or using specialist science equipment in school. Year 4 and Year 8 students reported that they most frequently accessed science information by listening to their teachers, followed by independently accessing information or using information from their family and whānau.
- Most teachers who responded to the questionnaire reported that they were responsible for teaching science to their class, although at Year 8 about a third of the teachers who responded were specialist science teachers. Although the majority of teachers at both Year 4 and Year 8 liked teaching science, smaller proportions of teachers at both year levels felt happy about their teaching or confident in their ability to teach science, particularly to a diverse group of students. This lack of confidence mirrored reports of somewhat low levels of professional support within schools and limited access to targeted professional development. This finding reflects that reported in TIMSS, and presents a less positive picture of professional confidence and support than was found for NMSSA writing in 2012.[2]
- These findings are generally consistent with those of the Education Review Office evaluation of science teaching and learning in Years 5 to 8 (2012)[3] and would support ERO's recommendations that the MoE investigates opportunities for support and ongoing professional learning and development for teachers, and that schools give priority to science teaching and learning in the curriculum, and to the quality of science teaching and learning.

Achievement of Māori and Pasifika students

Students could identify with up to three ethnic groups. All students who identified as Māori were included in the Māori analyses, and all students who identified as Pasifika were included in the Pasifika analyses. The Year 4 national sample included 423 Māori students and 262 Pasifika students. The Year 8 national sample included 353 Māori students and 206 Pasifika students. We compare Māori and Pasifika student subgroups to all students in the national sample. When making these comparisons the national sample is referred to as 'All Students'.

- Māori and Pasifika students were positive about how their culture, language and identity were valued at their school and were positive in their attitudes to learning science.
- Year 4 and Year 8 Māori and Pasifika students, on average, achieved at a lower level than NZ European students although the average annual growth between Year 4 and Year 8 was similar to that for NZ European students (Chapter 3).
- Between the year levels, as expected, Year 8 Māori and Pasifika students, on average, achieved higher scores than Year 4 Māori and Pasifika students respectively. However, there was a wide distribution of scores at both year levels and some overlap in the achievement of Year 4 students and Year 8 students.
- For both science measures, the average achievement of Year 4 Māori and Pasifika students was within the Developed Curriculum Level 1 and 2. This aligns with the level expectations described in The New Zealand Curriculum.
- However, the Year 8 average score for Māori and Pasifika students is below the expectations of Developed Level 3 and 4 described in The New Zealand Curriculum, and below that for All Students (although both were in Emerging Level 3 and 4).
- For both year levels and both measures of science, achievement, on average, was lower for Māori and Pasifika students from lower decile schools. The achievement in science was similar for boys and girls, and for Year 4 Māori and Pasifika students attending full primary and contributing schools. Achievement by school type showed less consistency at Year 8.
- The percentages of Year 4 and Year 8 Māori and Pasifika students who achieved above the national averages were lower than for All Students. In all groups fewer students achieved above the national average at Year 8 than at Year 4.

2 National Monitoring Study of Student Achievement, Writing 2012, Educational Assessment Research Unit, Otago University and the New Zealand Council for Educational Research

3 http://www.ero.govt.nz/National-Reports/Science-in-The-New-Zealand-Curriculum-Years-5-to-8-May-2012/

- At Year 4, 43 percent of Māori students and 23 percent of Pasifika students scored above the national average. At Year 8 the percentages were lower at 30 percent of Māori students and 19 percent of Pasifika students.
- Māori boys and girls at both year levels and Year 8 Pasifika boys and girls were equally represented in the above groups but a greater proportion of Pasifika girls than boys achieved above the national average at Year 4.
- Māori and Pasifika students attending high decile schools were more likely to score above average on the science measures than Māori and Pasifika students in middle or low decile schools. This reflects the relationship between achievement and school decile that was found for All Students. Just over 80 percent of all Māori students and almost 90 percent of Pasifika students attended low and mid decile schools. In contrast just over 50 percent of NZ European students attended low or mid decile schools.
- Achievement varied at both year levels for Pasifika students depending on the amount of English spoken at home. Students who spoke English more frequently at home achieved at a higher level although this was not consistent across all categories.

Achievement of students with special education needs

For the first time, students with special education needs were identified in national monitoring. This represents a major step forward in the inclusion of children with special education needs in reporting national level assessment.

Participating schools were asked to identify students who had special education needs as:

- High special education needs: For example, ORS funded, Supplementary Learning Support, 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, to Special Education or CYFS with action pending.

Students not falling into any of the above categories were assigned to a 'no special education needs' group.

Although the numbers of students with high special education needs were very small, students with moderate special education needs made up 8 percent of All Students at Year 4 and 5 percent at Year 8.

Overall, the numbers in Chapter 7 are relatively small and the findings should therefore 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. As such, this group cannot be considered a statistically representative sample.

- On average, Year 8 students with special education needs scored higher than Year 4 students with special education needs. As with All Students, there was some overlap in the achievement of Year 4 and Year 8 students with special education needs.
- At both year levels, students with high or moderate special education needs achieved at a lower level, on average, than those on referral or 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. Students identified as being on referral performed in very similar ways to All Students.
- Students with moderate special education needs demonstrated a similar difference in average achievement between Year 4 and Year 8 as students with no special education needs. These results suggest that on average, students with special education needs are progressing from Year 4 to Year 8 at a similar rate to those with no special education needs.
- At Year 4 the average score for students with high special education needs was within Emerging Levels 1 and 2 of the curriculum. For students with moderate special education needs the average was just within Developed Level 1 and 2. At Year 8, the average score for both high and moderate special education needs groups was at the top end of Developed Level 1 and 2. About 30 percent of students with high or moderate special education needs were achieving at least at Level 3 and 4.
- At both year levels, students with moderate and high special education needs demonstrated as favourable an attitude to science as their peers in the on referral and no special education needs groups. Similarly to the national sample, attitude to science declined slightly between Year 4 and Year 8 for students with special education needs.
- At both year levels, 17 percent of students with moderate special education needs and about 50 percent of students on referral achieved above the national averages. There was a greater percentage of boys than girls in the special education group compared with the All Students group.
- Students with special needs who achieved above the national average tended to come from mid and high decile schools as was the case with All Students.

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 curriculum 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 New Zealand Curriculum (NZC);
- To identify factors that influence 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.

The information on educational outcomes and influencing 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 TIMSS and 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 influencing factors in 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. (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 2012 study

In 2012, the dual focus for the NMSSA study was science and writing. A nationally representative sample of approximately 2000 students at each year level took group-administered paper-and-pencil assessments in both learning areas. These students also responded to questions about their attitudes, learning experiences and support for learning. A sub-sample of approximately 700 students at each year level also took part in individual assessments through one-to-one video-recorded interviews and performance activities. Individual assessments were used for assessing aspects of learning in science and writing most suited to in-depth assessment approaches. The assessments were conducted by experienced, specially-trained classroom teachers, with sound cultural awareness, 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 200 teachers from the schools involved in the study were invited to respond to a questionnaire about school learning environments and learning opportunities provided for students, their confidence in teaching science and writing, and professional support they received for teaching these learning areas.

3. Structure of the science report

The report of student achievement in science is set out in seven chapters:

1. Chapter 1 provides a broad overview of the National Monitoring Study of Student Achievement programme.
2. Chapter 2 sets out the development of the science achievement measures and data collection instruments. The analytical and reporting approaches used to present the findings are also set out in this chapter.
3. Chapter 3 presents the findings for Year 4 and Year 8 student achievement in science and reports these against levels of the science curriculum. It also compares achievement between Year 4 and Year 8 students, and differences between subgroups of gender, ethnicity, school decile and type of school.
4. Chapter 4 examines factors that may be associated with student achievement in science and draws on information collected from students about their attitude to science, the amount of English spoken at home, and their learning experiences in science at school. This is examined alongside information collected from teachers about their confidence in teaching science, the learning experiences they provide to students, and professional support for teaching science.
5. Chapter 5 reports the achievement of Māori students in science and their experiences at school. The characteristics of Māori students who achieve above the national mean are examined in relation to gender, attitude to science and school decile.
6. Chapter 6 presents the achievement of Pasifika students in science and their experiences at school in a parallel way to Māori students in Chapter 5. The influence of the amount of English spoken at home on achievement is also examined.
7. Chapter 7 reports the participation and achievement in science of students who have special education needs – high/very high needs, moderate needs and students on referral.

2

The NMSSA Science Assessment Programme

This chapter provides an overview of the NMSSA assessment programme for science. It includes seven parts.

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

1. Science in the New Zealand Curriculum

Science in the NZC is about exploring how the natural world, the physical world and science itself work so students can participate as critical, informed and responsible citizens in a society in which science plays a significant role.[4]

Several features of science in the NZC impact on assessment. These include:

- A framework for schools to develop their own science curriculum — it does not prescribe what should be taught, except at a high level.
- The Nature of Science is the core strand, and is required learning for students up to Year 10.
- The four contextual strands — Living World, Planet Earth and Beyond, Physical World and Material World — provide the contexts within which the Nature of Science is explored.
- Unlike the other learning areas in the NZC, the achievement objectives for Levels 1 and 2 are the same, and Levels 3 and 4 are almost the same.

[4] New Zealand Curriculum, page 17

2. The NMSSA Science Assessment Plan

An advisory panel of science education experts met with the NMSSA team to consider the science learning area of the NZC, including the key competencies and literacy and mathematics demands. The panel also identified key contextual questions to better understand students' achievement in science. The discussion with the advisory panel formed the basis for the NMSSA science assessment plan.

Table 2.1 sets out the science assessment plan. Several 'big questions' identified the important or significant issues to explore in science. These led to a number of more 'specific questions' relating to (i) assessing achievement in science and (ii) understanding achievement in science. The specific questions were used to guide the development of the different components that made up the NMSSA science assessment programme.

Table 2.1 The Science Assessment Plan

Big questions

- To what degree are students able to use science so that they can participate as critical, informed and responsible citizens in a society in which science plays a significant role?
- To what extent do students show the disposition to approach relevant issues from a science perspective?
- What affective and cognitive factors influence achievement in science?
- How do Year 4 and Year 8 differ?
- What is the change over time at Year 4 and Year 8?

Assessing achievement: specific questions

- To what extent are students developing the understandings and competencies described by the Nature of Science themes in the NZC?
- To what extent are students developing and using content knowledge/big ideas valued by the curriculum?

Demonstrated through:	*In the contexts of:*
Understanding about science • Using evidence • Recognising patterns • Open-mindedness	The Living World • Life processes • Ecology • Evolution
Investigating in science • Asking questions • Noticing/observing • Using models • Planning and analysing	Planet Earth and Beyond • Earth systems • Interacting systems • Astronomical systems
Communicating in science • Describing • Explaining • Interpreting texts	Physical World • Patterns and trends of physical phenomena
Participating and contributing in science • Deciding	Material World • Properties and changes of matter • Chemistry and society

Understanding achievement: specific questions

What do students bring to their learning in science?

- How interested are students in specific contexts? (e.g. about electrical circuits)
- What is the nature and range of learning experiences students have had in science at school or at home?
- What is the relationship between students' science knowledge and competencies in science (e.g. decision-making, explaining)

What do teachers bring to their students' learning in science?

- What interests, knowledge and experiences do teachers bring to their science teaching?
- Are teachers using local community resources and expertise?
- What opportunities for science professional development and learning have teachers taken up this year?

What do schools bring to their teaching of science?

- How is science learning structured at school?
- How much time is given to learning science?

What opportunities for professional development and learning in science has the school provided for teachers this year?

- What do communities provide students with for their learning in science?
- What resources that support the teaching of science are available in the community?

The components of the Science Assessment Programme

Four components related to assessing and understanding science achievement were developed to address the plan. Two were focused directly on assessing student achievement. One of these was designed to be administered to groups of students (a group-administered approach), and the other involved an individual assessment approach where Teacher Assessors interacted with individual students. The two remaining components were focused on collecting contextual and attitudinal information from students and teachers. Table 2.2 outlines the components.

Table 2.2 The components of the 2012 NMSSA Science Assessment Programme

Component	Focus	Assessment approach
Knowledge and Communication of Science Ideas	Understanding and using the big ideas from the four contextual strands Communicating in science using visual texts (writing, diagrams, photographs), numeric texts (graphs, tables) and mixed texts (visual and numeric)	Group-administered assessment: 45-minute paper-and-pencil assessment
Nature of Science	Participating and contributing (Living World and Planet Earth and Beyond) Investigating (Material World and Physical World) Understanding and using the big ideas from the four content strands Communicating in science using visual texts	Individual assessments: one-to-one interview tasks, and individual and team performance activities
Student attitudes and learning opportunities in science	Student views of their self-efficacy and engagement with science Student views of opportunities and experiences for learning science at school	Paper-and-pencil questionnaire
Teacher perspectives on science teaching and learning in the school	Teacher views of science learning in their school Teacher confidence as science educators Professional support for teaching science	Paper-and-pencil questionnaire

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

3. Knowledge and Communication of Science Ideas

The Knowledge and Communication of Science Ideas 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 a ddressed three different areas:

- Science knowledge
- Communicating in science (from the Nature of Science strand)
- Using science knowledge — this incorporates the Key Competencies: Thinking, Using Language, Symbols and Texts and, to a lesser extent, Participating and Contributing.

Taken together, the assessment focused on the extent to which students communicate their scientific ideas and understandings about the natural world and engage with a range of science stimulus material, including written and diagrammatical texts.

Assessment framework

To guide the assessment development process, frameworks describing the knowledge and competencies to be assessed at each year level were developed. These drew on the assessment plan developed with the advisory panel and the NZC science curriculum. The frameworks are shown in Appendix 2.

A blueprint that outlined the approximate number of questions to be written, and the types of stimuli and questions to be used, was drawn up for each year level.

A collection of science assessment 'units' was developed based on the frameworks and blueprints. Each unit was centred on a science theme and consisted of a stimulus and up to four separate questions (items). Items included a mix of selected response and constructed response (short and longer answer). The items were categorised according to their assessment focus (science knowledge, communicating in science, and using science knowledge). Figure 2.1 shows an example of a science assessment unit.

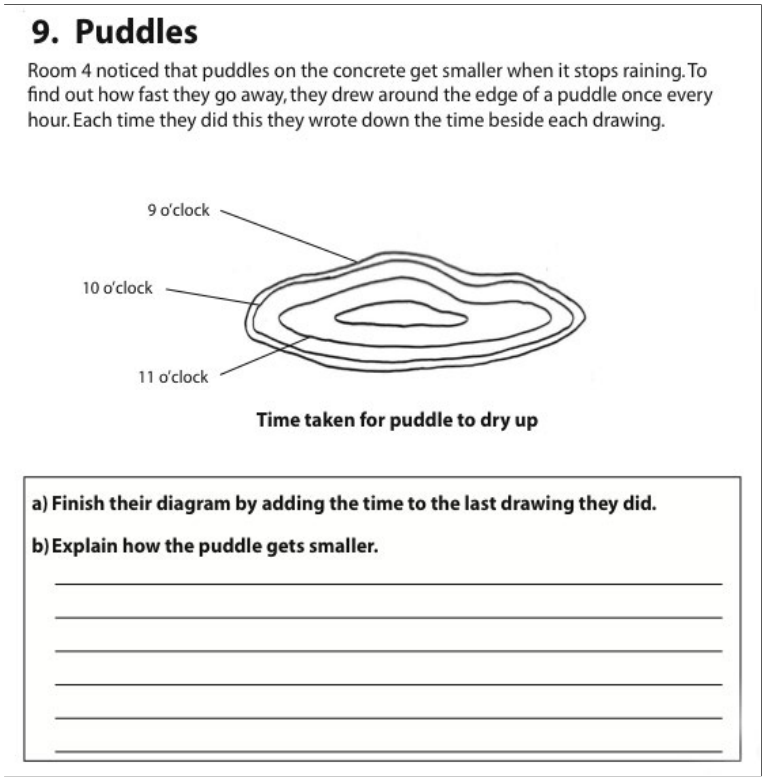


Figure 2.1 Example of science unit

Piloting and trialling units

All units were reviewed by the project team. Where relevant, this included a cultural review to make sure the stimulus material was used appropriately. The units were then piloted with several classes of students and the results used to select units to trial with larger numbers of students in several schools around New Zealand. For the trial, sets of units were organised into assessment booklets and were 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 units was administered to approximately 250 Year 6 students.

Draft scoring guides were developed for each item. Student responses from the trial were marked, and analysed using an Item Response Theory (IRT) model[5]. The results of the trial were used to make final decisions about each item's suitability for inclusion in the 2012 NMSSA science study and to refine scoring guides.

The 2012 NMSSA Science Study

The pool of units selected for the 2012 science study was used to construct a Year 4 and a Year 8 assessment. A small number of units was used at both year levels. For Year 4 there were 19 units consisting of 26 items, and for Year 8 there were 22 units consisting of 36 items. To minimise any item order effect, four variations of each booklet were constructed. Each variation presented the same units in a different order. 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 the assessment, just over 2000 students in total at each year level.

Linking Year 4 and Year 8 results

To enable student achievement to be linked across Year 4 and Year 8, additional booklets were constructed using a mix of units from both year levels. These were administered to a sample of approximately 600 Year 6 students from a number of schools outside the NMSSA sample.

Marking

A marking plan was developed and a group of markers employed to score the student responses. 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 was applied to all student responses including data from the linking study to construct a single measurement scale for the Knowledge and Communication of Science Ideas 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 Knowledge and Communication of Science Ideas scale. The scale is divided into three broad bands, each describing the knowledge and competencies associated with that part of the scale, along with examples from the assessments.

To create the scale description, each item used in the 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 competencies it required in order to be answered successfully. This allowed the science 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.

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

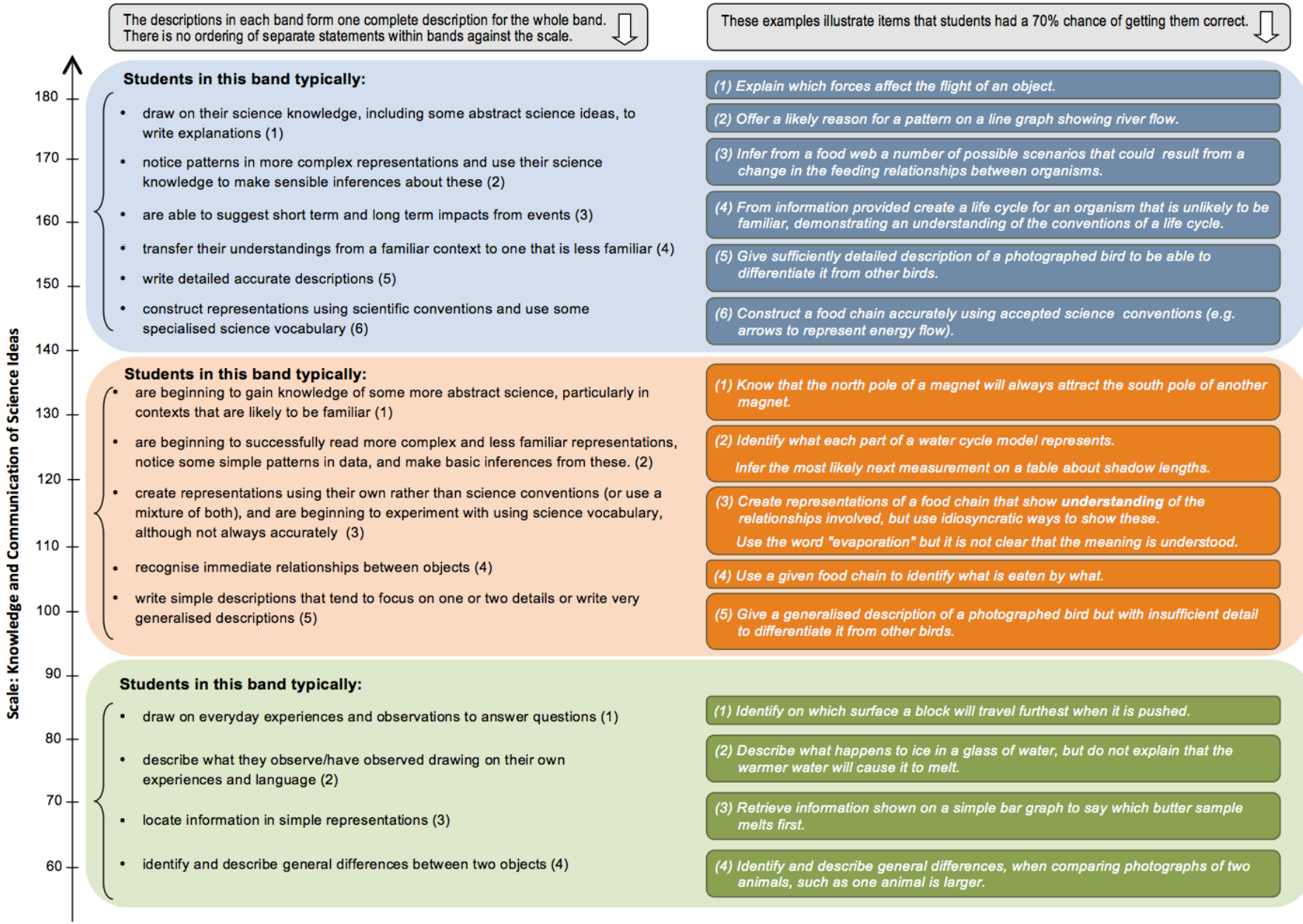


Figure 2.2 Scale description for Knowledge and Communication of Science Ideas

4. Nature of Science assessment

The Nature of Science assessment was an individual assessment made up of a range of tasks, including performance and extended interview tasks. Tasks were administered one to one, or while working in small groups. Most tasks were designed to be used at both Year 4 and Year 8. Approximately 700 students at each year level, a sub-sample of the NMSSA sample, completed the Nature of Science Assessment.

The assessment addressed the four Nature of Science themes from the NZC:

- Understanding about science
- Investigating in science
- Communicating in science
- Participating and contributing

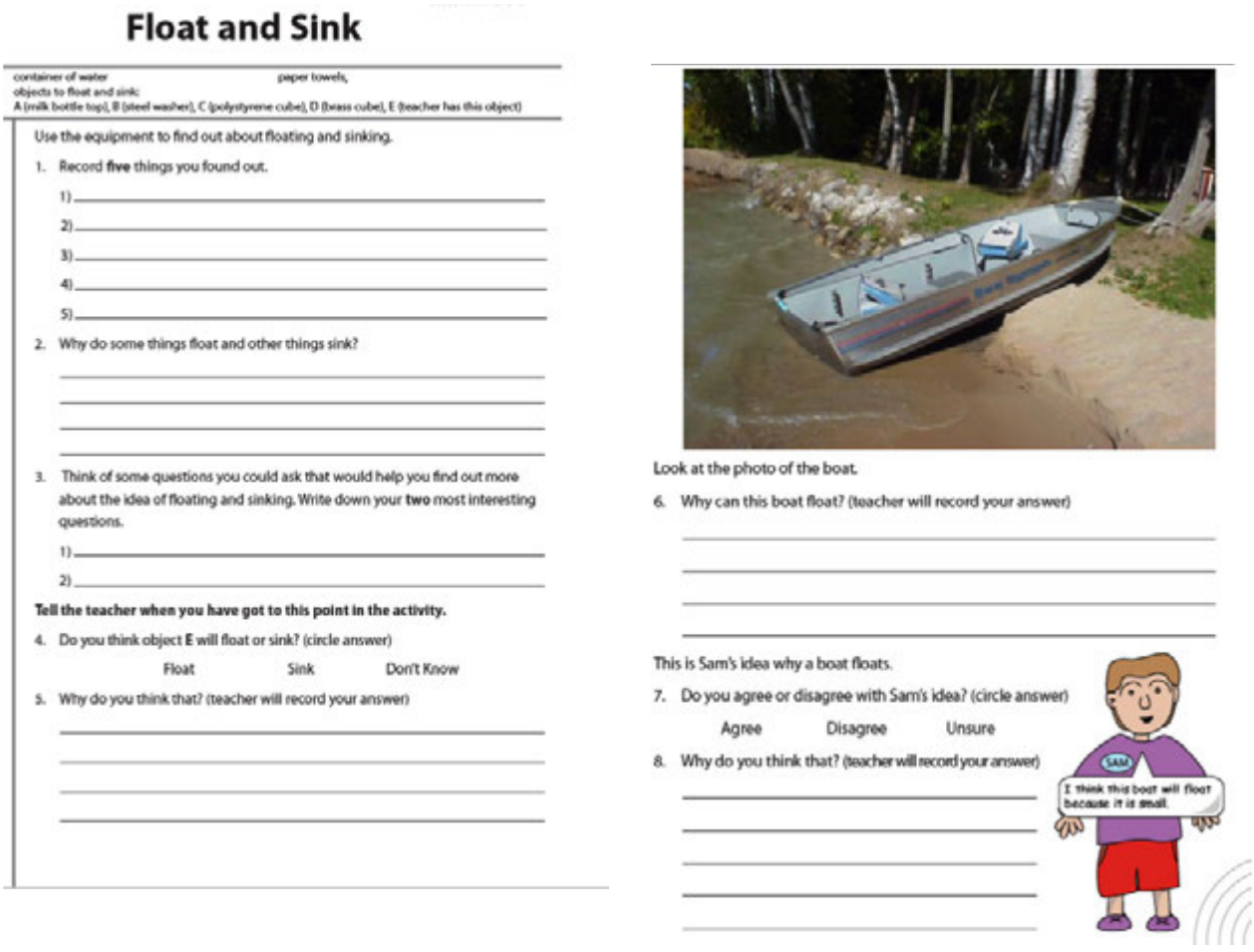
Taken together, the focus of the Nature of Science assessment is the extent to which students have developed the understandings and competencies described by the Nature of Science themes of the NZC.

Assessment Framework

An assessment framework was written to guide the development of the Nature of Science assessment drawing on the assessment plan and the NZC. As well as the Nature of Science strand in the NZC, the assessment framework drew on the achievement objectives from the Living World, Planet Earth and Beyond, Material World, and Physical World strands to provide the contexts and scientific ideas to be used in the assessments. It also described how opportunities for using the knowledge, attitudes and values that are expressed as key competencies in the NZC would be included. Examples of this are using creative, critical, and metacognitive processes to make sense of information, being able to interpret and use words, and relating to others.

For each task, a template was used to record the curriculum focus, the key competency opportunity, and the assessment approach (interview or performance). See Appendix 3 for an example of a task template. A range of task types was developed, including five one-to-one extended interview tasks.

Figure 2.3 shows an example of a Nature of Science task.



Float and Sink

container of water paper towels,
objects to float and sink:
A (milk bottle top), B (steel washer), C (polystyrene cube), D (brass cube), E (teacher has this object)

Use the equipment to find out about floating and sinking.

1. Record **five** things you found out.
   1) _____
   2) _____
   3) _____
   4) _____
   5) _____
2. Why do some things float and other things sink?
3. Think of some questions you could ask that would help you find out more about the idea of floating and sinking. Write down your **two** most interesting questions.
   1) _____
   2) _____

Tell the teacher when you have got to this point in the activity.

4. Do you think object **E** will float or sink? (circle answer)
   Float Sink Don't Know
5. Why do you think that? (teacher will record your answer)

Look at the photo of the boat.

6. Why can this boat float? (teacher will record your answer)

This is Sam's idea why a boat floats.

7. Do you agree or disagree with Sam's idea? (circle answer)
   Agree Disagree Unsure
8. Why do you think that? (teacher will record your answer)

Figure 2.3 An example of individual-assessment task for Nature of Science

Piloting and trialling

The tasks were piloted in Dunedin schools before being used in a NMSSA trial involving schools around New Zealand. The student responses from the trials 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 refine the tasks, explore the development of a reporting scale and inform the selection of tasks for the main study.

The 2012 NMSSA Science Study

Teacher assessors were trained in the administration of the Nature of Science tasks during a four-day training programme prior to the main study. During the study a selection of tasks was administered to 8 students in each school. Teacher assessors were carefully monitored and received feedback to ensure consistency of administration. Student responses were captured on video and paper and stored electronically for marking. Approximately 700 students in the main study completed Nature of Science tasks at Year 4 and Year 8.

Marking

Teacher markers, some 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 Nature of Science scale

An IRT model was applied to all student responses from the Nature of Science assessment to construct a measurement scale. The scale locates both student achievement and item difficulty on the same measurement continuum using scale scores.

Like the Knowledge and Communication of Science Ideas scale, the Nature of Science 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 2.4 describes the specific knowledge and competencies required to successfully complete the science questions at different parts of the scale for Nature of Science. The descriptions are provided in three broad bands, along with examples from the Nature of Science assessment tasks.

To develop the description each question from the Nature of Science assessment was placed on the scale where the probability of answering the question correctly was 70 percent. The demands of each question were examined and used to craft descriptions across three bands of the scale. The descriptions for each band were organised around the four focus areas of the Nature of Science assessment.

The scale description is used in later chapters to help interpret the data.

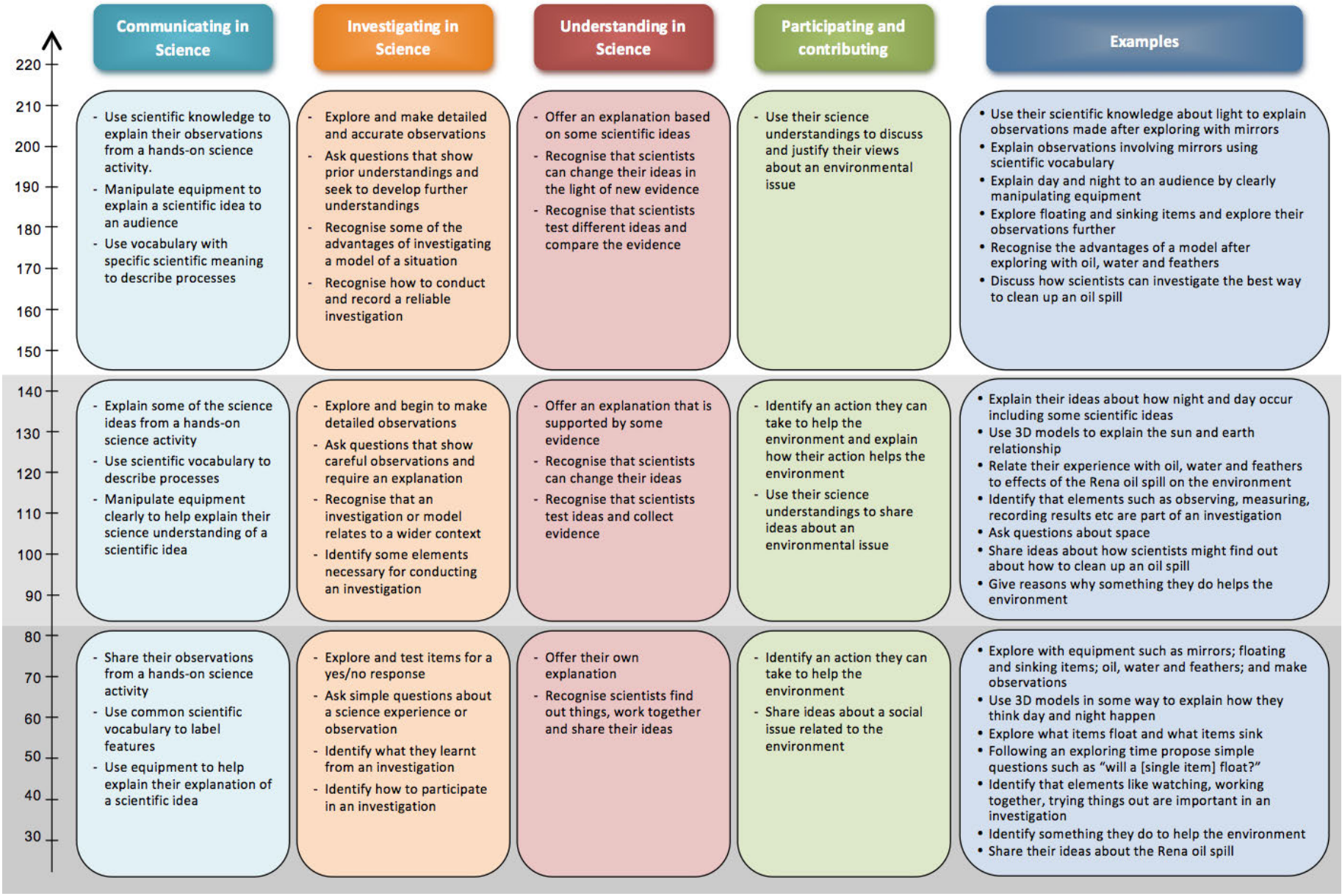


Figure 2.4 Scale description for Nature of Science

5. Student attitudes and learning opportunities in science

A questionnaire was developed containing sections related to student attitudes towards science, how students perceive learning opportunities, and how much English is spoken in their homes. The questionnaire was the same for Year 4 and Year 8 and was administered to all students in the 2012 NMSSA science study.

Attitude to science

The section related to attitudes to science asked students to show how much they agreed with a number of statements related to their feelings of self efficacy in science and level of engagement in science learning. Students used a four-point agreement scale to respond to each statement (heaps, quite a lot, a little, not at all). The statements were sourced from a range of relevant studies, including the National Education Monitoring Project. Some examples of the statements from the Attitude to Science section were:

- I am good at science.
- My teacher thinks I am good at science.
- I would like to do more science at school.
- I like doing science in my own time, when I am not at school.
- I think science is interesting.

A draft version of the attitudes to science 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. Responses from the trial were analysed using an IRT model and the results used to inform the development of the final set of statements used in the 2012 NMSSA science study.

After the main study, an IRT model was applied to the student responses to the attitudes to science section in order to construct a reporting scale. The scale allows the strength of each student's overall response to the set of statements to be located on a measurement continuum. Students who responded positively to a large number of statements were given high scale scores. Students whose responses were more negative overall received lower scale scores. As with other NMSSA scales, this scale has been set to have an average of 100 scale units and standard deviation of 20 scale units.

Learning opportunities in science

The second section of the questionnaire asked students about the opportunities they had to learn science. Students used a five-point scale (heaps, quite a lot, sometimes, hardly ever, and never) to show how often they experienced different opportunities to be involved in science learning activities. Examples of the learning opportunities included:

- Doing experiments
- Using special science equipment
- Entering science competitions
- Going on trips outside of school to learn more about your science topic
- Listening to the teacher talk about your science topic.

A draft list of learning opportunities was piloted and trialled and a final list selected for use in the main study. Results from the 2012 study are reported as the percentages of students selecting the different response categories for each learning opportunity.

Amount of English spoken at home

The questionnaire also asked students how often they spoke English at home. Students responded by selecting from: all the time, most of the time, about half of the time, sometimes, and never. To report these results responses have been collapsed into three categories: always, often, and sometimes/never. Always contains the "all the time" responses, Often contains the "most of the time" and "half of the time" responses and Sometimes/Never contains the "sometimes" and "never" responses. The results are reported using the percentage of students in each response category and achievement between students in the different response categories is compared.

6. Teacher perspectives on science teaching and learning in the school

The final component of the NMSSA science assessment programme was a teacher questionnaire. The questionnaire was developed to collect information related to teachers' perspectives on science teaching and learning in their school. It included questions related to their confidence as science educators, the types of science learning activities and experiences that they provided for their students, and their opportunities for professional development. 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 science to the students assessed in the science study were asked to complete the questionnaire.

7. Data analysis and reporting

In this section we provide some technical details around the scales developed to report the science 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: Knowledge and Communication of Science Ideas

The scales used in this report have been developed using the Partial Credit Model (Masters, 1982)[6]. The partial credit model (PCM) is one of the family of Rasch measurement models frequently used in studies such as this (PISA 2012[7], TIMSS 2011[8]). The IRT software package WINSTEPS (Linacre, 2009)[9] was used to develop the science scales. Some advantages of using the PCM are:

- Both items and students 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

The PCM is based on probabilistic units called logits. The model anchors the scale at the mean of the item difficulties, which is set to zero. As a consequence, logit scores generally range from about -7 to +7 logits. To make the scale units easier to understand and interpret we have transformed the logit scale. For each scale (the two science achievement scales, and the attitudinal scale) we have set the mean of all students (Year 4 and Year 8 combined) to be 100 scale units, and the average standard deviation of each year level to be 20 scale units. This means that scores on each of the science scales range from around 20 to 180 scale units.

The association between the achievement measures and scale reliability

The two components of the assessment programme focused on achievement (Knowledge and Communication of Science Ideas and Nature of Science) were centred on different, but overlapping aspects of science in the NZC. They also used different assessment approaches to gather information: group-administered paper-and-pencil assessments compared with individual assessments using interviews and performance tasks. The correlation between the two measures is relatively high (0.79) and indicates that they measure similar skills and competencies. Because of the differences in focus and approach, however, a decision was made to report the results from the assessments separately.

6 Masters, G.N. (1982). A Rasch model for partial credit scoring. Psychometrika, 47, 149-174

7 PISA 2012. http://www.educationcounts.govt.nz/topics/research/pisa_research/pisa_2012

8 TIMSS 2011. http://www.educationcounts.govt.nz/topics/research/timss

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

Scale reliability

Table 2.3 provides reliability indices for each of the reporting scales developed for use in the assessment programme. These relate to the reliability of students' scale scores and have been calculated by the WINSTEPS software used to construct the scales. The overall reliabilities are high and indicate that for each measure, student achievement has been located on the scale with a very satisfactory level of precision.

Table 2.3 The reliability of the NMSSA measures

Measure	Reliability
Knowledge and Communication in Science	0.87
Nature of Science	0.90
Attitude to Science	0.86

Reporting achievement against curriculum levels

The NZC provides achievement objectives for each learning area that set out selected learning processes, knowledge and skills relative to eight levels of learning. A curriculum alignment exercise was undertaken to link performance ranges on the two NMSSA science achievement scales to the first four levels of the NZC.[10] Creating this link allows scale scores for the two science measures to be reported in terms of curriculum levels.

Compared to other learning areas, science in the NZC is atypical, in that the achievement objectives for Levels 1 and 2 are exactly the same, and for Levels 3 and 4 almost the same. To differentiate between different levels of performance at Levels 1 and 2, and Levels 3 and 4, the curriculum alignment exercise defined an 'emerging' and 'developed' band for the achievement objectives contained in each pair of levels. This allowed the range of achievement covered by the scales to be mapped to the levels of the science curriculum using four bands:

- Emerging Level 1 and 2
- Developed Level 1 and 2
- Emerging Level 3 and 4
- Developed Level 3 and 4 and above

The alignment exercise focused on defining these bands for the Knowledge and Communications in Science scale. An equi-percentile approach was used to define the bands on the Nature of Science scale.

Defining expected achievement levels

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 at curriculum Level 2 by the end of Year 4 and curriculum Level 4 by the end of Year 8. For the purposes of this report, the 'Developed Level 1 and 2' band has been used to represent the performance level expected by the curriculum for Year 4 students and the 'Developed Level 3 and 4 and above' band to represent the level expected for Year 8 students. These benchmarks are used throughout the report to define expected performance bands for each year level.

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

[10] See Appendix 3 for details of the process and rationale for the level descriptions

Use of graphs in the report

Box and whisker plots

These 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 2.5.

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. The box plots in this report do not display outliers.

Colours used

Box plots for reporting scales use two colours 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 science are presented in a different pair of colours to distinguish them from those relating to achievement.

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.

Line graph of score distributions

Another type of graph used to display data in this report is the line graph (Figure 2.6). These are used to show how the distributions of scores for various groups compare with curriculum expectations. The graphs are a smoothed version of the data.

Horizontal lines are placed on the line graphs to show how the scale aligns to the science curriculum levels. A detailed exercise was undertaken to establish the locations on the scales where one curriculum level merges into the next. Full details of this 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 subgroup differences

A graph using bars has been developed to show the size of difference in scale score units between pairs of subgroups. An example of the display of differences is shown in Figure 2.7. The display shown compares pairs of Year 4 subgroups for ethnicity. The top of the bar marks the average score for the subgroup that scored higher. The bottom of the bar marks the average score for the subgroup that scored lower. The number above the bar indicates the difference between the averages in scale score points. The dotted red line shows the national average score for all students in Year 4.

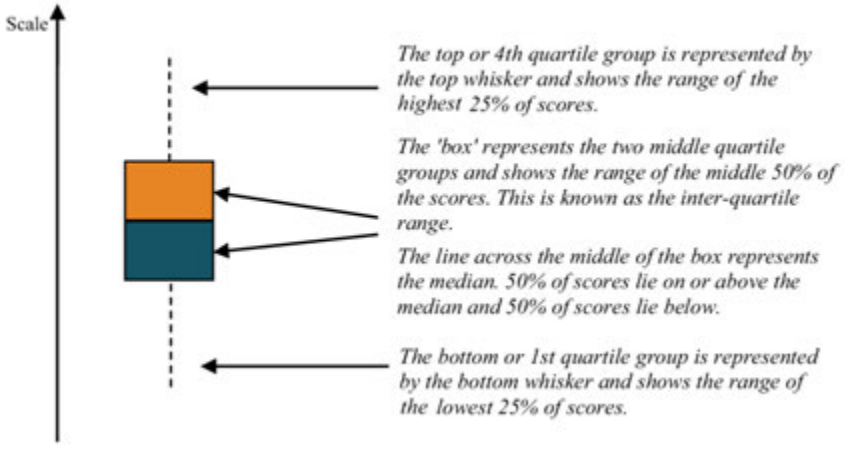


Figure 2.5 Understanding box plots

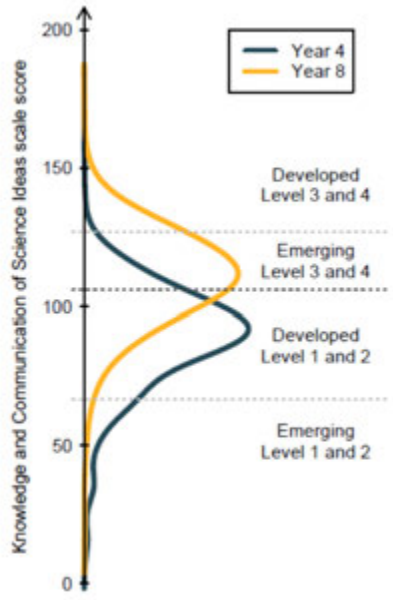


Figure 2.6 An example of a line graph

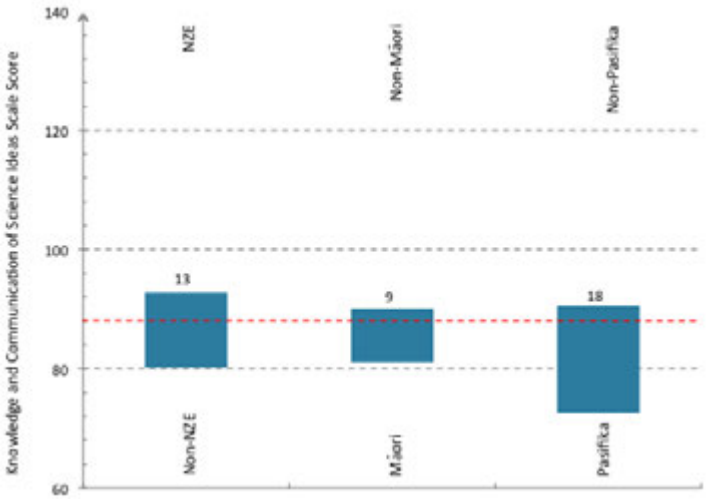


Figure 2.7 The display of subgroup differences between ethnicity groups

Effect size statistics and statistical significance

Effect sizes have been used throughout the report to help interpret differences between groups on the measures used in the science assessment programme. An effect size quantifies the difference between 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. Because the standard deviations and sample size for groups can vary, 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 helpful to consider the scale score differences, distribution of scores and size of group.

Ninety-five percent confidence intervals have been calculated for each effect size reported and used to determine when an effect is statistically significant. When an effect is statistically significant it means that the data supports the hypothesis that the effect size is real (non zero). Statistically significant effect sizes are shown in bold text in the tables of findings.

Effect sizes have been used to examine:

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

Tables of means, standard deviations, sample size, effect sizes and confidence intervals are included in Appendix 4.

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.

3

Student Achievement in Science

This chapter describes Year 4 and Year 8 student achievement in science based on the two measures of science achievement developed for the NMSSA study: Knowledge and Communication of Science Ideas, and Nature of Science. It examines how achievement varies within and between year levels, including variation by gender, ethnicity, school decile and type of school. Achievement is reported against the levels of the New Zealand science curriculum.

The chapter is organised into four 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.

Success and achievement of students in science – an overview

For both science measures, the average achievement of Year 4 students was within the Developed Curriculum Level 1 and 2 band, while for Year 8 students the average achievement was within the Emerging Curriculum Level 3 and 4 band. The results for Year 4 students aligned with expectations described in The New Zealand Curriculum while the Year 8 results did not reach the expected curriculum levels.

As expected, Year 8 students achieved higher scores, on average, than Year 4 students. However, there was a wide distribution of scores at both year levels and some overlap in the achievement of Year 4 students and Year 8 students.

The results show that the middle 50 percent of Year 4 students drew on everyday experiences and observations rather than specific science knowledge to answer questions, and were beginning to develop scientific vocabulary and recognise how scientists find things out. They knew how to carry out scientific investigations and could offer their own explanations for the outcomes observed.

The middle 50 percent of Year 8 students were able to use basic knowledge of more abstract science, notice simple patterns in data and make basic inferences from these. They demonstrated a developing understanding of scientific thinking, process and vocabulary.

Year 8 students were typically gaining knowledge of more abstract science, noticing simple patterns in data and making basic inferences from these. They demonstrated a developing understanding of scientific thinking, process and vocabulary.

On average, achievement varied by ethnicity and school decile. For both year levels and both measures of science, average scores 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. Achievement in science was similar for boys and girls at both year levels.

The increasing disparities between the school decile and ethnicity subgroups found in NEMP from 1995 or 1999 to 2007 continue to increase. The decreasing disparity between boys and girls found in NEMP over the same period has reversed at Year 4 with there being a greater discrepancy between boys and girls than in 2007, but a decline in the disparity at Year 8.

Apart from absence of a gender difference at Year 8 the pattern of results for these subgroups is generally consistent with the TIMSS 2010/2011 Year 9 science results.

There is a complex relationship between the effects of school decile and student ethnicity on science achievement and both are statistically significant. At both Year 4 and Year 8 and for both science measures, the differences between low, mid and high decile schools, and between NZ European, Māori and Pasifika students were statistically significant (at $p<.000$ for all but two comparisons). This was similar to the findings for NMSSA Writing (2012).

The ethnic group differences persisted for students from decile 1 schools only. This contrasts with the findings for NMSSA writing (2012) where there were no statistically significant differences in writing achievement between NZ European, Māori and Pasifika students from decile 1 schools.

The average annual progress between Year 4 and Year 8 was around 0.30, similar to progress found in other curriculum areas (Hattie, 2009), although lower than that found for NMSSA Writing for a Variety of Measures (0.36), (2012). The progress was similar for most sets of subgroups (e.g. boys and girls; ethnicity and types of school). However, students in high decile schools showed significantly greater progress than those in low decile schools (an overlap of confidence intervals of 0.03).

1. Year 4 achievement in science

Overall achievement

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

Table 3.1 Overall measures of science achievement at Year 4

	Knowledge and Communication of Science Ideas	Nature of Science
Average (scale score units)	88	86
SD (scale score units)	21	20
N	2076	711

Table 3.2 Percentage of Year 4 students achieving across science curriculum levels

	Knowledge and Communication of Science Ideas	Nature of Science
	%	%
Developed Level 3 and 4 and above	1	1
Emerging Level 3 and 4	18	11
Developed Level 1 and 2	66	76
Emerging Level 1 and 2	15	12

The average score for Year 4 students on the Knowledge and Communication of Science Ideas measure was 88 scale score units. Drawing on the scale description for this measure[11] this indicates that the 50 percent of Year 4 students clustered around the average (the middle 50 percent) were able to:

- Draw on everyday experiences and observations to explain scientific ideas
- Describe what they observe, drawing on their everyday experiences for explanations
- Locate information in simple representations
- Identify general differences between two objects.

On the Nature of Science measure, Year 4 students scored an average of 86 scale score units. Drawing this time on the scale description for the Nature of Science scale, this indicates that the middle 50 percent of Year 4 students were typically able to:

- Share their observations from a hands-on scientific activity
- Use common scientific vocabulary and equipment to help explain a scientific idea
- Identify how to participate in a scientific investigation, explore and test items, ask simple questions about a scientific experience, and identify what they learnt from it
- Recognise that scientists work together to find things out and share their ideas
- Share ideas about a social issue related to the environment, and identify an action they could take to help the environment.

As described in Chapter 2, a curriculum alignment exercise was undertaken to link performance ranges on the two NMSSA science achievement scales to the NZC. Creating this link allowed scale scores to be reported in terms of curriculum expectations. Table 3.2 shows that Year 4 students' scores on both measures covered four curriculum bands, with most students achieving in the Developed Level 1 and 2 band. The Developed Level 1 and 2 band represents the expected level of performance for an average Year 4 student at the end of the year.

[11] Details of scale descriptions for both science measures are provided in Chapter 2.

Year 4 Achievement by subgroup

Figures 3.1 and 3.2 display the level and spread of scores for key population subgroups in Year 4 on the two science measures. Box plots are used to show results by gender, ethnicity[12], school decile[13] and type of school[14]. The number of students that participated in assessments within each subgroup is provided in Appendix 4.

The pattern of achievement at Year 4 for these subgroups was similar on both science measures: gender differences were small, and differences by ethnic group and school decile were notable. This pattern of results is generally consistent with the TIMSS 2010/2011 Year 5 science results. However, on the Knowledge and Communication of Science Ideas measure, the average score was lower and the spread of scores wider for boys than girls, for Māori and Pasifika students than for New Zealand European students, and for students attending low compared to high decile schools. The wider spread of scores on the Knowledge and Communication of Science Ideas measure may be due in part to the greater literacy demands of this paper-and-pencil assessment. The Nature of Science assessment involved oral questions and responses.

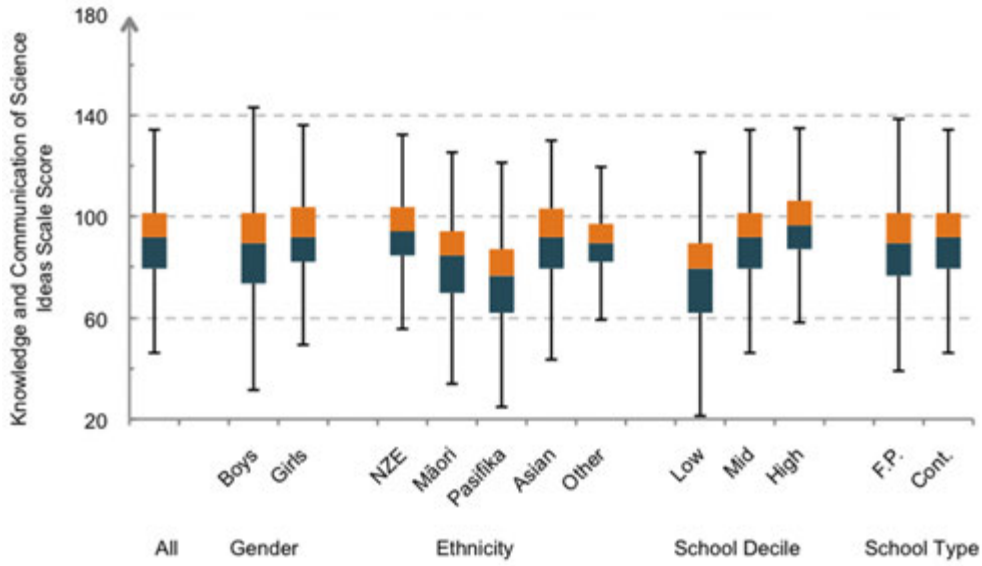


Figure 3.1 Year 4 student scores for Knowledge and Communication of Science Ideas by gender, ethnicity, school decile and type (NZE=NZ European, F.P.=Full Primary, Cont.=Contributing)

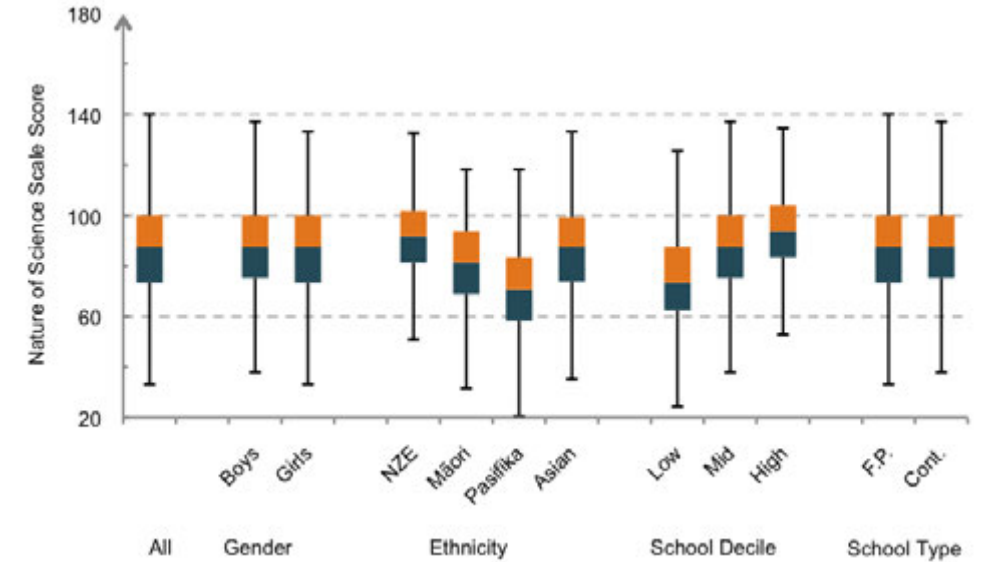


Figure 3.2 Year 4 student scores for Nature of Science by gender, ethnicity, school decile and type (NZE=NZ European, F.P.=Full Primary, Cont.=Contributing)

Note: The 'Other' ethnic group is not shown for Nature of Science because the sample size was too small.

[12] Students could identify with up to three ethnic groups and could therefore be present in multiple ethnic groups. Student ethnicity data was obtained from student NSN information held on the Ministry of Education ENROL database.

[13] 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)

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

Figures 3.3 and 3.4 display the **differences** in average scale scores between the subgroups, illustrating their relative effect sizes on the two science measures. Table 3.3 summarises average scale score differences and effect sizes between subgroups on the two science measures. The full tables of means, standard deviations, sample sizes, effect sizes and 95 percent confidence intervals are in Appendix 4.

Across both measures, Year 4 students from low decile schools scored, on average, 21 scale points lower than those from high decile schools, an approximate effect size of 1.0. The difference between low and mid decile groups was still considerable with an effect size of about 0.75, while the difference between mid and high decile groups was smaller with an effect size of about 0.30. These effect size differences were statistically significant (with non-overlapping confidence intervals) for Knowledge and Communication of Science Ideas, but not for Nature of Science.

Across ethnic groups at both year levels, the difference between Pasifika and non-Pasifika was the greatest on both scales (effect size approximately 0.90). Differences between New Zealand European and non-NZ European were smaller with an effect size of about 0.70. The difference between Māori and non-Māori was equivalent to an effect size of approximately 0.40.

It is important to note that differences between ethnic groups may be confounded with decile differences and with the non-Māori group including Pasifika students who scored lower than Māori. This issue is discussed further in part 3 of this chapter and in Chapters 5 and 6.

The findings indicate that the increasing disparities between the school decile and ethnicity subgroups found in NEMP from 1995 or 1999 to 2007 are continuing to increase. The decreasing disparity between boys and girls found in NEMP over the same period has reversed with there being a greater discrepancy between Year 4 boys and girls than in 2007.

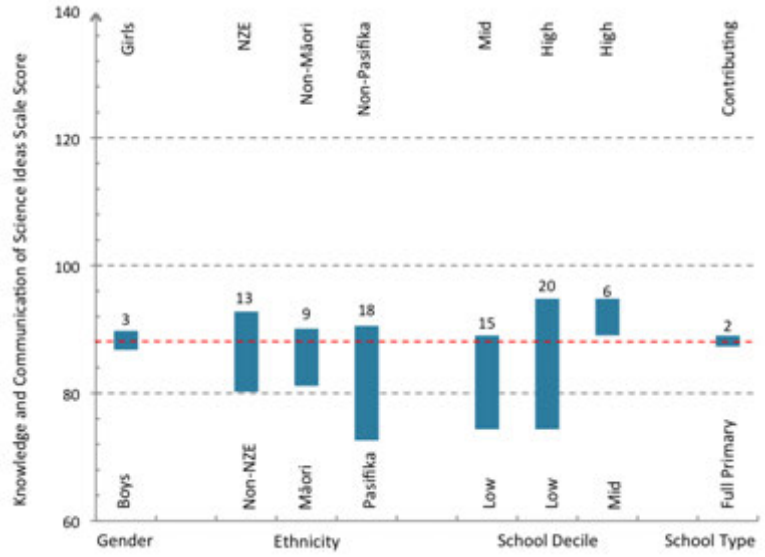


Figure 3.3 Year 4 students: Difference in average scores for Knowledge and Communication of Science Ideas by subgroup (NZE=NZ European)

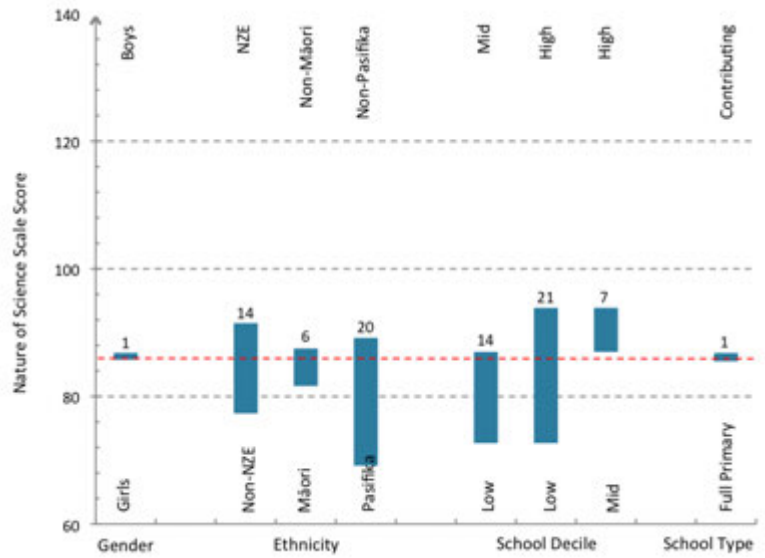


Figure 3.4 Year 4 students: Difference in average scores for Nature of Science by subgroup (NZE=NZ European)

Table 3.3 summarises average scale score differences and effect sizes between subgroups on the two science measures. The full tables of means, standard deviations, sample sizes, effect sizes and 95 percent confidence intervals are in Appendix 4.

Table 3.3 Year 4 subgroup differences on science achievement scales

	Knowledge and Communication of Science Ideas		Nature of Science	
	Scale score differences (scale score units)	Effect size	Scale score differences (scale score units)	Effect size
Gender				
Boys/Girls	3	**-0.14**	1	0.05
Ethnicity				
NZ European/Non-NZ European	13	**0.62**	14	**0.74**
Māori/Non-Māori	9	**-0.43**	6	**-0.31**
Pasifika/Non-Pasifika	18	**-0.87**	20	**-1.02**
School Decile				
Low/Mid	15	**-0.73**	14	**-0.73**
Low/High	21	**-1.01**	21	**-1.14**
Mid/High	6	**-0.31**	7	**-0.40**
Type of school				
Full Primary/Contributing	2	0.08	1	0.06

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

2. Year 8 achievement in science

Overall achievement

Table 3.4 provides the average scale scores, standard deviations and sample sizes for Year 8 students on the two NMSSA science achievement measures.

Table 3.4 Overall measures of science achievement at Year 8

	Knowledge and Communication of Science Ideas	Nature of Science
Average (scale score units)	112	114
SD (scale score units)	19	20
N	1914	698

The average score for Year 8 students on the Knowledge and Communication of Science Ideas measure was 112 scale score units. The middle 50 percent of Year 8 students demonstrated the competencies described for Year 4 students, and were also typically able to:

- Recognise direct relationships between objects or events
- Write short, simple descriptions with a few details
- Create representations using their own rather than science conventions
- Experiment with more specific science vocabulary although not always accurately
- Demonstrate knowledge of some more abstract science, particularly in familiar contexts
- Read more complex and less familiar representations, notice some simple patterns in data, and make basic inferences from these.

Year 8 students achieved an average of 114 scale score units on the Nature of Science measure. The middle 50 percent of Year 8 students were competent in the areas described earlier for Year 4 students, and typically were also able to show some of the following competencies:

- Demonstrate that they could manipulate scientific equipment to explain science understandings, use scientific vocabulary, and explain the science ideas from hands-on inquiry
- Ask questions that show careful observation and require explanation, explore their observations, recognising the wider context an investigation sits in, and identify some aspects of how to conduct an investigation
- Recognise that scientists test ideas by collecting evidence, that their explanations are supported by evidence, and that scientists can change their ideas
- Use their science understandings to share ideas about environmental issues and explain how a proposed action would help the environment.

Table 3.5 shows how Year 8 students performed against the curriculum on the two NMSSA science assessments. Student achievement was distributed across the curriculum levels, with over 65 percent of students achieving at Emerging and Developed Level 3 and 4, and about a third of students at Developed Level 1 and 2. The Developed Level 3 and 4 band represents the curriculum expectation for Year 8 students at the end of the year.

Table 3.5 Percentage of Year 8 students achieving across science curriculum levels

	Knowledge and Communication of Science Ideas	Nature of Science
	%	%
Developed Level 3 and 4 and above	19	21
Emerging Level 3 and 4	47	44
Developed Level 1 and 2	32	34
Emerging Level 1 and 2	2	1

Year 8 Achievement by subgroup

Figures 3.5 and 3.6 display the achievement results for key population subgroups in Year 8 on the two science measures. Box plots are used to show results by gender, ethnicity, school decile and type. The number of students that participated in assessments within each subgroup is provided in Appendix 4.

As was the case at Year 4, the pattern of achievement at Year 8 was similar for key population subgroups across both science measures. Across both measures, Māori and Pasifika students scored lower, on average, than non-Māori and non-Pasifika students respectively. Similarly, students attending low decile schools scored lower, on average, than those from mid or high decile schools. No gender differences were apparent at Year 8 on either measure. In contrast, for the first time in 2010, the TIMSS study showed higher average science achievement for boys than for girls at Year 9 (TIMSS 2010/11). Further investigation of this finding is required to determine if a genuine difference is emerging.

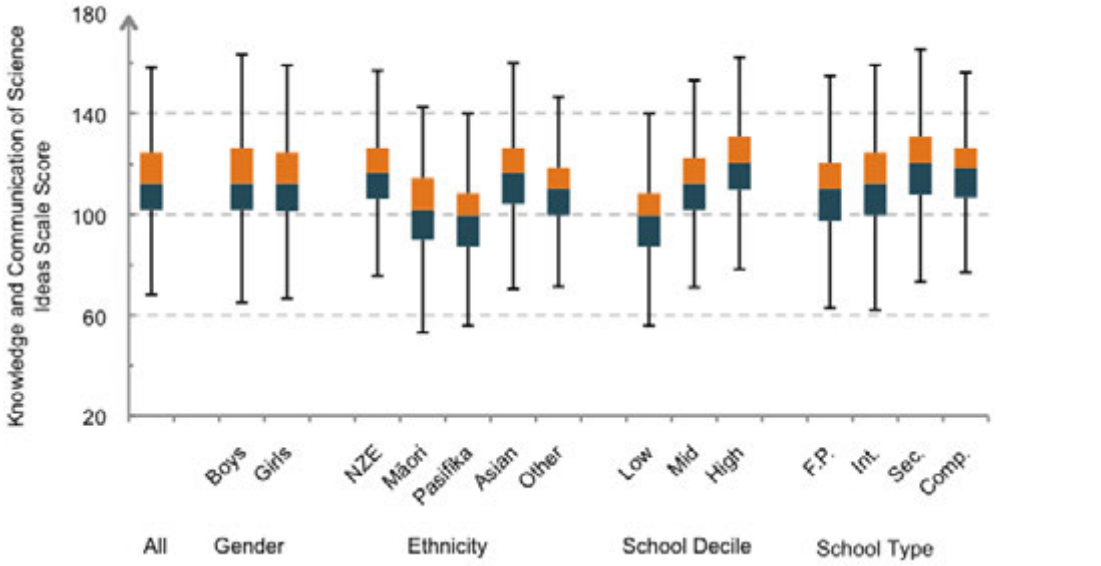


Figure 3.5 Year 8 student scores for Knowledge and Communication of Science Ideas by gender, ethnicity, school decile and type of school (NZE=NZ European, F.P.=Full Primary, Int.=Intermediate, Sec.=Secondary, Comp.=Composite)

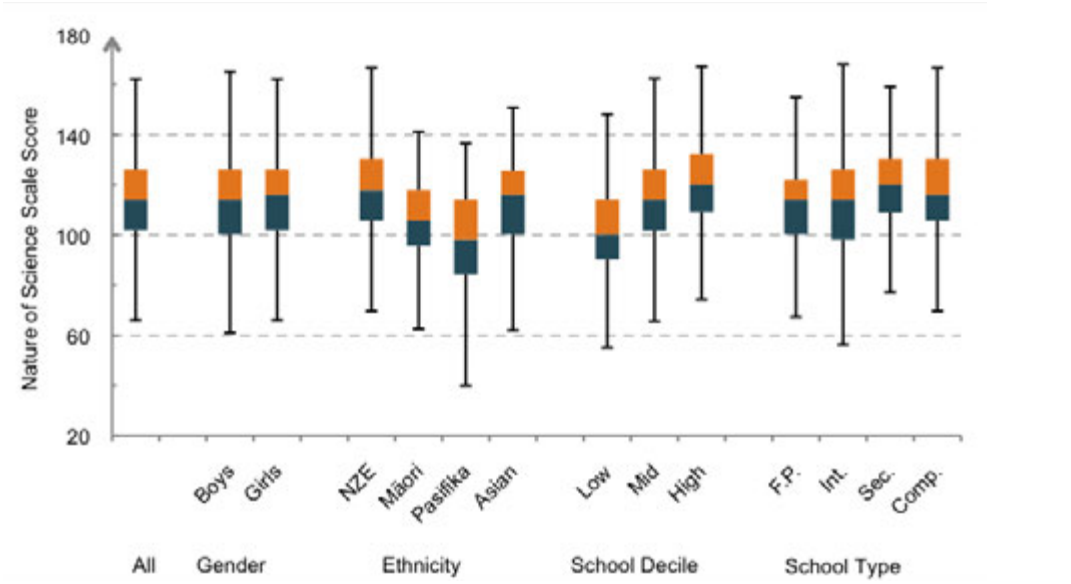


Figure 3.6 Year 8 student scores for Nature of Science by gender, ethnicity, school decile and type (NZE=NZ European, F.P.=Full Primary, Int.=Intermediate, Sec.=Secondary, Comp.=Composite)

Note: The 'Other' ethnic group is not shown for Nature of Science because the sample size was too small.

Figures 3.7 and 3.8 display the differences in average scale scores between the subgroups, illustrating their relative effect sizes on the two science measures. Table 3.6, on the following page, summarises the subgroup information, showing differences in average scale scores between subgroups and their effect sizes, on the two science measures. Full tables of means, standard deviations, sample sizes, effect sizes and 95 percent confidence intervals are in Appendix 4.

Across both measures, Year 8 students from low decile schools scored, on average, about 21 scale points lower than those from high decile schools (an effect size of approximately 1.0). Differences between low and mid decile groups were still considerable with an effect size of about 0.70, while those between mid and high decile groups were smaller with an effect size of about 0.40.

The difference on both scales between Pasifika and non-Pasifika was the largest across the ethnic groups, with an effect size of around 0.80. Scale score differences between NZ European and non-NZ European, and between Māori and non-Māori were smaller with an effect size of about 0.60 for both groups. Achievement of Māori and Pasifika students by decile group is discussed in Chapters 5 and 6.

The pattern of results for the different subgroups at Year 8 is similar to that for the corresponding groups at Year 4. At Year 8 the small difference between the average scores recorded for boys and girls is not statistically significant on either measure.

The average scores for Māori and Pasifika students are lower on both measures compared to non-Māori and non-Pasifika students, as are the average scores for students in low decile schools.

It is important to note that differences between ethnic groups may be confounded with decile differences and with the non-Māori group including Pasifika students who scored lower than Māori. This issue is discussed further in part 3 of this chapter and in Chapters 5 and 6.

The results by type of school indicate that Year 8 students at secondary schools scored higher, on average, than students at full primary or intermediate schools. The results in this study may be due to over three quarters of the secondary schools being high decile and the remainder mid decile. This contrasts with about 60 percent of intermediate schools being mid decile, 24 percent being high decile and 15 percent low decile; and full primary schools falling evenly across all three decile groups. Differences in achievement between full primary and intermediate schools were smaller and varied across the different measures. This confounding of school type and decile means that we should be very cautious about drawing any definitive conclusions about achievement with respect to school type.

The findings indicate that the increasing disparities between the school decile and ethnicity subgroups found in NEMP from 1995 or 1999 to 2007 are continuing to increase. The decreasing disparity between boys and girls found in NEMP over the same period has continued to decline. Apart from the gender difference noted earlier, the pattern of results for these subgroups is generally consistent with the TIMSS 2010/2011 Year 9 science results.

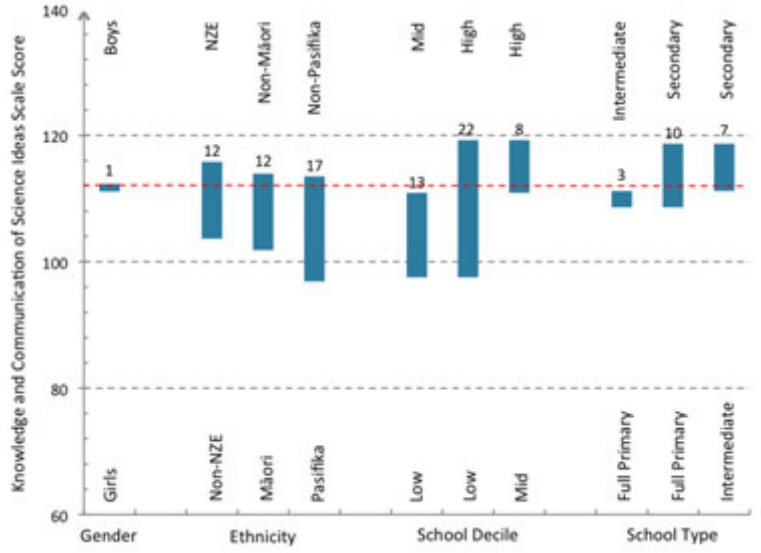


Figure 3.7 Year 8 students: Difference in average scores for Knowledge and Communication of Science Ideas by subgroup (NZE=NZ European)

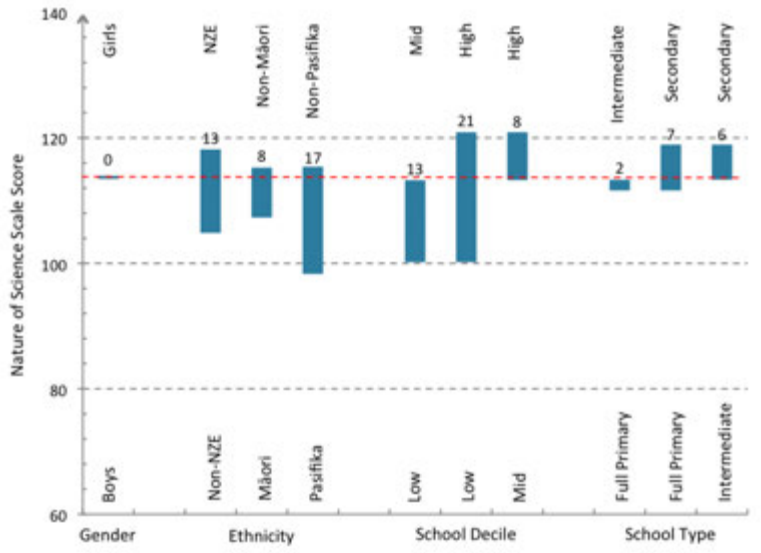


Figure 3.8 Year 8 students: Difference in average scores for Nature of Science (NZE=NZ European)

Table 3.6 Year 8: Subgroup difference on science achievement

	Knowledge and Communication of Science Ideas		Nature of Science	
	Scale score differences	Effect size	Scale score differences	Effect size
Gender				
Boys/Girls	1	0.06	0	-0.02
Ethnicity				
NZ European/Non-NZ European	12	**0.65**	13	**0.68**
Māori/Non-Māori	12	**-0.66**	8	**-0.42**
Pasifika/Non-Pasifika	17	**-0.87**	17	**-0.83**
School Decile				
Low/Mid	13	**-0.75**	13	**-0.68**
Low/High	21	**-1.25**	21	**-1.08**
Mid/High	8	**-0.48**	8	**-0.41**
Type of School				
Full Primary/Contributing	2	**-0.14**	1	-0.09
Full Primary/Secondary	10	**-0.54**	7	**-0.38**
Intermediate/Secondary	8	**-0.40**	6	**-0.29**

Note: 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 very important factors associated with science achievement and that there is a complex interaction between them. Larger proportions of Māori and Pasifika students attend lower decile schools than NZ European students (see Chapters 5 and 6 respectively). Two-way analyses of variance (ANOVA) with Scheffe post hoc analyses were undertaken using prioritised ethnicity groups (NZ European, Māori and Pasifika) that removed the conflation of multiple ethnicities that were used in the findings in the previous sections. The results are summarised in Appendix 5.

The results showed that both ethnicity and decile were significant factors. At both Year 4 and Year 8 and for both science measures, the differences between low, mid and high decile schools, and between NZ Europena, Māori and Pasifika students were statistically significant (at p< .000 for all but two comparisons). This was similar to the findings for NMSSA Writing (2012).

To examine the effect of ethnicity by controlling for school decile, a one-way ANOVA for students from decile 1 schools (where there was a sufficient number of students in each ethnic group) showed that statistically significant effects persisted (p< .000). This contrasts with the findings for NMSSA Writing (2012) where there were no statistically significant differences between NZ European, Māori and Pasifika students in writing achievement.

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 3.9 and 3.10 show the distribution of Year 4 and Year 8 students on the Knowledge and Communication of Science Ideas, and the Nature of Science scales respectively. As expected, Year 8 students achieved higher scores, on average, than Year 4 students. However, 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.

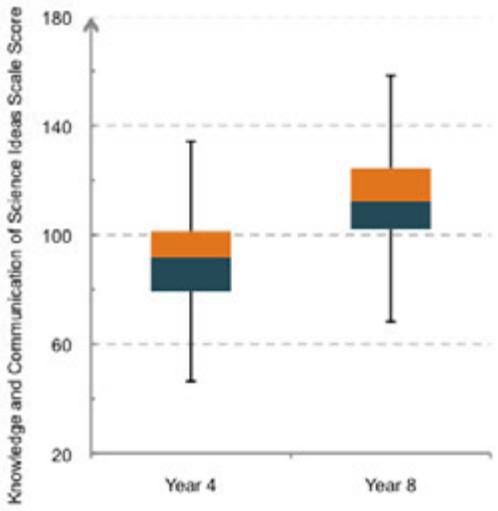


Figure 3.9 Student achievement for Knowledge and Communication of Science Ideas

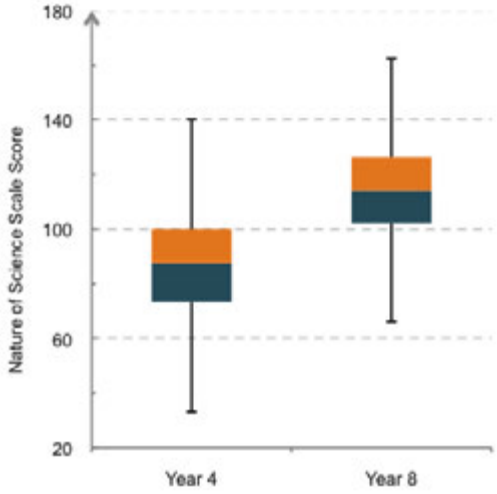


Figure 3.10 Student achievement for Nature of Science

This overlap in achievement is illustrated for each science scale against the curriculum levels in Figures 3.11 and 3.12[15]. The figures show that the average scale score for Year 4 students sits within the Developed Level 1 and 2 band while for Year 8 students it falls within Emerging Level 3 and 4 band. The results for Year 4 students are in line with the NZC end-of-year expectations. However, those for Year 8 are below the end-of-year curriculum expectations for this level.

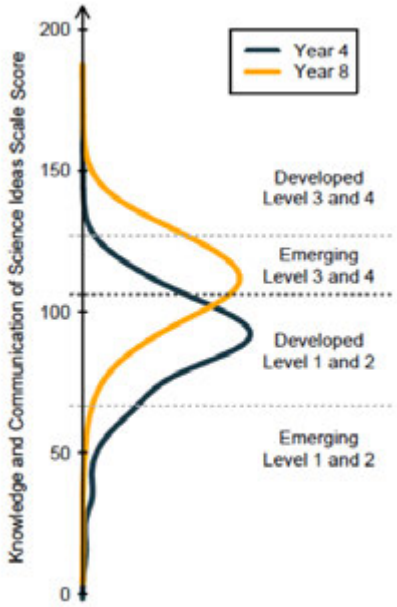


Figure 3.11 Distribution of achievement on Knowledge and Communication of Science Ideas against level of the science curriculum

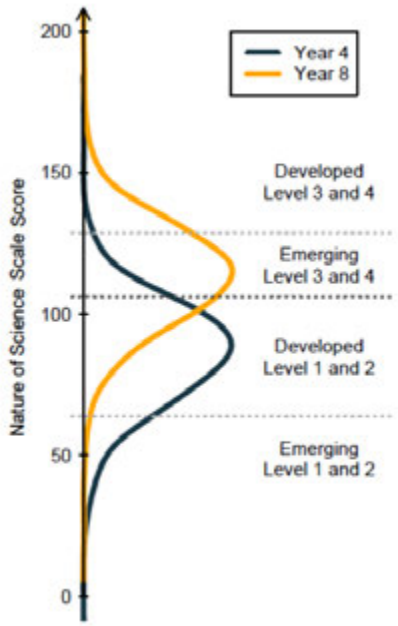


Figure 3.12 Distribution of achievement on Nature of Science against level of the science curriculum

[15] Figures are smoothed versions of the data

Table 3.7 shows the averages and standard deviations for both science measures along with the differences in average scores between Year 4 and Year 8 expressed in scale score units and as effect sizes for the four year difference and as an average effect size per year. The differences between the average score for Year 4 and Year 8 students on both measures were similar: 24 scale points for Knowledge and Communication of Science Ideas, and 28 scale points for Nature of Science. Both these differences represent an effect size of about 1.2 to 1.4 and an average annual effect size of 0.30 to 0.34.

Table 3.7 Overall measures of Science achievement and difference of achievement by year level

	Knowledge and Communication of Science Ideas		Nature of Science	
	Year 4	Year 8	Year 4	Year 8
Average (scale score units)	88	112	86	114
SD (scale score units)	21	19	20	20
N	2076	1914	711	698
Year 8/Year 4 difference	24		28	
Effect size	**1.18**		**1.37**	
Annual average effect size	0.30		0.34	

Subgroup achievement between Year 4 and Year 8

Table 3.8 displays for gender, decile and ethnic groups, the Year 4 and Year 8 average scores on Knowledge and Communication of Science Ideas, the differences between them in scale score units and the effect sizes related to the differences. Full tables of means, standard deviations, sample sizes and effect sizes are in Appendix 4.

The 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.

On average, the difference in scores for boys between Year 4 and Year 8 was greater than that for girls.

Differences between NZ European, Māori, and Pasifika at Year 4 were notable and remained so at Year 8. Pasifika and NZ European students appear to have made a similar amount of progress between year levels. However, Māori students did not progress as much as NZ European students between Year 4 and Year 8.

The difference in average achievement between Year 4 and Year 8 for low, mid and high decile groups is broadly similar. However, the notable differences in average achievement between these groups at Year 4 remain at Year 8.

All effect sizes in Table 3.8 lie between 1.0 and 1.4 showing average annual effect sizes between 0.27 and 0.35. In comparing the effect sizes between subgroups, students in high decile schools showed significantly greater progress than those in low decile schools (confidence intervals overlapped by 0.03); boys showed significantly more progress than girls (the confidence intervals overlap by 0.01); and NZ European students showed significantly more progress than Māori students (the confidence intervals overlap by 0.01).

Table 3.8 – Differences in science achievement between Year 4 and Year 8 by subgroup[16]

	Knowledge and Communication of Science Ideas				
	Year 4 average (scale score units)	Year 8 average (scale score units)	Score difference (scale score units)	Effect size[16]	Average annual effect size
Gender					
Boys	87	112	25	**1.26**	0.32
Girls	90	111	21	**1.09**	0.27
Ethnicity					
NZ European	93	116	23	**1.27**	0.32
Māori	81	102	21	**1.07**	0.27
Pasifika	73	97	24	**1.17**	0.29
School Decile					
Low	74	98	24	**1.17**	0.29
Mid	89	111	22	**1.20**	0.30
High	95	119	24	**1.38**	0.35

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

[16] Effect sizes for this table are calculated as Mean $_{\text{Year 8}}$ – Mean $_{\text{Year 4}}$

4

Understanding Achievement in Science

Understanding factors that impact on students' achievement is an important aspect of NMSSA. As described in Chapter 2, the NMSSA science assessment programme used student and teacher questionnaires to collect data focused on a number of contextual factors. The questionnaires included sections related to:

- student attitude to science
- the amount of English spoken at home
- the opportunities to learn science at school
- the organisation of science teaching in the school
- teachers' attitudes and confidence regarding the teaching of science
- professional support and development for teachers in science.

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

Understanding achievement in science – an overview

Overall, students at Year 4 reported a more positive attitude to science than at Year 8, which is consistent with the findings from NEMP and TIMSS. Moreover, NEMP (2007) found that Year 8 students were significantly less engaged in science than they had been in previous years.

Attitude to science was related to achievement particularly for students with low Attitude to Science scores and was stronger at Year 8 than Year 4.

Students who always spoke English at home were more likely to achieve at a higher level at both Year 4 and Year 8 than students who spoke English sometimes or never. This difference held for both group-administered and individual assessments.

There appear to be very few opportunities for hands-on science activities such as doing science experiments or using specialist science equipment. Year 4 and Year 8 students reported that they most frequently accessed science information by listening to their teachers, followed by independently accessing information or using information from their family and whānau. Teacher reports of activities were similar to those of students, however teachers and Year 8 students reported fewer trips outside of school than Year 4 students. It is possible that students at Year 4 interpret 'trips outside school' more broadly than either their teachers or students at Year 8.

Most teachers who responded to the questionnaire reported that they were responsible for teaching science to their class, although at Year 8 specialist science teachers were available. Although the majority of teachers at both Year 4 and Year 8 liked teaching science, smaller proportions of teachers at both year levels felt happy about their teaching or confident in their ability to teach science, particularly to a diverse group of students. This lack of confidence mirrored reports of somewhat low levels of professional support within schools and limited access to targeted professional development. This finding reflects that reported in TIMSS, and presents a less positive picture of professional confidence and support than was found for NMSSA writing in 2012[17].

These findings are generally consistent with those of the Education Review Office's (2012)[18] evaluation of science teaching and learning in Years 5 to 8 and would support ERO's recommendations that the MoE investigates opportunities for support and ongoing professional learning and development for teachers, and that schools give priority to science teaching and learning in the curriculum, and to the quality of science teaching and learning.

[17] National Monitoring Study of Student Achievement, Writing 2012, Educational Assessment Research Unit, Otago University and the New Zealand Council for Educational Research

[18] http://www.ero.govt.nz/National-Reports/Science-in-The-New-Zealand-Curriculum-Years-5-to-8-May-2012/

1. Year 4 and Year 8 attitude to science

Students develop important attitudes and beliefs about science and their ability as science learners. A section of the NMSSA student questionnaire focused on students' attitudes to learning science. This included their sense of self-efficacy in science and engagement as science learners. An IRT scale was developed to measure the overall strength of each student's response to the section on attitudes. Chapter 2 describes this section of the questionnaire and the Attitude to Science scale in more detail.

Figure 4.1 displays the distribution of scale scores on the Attitude to Science measure for Year 4 and Year 8 students. Scores, on average, become less positive between Year 4 and Year 8. The scores varied a similar amount within each year level.

Table 4.1 shows the average Attitude to Science scale score and standard deviation for each year level. The average scale score is 16 scale score units lower in Year 8 than Year 4. This decline in the average scores represents an effect size of –0.77 and is consistent with findings reported in other studies (for example, TIMSS, 2011/12).

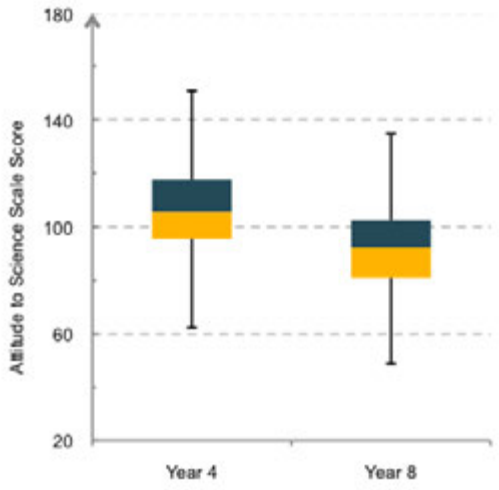


Figure 4.1 Year 4 and Year 8 student scale scores for Attitude to Science

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

	Year 4	Year 8
Average (scale score units)	108	92
SD (scale score units)	22	18
N	2054	1984
Effect Size	**– 0.77**	

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 score is 5 scale score units lower than the boys' at Year 8, indicating that the decline in attitudes between Year 4 and Year 8 is significantly greater for girls than for boys.

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

	Boys		Girls	
	Year 4	Year 8	Year 4	Year 8
Average (scale score units)	107	95	108	90
SD (scale score units)	24	18	20	17
N	1026	987	1028	997
Difference in average	12		18	
Effect Size	**– 0.60**		**– 0.98**	

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

Figures 4.2 and 4.3 display the Attitude to Science results by subgroup for Year 4 and Year 8 respectively. The subgroups shown relate to gender, ethnicity[19], school decile[20] and type of school[21]. The number of students that completed the Attitude to Science section of the questionnaire within each subgroup can be seen in Appendix 4.

At Year 4, the score distributions were fairly similar for each of the subgroups. At Year 8, however, some subgroups did record higher average attitude scores than others. For instance, as already reported, boys on average, scored higher than girls (effect size = 0.28) and Asian students, on average, scored higher than students from any of the other ethnic groups.

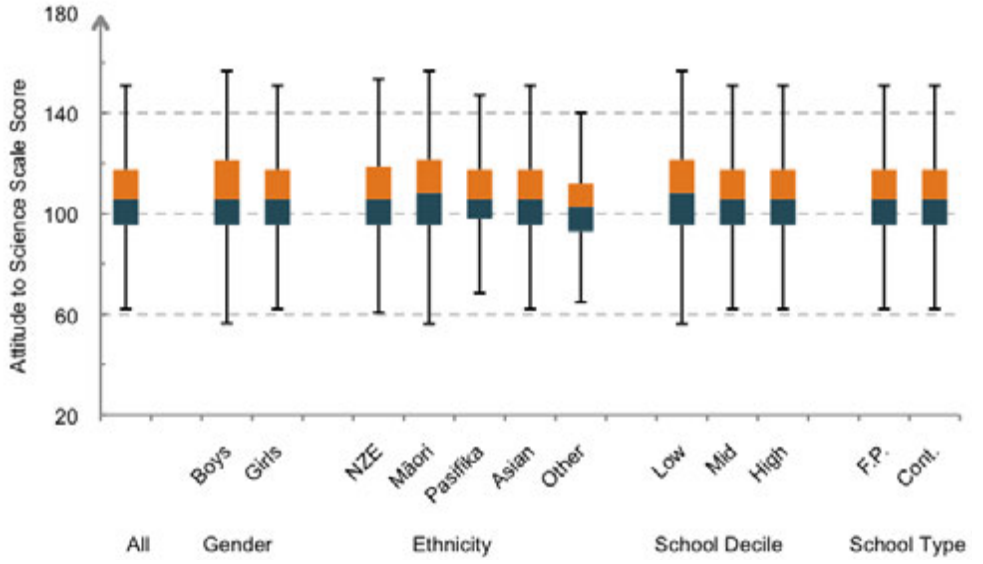


Figure 4.2 Year 4 student Attitude to Science scores by gender, ethnicity, school decile and type (NZE=NZ European, F.P.=Full Primary, Cont. = Contributing)

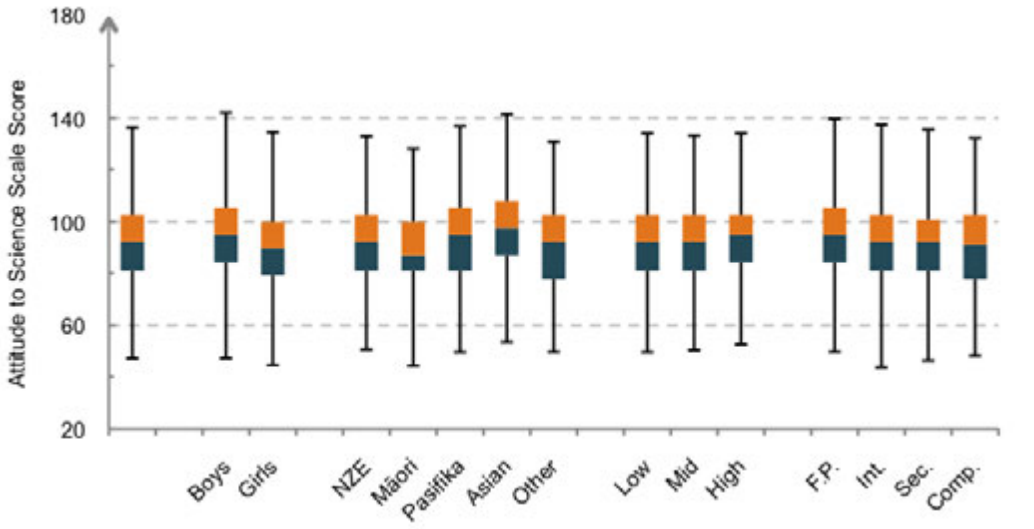


Figure 4.3 Year 8 student Attitude to Science scores by gender, ethnicity, school decile and type (NZE=NZ European, F.P.=Full Primary, Int.=Intermediate, Sec.=Secondary, Comp.=Composite)

[19] Students could identify with up to three ethnic groups and could therefore be present in multiple ethnic groups. Student ethnicity data was obtained from student NSN information held on the Ministry of Education ENROL database.

[20] 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)

[21] 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 science and science achievement

Table 4.3 shows the relationship between attitude to science and science achievement using the Pearson product-moment correlation coefficient (r). Although the relationship between attitude to science and science achievement was generally not high, it was stronger at Year 8 than at Year 4.

Table 4.3 Correlation (r) between attitude to science and science achievement at Year 4 and Year 8

	Knowledge and Communication of Science Ideas (r)	Nature of Science (r)
Year 4	0.15	0.15
Year 8	0.28	0.24

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

On both science achievement measures and at both year levels students who reported a more positive attitude to science, on average, had higher achievement scores.

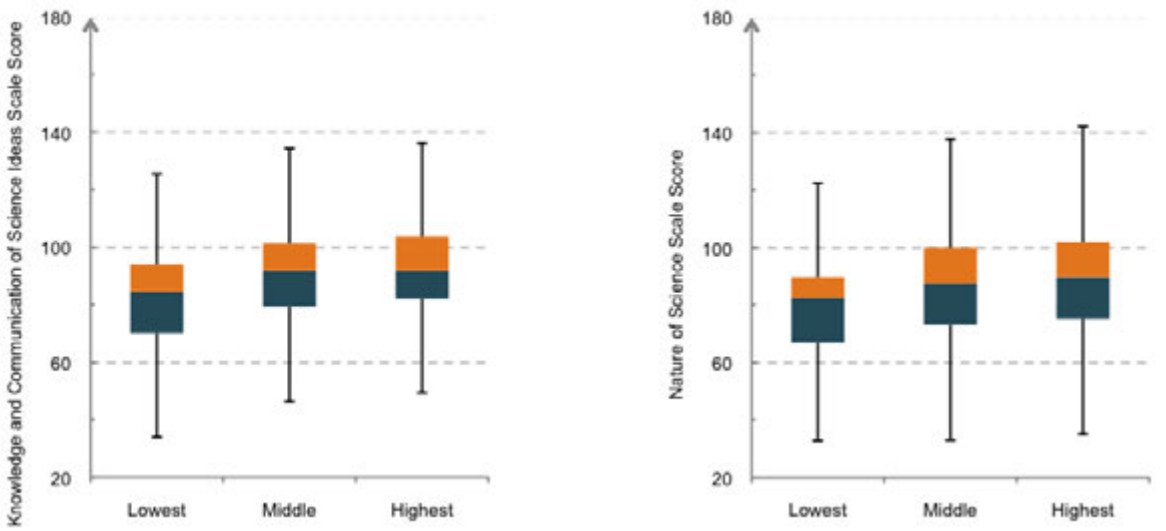


Figure 4.4 Year 4 student science achievement scores by level of Attitude to Science

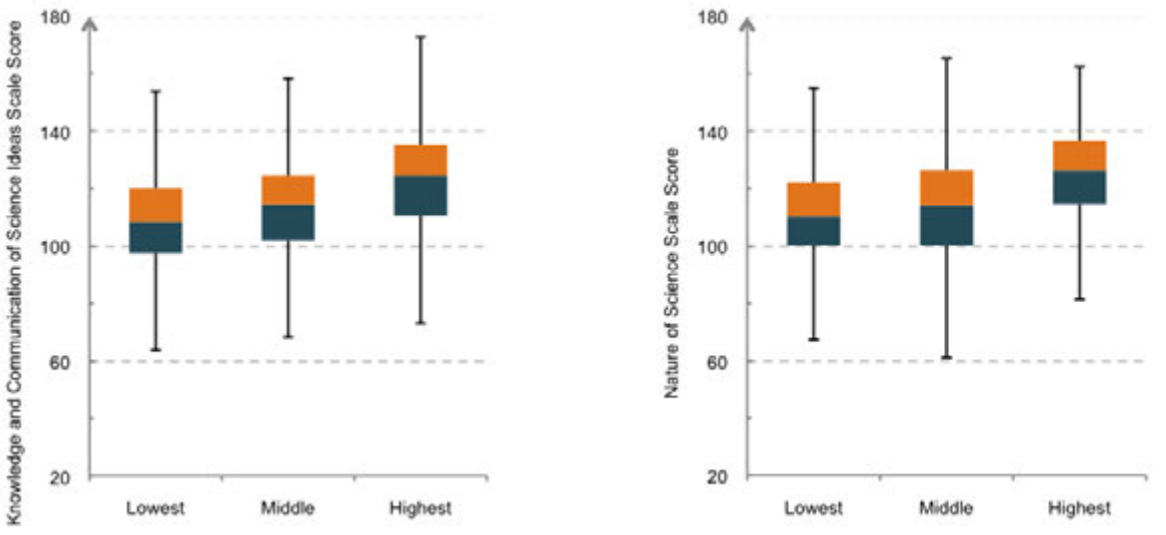


Figure 4.5 Year 8 student science achievement scores by level of Attitude to Science

Tables 4.4 and 4.5 show the differences in average achievement between the three Attitude to Science score groups on the two science measures. An effect size related to each difference is also reported. On Knowledge and Communication of Science Ideas, the difference in average achievement scores between the highest attitude group and the lowest group is significantly greater at Year 8 than at Year 4. The full tables of means, standard deviations, sample sizes, effect sizes and 95 percent confidence intervals are in Appendix 4.

Table 4.4 - Year 4 students: Differences on science achievement by level of Attitude to Science

	Knowledge and Communication of Science Ideas		Nature of Science	
	Scale score difference	Effect size	Scale score difference	Effect size
Year 4				
Middle/Lowest	8	**0.38**	6	**0.34**
Highest/Lowest	10	**0.50**	9	**0.48**
Highest/Middle	2	**0.12**	3	-0.14

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

Table 4.5 - Year 8 students: Differences on science achievement by level of Attitude to Science

	Knowledge and Communication of Science Ideas		Nature of Science	
	Scale score difference	Effect size	Scale score difference	Effect size
Year 8				
Middle/Lowest	6	**0.31**	3	0.12
Highest/Lowest	15	**0.81**	13	**0.72**
Highest/Middle	9	**0.49**	10	**0.53**

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

2. English spoken at home

NMSSA monitors achievement in schools where English is the medium of instruction. Some students in these schools, however, speak other languages besides English or come from homes where other languages are spoken. The questionnaire asked students how often they spoke English at home. Table 4.6 shows how the students responded.

Table 4.6 - Year 4 and Year 8 student frequency of speaking English at home

	Year 4	Year 8
	%	%
Always	67	80
Often	21	15
Sometimes/never	12	5

Figures 4.6 and 4.7 display the distributions of science achievement scores for Year 4 and Year 8 students according to their responses to the question regarding English spoken at home. On average, students in both year levels who reported they sometimes or never spoke English at home scored at a lower level on the two science achievement measures than students who reported speaking English at home always or often.

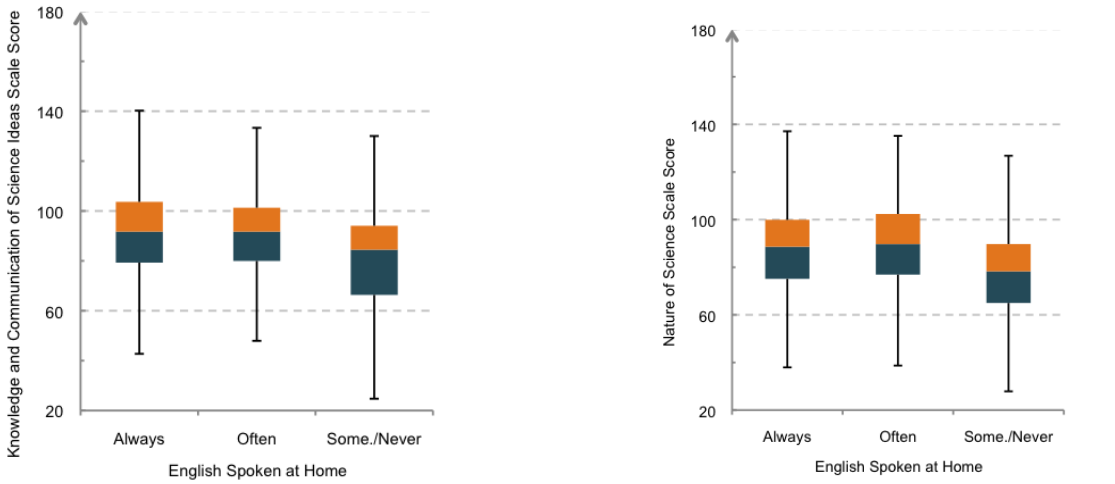


Figure 4.6 Year 4 student science achievement scores by amount of English spoken at home (Some.=Sometimes)

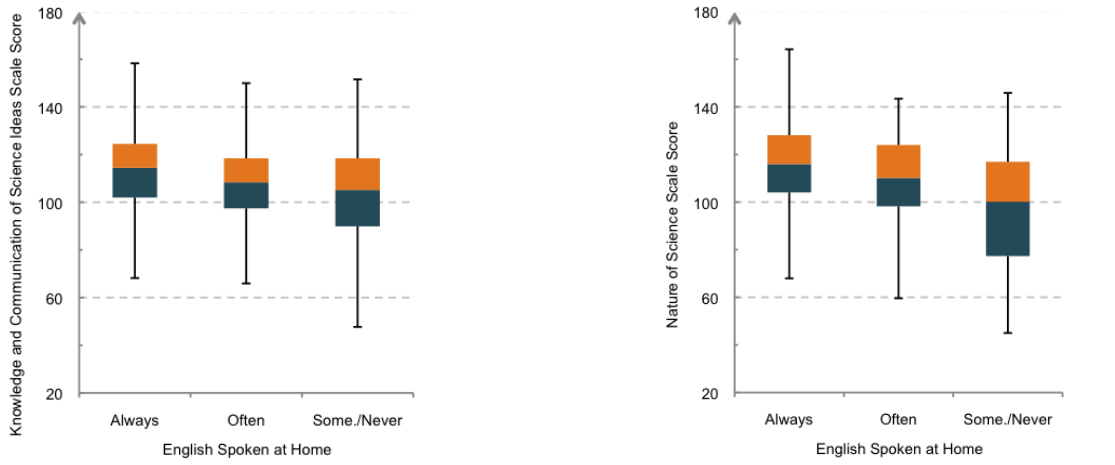


Figure 4.7 Year 8 student science achievement scores by amount of English spoken at home (Some.=Sometimes)

Tables 4.7 and 4.8 show the differences in average scale scores for Year 4 and Year 8 students who reported different levels of English spoken at home. These differences are also shown as effect sizes. The difference between speaking English at home always compared to often was significantly greater at Year 8 than Year 4 (no overlap in confidence intervals for these two effect sizes).

Table 4.7 Year 4 students: Differences in science achievement by how often English is spoken at home

	Knowledge and Communication of Science Ideas		Nature of Science	
	Scale score difference	Effect size	Scale score difference	Effect size
English Spoken at Home				
Always/Often	0	0.00	1	– 0.09
Always/Sometimes-never	10	**0.45**	10	**0.46**
Often/Sometimes-never	10	**0.44**	11	**0.54**

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

Table 4.8 Year 8 students: Differences in science achievement by how often English is spoken at home

	Knowledge and Communication of Science Ideas		Nature of Science	
	Scale score difference	Effect size	Scale score difference	Effect size
English Spoken at Home				
Always/Often	6	**0.35**	7	**0.34**
Always/Sometimes-never	10	**0.48**	17	**0.76**
Often/Sometimes-never	4	0.15	10	**0.42**

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

3. Opportunities to learn science at school

A section of the student questionnaire asked students to rate how frequently they were involved in a range of science learning experiences at school. It should be noted that in many New Zealand primary and intermediate schools science is often addressed in topic studies or as part of inquiry learning. Because of this, some students may not always recognise when science is the focus for learning. There is the potential, therefore, for students to under-report the amount of science they do in school.

Figures 4.8 and 4.9 show how frequently students in Year 4 and Year 8 reported being involved in a range of science activities. Overall, Year 4 students reported more frequent involvement in science activities at school than Year 8 students. The activities most often rated as highly frequent at both year levels were listening to their teacher talk about science, finding information by themselves, and using what they have learned from their family/whānau. Year 4 students reported more frequent trips outside of school to learn more about science than Year 8.

However, it is possible that students at Year 4 interpret 'trips outside school' more broadly than either their teachers or students at Year 8. Year 8 students reported using special science equipment and doing experiments more often and entering science competitions less often than Year 4 students.

At both year levels, and particularly at Year 8, the findings suggest that students see a large part of their science experiences as retrieving or receiving factual information, rather than investigating their own questions or applying science to issues of concern to them. It may be that students need to experience more opportunities in the latter two activities if they are to achieve the goal described in the essence statement for science in the NZC of being able to "participate as critical, informed and responsive citizens in a society in which science plays a significant part"[22].

[22] NZC, page 17

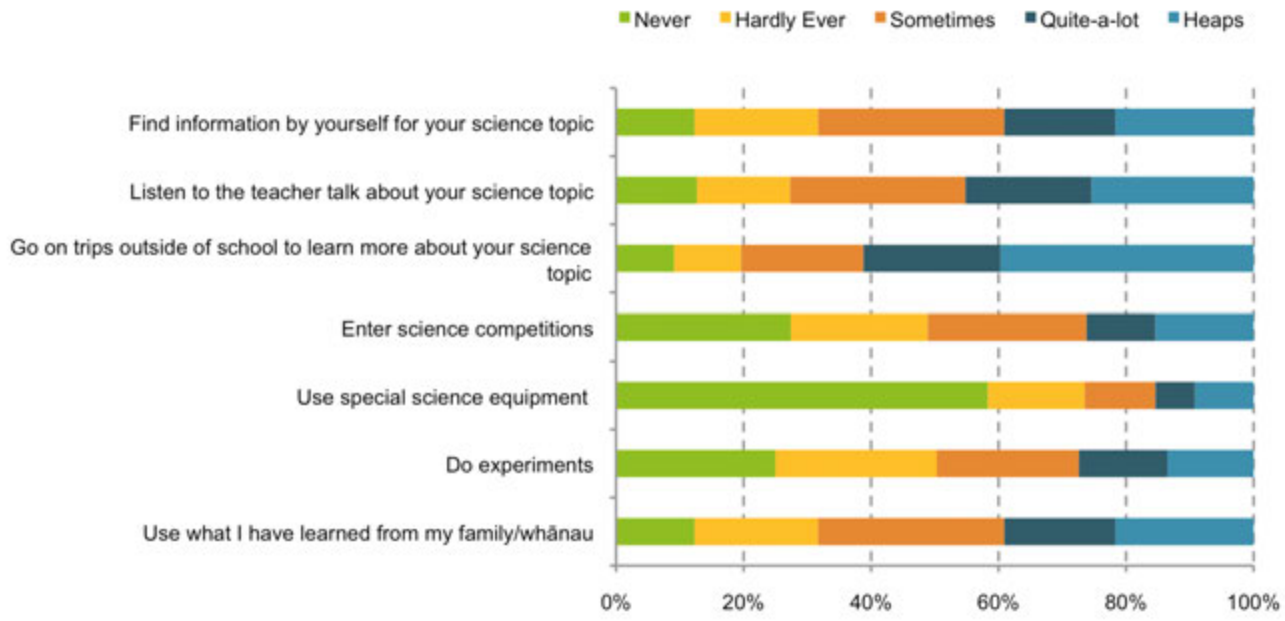


Figure 4.8 Frequency of science activities reported by Year 4 students

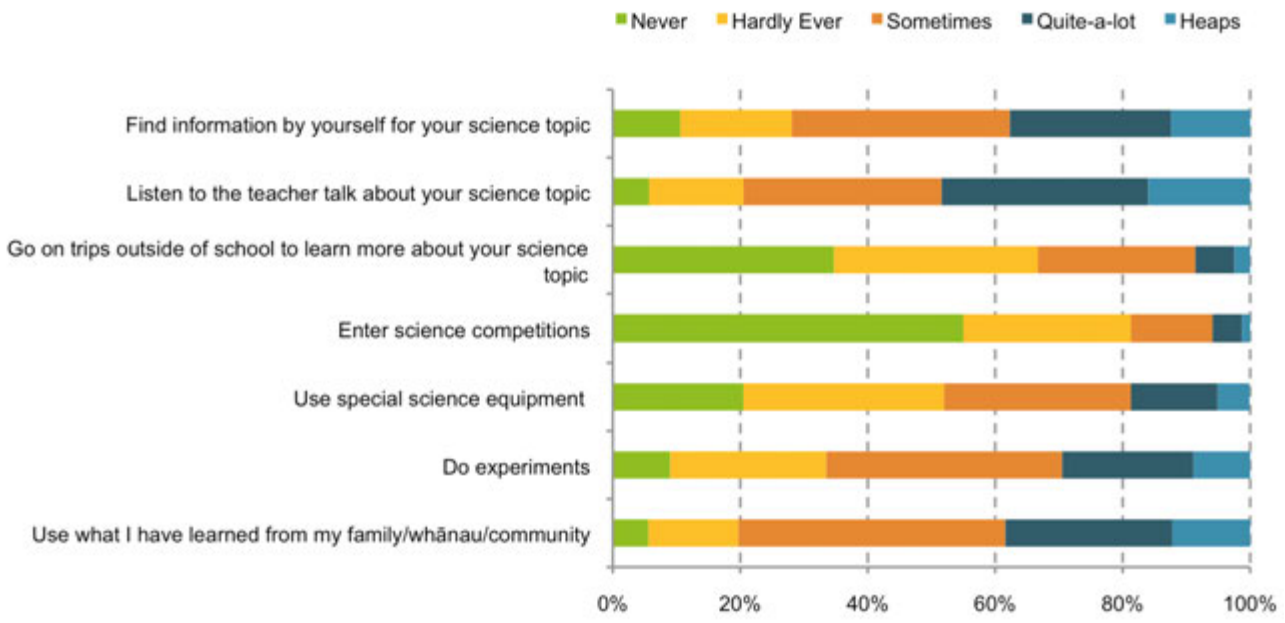


Figure 4.9 Frequency of science activities reported by Year 8 students

4. Teaching science at Year 4 and Year 8

Up to two teachers per school were asked to complete a questionnaire about the teaching of science at Year 4 or Year 8. Where one existed, the specialist teacher of science completed one of the questionnaires. At Year 4, 186 teachers completed the questionnaire (2 specialists) and at Year 8 the number was 123 (37 specialists).

Teaching Science

The first section of the questionnaire asked the teachers some general questions about their science teaching. Table 4.9 shows the percentage of teachers who responded "Yes" to each of the questions. About a quarter of teachers at Year 4 reported that they had syndicate or school leadership responsibility for science. The figure at Year 8 was greater at 41 percent. However, only 10 percent of teachers at Year 4 and 21 percent of teachers at Year 8 had specialist qualifications in science. Support in the classroom was received from a wide variety of sources. However, no one source was involved in more than 16 percent of classrooms. Most often the support was from a teacher aide, another teacher, or people from the community.

Table 4.9 Year 4 and 8 teaching of science

Question	Percentage answering yes	
	Year 4 (%)	Year 8
	%	%
Do you personally have syndicate or school leadership responsibility for science?	23	41
Do you have specialist qualifications in science?	10	21
Do any of the following people help in the classroom with science?		
Teacher aide	16	11
Parent(s)/whānau	6	5
People from the community	9	10
Peers	7	6
Another teacher	12	10
Science specialist	4	6
Senior students in the school or tuakana/teina relationships	4	2

Teacher attitudes and confidence in science teaching

Figure 4.10 shows the percentage of teachers who either strongly agreed or agreed with statements involving their attitude to teaching science. Overall, at both year levels, teachers responded reasonably positively regarding their enjoyment of science and how much they liked teaching it. They were less positive about how happy they were with the way they taught science and their confidence as science teachers, including their confidence to teach a diverse range of students. Teachers at Year 4 were generally less positive than those at Year 8, possibly reflecting the greater number of responses from specialist teachers in Year 8.

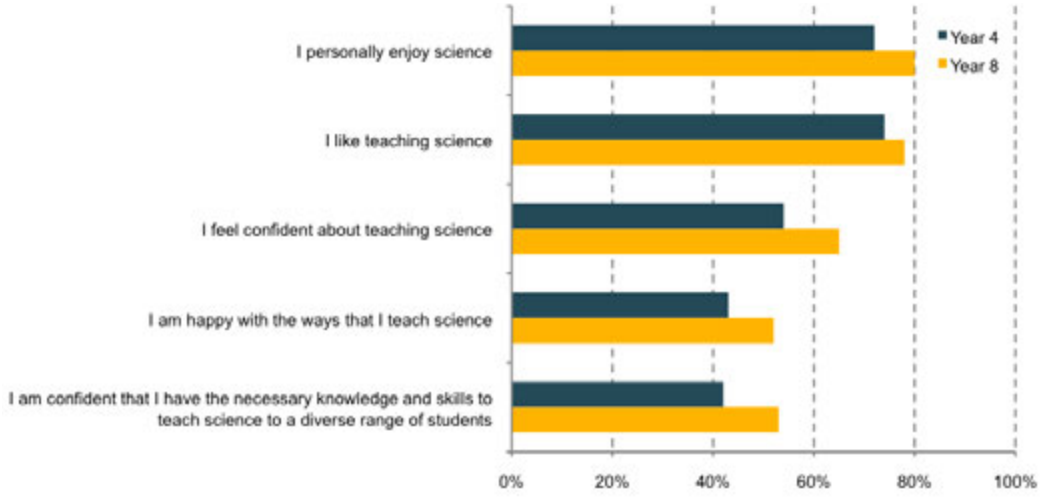


Figure 4.10 Percentage of Year 4 and Year 8 teachers who 'strongly agree' or 'agree' with statements about science

Science activities provided by teachers in the classroom

Teachers were asked to report how frequently students in their class were involved in a range of opportunities to learn science. As noted above, in many primary schools science is included as a topic study or an inquiry. Science, therefore, may be planned as a block of work during a term or even once a year. This differs from learning areas such as mathematics where teaching generally occurs daily. This should be kept in mind when interpreting the frequency of the different activities described.

Figures 4.11 and 4.12, on the following page, present the teachers' responses. As might be expected, at both year levels, the activities that were least likely to occur once a month or more were taking part in organised science fairs, having experts/visitors in the classroom, and going outside school to find out about science ideas. The activities that were most often reported as happening frequently at both year levels were accessing science information independently and accessing information through the teacher. Year 4 and Year 8 teachers reported similar frequencies for all these activities apart from taking part in science fairs, which Year 4 teachers reported happened less frequently. Differences between the year levels occurred for the opportunities to take part in organised science activities and investigations, and to use "everyday" or specialist science equipment. The year 8 teachers reported that students had more opportunities in all these areas.

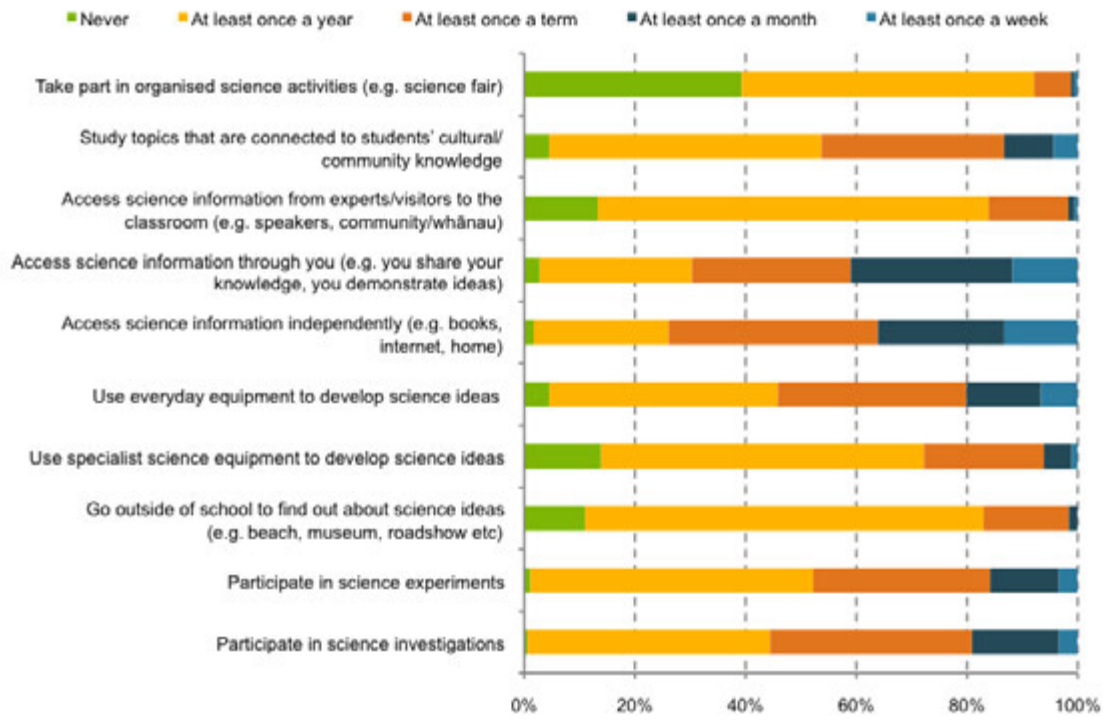


Figure 4.11 Year 4 teacher report of how often their students are involved in science activities

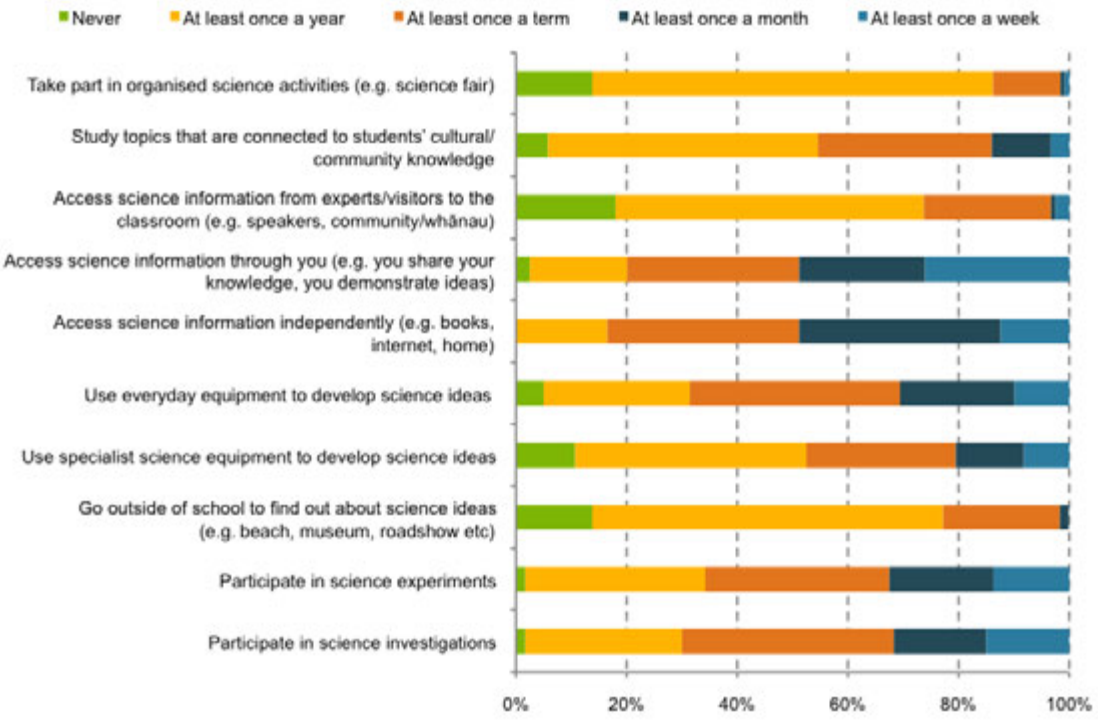


Figure 4.12 Year 8 teacher report of how often their students are involved in science activities

Professional support and development for teachers in science

Figures 4.13 and 4.14 display teachers' reports regarding how often they had different types of interactions with colleagues related to the teaching of science. Most interactions were infrequent, seldom occurring more than once a term. Teachers were least likely to observe a colleague teach science, with a third of, or fewer, teachers doing so once a year and the majority never observing a colleague.

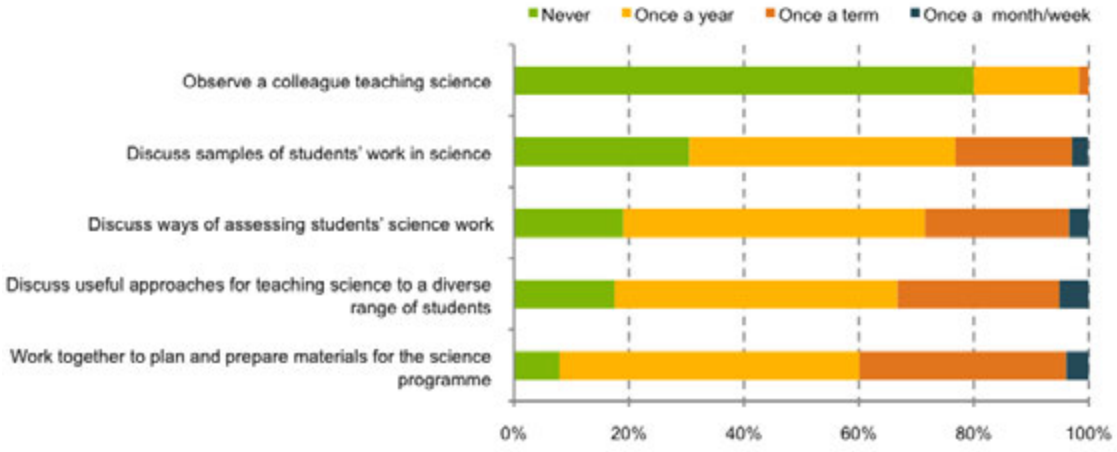


Figure 4.13 Year 4 teacher interactions with colleagues about science

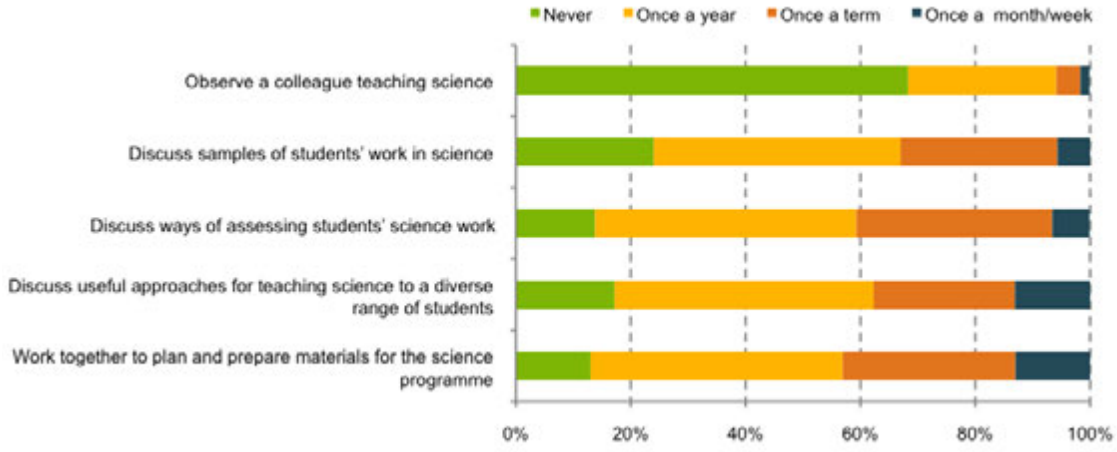


Figure 4.14 Year 8 teacher interactions with colleagues about science

Figure 4.15 displays how recently Year 4 and Year 8 teachers reported receiving science professional learning and development (PLD). The figure shows that just over one third of Year 4 and Year 8 teachers had received science PLD in the last two years. For 25 percent of Year 4 teachers and 20 percent of Year 8 teachers, their most recent science PLD was more than five years ago. About a fifth of teachers at each year level reported never having received science PLD. TIMSS also reported low rates of professional development for New Zealand teachers in comparison to the international average.

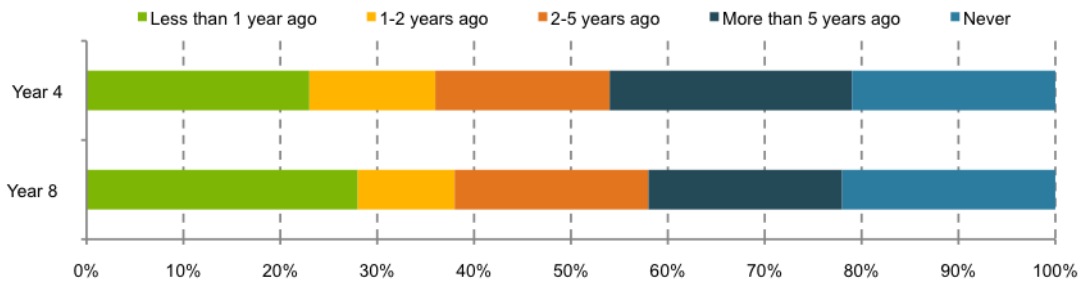


Figure 4.15 Year 4 and Year 8 teacher science professional development and learning

5

Māori Student Achievement in Science

This chapter presents the findings for Māori[23] student achievement in science at Year 4 and Year 8. It looks at the variation of achievement within year levels and presents results against the levels of the science curriculum. It examines the difference in achievement between Year 4 and Year 8, and differences between subgroups of gender, school decile and type of school. It presents a profile of Māori students who scored above the national average at Year 4 and Year 8 with respect to gender and school decile. It also provides information on Māori students' attitudes to science and their experiences of their culture, language and identity at school.

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

Success and achievement of Māori students in science – an overview

Māori students were positive about how their culture, language and identity were valued at their school and were positive in their attitudes to learning science.

While Year 4 and Year 8 Māori students tended to achieve at a lower level than NZ European students (Chapter 3), many features of Māori student achievement followed similar patterns to the national samples. However, the progress between Year 4 and Year 8 was lower for Māori students than for NZ European students and Pasifika students.

Between the year levels, as expected, Year 8 Māori students, on average, achieved higher scores than Year 4 Māori students. However, there was a wide distribution of scores at both year levels and some overlap in the achievement of Year 4 students and Year 8 students.

For both science measures, the average achievement of Year 4 Māori students was within the Developed Curriculum Level 1 and 2. This aligns with the level expectations described in The New Zealand Curriculum. In Year 8 the average achievement was just below the boundary for Emerging Level 3 and 4 for Knowledge and Communication of Science Ideas, and within Emerging Level 3 and 4 for Nature of Science. This is below the expectations described in The New Zealand Curriculum.

For both year levels and both measures of science, achievement, on average, was lower for Māori students from lower decile schools. The achievement in science was similar for boys and girls, and for Year 4 Māori students attending full primary and contributing schools. School type showed less consistent results at Year 8.

While 43 percent of Māori students at Year 4 scored above the national average, fewer Māori students at Year 8 (30 percent) scored above the national average. Boys and girls were equally represented in the above average groups.

Just over 80 percent of all Māori students attended low and mid decile schools. When these figures are accounted for, they show that a greater proportion of Māori students at high decile schools scored above the national average. This reflects the relationship between achievement and school decile that was found for All Students. It also contrasts with just over 50 percent of NZ European students attending low or mid decile schools.

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

1. Year 4 Māori student achievement in science

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

Table 5.1 Overall measures of science achievement for Māori students at Year 4

	Knowledge and Communication of Science Ideas	Nature of Science
Average (scale score units)	81	82
SD (scale score units)	21	17
N	423	148

The average score and the variation within the scores for Māori students on Knowledge and Communication of Science Ideas scale were similar to the results for Nature of Science. This was also the case for the national sample.

At Year 4, the average score for Māori students on the Knowledge and Communication of Science Ideas scale[24] was 81 scale score units and on the Nature of Science scale 82 scale score units. As for all Year 4 students (Chapter 3), these results show that the 50 percent of Year 4 Māori students clustered around the average (the middle 50 percent) typically drew on everyday experiences and observations to answer questions. They were learning how to use scientific vocabulary and to participate in hands-on scientific investigations. Students were beginning to recognise how scientists find things out and to offer their own explanations for investigations.

Table 5.2 sets out the percentage of Year 4 Māori students in each curriculum band for the two science measures. The largest proportion of Year 4 Māori students achieved in the Developed Level 1 and 2 band as did All Students. This band represents the expected level of performance for an average Year 4 student at the end of the school year. However, Year 4 Māori students are distributed across the curriculum bands differently from All Students on the Knowledge and Communication of Science Ideas scale, with a smaller proportion scoring in the Emerging Level 3 and 4 band, and a larger proportion in the Emerging Level 1 and 2 band. On the Nature of Science scale this contrast is less apparent.

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

	Knowledge and Communication of Science Ideas		Nature of Science	
	Māori students (%)	All students (%)	Māori students (%)	All students (%)
Developed Level 3 and 4 and above	-	1	-	1
Emerging Level 3 and 4	8	18	8	11
Developed Level 1 and 2	70	66	79	76
Emerging Level 1 and 2	22	15	13	12

Rounding to integers means that percentages do not always add up to 100 percent.

The curriculum alignment exercise undertaken to link performance on the two science achievement scales to the NZC allows these results to be reported in terms of curriculum expectations (Appendix 3).

[24] See Chapter 2 for details of the science scale descriptions.

2. Year 8 Māori student achievement in science

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

Table 5.3 Overall measures of science achievement for Māori students at Year 8

	Knowledge and Communication of Science Ideas	Nature of Science
Average (scale score units)	102	107
SD (scale score units)	18	18
N	353	135

The average achievement for Year 8 Māori students on the Knowledge and Communication of Science Ideas measure was 102 scale score units and for Nature of Science it was 107 scale score units. As for all Year 8 students (Chapter 3), the middle 50 percent of Year 8 Māori students typically demonstrated the competencies described for Year 8, and were also beginning to gain knowledge of more abstract science, to notice simple patterns in data and make basic inferences from these. They demonstrated a developing understanding of scientific thinking, process and vocabulary.

Table 5.4 shows how Year 8 Māori students performed against the curriculum on the two NMSSA science assessments. Achievement was distributed across the curriculum levels with the largest group of students across Developed Level 1 and 2 and Emerging Levels 3 and 4 on both science scales. Although this pattern was similar to the All Students group, a smaller proportion of Māori students than All Students scored within Developed Level 3 and 4 and above.

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

	Knowledge and Communication of Science Ideas		Nature of Science	
	Māori students (%)	All students (%)	Māori students (%)	All students (%)
Developed Level 3 and 4 and above	6	19	11	21
Emerging Level 3 and 4	38	47	38	44
Developed Level 1 and 2	54	32	50	34
Emerging Level 1 and 2	2	2	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 Knowledge and Communication of Science Ideas, and the Nature of Science scales respectively. As expected, Year 8 Māori 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 Māori students.

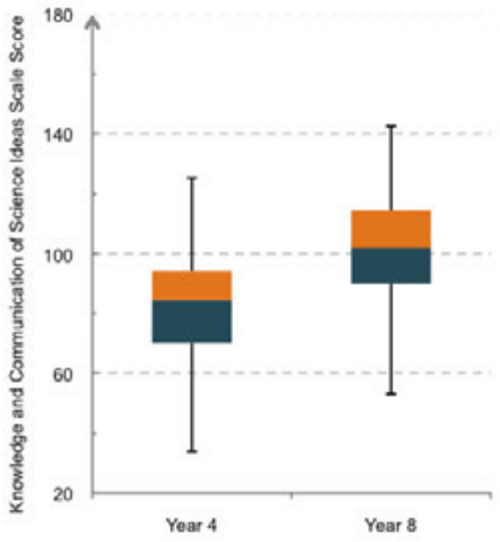


Figure 5.1 Māori student achievement for Knowledge and Communication of Science Ideas

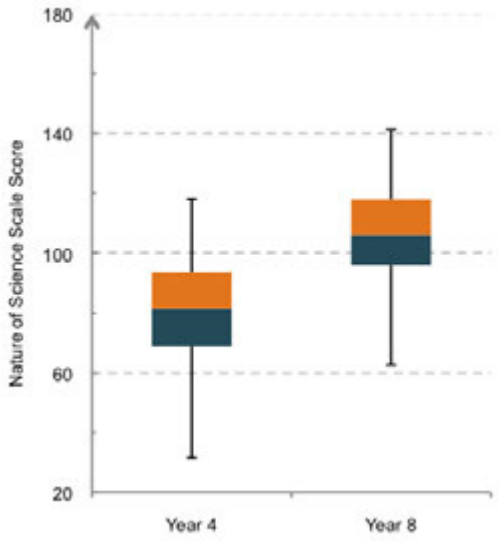


Figure 5.2 Māori student achievement for Nature of Science

Figures 5.3 to 5.6[25], on the following page, illustrate the spread of achievement across the curriculum levels for Year 4 and Year 8 Māori students on both science measures. They confirm the extent of the overlap between the year levels. The results for Year 4 are in line with NZC end of year expectations. However, results for Year 8 are below the curriculum expectations (Developed Level 3 and 4) as is the case for the All Students group. Figures 5.3 to 5.6 also indicate that although the distributions of both groups were similar, Māori students, on average, scored lower than All Students on both scales.

[25] Figures are smoothed versions of the data

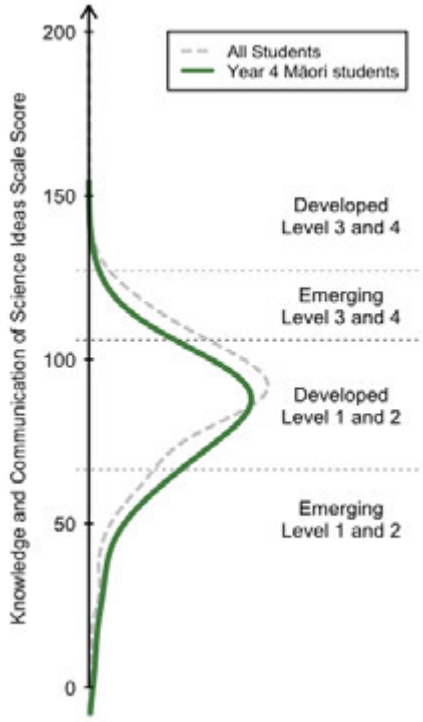


Figure 5.3 Distribution of Year 4 Māori student achievement on Knowledge and Communication of Science Ideas against levels of the science curriculum

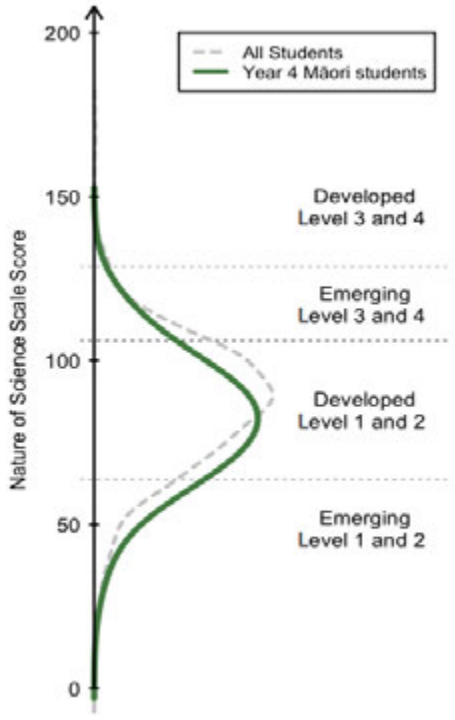


Figure 5.4 Distribution of Year 4 Māori student achievement on Nature of Science against levels of the science curriculum

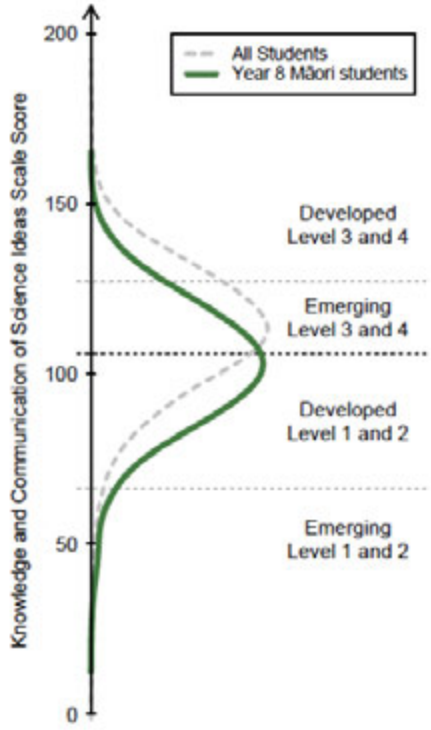


Figure 5.5 Distribution of Year 8 Māori student achievement on Knowledge and Communication of Science Ideas against levels of the science curriculumt

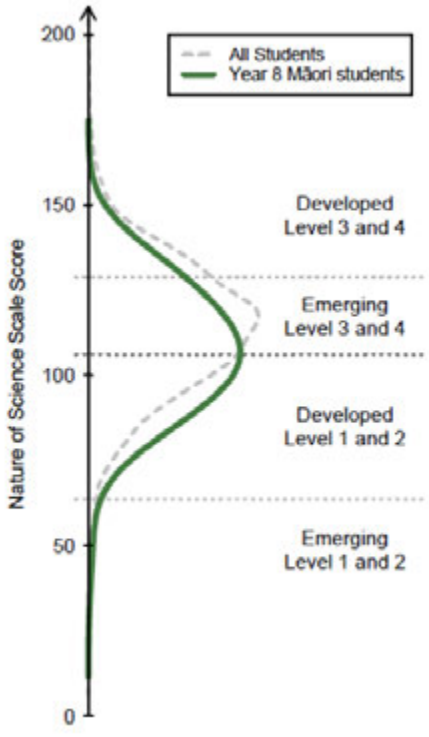


Figure 5.6 Distribution of Year 8 Māori student achievement on Nature of Science against levels of the science curriculum

Table 5.5 shows the differences in average scores between Year 4 and Year 8 Māori students expressed in scale score units and effect sizes, and the averages and standard deviations for both science measures. The differences between the average score for Year 4 and Year 8 students was 21 scale points on the Knowledge and Communication of Science Ideas measure and 25 scale points on the Nature of Science measure. Both of these differences represented effect sizes of between about 1.0 and 1.5 with an average annual effect size of 0.27 to 0.37.

Table 5.5 Overall measures of Māori science achievement and difference of achievement by year level[26]

	Knowledge and Communication of Science Ideas		Nature of Science	
	Year 4	Year 8	Year 4	Year 8
Average (scale score units)	81	102	82	107
SD (scale score units)	21	18	17	18
N	423	353	148	135
Difference (scale score units)	21		25	
Effect size[26]	**1.07**		**1.47**	
Average annual effect size	0.27		0.37	

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

The average scores for Māori students were lower, on average, than those for the full national sample at both year levels on both measures (See Chapter 3). However, the difference between Year 4 and Year 8 for Māori students is similar to the difference in the All Students group (Table 3.7).

Subgroup comparisons

Figures 5.7 and 5.8 display the level and spread of scores for Knowledge and Communication of Science Ideas and Nature of Science scales for Year 4 Māori students. Distributions are shown for gender, school decile[27], and type of school[28]. The overall pattern of results was the same for both scales. There is a pattern of increasing average scores for Year 4 Māori students attending low, mid and high decile schools. Differences by gender and school type are not notable. The number of students that participated in assessments within each subgroup is provided in Appendix 4.

Figures 5.9 and 5.10 show comparative subgroup 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. There is no notable difference between girls and boys at Year 8 on either scale. The pattern of achievement is different on the two scales when examined by school type. Table 5.6 shows these differences in more detail.

[26] Effect size is reported as Mean $_{\text{Year 8}}$ – Mean $_{\text{Year 4}}$

[27] 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)

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

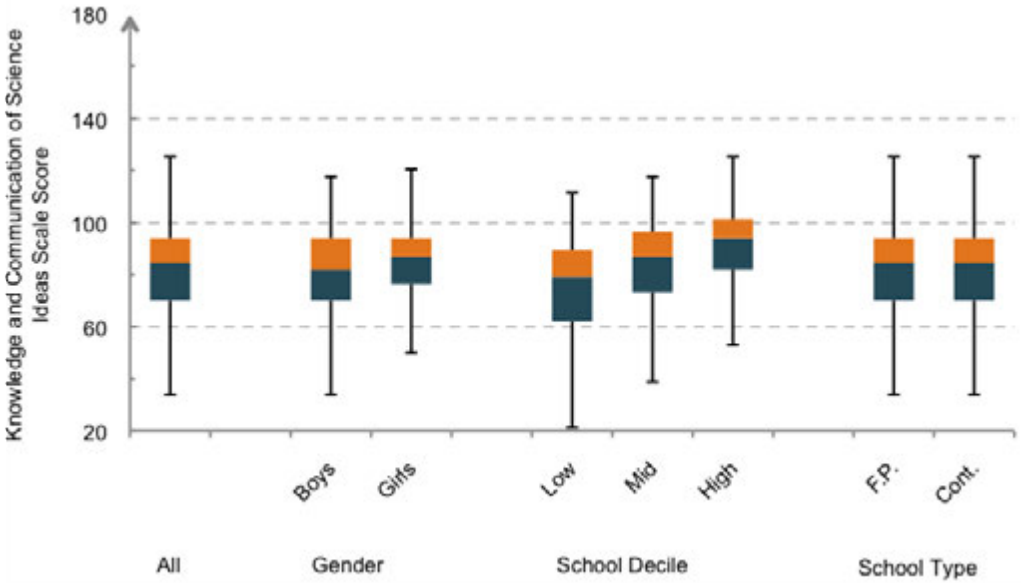


Figure 5.7 Year 4 Māori student scores for Knowledge and Communication of Science Ideas by gender, school decile and type (F.P.=Full Primary, Cont.=Contributing)

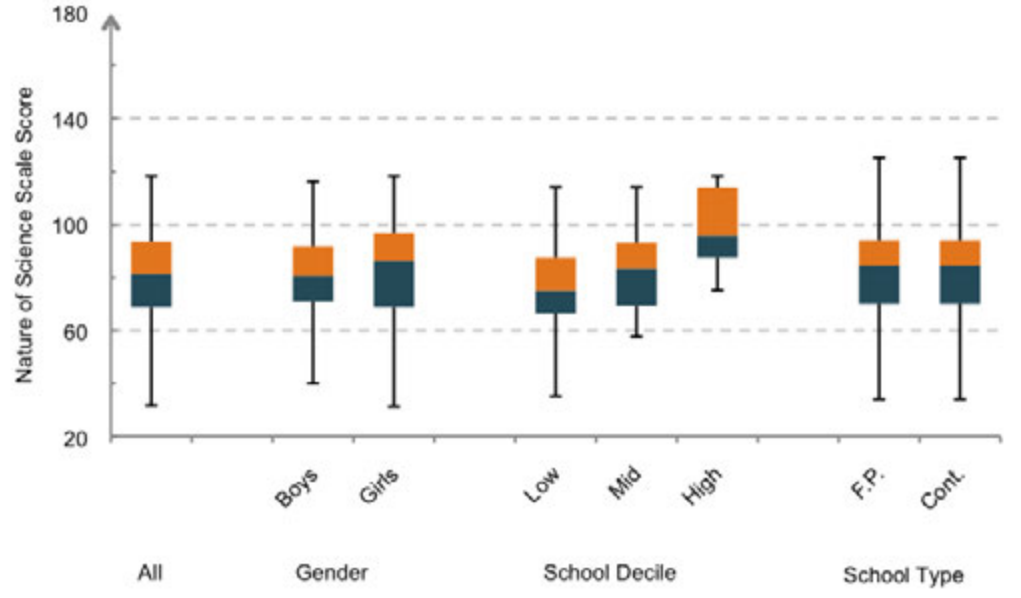


Figure 5.8 Year 4 Māori student scores for Nature of Science by gender, school decile and type (F.P.=Full Primary, Cont.=Contributing)

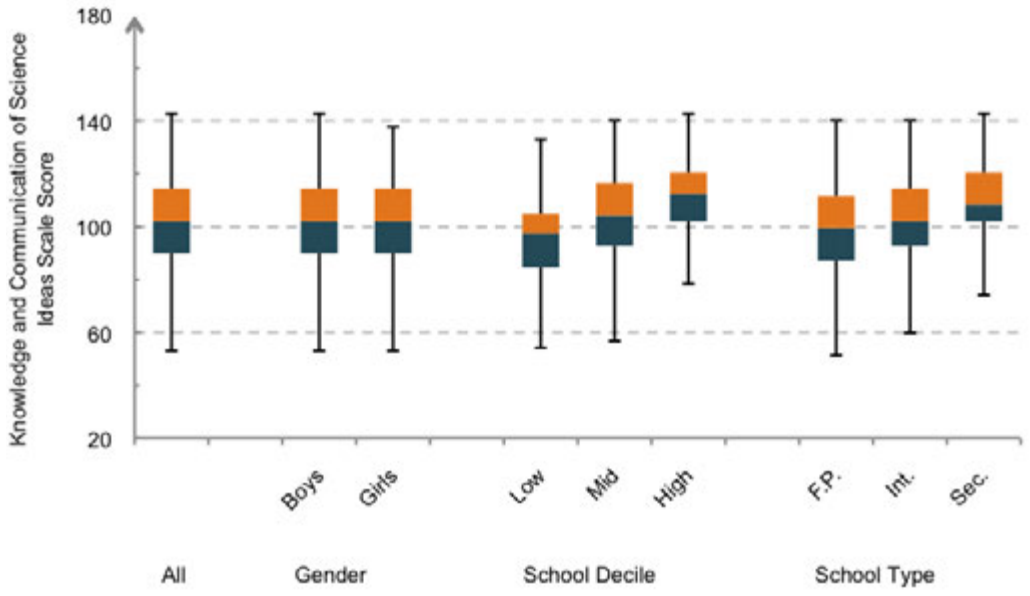


Figure 5.9 Year 8 Māori student scores for Knowledge and Communication of Science Ideas by gender, school decile and type of school (F.P.=Full Primary, Int.=Intermediate, Sec.=Secondary, Comp.=Composite)

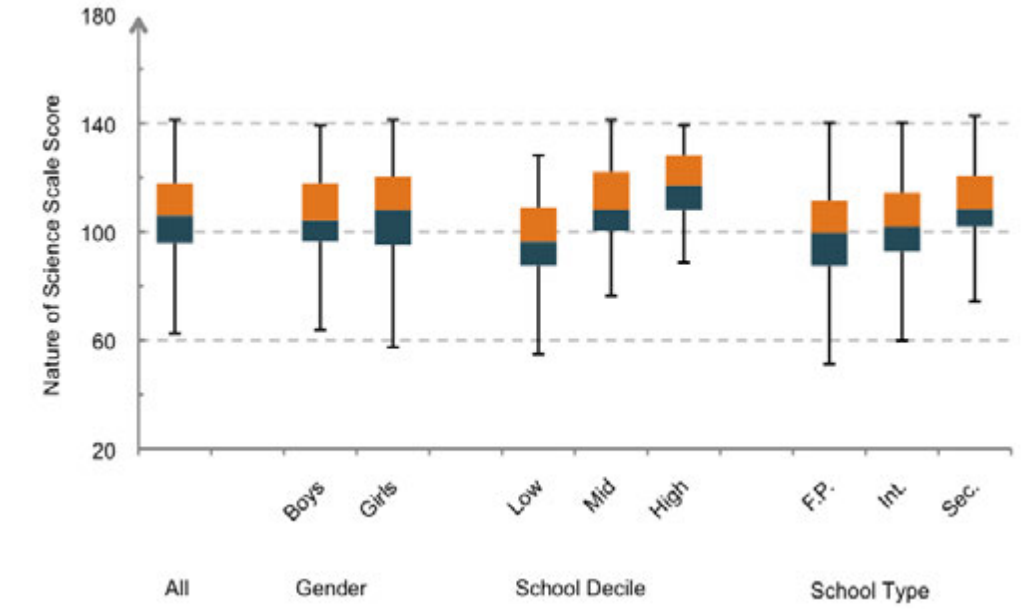


Figure 5.10 Year 8 Māori student scores for Nature of Science by gender school decile, and type of school (F.P.=Full Primary, Int.=Intermediate, Sec.=Secondary, Comp.=Composite)

Tables 5.6 and 5.7 set out the average scale score differences between subgroups and corresponding effect sizes at Year 4 and Year 8. The subgroup analysis shows that, on average, achievement of Māori students at both year levels varied by school decile but not by gender. Achievement did not vary by school type at Year 4. However, the pattern of achievement by school type at Year 8 was inconsistent across the two scales.

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 about 0.8 at Year 4 and 1.1 at Year 8 for Knowledge and Communication of Science Ideas, indicating considerable difference. As a comparison, the effect size of the difference between Year 4 and Year 8 students overall was just over 1.0.

Table 5.6 Year 4 and Year 8 Māori students: Subgroup differences on Knowledge and Communication of Science Ideas

	Knowledge and Communication of Science Ideas			
	Year 4		Year 8	
	Scale score difference	Effect size	Scale score difference	Effect size
Gender				
Boys/Girls	4	-0.18	1	0.06
School decile group				
Low/Mid	10	**-0.51**	9	**-0.55**
Low/High	16	**-0.78**	17	**-1.06**
Mid/High	6	**-0.33**	8	**-0.49**
Type of school				
Contributing/Full primary	4	0.16	-	-
Full primary/Intermediate	-	-	4	-0.20
Full primary/Secondary	-	-	10	**-0.56**
Intermediate/Secondary	-	-	6	-0.35

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

Table 5.7 Year 4 and Year 8 Māori students: Subgroup differences on Nature of Science

	Nature of Science			
	Year 4		Year 8	
	Scale score difference	Effect size	Scale score difference	Effect size
Gender				
Boys/Girls	2	-0.12	1	-0.05
School decile group				
Low/Mid	8	**-0.51**	13	**-0.82**
Low/High	23	**-1.44**	20	**-1.27**
Mid/High	15	**-1.04**	7	**-0.47**
Type of school				
Contributing/Full primary	4	0.22	-	-
Full primary/Intermediate	-	-	5	**-0.29**
Full primary/Secondary*	-	-	13	-
Intermediate/Secondary*	-	-	8	-

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

* Effect sizes not calculated due to small numbers (n = 12 secondary schools)

4. Benchmarking Māori success

This section contrasts the profiles of Year 4 and Year 8 Māori students who scored above the national average at their year level. They are compared with the students from the national sample (All Students) who also scored above the national averages for Year 4 and Year 8 respectively. The 2012 national average serves as a benchmark to compare science results for different groups in this year. This benchmark may also be used to compare science results across future cycles of NMSSA Science.

In this section we examine the Knowledge and Communication of Science Ideas benchmark only. Numbers are too small in the relevant subgroups on the Nature of Science measure to make reliable statements about differences.

Table 5.8 shows the number (and percentage) of Year 4 and Year 8 Māori students who scored above the benchmark for their year level, along with the average level and spread of their science achievement scores. On the Knowledge and Communication of Science Ideas scale at Year 4, 43 percent of Māori students scored above the benchmark compared with 56 percent of All Students. At Year 8, a smaller percentage of Māori students scored above the benchmark compared with All Students at Year 8 (30 percent compared with 53 percent). At both year levels the average scores for Māori students were four scale points lower than for all students (effect size of approximately 0.2).

Table 5.8 Year 4 and Year 8: Summary statistics for students scoring above the benchmarks for their year

	Year 4 students scoring above the national Year 4 average		Year 8 students scoring above the national Year 8 average	
	Knowledge and Communication of Science Ideas			
	Māori students	All students	Māori students	All students
Number above benchmark (of total group)	180 (of 423)	1170 (of 2076)	106 (of 353)	1022 (of 1914)
Percentage of respective group	43%	56%	30%	53%
Average (scale score units)	98	102	122	126
SD (scale score units)	8	11	8	11

Figures 5.11 and 5.12 contrast the group of Māori students who achieved above the benchmark with the All Students group who scored above the ben chmark at Year 4 and Year 8 respectively in relation to gender, school decile and attitudes to science.

There were similar percentages of boys and girls in the two groups of students at both year levels. About half of the Māori students came from mid decile schools with the other half coming from low and high decile schools combined. This contrasted with All Students where the percentage of students in the group increased progressively through the decile groups.

At both year levels the above benchmark groups of Māori and All Students showed similar patterns with respect to Attitude to Science. There were more students with a lower Attitude to Science score in the above benchmark groups at Year 8 than Year 4. These results may reflect the fact that Attitude to Science scores declined overall from Year 4 to Year 8.

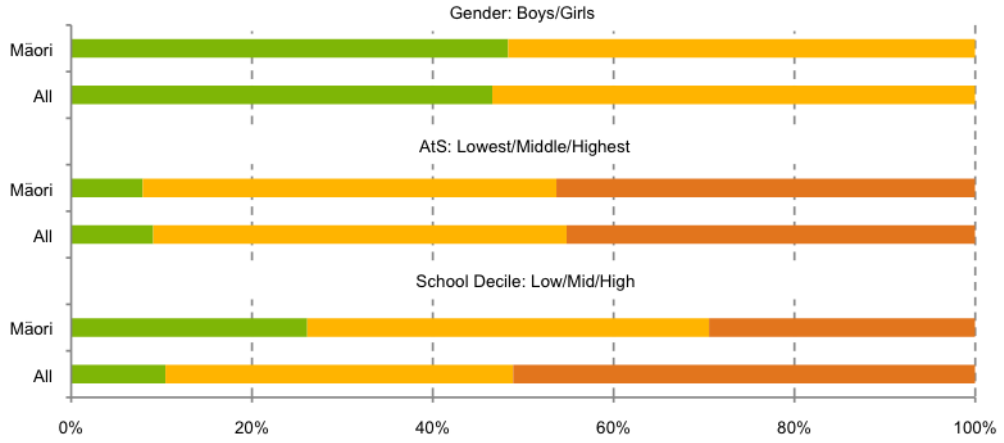


Figure 5.11 Year 4: Percentage of Māori students and All Students scoring above the benchmark in science by gender, Attitude to Science and school decile (AtS=Attitude to Science)

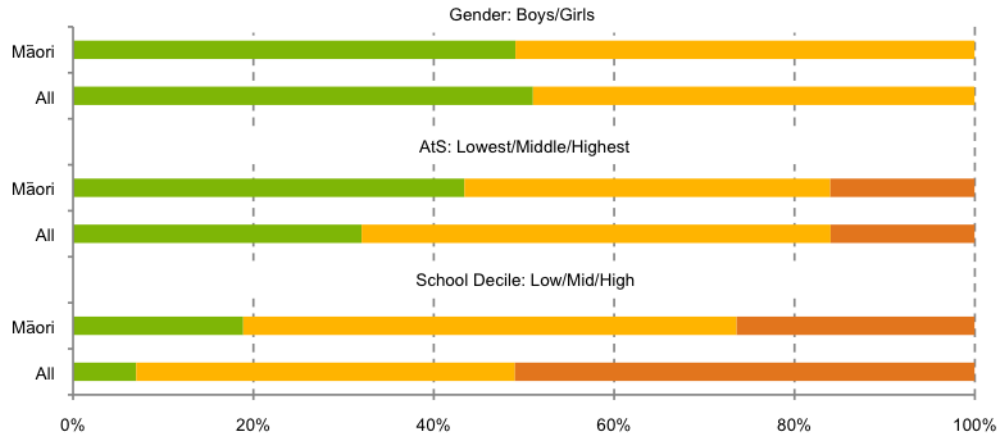


Figure 5.12 Year 8: Percentage of Māori students and All Students scoring above the benchmark in science by gender, Attitude to Science and school decile (AtS=Attitude to Science)

Māori student achievement by school decile

Tables 5.9 and 5.10 show the total number of Māori students assessed in science and the number of Māori students who achieved above the benchmark for their year, broken down by school decile.

At both year levels at least 80 percent of Māori students came from low and mid decile schools. This contrasts with just over 50 percent of NZ European students attending low and mid decile schools (Table 5.11). By number, the group of Māori students from mid decile schools who scored above the benchmark is the largest. However, a greater **proportion** of Māori students at high decile schools achieved above the benchmark than from mid and lower decile schools – in a similar way to the national sample (see Chapter 3). For example, 20 percent of all Year 4 Māori students attended a high decile school and 65 percent of those scored above the benchmark. In contrast, 41 percent of Māori students attended a low decile school, but only 27 percent of those achieved above the benchmark. This was similar to the national sample (Chapter 3).

Table 5.9 Year 4: Number and percentage of Māori students by school decile

	All Māori students		Māori students who achieved above the national average as a percentage of all Māori in that decile group	
	N	%	N	%
School Decile				
Low	175	41	47	27
Middle	166	39	80	48
High	83	20	53	65
Total	424	100	180	-

Table 5.10 Year 8: Number and percentage of Māori students by school decile

	All Māori students		Māori students who achieved above the national average as a percentage of all Māori in that decile group	
	N	%	N	%
School Decile				
Low	124	35	20	16
Middle	174	49	58	33
High	55	16	28	51
Total	353	100	106	-

Table 5.11 Number and percentage of NZ European students by school decile

	NZ European students	
	Year 4 (%)	Year 8 (%)
School Decile		
Low	8	9
Middle	44	45
High	49	46

Rounding to integers means that percentages do not always add up to 100 percent.

5. Being Māori at school

Māori students were asked four questions about their experiences at school as part of gaining an understanding of schools' cultural responsiveness. Figure 5.13 shows the percentage of Māori students who agreed that it feels good to be a Māori in their school, that Māori students can be successful in their school, their Māori culture is important in their school and te reo Māori is spoken at school. The vast majority of Māori students at both year levels were positive about these aspects of their school experience. Year 8 students tended to be slightly more positive than Year 4 students.

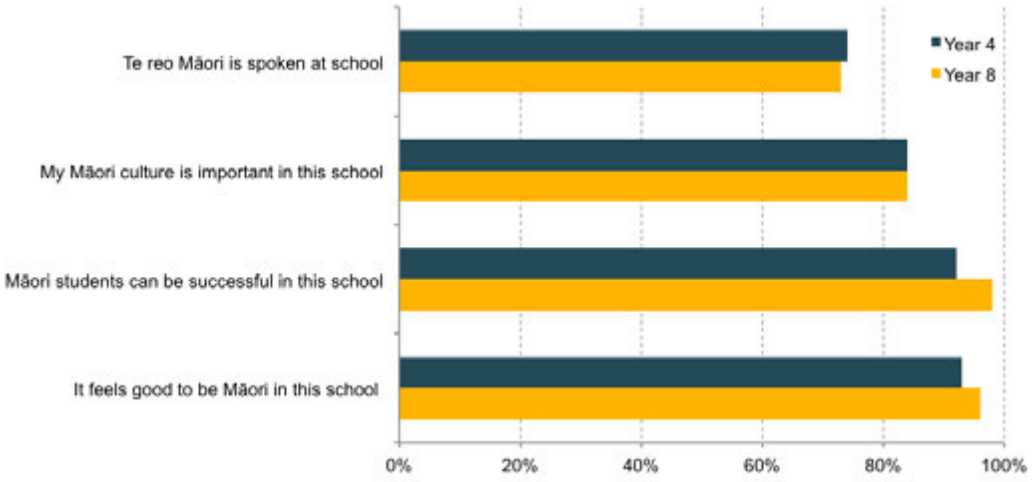


Figure 5.13 Year 4 and Year 8: Percentage of Māori students responding 'yes' to statements about school

6

Pasifika Student Achievement in Science

This chapter presents the findings for Pasifika[29] student achievement in science at Year 4 and Year 8. It looks at achievement within year levels and presents it against the levels of the science curriculum. It examines the difference in achievement between Year 4 and Year 8, and differences among subgroups of gender, school decile and type of school, and amount of English spoken in the home. It presents details about the decile, gender and attitudes of Pasifika students who achieve above the national average in science at Year 4 and Year 8. It also provides information on Pasifika students' attitudes to science and their experiences of their culture, language and identity at school.

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

Success and achievement of Pasifika students in science – an overview

Pasifika students were positive about how their culture, language and identity were valued at their school and were positive in their attitudes to learning science.

Achievement at both year levels for Pasifika students varied with the amount of English spoken at home. Students who spoke English more frequently at home tended to achieve at a higher level although this was not consistent across all categories.

As expected, Year 8 Pasifika students, on average, achieved higher scores than Year 4 Pasifika students. However, there was a wide disttribution of scores at both year levels and some overlap in the achievement of Year 4 students and Year 8 students. Although, on average, Pasifika student scores at Year 4 and Year 8 were lower than those for NZ European students, the differences between the year levels were similar for both groups.

For both science measures, the average achievement of Year 4 and Year 8 Pasifika students was within the Developed Curriculum Levels 1 and 2. This aligns with the level expectations for Year 4 described in The New Zealand Curriculum. However, the Year 8 average score is below the expectations of Developed Level 3 and 4 described in The New Zealand Curriculum, and below that for All Students (Emerging Levels 3 and 4).

For both year levels and both measures of science, achievement, on average, was lower for Pasifika students from low decile schools. Achievement in science was similar for boys and girls at both year levels, and for school type at Year 4. On average, achievement of Year 8 Pasifika students who attended full primary or intermediate schools was lower than for those attending secondary schools.

While 23 percent of Pasifika students at Year 4 scored above the national average, slightly fewer Pasifika students at Year 8 (19 percent) scored above the national average. A greater proportion of girls than boys achieved above the national average at Year 4, however, the genders were equally represented at Year 8.

Almost 90 percent of all Pasifika students at both year levels attended low and mid decile schools. When this is accounted for, results show that a greater proportion of Pasifika students at high decile schools scored above the national average. This reflects the relationship between achievement and school decile that was found for All Students. This also contrasts with just over 50 percent of NZ European students attending low or mid decile schools.

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

1. Year 4 Pasifika student achievement in science

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

Table 6.1 Year 4 Pasifika student science achievement

	Knowledge and Communication of Science Ideas	Nature of Science
	Year 4	Year 4
Average (scale score units)	73	69
SD (scale score units)	22	21
N	262	102

The average score and the variation within the scores for Pasifika students on Knowledge and Communication of Science Ideas were similar to the results for Nature of Science. This was also the case for the national sample.

At Year 4 the average score for Pasifika students was 73 scale score units in Knowledge and Communication of Science Ideas and 69 for the Nature of Science scale. These results show that the 50 percent of Year 4 Pasifika students who clustered around the average (the middle 50 percent) typically drew on everyday experiences and observations to answer questions. They were beginning to use scientific vocabulary and participate in hands-on scientific investigations. Students were beginning to recognise how scientists find things out and to offer their own explanations for investigations.

A curriculum alignment exercise was undertaken to link performance ranges on the two NMSSA science achievement scales to the NZC (Appendix 3). Creating this link allowed scale scores for the two science measures to be reported in terms of curriculum expectations.

Table 6.2 shows Year 4 Pasifika student performance on both science measures across the four curriculum bands. It compares these results to those for All Students. About two thirds of Pasifika students achieved in the Developed Level 1 and 2 band, similar to All Students on Knowledge and Communication of Science Ideas. This band represents the expected level of performance for an average Year 4 student at the end of the year. The percentage of Pasifika students in Emerging Level 3 and 4 was smaller than that of All Students, and the percentage in the Emerging Level 1 and 2 was larger.

Table 6.2 Percentage of Year 4 Pasifika and All Students achieving across the curriculum levels

	Knowledge and Communication of Science Ideas		Nature of Science	
	Pasifika students (%)	All students (%)	Pasifika students (%)	All students (%)
Developed Level 3 and 4 and above	-	1	-	1
Emerging Level 3 and 4	3	18	3	11
Developed Level 1 and 2	62	66	62	76
Emerging Level 1 and 2	35	15	35	12

2. Year 8 Pasifika student achievement in science

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

At Year 8, the average score for Pasifika students in Knowledge and Communication of Science Ideas was 97 scale score units and for Nature of Science was 98 scale score units. The middle 50 percent of Year 8 Pasifika students typically demonstrated the competencies described for Year 4, and were also beginning to gain knowledge of more abstract science, to notice simple patterns in data and make basic inferences from these. They demonstrated a developing understanding of scientific thinking, process and vocabulary.

Table 6.4 shows how Year 8 Pasifika students performed on the two science measures in terms of the curriculum levels. It provides the percentages of students that achieved within each level. The majority of Year 8 Pasifika students achieved within Developed Curriculum Level 1 and 2 for both measures of science. Just over 35 percent of Year 8 Pasifika students achieved within Level 3 and 4 for both measures of science. In contrast, 65 percent of the Year 8 All Students group scored within Level 3 and 4.

Table 6.3 - Year 8 Pasifika student science achievement

	Knowledge and Communication of Science Ideas	Nature of Science
	Year 8	Year 8
Average (scale score units)	97	98
SD (scale score units)	20	22
N	206	69

Table 6.4 – Percentage of Year 8 Pasifika and All Students achieving across science curriculum levels

	Knowledge and Communication of Science Ideas		Nature of Science	
	Pasifika students (%)	All students (%)	Pasifika students (%)	All students (%)
Developed Level 3 and 4 and above	5	19	7	21
Emerging Level 3 and 4	32	47	29	44
Developed Level 1 and 2	59	32	58	34
Emerging Level 1 and 2	4	2	6	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 Knowledge and Communication of Science Ideas, and the Nature of Science scales respectively. As expected, on average, Year 8 Pasifika students had higher achievement scores than Year 4 Pasifika students. However, similar to the full national student group, there was a wide distribution of scores at both year levels and some overlap in the achievement of Year 4 students and Year 8 students.

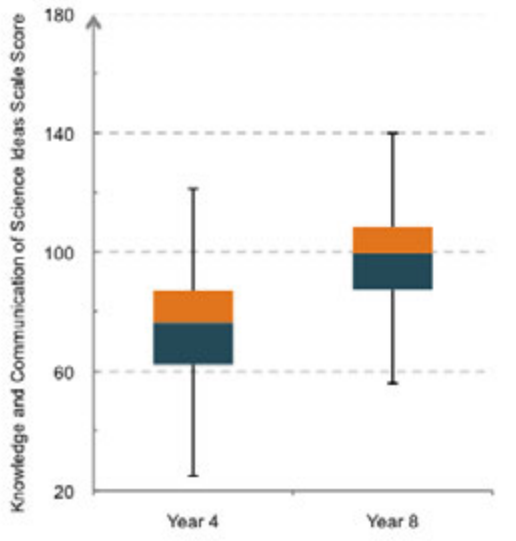


Figure 6.1 Pasifika student achievement for Knowledge and Communication of Science Ideas

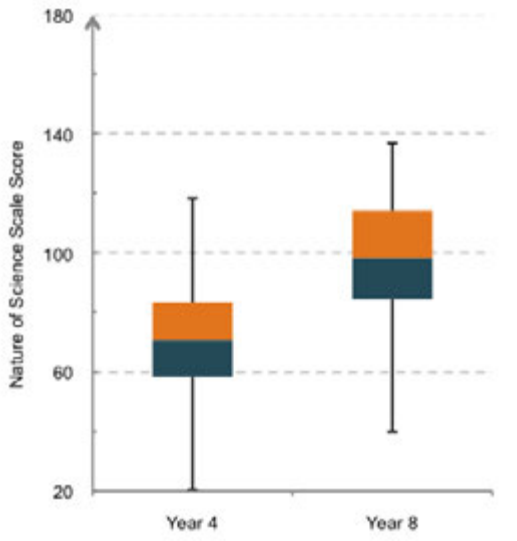


Figure 6.2 Pasifika student achievement for Nature of Science

Figures 6.3 to 6.6[30] illustrate the spread of achievement across the curriculum levels for Year 4 and Year 8 Pasifika students on both science measures. They confirm the extent of the overlap between the year levels, showing that the average score for both Year 4 and Year 8 Pasifika students was within Developed Level 1 and 2 for both measures of science. However, it should be noted that for Pasifika students at Year 4, the average score was at the lower end of Developed Level 1 and 2, and at the higher end at Year 8. The average for All Students at Year 8 was higher, and fell within Emerging Level 3 and 4.

The results for Year 4 Pasifika students are in line with NZC end of year expectations. However, those for Year 8 Pasifika students are below the curriculum expectations for this level (Developed Level 3 and 4).

[30] Figures are smoothed versions of the data

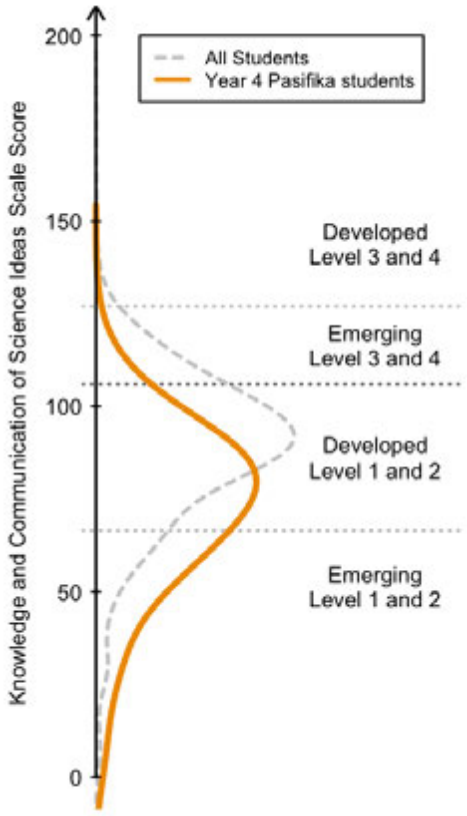


Figure 6.3 Distribution of Year 4 Pasifika and All Student achievement on Knowledge and Communication of Science Ideas against levels of the science curriculum

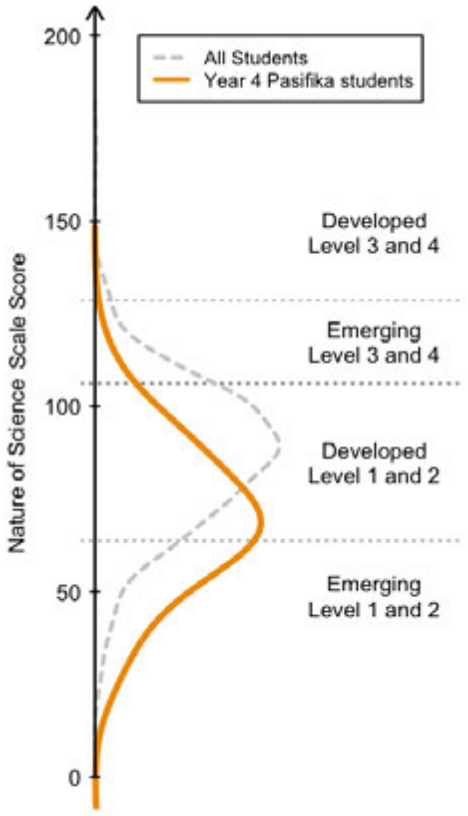


Figure 6.4 Distribution of Year 4 Pasifika and All Student achievement on Nature of Science against levels of the science curriculum

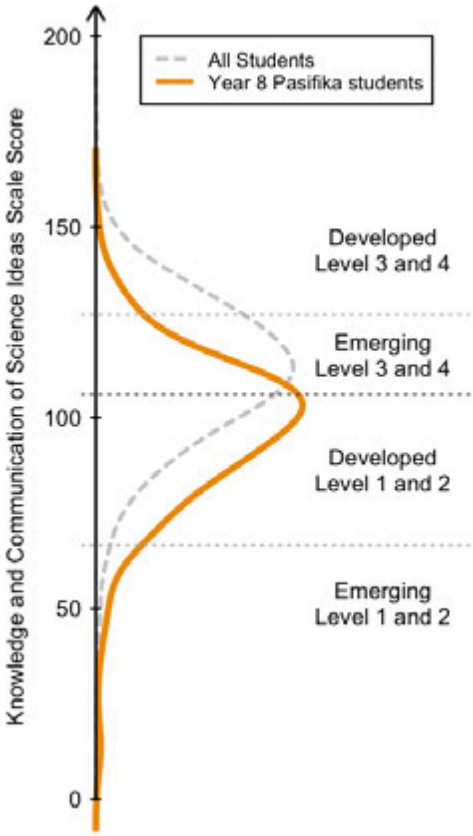


Figure 6.5 Distribution of Year 8 Pasifika and All Student achievement on Knowledge and Communication of Science Ideas against levels of the science curriculum

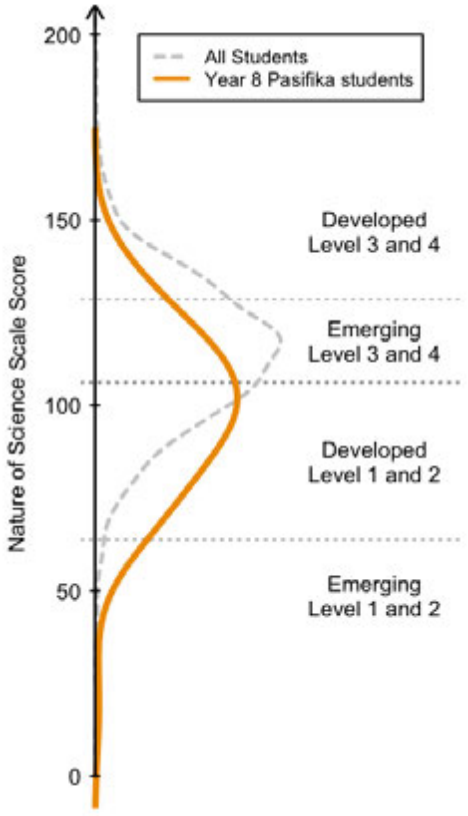


Figure 6.6 Distribution of Year 8 Pasifika and All Student achievement on Nature of Science against levels of the science curriculum

Table 6.5 shows, for both science measures, the differences in average scores between Year 4 and Year 8 Pasifika students expressed in scale score units and effect sizes, and the averages and standard deviations. The differences between the average score for Year 4 and Year 8 students was 24 scale points on the Knowledge and Communication of Science Ideas measure and 29 scale points on the Nature of Science measure.

The Pasifika student average scores were lower than those of All Students at both year levels on both measures (See Chapter 3). However, the effect sizes of the difference between Year 4 and Year 8 for All Students on Knowledge and Communication of Science Ideas and Nature of Science were very similar to those for Pasifika students (about 1.2 and 1.4 respectively) with an average annual effect size of 0.29 to 0.34.

Table 6.5 - Pasifika student science achievement and difference of achievement by year level[31]

	Knowledge and Communication of Science Ideas		Nature of Science	
	Year 4	Year 8	Year 4	Year 8
Average (scale score units)	73	97	69	98
SD (scale score units)	22	20	21	22
N	262	206	102	69
Difference (scale score units)	24		29	
Effect size[31]	**1.17**		**1.35**	
Average annual effect size	0.29		0.34	

Subgroup comparisons

Figures 6.7 and 6.8 display the level and spread of scores for Knowledge and Communication of Science Ideas for Year 4 and Year 8 Pasifika students respectively, for gender, school decile[32], type of school[33], and the frequency with which English is spoken at home. The overall pattern of results was the same for Nature of Science at both year levels. The number of students that participated in assessments within each subgroup is provided in Appendix 4.

Table 6.6 (page 68) summarises average scale score differences and effect sizes between subgroups at Year 4 and Year 8, for Knowledge and Communication of Science Ideas. The numbers of Pasifika students in the Nature of Science sample group were too small to calculate reliable subgroup differences. The full tables of means, standard deviations, sample sizes, effect sizes and 95 percent confidence intervals are in Appendix 4.

On average, results at both year levels varied by school decile but not by gender. Results did not vary by school type at Year 4, but did at Year 8, where achievement for Pasifika students was higher at secondary schools than intermediate or full primary. Differences between full primary and intermediate schools were not significant.

Results varied at both year levels for Pasifika students depending on the amount of English spoken at home. On average, students who spoke English more frequently at home tended to achieve at a higher level although this was not consistent across all categories. The most notable difference for Pasifika students at Year 8 was between students who spoke English at home always versus sometimes or never with an effect size of about 1.1. At Year 4, the difference in student achievement by amount of English spoken at home was much smaller.

[31] Effect size in this table is reported as Mean $_{\text{Year 8}}$ – Mean $_{\text{Year 4}}$

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

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

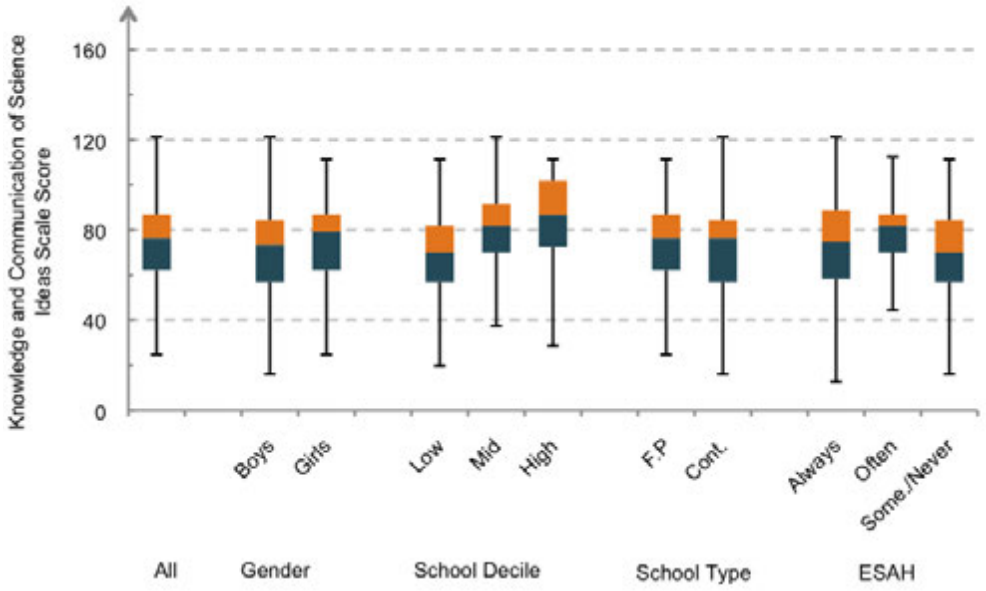


Figure 6.7 Year 4 Pasifika student scores for Knowledge and Communication of Science Ideas by gender, school decile and type, and English spoken at home (F.P.=Full Primary, Cont.=Contributing, Some.=Sometimes, ESAH=English spoken at home)

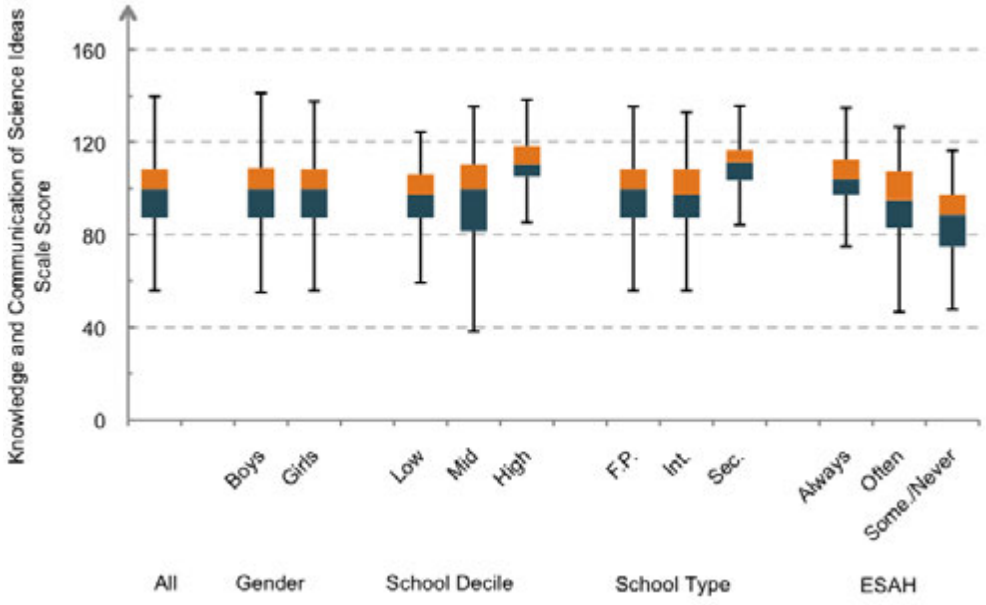


Figure 6.8 Year 8 Pasifika student scores for Knowledge and Communication of Science Ideas by gender, school decile and type, and English spoken at home (F.P.=Full Primary, Int.=Intermediate, Sec.=Secondary, Some.=Sometimes, ESAH=English spoken at home)

Table 6.6 Year 4 and Year 8 Pasifika students: Subgroup differences on science achievement

	Knowledge and Communication of Science Ideas			
	Year 4		Year 8	
	Scale score difference	Effect size	Scale score difference	Effect size
Gender				
Boys/Girls	3	-0.16	0	-0.03
School decile group				
Low/Mid	13	**-0.69**	3	-0.12
Low/High	14	**-0.60**	15	**-0.79**
Mid/High	1	-0.03	13	**-0.57**
Type of school				
Contributing/Full primary	2	-0.08	-	-
Full primary/Intermediate	-	-	2	-0.12
Intermediate/Secondary*	-	-	15	-
Full primary/Secondary*	-	-	17	-
English spoken at home				
Always/Often	6	**-0.31**	12	0.68
Always/Sometimes-Never	2	0.07	20	**1.14**
Often/Sometimes-Never	8	**0.40**	8	0.39

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

* Effect sizes not calculated due to small numbers (n = 12 secondary schools)

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. They are compared with students from the All Students group who also scored above the national averages for Year 4 and Year 8 respectively, on the Knowledge and Communication of Science Ideas scale. The 2012 national mean serves as a benchmark to compare results for different groups in this year. It may also be used to compare science results from future cycles of NMSSA assessment.

Table 6.7 shows the number (and percentage) of Year 4 and Year 8 Pasifika and All Students who scored above the benchmarks for their year level, along with the level and spread of their science scores. At Year 4, 23 percent of Pasifika students scored above the benchmark compared with 56 percent of All Students at Year 4. At Year 8, a slightly smaller percentage of Pasifika students scored above the benchmark compared with All Students at Year 8 (19 percent compared with 53 percent). At both year levels, of the students scoring above the benchmarks, Pasifika students scored five scale points lower than All Students (an effect size of about 0.25).

Table 6.7 Summary statistics for Year 4 and Year 8 Pasifika and All Students scoring above their respective benchmarks

	Year 4 students scoring above the national Year 4 average		Year 8 students scoring above the national Year 8 average	
	Knowledge and Communication of Science Ideas			
	Pasifika students	All students	Pasifika students	All students
Number above benchmark (of total group)	59 (of 262)	1170 (of 2076)	39 (of 206)	1022 (of 1914)
Percentage of respective group	23%	56%	19%	53%
Average (scale score units)	97	102	121	126
SD (scale score units)	8	11	9	11

Figures 6.9 and 6.10 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, school decile and attitudes to science.

The profiles of the groups scoring above the benchmark showed some differences. In contrast to All Students at Year 4, the Pasifika group included a higher percentage of girls than boys. There were similar percentages of boys and girls in both groups of students at Year 8. The Pasifika students came almost equally from each of the decile groups at both year levels. This contrasted with the All Students group where the percentage of students in the group increased progressively with the decile groups.

At both year levels the above benchmark groups of Pasifika and All Students showed similar patterns with respect to attitude to science. A greater proportion of students came from the lowest attitude group at Year 8 than Year 4. These results may reflect the fact that attitude overall declined from Year 4 to Year 8.

There was no clear pattern relating science achievement with attitude to science for students who achieved above the benchmark.

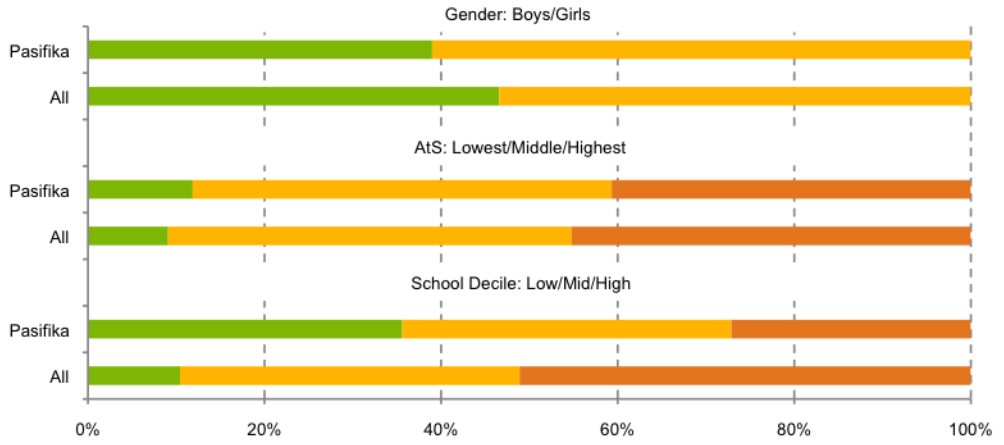


Figure 6.9 Year 4: Percentage of Pasifika students and All Students scoring above the national mean in science by gender, Attitude to Science, and school decile (AtS=Attitude to Science)

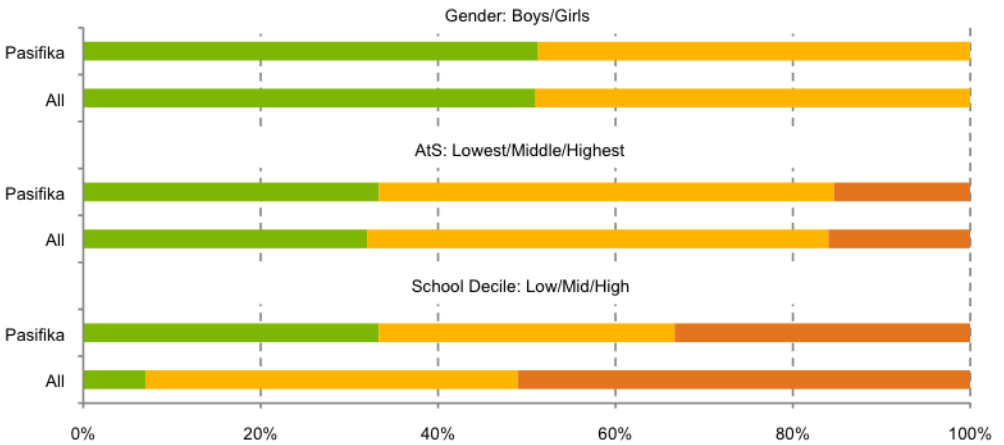


Figure 6.10 Year 8: Percentage of Pasifika students and All Students scoring above the national mean in science by gender, Attitude to Science and school decile (AtS=Attitude to Science)

Pasifika student achievement by school decile

Tables 6.8 and 6.9 show, for Year 4 and Year 8, the total number of Pasifika students assessed in Knowledge and Communication of Science Ideas and the number of Pasifika students who achieved above the benchmark for their year, broken down by school decile.

At both year levels almost 90 percent of Pasifika students came from low and mid decile schools, with two thirds from low decile. This contrasts with just over 50 percent of NZ European students attending low and mid decile schools (Table 6.10). By number, the majority of Pasifika students who scored above the benchmark came equally from low and mid decile schools.

However when one considers the total number of Pasifika students attending each decile group, the picture changes. A greater proportion of the Pasifika students from high decile schools scored above the benchmark than those who attended mid and low decile schools. This was similar to the national sample and the Māori sample (Chapters 3 and 5). For example, at Year 4, 12 percent of all Pasifika students attended high decile schools. Fifty percent of those students scored above the benchmark. In contrast 65 percent of all Pasifika students attended low decile schools but only 12 percent of those scored above the benchmark.

Table 6.8 Year 4: Number and percentage of Pasifika students by school decile

	All Pasifika students		Pasifika students who achieved above the national average as a percentage of all Pasifika in that decile group	
	N	%	N	%
School Decile				
Low	169	65	21	12
Middle	61	23	22	36
High	32	12	16	50
Total	262	100	59	–

Table 6.9 Year 8: Number and percentage of Pasifika students by school decile

	All Pasifika students		Pasifika students who achieved above the national average as a percentage of all Pasifika in that decile group	
	N	%	N	%
School Decile				
Low	125	61	13	10
Middle	53	26	13	25
High	28	13	13	46
Total	206	100	39	–

Table 6.10 Number and percentage of NZ European students by school decile

	NZ European students	
	Year 4 (%)	Year 8 (%)
School Decile		
Low	8	9
Middle	44	45
High	49	46

Rounding to integers means that percentages do not always add up to 100 percent.

5. Being Pasifika at school

Pasifika students were asked three questions about their experiences at school as part of gaining an understanding of the cultural responsiveness of schools. Figure 6.11 shows the percentage of Pasifika students who agreed that it felt good to be Pasifika in their school, that Pasifika students could be successful in their school, and that their Pasifika culture was important in their school. The vast majority of Pasifika students at both year levels were positive about these aspects of their school experience. Year 4 students were more positive than Year 8 students about their culture being important in their school, while Year 8 students tended to be more positive than Year 4 students in the other aspects of their school experience.

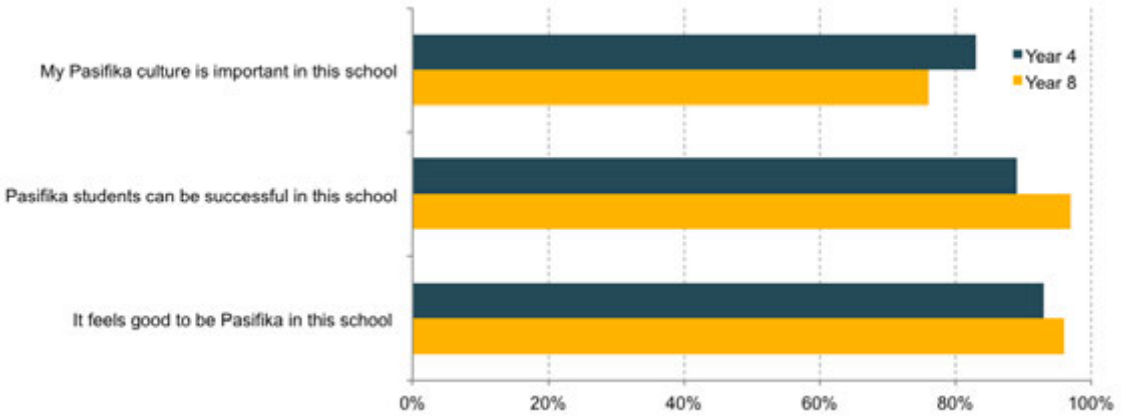


Figure 6.11 Year 4 and Year 8: Percentage of Pasifika students responding 'yes' to statements about school

7

Science Achievement of Students with Special Education Needs

This chapter presents the findings for achievement in science of students with special education needs at Year 4 and Year 8. It examines the variation of achievement within year levels and the differences in science achievement and attitude to science between Year 4 and Year 8, and differences in achievement between students in different categories of special education need. The chapter presents achievement of students with special education needs against the levels of the science curriculum and provides details about the decile, gender and attitudes to science of students with special education needs who achieved above the national average in science at Year 4 and Year 8.

Results are presented for the Knowledge and Communication of Science Ideas measure of science achievement developed for this study. The numbers of students with special education needs who undertook the individual assessments were too small to report.

In this chapter, we compare students with special education needs to all students in the national sample. When making these comparisons the national sample will be referred to as 'All Students'. We also make comparisons to a complementary group of students who do not fall into any of the special needs categories. This group is referred to as the 'no special education needs' group.

Consider success and achievement of students with special education needs in science – an overview

For the first time in national monitoring, students with high and moderate special education needs were identified. This represents a major step forward in the inclusion of children with special education needs in national level assessment. Although the numbers of students with high special needs were modest, students with moderate special needs made up 8 percent of All Students at Year 4 and 5 percent at Year 8.

On average, Year 8 students with special education needs scored higher than Year 4 students. As with All Students, there was some overlap in the achievement of Year 4 and Year 8 students.

At both year levels, students with high or moderate special needs tended to achieve at a lower level than those on referral or with no special education needs. However, the overlap between the groups indicated that there were students, particularly those with moderate special needs, who were achieving at the same level as students with no special education needs. Students identified as being on referral performed in very similar ways to All Students.

Students in the moderate special needs groups demonstrated a similar difference in average achievement between Year 4 and Year 8 as students with no special education needs. These results suggest that, on average, students with special education needs are progressing from Year 4 to Year 8 at a similar rate to those with no special education needs.

At Year 4 the average score for students with high special needs was within Emerging Level 1 and 2 of the curriculum. For students with moderate special needs, the average was just within Developed Level 1 and 2. At Year 8, the average score for both high and moderate special needs groups was at the top end of Developed Level 1 and 2. About 30 percent of students with high or moderate special needs were achieving at least at Level 3 and 4.

At both year levels, students with moderate and high special needs demonstrated as positive an attitude to science as their peers in the on referral and no special education needs groups. Similarly to the national sample, attitude to science declined slightly between Year 4 and Year 8 for students with special education needs.

Students with special education needs reported having a similar range of opportunities to learn science in school as the students with no special education needs.

At both year levels, 17 percent of students with moderate special needs and about 50 percent of students on referral achieved above the national averages. There was a slightly greater percentage of boys in the special education group compared with the All Students group.

Students with special needs who achieved above the national average tended to come from mid and high decile schools as was the case with All Students.

1. Including students with special education needs in NMSSA

For the first time in national monitoring, students with high and moderate education needs were included in the study. This represents a major step forward in the inclusion of children with special education needs in national level assessment.

Participating schools identified students' special education needs[34] as:

- **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 not falling into any of the above categories were assigned to the no special education needs group. Students with special education needs were encouraged to participate using the level of assistance normally provided to them. Schools and parents were able to withdraw any students for whom the experience of 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 about 1.6 percent of the respective intended NNMSA samples (see Appendix 1).

Table 7.1 displays the Year 4 and Year 8 groups of students with special education needs who completed the Knowledge of Communication and Science Ideas assessment. Although the numbers of students with high special education needs were very small, the numbers with moderate special education needs were larger and allowed analysis of achievement and some comparison with the national sample. Students with moderate special needs made up 8 percent of the national sample at Year 4 and 5 percent at Year 8.

Overall, the numbers in this chapter are relatively small and the findings should therefore 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. As such, this group cannot be considered a statistically representative sample.

Table 7.1 Breakdown of students with special education needs and no special education needs by year level

	Year 4		Year 8	
	N	%	N	%
High special education needs	8	<1	9	<1
Moderate special education needs	162	8	95	5
On referral	74	4	85	4
No special education needs	1820	88	1716	90
Total	**2064**	**100**	**1905**	**100**

[34] The categories of special education need 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.

2. Year 4 achievement in science for students with special education needs

Table 7.2 shows the average science score and standard deviation for Year 4 students in different categories of special education need compared with students with no special education needs.

Table 7.2 Science achievement of Year 4 students with special education needs and no needs

	Knowledge and Communication of Science Ideas			
	High special education needs	Moderate special education needs	On referral	No special education needs
Average (scale score units)	58	69	91	90
SD (scale score units)	21	21	20	20
N	8	162	74	1820

The average score for Year 4 students in Knowledge and Communication of Science Ideas was 58 scale score units for students with high special education needs, 69 for students with moderate special education needs, and 91 for those who were on referral. The group of Year 4 students with moderate special education needs clustered around the average (the middle 50 percent) typically drew on everyday experiences and observations to answer questions. They were learning how to use scientific vocabulary and to participate in hands-on scientific investigations. Students were beginning to recognise how scientists find things out and to offer their own explanations for investigations.

As the high special education needs group was very small it is not appropriate to describe 'typical' performance for this group at either year level. The middle 50 percent of the on referral group typically displayed the competencies described for Year 4 students in Chapter 3.

A curriculum alignment exercise was undertaken to link performance ranges on the two NMSSA science achievement scales to the NZC.. Creating this link allowed scale scores to be reported in terms of curriculum expectations (see Appendix 3).

Table 7.3 shows that, for Knowledge and Communication of Science Ideas, the majority of Year 4 students with high special education needs scored within Emerging Level 1 and 2, while the majority of students with moderate special education needs and those on referral scored within Developed Level 1 and 2. Over 40 percent of students with moderate special education needs achieved within Emerging Level 1 and 2.

Table 7.3 Percentage of Year 4 students with different categories of special education needs achieving within the science curriculum levels

	Knowledge and Communication of Science Ideas			
	High special education needs (%)	Moderate special education needs (%)	On referral (%)	All students (%)
Developed Level 3 and 4 and above	-	-	1	1
Emerging Level 3 and 4	-	1	23	18
Developed Level 1 and 2	25	55	64	66
Emerging Level 1 and 2	75	44	12	15

Table 7.4 displays the differences in scale scores between groups of students at Year 4. Effect sizes, calculated to quantify the differences in achievement, are also displayed for the moderate special education needs, on referral and no special education needs groups. No effect sizes have been calculated for the high special education needs group due to the small numbers involved. The difference between students with moderate special education needs and those with no special education needs generated an effect size of about 1.0 at Year 4. There was no significant difference in average scores between students on referral and those with no special education needs.

Table 7.4 Year 4 difference in science achievement between categories of special education needs and no special education needs

	Knowledge and Communication of Science Ideas	
	Scale score difference	Effect size
Moderate special education needs/No special education needs	21	**-1.06**
Moderate special education needs/On referral	23	**-1.11**
On referral/No special education needs	1	0.05

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

3. Year 8 achievement in science for students with special education needs

Tables 7.5 displays the mean and standard deviation of science achievement for Year 8 students in different categories of special education needs compared with students with no special education needs.

Table 7.5 Science achievement of Year 8 students with special education needs and no needs

	Knowledge and Communication of Science Ideas			
	High special education needs	Moderate special education needs	On referral	No special education needs
Average (scale score units)	95	93	109	113
SD (scale score units)	27	19	22	18
N	9	95	85	1716

The average score for Year 8 students in Knowledge and Communication of Science Ideas was 95 scale score units for students with high special education needs, 93 for students with moderate special education needs, and 109 for those who were on referral. The middle 50 percent of students with moderate special education needs typically demonstrated the competencies described for Year 4 and was also beginning to gain knowledge of more abstract science, to notice simple patterns in data and make basic inferences from these. They demonstrated a developing understanding of scientific thinking, process and vocabulary. The middle 50 percent of the on referral group typically displayed the competencies described for Year 8 students in Chapter 3.

Table 7.6 shows how Year 8 students with special education needs performed on the science measure in terms of the curriculum levels. Over 50 percent of Year 8 students with high or moderate special education needs achieved within Developed Level 1 and 2. About 30 percent of students with high or moderate special education needs achieved at curriculum Level 3 and 4 and above. This result contrasts with the on referral group where, similar to the no special education needs group, over 60 percent of students achieved at Level 3 and 4.

Table 7.6 Percentage of Year 8 students with different categories of special education needs and all students achieving within the different science curriculum levels

	Knowledge and Communication of Science Ideas			
	High special education needs (%)	Moderate special education needs (%)	On referral (%)	All students (%)
Developed Level 3 and 4 and above	22	2	21	19
Emerging Level 3 and 4	11	28	40	47
Developed Level 1 and 2	56	64	34	32
Emerging Level 1 and 2	11	6	5	2

Table 7.7 displays the differences in scale scores between groups of students at Year 8 and their effect sizes. The difference in achievement between students with moderate special education needs and those with no special education needs was about 1.0 at Year 8. There was no significant difference in achievement between students who were on referral or had no special education needs.

Table 7.7 Year 8 difference in achievement between categories of special education needs and no special education needs

	Knowledge and Communication of Science Ideas	
	Scale score difference	Effect size
Moderate special education needs/No special education needs	**20**	**-1.05**
Moderate special education needs/On referral	**15**	**-0.76**
On referral/No special education needs	4	-0.22

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

4. Comparison of Year 4 and Year 8 student achievement in science 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 for the Knowledge and Communication of Science Ideas scale. The average score and the variation within the scores for each of the special needs groups was more dispersed at Year 8 than at Year 4.

On average, Year 8 students with special education needs had higher achievement scores than Year 4 students. However, similar to the full national student group, there was considerable overlap in the achievement of Year 4 and Year 8 students.

Students with high special education needs, on average, scored lower than those with moderate special education needs at Year 4, but at a similar level at Year 8. Students who were on referral or had no special education needs scored, on average, at a higher level than the high and moderate special education needs groups at both year levels.

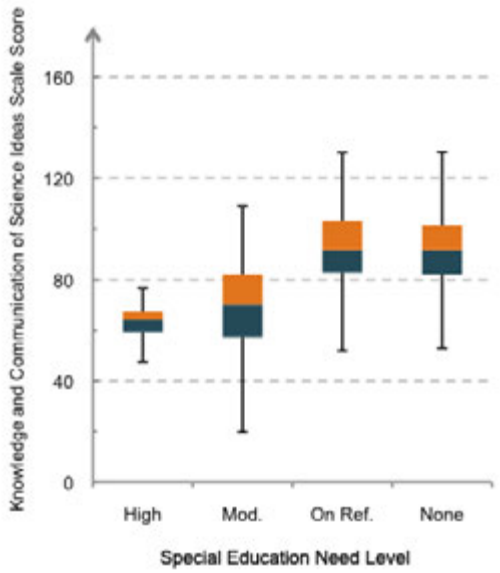


Figure 7.1 Achievement of Year 4 students with special education needs for Knowledge and Communication of Science Ideas (Mod.=Moderate, Ref.=Referral)

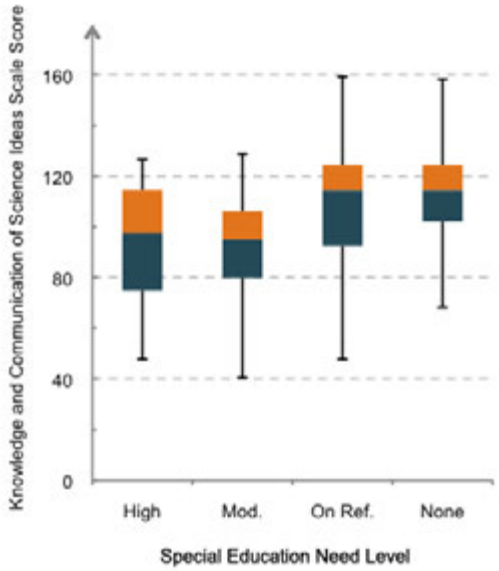


Figure 7.2 Achievement of Year 8 students with special education needs for Knowledge and Communication of Science Ideas (Mod.=Moderate, Ref.=Referral)

The average score for both Year 4 and Year 8 students with moderate special education needs was within Developed Level 1 and 2 of the NZC for Knowledge and Communication of Science Ideas. However, at Year 4, the average score for this group was at the lower end of Developed Level 1 and 2, and at the higher end at Year 8. The results for Year 4 students are in line with NZC end of year expectations. However, those for Year 8 are below the curriculum expectations for this level (Developed Level 3 and 4). The average for All Students was within Emerging Level 3 and 4.

Table 7.8, on the following page, displays, for the different categories of special education needs, the differences between Year 4 and Year 8 students in scale score units and effect sizes. 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.

The differences between Year 4 and Year 8 students in the categories of moderate special education needs and no special education needs generated effect sizes of at least 1.20. These results suggest that on average, students with special education needs are progressing from Year 4 to Year 8 at a similar rate to those with no special education needs. The effect size of the difference between scores for students on referral was not significantly lower at 0.85. The on-referral group includes students who require assessment and intervention. As such, it represents students whose current challenges have not yet been planned for and managed.

Table 7.8 Difference in science achievement by category of special education needs and no special education needs[35]

	Difference between Year 4 and Year 8 on Knowledge and Communication of Science Ideas	
	Scale score difference	Effect size[35]
Moderate special education needs	24	**1.25**
On referral	18	**0.85**
No special education needs	23	**1.20**

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

5. Year 4 and Year 8 student Attitude to Science

Figure 7.3 and Table 7.9 display the Year 4 and Year 8 scores on Attitude to Science and the differences in attitude between the year levels for students in the different categories of education needs. Average Attitude to Science was similar across all groups of students within each year level, and declined slightly overall from Year 4 to Year 8. Overall differences between Year 4 and Year 8 were similar for the moderate special education needs, on referral and no special needs groups.

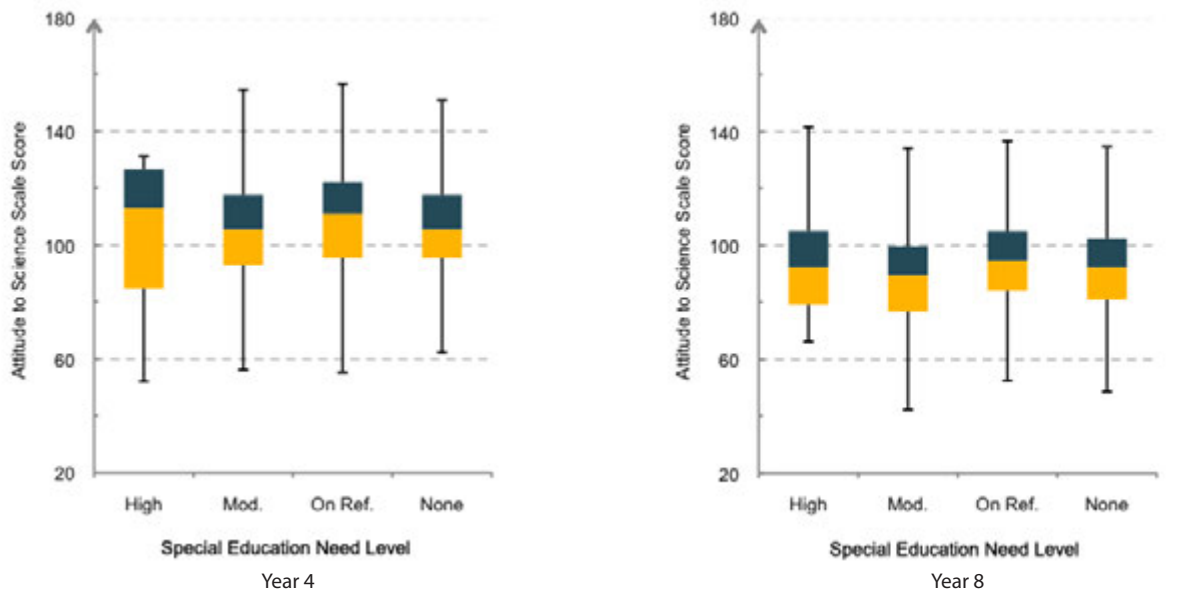


Figure 7.3 Year 4 and Year 8 student scores on Attitude to Science for different categories of special education needs (Mod.=Moderate special education needs, On Ref.=On referral)

Table 7.9 Year 4 and Year 8 student difference in Attitude to Science for different categories of education needs and no special education needs

	Difference between Year 4 and Year 8 on Attitude to Science							
	High special education needs		Moderate special education needs		On referral		No special education needs	
	Year 4	Year 8	Year 4	Year 8	Year 4	Year 8	Year 4	Year 8
Average (scale score units)	103	94	105	88	111	95	108	93
SD (scale score units)	30	21	22	20	26	20	22	18
N	8	11	161	100	76	87	1799	1777
Scale score difference	9		17		16		15	
Effect size	*		**-0.81**		**-0.72**		**-0.78**	

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

* Effect size is not reported for the high special education needs group due to the small sample size

[35] Effect size in this table is reported as Mean $_{\text{Year 8}}$ – Mean $_{\text{Year 4}}$

6. Opportunities to learn science

Students were asked to identify how often they were involved in a range of science learning activities at school. Appendix 4 shows the distribution of responses for students with high special education needs, moderate special education needs, students on referral and those with no special education needs. The range and frequency of learning experiences reported by students with special education needs were very similar to those for students on referral or with no special education needs. The most frequently reported activities at Year 4 were using what they have learned from their family/whānau/community, listening to their teacher talk about science, finding information by themselves for their science topic.

7. Benchmarking success for students with special education needs

This section contrasts the profiles of Year 4 and Year 8 students with different categories of special education needs who scored above the national average at their year level. As for Māori and Pasifika students, they are compared with the students from the All Student group who also scored above the national averages for Year 4 and Year 8 respectively, on the Knowledge and Communication of Science Ideas scale. The 2012 national average serves as a benchmark to compare results for different groups in this year. It may also be used to compare science results from future cycles of NMSSA assessment.

Tables 7.10 and 7.11 show the number and percentage of Year 4 and Year 8 students with special education needs who scored above the benchmarks for their year, and the level and spread of their scores. At Year 4, 17 percent of students with moderate special education needs and no students with high special education needs scored above the benchmark. The percentage of students on referral that scored above the benchmark was essentially the same as for All Students (58 percent compared with 56 percent).

At Year 8, the pattern of achievement above the benchmark was similar overall to Year 4, apart from the high special education needs group where a very small number of students influenced results.

Table 7.10 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			
	High special education needs	Moderate special education needs	On referral	No special education needs
Number above benchmark (and total group)	0 (of 8)	27 (of 162)	43 (of 74)	1170 (of 2076)
Percentage of respective group	0%	17%	58%	56%
Average (scale score units)*		100		102
SD (scale score units)		10		11

*the groups of students with special education needs have been combined

Table 7.11 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			
	High special education needs	Moderate special education needs	On referral	No special education needs
Number above benchmark (and total group)	3 (of 9)	16 (of 95)	44 (of 85)	1022 (of 1914)
Percentage of respective group	33%	17%	52%	53%
Average (scale score units)*		123		126
SD (scale score units)		10		11

*the groups of students with special education needs have been combined

Figures 7.4 and 7.5 contrast the profiles of students with special education needs who scored above the national average with those of all students, by gender, Attitude to Science and school decile. The profile of students with special education needs was created by combining the three needs groups because of the small numbers in the individual categories. At both year levels in the above benchmark groups there were proportionately more boys than girls in the special education needs group compared with All Students.

At both year levels the above benchmark groups of students with special needs and All Students showed similar patterns with respect to Attitude to Science. At Year 4, about 40 percent of students came from each of the middle and highest Attitude to Science groups, with the balance coming from the lowest group. At Year 8, about 50 percent were from the middle group and approximately 30 percent from the lowest attitude group. These results may reflect the fact that attitude declined from Year 4 to Year 8 for All Students.

Similarly to the national group, most special education needs students scoring above the national mean came from mid or high decile schools. At Year 8, a majority of students with special education needs attended mid decile schools.

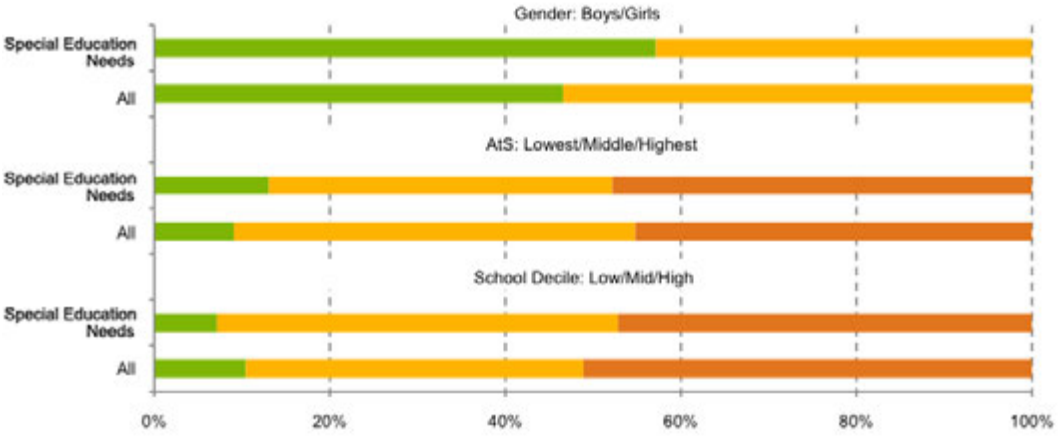


Figure 7.4 Percentage of Year 4 students with special education needs and All Students scoring above the national mean in science by gender, Attitude to Science and school decile (AtS=Attitude to Science)

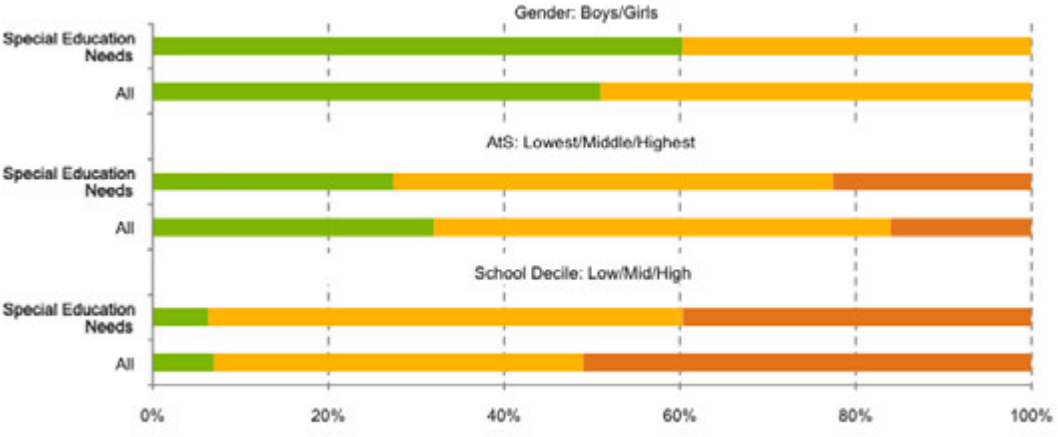


Figure 7.5 Percentage of Year 8 students with special education needs and All Students scoring above the national mean in science by gender, Attitude to Science and school decile (AtS=Attitude to Science)

APPENDIX 1:
National Monitoring Study of Student Achievement 2012–2013

Samples for 2012

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-five students were randomly selected from each school making 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 2012, the MoE 2011 school returns for Year 3 and Year 7 respectively were used.

Sampling of schools

The following bullet points describe the sampling algorithm:

- From the complete list of NZ schools select two datasets – one for Year 3 students and the other for Year 7 students.
- Exclude:
  - Schools which have fewer than 8 Year 3[7] students
  - Private schools
  - Special schools
  - Correspondence School
  - Secondary schools that do not have Year 3 or 7 students
  - Kura Kaupapa Māori.
- Stratify the sampling frame by region and within that by quintile[36] (decile bands).
- Within each region by quintile stratum order schools by Year 3 [7] roll size[37].
- Arrange strata alternately in increasing and decreasing order of roll size[38].
- Select a random starting point.
- From the random starting point cumulate the Year 3[7] roll, continuing cyclically at start of file.
- Calculate the sampling interval as
  - Total number of Year 3[7] students / 100 (number of schools required in sample).
- 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.

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 its replacement school (next on list).
- Repeat the process for each school selected in both samples.

[36] Decile 1 and 2 = Quintile 1; Decile 3 and 4 = Quintile 2; Decile 5 and 6 = Quintile 3; Decile 7 and 8 = Quintile 4; Decile 9 and 10 = Quintile 5.

[37] Roll size refers to the year level in question i.e. roll size for Year 3 [7] students

[38] 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.

The sample frames constituted 1439 schools for Year 3 and 1234 schools for Year 7 after exclusions had been applied. One school was listed in both samples. It was retained in the Year 4 sample and replaced in the Year 8 sample.

Schools were then 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 not of a similar profile, re-select by going to one row above the school withdrawn.
- Verify profile. If not similar, select school two rows below the school withdrawn. Continue in this sequence until a substitute is found.

In total, 77 schools (34 at Year 4 and 43 at Year 8) were approached to participate in NMSSA either as part of the original sample or as a replacement school and declined to do so, or withdrew after agreeing to participate. Sixteen schools were unable to be replaced due to lack of available time before school visits commenced. This resulted in a slightly reduced sample of schools overall.

The achieved samples of schools

The participation rate of schools before substitution was 66 percent at Year 4 and 57 percent at Year 8. After substitution, the achieved sample of 93 schools at Year 4 represented a participation rate[39] of 93 percent; and the achieved sample of 91 schools at Year 8 represented a response rate of 91 percent[40].

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, very limited English language). 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[8] (in 2012). The lists were arranged alphabetically. 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 25 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 five students next on the list were selected as 'reserves' for potential replacements if required.
- The school lists of selected students were returned to schools and letters of consent were sent to the parents of all students.
- The children of parents who declined to have their child participate were withdrawn from the list. Principals also identified additional students for whom the experience would be inappropriate (e.g. students with very high needs, students with very limited English language, or students who had been incorrectly listed as Year 3 or 7 students).
- Prior to the start of school visits, withdrawn students were replaced by the student with the next rank on the school's student sample list. Students continued to be replaced 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 with student 9 and/or 10 only.
  - any of students 9 – 25 were absent or withdrawn (e.g. by principal) on the first day the TA replaced from 26 - 30 using 26 first, then using progressively down the list. Students 26 - 30 were not allowed to be included in the individual sample.
- If students were absent or withdrawn (e.g. by principal) after the start of the assessment programme, no replacements were made.

[39] School participation rate is defined as the number of schools that participated (the achieved sample) as a percentage of the number of schools required.

[40] Due to the educational political climate at the time it was difficult to recruit schools.

The achieved samples of students at Year 4

Table A1.1 shows that at Year 4 initial lists with 2156 randomly selected students were returned to schools. Principals identified 156 students for whom the experience would be unsuitable. The 'eligible' sample was reduced to 2000. Forty-seven students were withdrawn from the study by parents. Substitutions were selected for 157 students, and not available for 26.

The achieved group-administered sample included 2096 students representing a participation rate[41] of 90 percent. The achieved individual sample at Year 4 was 736 students representing a participation rate of 92 percent. The combined school and student participation rates for the two samples were 84 percent and 86 percent respectively.Table A1.2 contrasts the characteristics of the samples with the population.

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

Table A1.1 The selection of Year 4 students for the group-administered sample

	N
Intended sample of students	2156
Students withdrawn by principal before sample selected	156
Eligible sample	2000
Students withdrawn by parents after sampling	47
Supplement students used	157
Students for whom there were no substitutes	26
Achieved sample	2096

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

	Population	Group-administered sample n = 2096	Individual sample n = 736
	%	%	%
Gender			
Boys	51	50	52
Girls	49	50	48
Ethnicity			
European	54	58	57
Maori	23	19	20
Pasifika	11	11	13
Asian	10	10	10
Other	3	2	2
School Decile			
Low	26	21	24
Middle	34	38	38
High	40	41	39
School Type			
Contributing (Year 1-6)	55	58	55
Full Primary (Year 1-8)	40	41	44
Composite (Year 1-13)	5	1	1
MOE Region			
Central North	21	17	17
Central South	18	19	21
Northern	39	42	40
Southern	22	21	22

* Rounding to integers means that percentages do not always add up to 100 percent

[41] Student participation rate is defined as the number of students assessed (the achieved sample) as a percentage of the total number of participating students who were originally selected, substitute students, originally selected students who did not participate where there were substitute students or not.

The achieved samples of students at Year 8

Table A1.3 shows that at Year 8 initial lists with 2128 randomly selected students were returned to schools. Principals identified 71 students for whom the experience would be unsuitable. The 'eligible' sample was reduced to 2057. Forty-four students were withdrawn from the study by parents. Supplements were selected for 281 students, and not available for 54.

The achieved group-administered sample included 2014 students representing a participation rate of 82 percent.

The achieved individual sample at Year 8 was 719 students representing a participation rate of 90 percent. The combined school and student participation rates for the two samples were 75 percent and 82 percent respectively.

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

Table A1.3 The selection of Year 8 students for the group-administered sample.

	N
Intended sample of students	2128
Students withdrawn by principal before sample selected	71
Eligible sample	2057
Students withdrawn by parents after sampling	44
Supplement students used	281
Students for whom there were no substitutes	54
Achieved sample	2014

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

	Population	Group-administered sample n = 2096	Individual sample n = 736
	%	%	%
Gender			
Boys	51	50	49
Girls	49	50	51
Ethnicity			
European	56	61	62
Maori	22	18	19
Pasifika	10	8	8
Asian	9	10	8
Other	3	2	3
School Decile			
Low	22	18	18
Middle	42	44	44
High	36	38	38
School Type			
Full Primary (Year 1-8)	35	38	44
Intermediate	47	40	36
Secondary (Year 7-13)	14	14	13
Composite (Year 1-13 & 7-10)	4	7	7
MOE Region			
Central North	22	24	25
Central South	17	18	19
Northern	39	35	33
Southern	22	24	23

* Rounding to integers means that percentages do not always add up to 100 percent

Should weights be applied to the NMSSA sample?

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

Integrity of demographic data available for weighting

At the time of investigation the only ethnicity data we had was approximate. To get full ethnicity data for each school involved (from ENROL, for instance) would have exceeded our time constraints. We used the MoE school demographic files, which carry ethnicity data only as a school variable. The proportions of NZ European, Māori, Pasifika and Asian students are specified at school level only. This means, for example, that the proportion of Māori students in a school in Year 4 was approximated by the overall proportion of Māori students for the whole school. The outcomes of this investigation reflect this approximated data. We also do not know how ethnicity has been recorded on the MoE files. It appears to be prioritised ethnicity which is at odds with the analyses by ethnicity in NMSSA.

Other weighting issues

The sample numbers and percentages in the previous sections show that a reasonably representative sample has already been achieved. In general, weighting a sample should not be regarded as a "fix all" method which will always remove bias from estimates.

Serious deviations from representativeness in the sample may cause sample weights to become very small or very large. Under-represented subgroups will tend to have large weights applied. In this case we would have to assume that the under-sized sample subgroup is actually representative of the population subgroup. The smaller the sample subgroup the less sure we can be that this is the case.

Weighting

In this investigation weights were calculated for Quintile x Gender x Māori/Non-Māori classes. There were 20 weighting classes at each year level.

Weight = Class probability$_N$ / Class probability$_S$

where

Class probability$_N$ = P(belonging to quintile 1 – 5) * P(being M/F) * P(being Māori/Non-Māori) in the population,

and

Class probability$_S$ = P(belonging to quintile 1 – 5) * P(being M/F) * P(being Māori/Non-Māori) in the sample

Note: Subscript N denotes "national", and subscript S denotes "sample"

The largest weight at Year 4 was 2.9, and at Year 8 the largest weight was 2.2.

Results

- Weighting would be unlikely to make a substantial difference to the national averages reported
- Weighting would be unlikely to make a substantial difference to the results reported by gender
- Weighting would be unlikely to make a substantial difference to the results reported by decile
- Weighting may make a slight difference to results by the Māori/non-Māori subgroup

The differences for the Māori subgroup indicated that levels of science achievement in this subgroup may be slightly under-estimated. However, it is important to note that the weights have been calculated using approximated ethnicity data. The amount of difference to results in this round of NMSSA incurred by not using sample weights would be very unlikely to change overall inferences.

The possibility of weighting would need to be looked into at a much earlier stage in future rounds of the NMSSA if an accurate and robust weighting procedure is to be carried out to remove sample bias.

Table A1.5 Composition of the Year 4 and Year 8 Māori samples for science

	Knowledge and Communication of Science and Ideas		Nature of Science	
	N	%	N	%
Year 4 Boys	235	55	90	58
Girls	188	45	64	42
Total	**423**		**154**	
Year 8 Boys	179	47	66	47
Girls	199	53	74	53
Total	**378**		**140**	

Table A1.6 Composition of the Year 4 and Year 8 Pasifika samples for science

	Knowledge and Communication of Science and Ideas		Nature of Science	
	N	%	N	%
Year 4 Boys	111	42	47	44
Girls	149	58	59	56
Total	**260**		**106**	
Year 8 Boys	98	45	32	45
Girls	118	55	39	54
Total	**216**		**71**	

Table A1.7 Composition of the Year 4 and Year 8 samples of students with special education needs and the comparison group of those with no special education needs for science

	Year 4		Year 8	
	N	%	N	%
High Needs	8	<1	9	<1
Moderate Needs	162	8	95	5
On Referral	74	4	85	4
No Needs	1820	88	1716	90
Total	**2064**	**100**	**1905**	**100**

APPENDIX 2: Frameworks for the Group-administered and Individual Science Assessments

1. Framework for the science group-administered assessment: Knowledge and Communication of Science Ideas

The following frameworks were developed from the science assessment plan. They formed the specifications for preparing the group-administered assessment in Knowledge and Communication of Science Ideas at Year 4 and Year 8 respectively.

Table A2.1 Year 4 framework

Science claim	**Students can communicate their developing ideas about the natural world and engage with a range of science texts.**	
Sub claims	**Students will be able to:**	**Students will know:**
Written text Students can describe what they notice about the natural world.	• Use rich vocabulary to describe precisely • Attend to multiple elements • Observe accurately • Sequence events in logical order	Living World • All living things need food, water, air, warmth and shelter to survive. • Living things are adapted to live in a particular environment. • There are lots of different living things in the world. Planet Earth and Beyond • Planet Earth provides living things with air, water and shelter. • Planet Earth's features are changed by weather, earthquakes, volcanic eruptions, water, erosion and people. Any changes that occur to or in an environment affect everything living there. • Planet Earth's light and heat come from the sun. Physical World • A shadow forms on a surface when an object is between a light source and the surface. • Heat travels from one place to another. It travels through some materials more quickly than others. • Pushes and pulls make objects move. Material World • Different materials have different properties. • Water exists in 3 states – solid, liquid and gas. The state is dependent on its temperature. • A material's properties affect how it interacts with other things.
Students can construct simple explanations about the natural world.	• Use simple connectives to denote cause and effect or to justify (when, because, so, etc.) • Use evidence from their experience to justify their ideas	
Diagrams Students can construct and read simple scientific diagrams.	• Complete and interpret a simple diagram • Recognise that labels and headings add important information to a diagram	
Tables Students can construct and read data sets in a simple table.	• Read data from a table • Identify simple patterns • Use data headings • Draw conclusions from a table • Put data sets into a table	
Graphs Students can recognise patterns in simple graphs.	• Read individual data points on a bar graph • Identify overall patterns on a bar graph • Draw conclusions from a bar graph	
Models Students can discuss simple scientific models.	• Interpret and construct simple food chains	

Table A2.2 Year 8 framework

Science claim	**Students can communicate their developing ideas about the natural world and engage with a range of science texts.**	
Sub claims	**Students will be able to:**	**Students will know:**
Written text Students can describe what they notice about the natural world.	• Use rich vocabulary, including some science vocabulary, to describe precisely • Attend to multiple elements • Write factually and objectively about what they observe • Sequence events in logical order	Living World • All living things need food, water, air, warmth and shelter to survive, and have different ways of meeting these needs. • Living things have strategies for responding to changes, both natural and human induced, in their environment. • Living things on Planet Earth change over long periods of time and evolve differently in different places. Scientists have particular ways of classifying living things. Planet Earth and Beyond • Planet Earth is made up of water, air, rocks and soil, and life forms, and these are our planet's resources. • Water is a finite resource that is constantly recycled. The water cycle impacts on our weather, the landscape and life on Earth. • Planet Earth is part of a vast solar system that consists of the Sun, planets and moons. Physical World • The sun is the original source of all energy on Planet Earth. • Heat, light, sound, movement and electricity are forms of energy. Energy can transform from one form to another. • Contact forces (e.g. frictional) and non-contact forces (e.g. gravity and magnetism) affect the motion of objects. Material World • Materials can be grouped in different ways according to their physical and chemical properties. • Matter is made up of tiny particles that behave differently as heat is added or removed. • When materials are heated or mixed with other materials the resulting changes may be permanent or reversible.
Students can construct simple explanations about the natural world.	• Use connectives to denote cause and effect or to justify (when, because, so, although, however, in order to, despite, etc.) • Use evidence from their experience to justify their ideas and begin to include reference to scientific explanations	
Diagrams Students can construct and read simple scientific diagrams.	• Complete and interpret increasingly complex diagrams • Recognise that labels and headings add extra information to a diagram • Recognise that diagrams are constructed to clarify aspects of the target concept	
Tables Students can construct and read data sets in a simple table.	• Read data from increasingly complex tables • Identify overall patterns • Use data headings • Draw conclusions from a table • Put data sets into a table	
Graphs Students can recognise patterns in simple graphs.	• Interpret different sorts of graphs • Read individual data points • Use x and y axis headings • Identify overall patterns • Draw conclusions from a graph	
Models Students can discuss simple scientific models.	• Interpret models, e.g. the water cycle, the solar system, food webs • Describe what the components of a model represent • Identify the weaknesses of a model	

2. Framework for the science individual assessments: Nature of Science

The following framework was developed from the science assessment plan to guide the development of the individual assessment tasks across the aspects of the Nature of Science and science contexts. Year 4 and Year 8 students responded to the same tasks.

Table A2.3 Framework for science individual assessment

Task Name Science	Understanding	Investigating	Communicating	Participating & contributing	Living World	Planet Earth	Physical World	Material World
Interview								
Mirror Mirror		X	X				X	
Plastic Wrap	X			X				X
Sort and Talk	X				X			
Investigations		X		X				
Space	X		X			X		
Performance								
Float and Sink		X					X	
Toy Boat		X	X					X

Table A2.4, on the following page, is an example of the specifications for one of the individual assessment tasks. Task development is an iterative process and this specification sheet is used to outline the intent of the task, the links to the science curriculum, specific questions (and justifications) and marking criteria.

Table A2.4 Task specifications

PLANNING QUESTIONS:		
• What we want to find out: Can students make careful observations from their exploration? Can they generate questions they can investigate? Can they plan an investigation? • How we would know: Are their observations relevant to the ideas being explored? Do they ask questions related to the concept? Do they plan an investigation that would be practical to conduct, and would provide more information about the concept? • How it could be done: Students are provided with equipment to explore the idea of floating and sinking. They are asked to record their observations, generate some questions they could investigate, and then choose one question and suggest how they could investigate it.		
FRAMEWORK/CURRICULUM LINKS:	**CURRICULUM LEVEL: • 2 • 3 • 4**	**LLP LEVEL: • 3 • 4 • 6 • 8**
Level 1, 2	Physical World: explore everyday examples of physical phenomena	
Level 3, 4	Physical World: explore, describe and represent patterns and trends for everyday examples of physical phenomena	
Level 2, 3, 4	Investigating in Science – being curious, making observations, generating questions to investigate, planning an investigating	
KEY COMPETENCIES	• THINKING • USING LANGUAGE SYMBOLS + TEXT • MANAGING SELF • RELATING TO OTHERS • PARTICIPATING + CONTRIBUTING	
SYNERGIES	• SCIENCE • LITERACY • NUMERACY	
TASK TITLE: Float and Sink		**CODE: 2011**
CURRICULUM AREA:	• WRITING • SCIENCE	**SUPPLIES:**
APPROACH:	• IN-DEPTH • SURVEY • Interview • Performance • Group/Team	Container (beaker) of water Objects to float and sink: labelled A, B, C, D
YEAR LEVEL:	• 4 + 8 • 4 • 8	Paper towels

Table A2.4 *continued.*

QUESTIONS	JUSTIFICATION / RATIONALE	MARKING CRITERIA
1. Use the equipment to find out about floating and sinking. Record 5 things you found out. 2. Think of some questions you could ask that would help you find out more about the idea of floating and sinking. 3. Write a question about floating and sinking that you could find the answer to by doing an investigation. You will not have to do this investigation so it could involve different equipment . 4. Record how you would do the investigation to find the answer to your question. You don't need to know the answer.	**Reasons for equipment:** give variety of shape and material; allow student to combine items; have items that can sink and float by making changes. Small heavy brass cube – idea of density. Bottle cap – plastic, float on top and just under water surface; sinks with washer or cube in it. Polystrene cube – bigger than metal cube. Metal washer – metal ,heavy, hole. Give 4 objects but ask for 5 observations so students do more than just drop each item in. Being curious, exploring ideas, making observations, opportunity to make generalisations, link new findings to prior knowledge. Asking questions that relate to a concept and would provide new learning. Ask a question that could lead to an investigation. Design an investigation.	**Quality of observations:** relate to equipment; itemised or generalisations; shows evidence of exploring with variables e.g sitting cube on bottle cap or discovering how same object can be made to sink and float. **Quality of questions:** questions not statements; related to concept; relate directly to equipment or are more generalised; variety of questions (how, why, what, if). **Quality of question chosen:** relates to concept; could be investigated by the student; closely related to exploration equipment or is more creative. **Design of investigation:** includes equipment; clear instructions about how to conduct it; considers design elements such as repeat trials; control variables as appropriate; suggests how the conclusion will be made, e.g. item will sink.

APPENDIX 3: Alignment of the Science Scales to the New Zealand Science Curriculum

Knowledge and Communication of Science Ideas

This appendix describes the process undertaken to link the levels of performance described in the science curriculum with the measures of performance provided by the Knowledge and Communication of Science Ideas scale.

The bank of questions used in the group-administered assessment probed knowledge and skills relevant to several curriculum levels. This made it possible to define regions on the scale that align with performance expectations described by the curriculum at Levels 1 to 4.

The Bookmarking Procedure

The bookmarking method was used to align the Knowledge and Communication of Science Ideas scale with the curriculum. The alignment exercise was carried out by a panel of eight New Zealand science education experts in a workshop style session over one day.

The introduction

- The NMSSA science framework which informed the development of the group-administered science assessment and its relevance to the science curriculum was carefully explained.
- The intended methodology was also carefully explained so that the science education experts could understand and validate the process in hand.
- The panel members completed a mock assessment made up of some of the questions from the item bank. This gave them a taste of the skills and knowledge required to answer the questions, and a chance to form a view on what the questions were probing, without first seeing the official version.
- Each panel member was given an ordered item booklet. The booklets contained all items used in the assessments and the items were presented in order of difficulty, from easiest to most difficult. Each item was presented on a separate page along with its purpose, category, marking rubric and scoring guide.
- Ongoing discussion and questions were actively encouraged throughout the day.

Finding cut-points

The overall task of the panel was to identify a series of boundaries (cut-points) at which one curriculum level progresses to the next.

Each cut-point was considered separately. The first task was to find a point on the scale that defined the line between Curriculum Level 1 and 2, and Curriculum Level 3 and 4. The process is laid out in detail in the following bullet points. Determination of each of the three cut-points followed a similar process.

- Panel members were asked to imagine a group of minimally competent students at Level 3 and 4; that is, students who are achieving just higher than Level 1 and 2, but only just making it into Level 3 and 4. Working through each item in the ordered item booklet in turn, panel members considered the question:

  Would these minimally competent students have at least a 70 percent chance answering this item correctly?

- If the answer was 'yes', they moved onto the next question in the booklet, and so on until they came to an item where the answer was 'no'. That is, the minimally competent students would be judged to have less than a 70 percent chance of answering this item correctly. A bookmark was placed between the last 'yes' item and the first 'no' item.
- Although discussion and questions were encouraged in general, all bookmarking judgements were made completely independently.
- Page numbers for selected cut-points from each of the panel members were recorded and entered into a program which interpreted the results on the NMSSA science scale so that the panel could see the range of their judgements. Some discussion followed, and panel members had the opportunity to update their judgements if they wished.
- The official cut-point was calculated as the mean of the cut-points established by each panel member in their final judgements.
- As a validation step, the distributions of Year 4 and Year 8 achievement were plotted against the cut-off so that panel members could see the impact of their judgements.

Cut-points were decided in the following order:

1. Entry to Curriculum Level 3 and 4.
2. Beyond Curriculum Level 3 and 4 i.e. probable entry level to Curriculum Level 5.[42]
3. Cut-off between Emerging Level 3 and 4 and Developed Level 3 and 4.
4. Cut-off between Emerging Level 1 and 2 and Developed Level 1 and 2.

Consistency among judges

All final judgements for all cut-points were made within one or two items of each other. It is worth noting that despite judgements being made independently, the level of agreement was high amongst panel members. This can be interpreted as high inter-rater reliability. The small number of judges made it possible for all panel members to contribute to some lively discussion, and engage effectively with each others' professional opinions.

Naming the regions of the scale

Panel members held a strong collective opinion on the naming of the scale regions with reference to the NZ science curriculum. They could see their way clearly to establishing the cut-points between

- Levels 1 and 2, and Levels 3 and 4

  and
- Levels 3 and 4, and Level 5

However, there is no difference between the descriptions for Levels 1 and 2 in the science curriculum, and very little difference between Levels 3 and 4. This poses a problem for establishing cut-points between Levels 1 and 2, and between Levels 3 and 4. The solution was to think of Levels 3 and 4 in two parts; a basic level and a more advanced level. Panels members agreed that they could visualise differences between the basic and more advanced levels, and after more debate were able to find a satisfactory cut-point between the two. A similar process was applied to Curriculum Levels 1 and 2.

Panel members stressed the importance of naming these scale regions appropriately. They were named:

- Emerging Level 1 and 2
- Developed Level 1 and 2
- Emerging Level 3 and 4
- Developed Level 3 and 4

Nature of Science

A series of extended individual tasks were used to measure students' understanding of the Nature of Science. The Nature of Science scale is based on responses to these tasks which have been marked using rubrics and scoring schemes that are directly related to curriculum levels. Tasks were carefully selected to allow for responses to be able to demonstrate performance at multiple curriculum levels. Many of the tasks were done by both Year 4 and Year 8 students, and some by one year group only.

An equipercentile scaling procedure was applied to align the Nature of Science scale to the curriculum. We made use of the results from the Knowledge and Communication of Science Ideas curriculum alignment exercise to achieve this.

Equipercentile equating can be justified if the scales involved are deemed to be comparable. In this case there is a strong correlation of 0.79 between students' scores on each scale. Person reliabilities were also high for both scales (Knowledge and Communication of Science Ideas: 0.87; Nature of Science: 0.90), suggesting that the scales are both robust and consistent enough to be compared in this way.

[42] The panel discussed and identified a cut-point on the scale that related to a level of achievement beyond curriculum Level 3 and 4. However, the assessment itself did not contain contextual material suitable for assessing achievement at Level 5 of the science curriculum. For this reason, this upper cut-point is not reported in the chapters. The highest reported level is 'Developed Level 3 and 4 and above'.

The equipercentile equating process

1. Curriculum alignment was achieved by analysing the subsample of students who had scores on **both** measures of science achievement - 735 students.
2. The distribution of scores on the Knowledge and Communication of Science Ideas scores, and Nature of Science scores were normalised i.e. the distributions were smoothed using the means and standard deviations of the data to represent the assumed underlying normal distribution.
3. The probabilities defining the curriculum cut-points in the cumulative normal Knowledge and Communication of Science Ideas distribution were identified.
4. These probabilities were then mapped to the normalised Nature of Science distribution to establish the curriculum level cut-points on the Nature of Science scale.

Figure A4.1 gives a graphical representation of the process. The cumulative distribution for the Knowledge and Communication of Science Ideas scale is shown by the solid blue line (Step 3), and the dotted blue lines mark the cut-points established by the curriculum alignment for this scale. The **height** of the blue cumulative distribution curve at these points gives the cumulative probabilities (horizontal dotted lines) which are then mapped onto the Nature of Science scale shown by the red lines (Step 4).

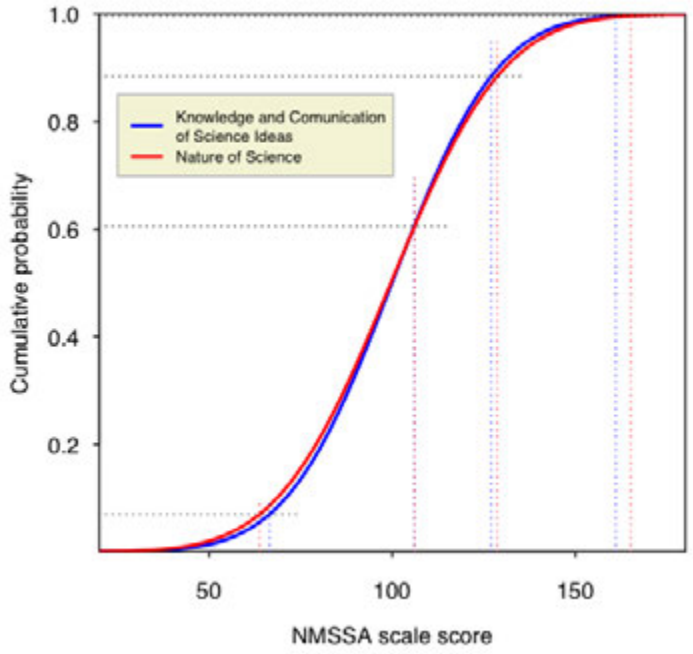


Figure A4.1 Aligning the Nature of Science Scale with the Knowledge and Communication of Science Ideas ScaleSummary

Summary

The final cut-points for curriculum levels on both scales are given in Table A4.1:

Table A4.1 Final cut-points showing the division of curriculum levels on the two science achievement scales

	Knowledge and Communication of Science Ideas	Nature of Science
	Scale score units	Scale score units
Emerging Level 1 and 2	up to 67	up to 64
Developed Level 1 and 2	>67 - 106	>64 - 106
Emerging Level 3 and 4	>106 - 127	>106 - 129
Developed Level 3 and 4 and above	>127	>129

APPENDIX 4:
Effect Sizes Analyses

1. All Students

1.1 Year 4 All Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas			Nature of Science			Attitude to Science		
Variable		Boys	Girls		Boys	Girls		Boys	Girls	
Gender	N	1035	1041		366	345		1026	1028	
	Mean	86.8	89.8		86.8	85.7		107.3	108.1	
	SD	20.9	20.5		18.8	21.0		23.5	20.1	
		NZ European	Māori	Pasifika	European	Māori	Pasifika	European	Māori	Pasifika
Ethnicity	N	1334	423	262	450	148	102	1325	420	258
	Mean	92.8	81.1	72.6	91.5	81.6	69.1	108.0	108.7	107.6
	SD	18.7	21.0	21.7	17.3	17.4	21.4	22.0	22.8	20.8
		Non-NZ Euro	Non-Māori	Non-Pasifika	Non-NZ Euro	Non-Māori	Non-Pasifika	Non-NZ Euro	Non-Māori	Non-Pasifika
Ethnicity	N	743	1653	1816	261	563	611	730	1634	1798
	Mean	80.2	90.1	90.5	77.3	87.5	89.2	107.1	107.4	107.7
	SD	21.7	20.3	19.6	20.8	20.3	18.1	21.4	21.6	22.0
		Low	Mid	High	Low	Mid	High	Low	Mid	High
School Decile	N	440	789	847	167	269	275	435	786	833
	Mean	74.4	89.0	94.8	72.7	87.0	93.9	109.0	107.9	106.8
	SD	22.1	18.4	18.5	20.9	18.0	16.4	22.8	21.7	21.4
		Contributing	Full Primary		Contributing	Full Primary		Contributing	Full Primary	
School Type	N	1200	851		390	314		1181	849	
	Mean	89.0	87.3		86.8	85.5		107.4	108.1	
	SD	20.3	21.4		19.4	20.3		21.7	21.7	
		Lowest	Middle	Highest	Lowest	Middle	Highest			
Attitude to Science	N	255	929	769	58	280	324			
	Mean	80.7	88.5	90.8	79.7	85.9	88.6			
	SD	20.6	20.7	19.7	17.3	19.6	19.8			
		Always	Often	Sometimes/ Never	Always	Often	Sometimes/ Never	Always	Often	Sometimes/Never
English Spoken at Home	N	1386	426	245	466	140	94	1376	420	239
	Mean	89.6	89.6	80.1	87.5	89.2	78.3	107.0	109.4	108.7
	SD	20.2	19.7	22.2	18.7	19.0	21.1	22.0	20.9	22.9

1.2 Year 4 All Students: Subgroup effect sizes and confidence intervals

		Knowledge and Communication of Ideas			Nature of Science			Attitude to Science		
Variable	Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Gender	Boys/Girls	-0.14	-0.23	-0.06	0.05	-0.09	0.20	-0.04	-0.12	0.05
Ethnicity	NZ Euro/Non-NZ Euro	0.62	0.53	0.71	0.74	0.59	0.90	0.04	-0.05	0.13
	Māori/Non-Māori	-0.43	-0.54	-0.33	-0.31	-0.49	-0.14	0.06	-0.05	0.16
	Pasifika/Non-Pasifika	-0.87	-1.00	-0.74	-1.02	-1.24	-0.79	-0.01	-0.13	0.12
School Decile	Low/Mid	-0.73	-0.85	-0.61	-0.73	-0.93	-0.54	0.05	-0.07	0.17
	Low/High	-1.01	-1.13	-0.89	-1.14	-1.34	-0.94	0.10	-0.02	0.22
	Mid/High	-0.31	-0.41	-0.21	-0.40	-0.57	-0.23	0.05	-0.05	0.15
School Type	Contributing/Full Primary	0.08	-0.01	0.17	0.06	-0.08	0.21	-0.03	-0.12	0.06
Attitude to Science	Lowest/Middle	-0.38	-0.51	-0.24	-0.34	-0.61	-0.07			
	Lowest/Highest	-0.50	-0.64	-0.36	-0.48	-0.75	-0.21			
	Middle/Highest	-0.12	-0.21	-0.02	-0.14	-0.30	0.02			
English Spoken at Home	Always/Often	0.00	-0.11	0.11	-0.09	-0.28	0.10	-0.11	-0.22	0.00
	Always/(Sometimes/Never)	0.45	0.31	0.59	0.46	0.23	0.69	-0.07	-0.21	0.06
	Often/(Sometimes/Never)	0.45	0.29	0.61	0.54	0.28	0.81	0.03	-0.13	0.19

1.3 Year 8 All Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas			Nature of Science			Attitude to Science		
Variable		Boys	Girls		Boys	Girls		Boys	Girls	
Gender	N	958	956		345	353		987	997	
	Mean	112.3	111.1		113.5	114.0		94.9	89.8	
	SD	19.7	18.6		20.8	19.4		18.3	17.2	
		European	Māori	Pasifika	European	Māori	Pasifika	European	Māori	Pasifika
Ethnicity	N	1272	353	206	465	135	69	1315	374	211
	Mean	115.8	101.8	96.9	118.2	107.3	98.3	92.0	88.2	92.4
	SD	17.4	17.9	19.7	18.4	17.5	21.8	17.5	18.9	18.6
		Non-NZ Euro	Non-Māori	Non-Pasifika	Non-NZ Euro	Non-Māori	Non-Pasifika	Non-NZ Euro	Non-Māori	Non-Pasifika
Ethnicity	N	642	1562	1708	233	563	629	669	1611	1773
	Mean	103.6	113.9	113.5	104.8	115.3	115.4	93.0	93.3	92.3
	SD	20.0	18.8	18.3	20.6	20.4	19.2	18.7	17.6	17.8
		Low	Middle	High	Low	Middle	High	Low	Middle	High
School Decile	N	345	829	740	130	304	264	357	864	763
	Mean	97.5	110.9	119.3	100.2	113.3	120.9	91.3	91.1	94.1
	SD	17.6	18.1	17.0	19.8	18.6	18.5	18.7	17.9	17.5
		Composite	Full Primary		Full Primary			Composite	Full Primary	
School Type	N	118	730		305			124	758	
	Mean	116.5	108.6		111.6			91.6	94.5	
	SD	19.0	18.9		19.7			18.9	17.5	
		Intermediate	Secondary		Intermediate	Secondary		Intermediate	Secondary	
	N	762	304		253	103		791	311	
	Mean	111.2	118.7		113.3	118.9		91.1	90.3	
	SD	18.9	18.5		20.5	18.5		17.9	18.2	
		Lowest	Middle	Highest	Lowest	Middle	Highest			
Attitude to Science	N	742	934	221	253	348	82			
	Mean	107.2	112.9	122.4	111.1	113.5	124.1			
	SD	17.7	19.1	19.7	17.7	21.4	18.1			
		Always	Often	Sometimes/ Never	Always	Often	Sometimes/ Never	Always	Often	Sometimes/ Never
English Spoken at Home	N	1521	286	102	566	89	39	1575	297	106
	Mean	113.3	106.6	103.2	115.6	108.7	99.0	91.6	94.2	97.4
	SD	18.3	20.1	23.9	18.8	21.5	25.0	17.8	18.3	17.6

1.4 Year 8 All Students: Subgroup effect sizes and confidence intervals

		Knowledge and Communication of Science Ideas			Nature of Science			Attitude to Science		
	Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Gender	Boys/Girls	0.06	-0.03	0.15	-0.02	-0.17	0.12	0.28	0.20	0.37
Ethnicity	NZ Euro/Non-NZ Euro	0.65	0.55	0.75	0.68	0.52	0.84	-0.05	-0.15	0.04
	Māori/Non-Māori	-0.66	-0.77	-0.55	-0.42	-0.60	-0.24	-0.28	-0.39	-0.16
	Pasifika/Non-Pasifika	-0.87	-1.02	-0.72	-0.83	-1.09	-0.57	0.01	-0.14	0.15
School Decile	Low/Mid	-0.75	-0.87	-0.62	-0.68	-0.89	-0.47	0.01	-0.20	0.22
	Low/High	-1.25	-1.38	-1.12	-1.08	-1.29	-0.87	-0.15	-0.37	0.06
	Mid/High	-0.48	-0.58	-0.38	-0.41	-0.58	-0.25	-0.17	-0.34	0.00
School Type	Comp/Full Primary	0.42	0.22	0.61	0.37	0.01	0.72	-0.16	-0.36	0.03
	Comp/Intermediate	0.28	0.09	0.48	0.28	-0.08	0.63	0.02	-0.17	0.22
	Comp/Secondary	-0.11	-0.33	0.10	0.02	-0.38	0.41	0.07	-0.14	0.28
	Full Primary/Intermediate	-0.14	-0.24	-0.03	-0.09	-0.25	0.08	0.19	0.09	0.29
	Full Primary/Sec	-0.54	-0.67	-0.41	-0.38	-0.60	-0.16	0.24	0.11	0.37
	Intermediate/Sec	-0.40	-0.53	-0.27	-0.29	-0.51	-0.06	0.05	-0.08	0.18
Attitude to Science	Lowest/Middle	-0.31	-0.40	-0.21	-0.12	-0.28	0.04			
	Lowest/Highest	-0.81	-0.96	-0.66	-0.72	-0.97	-0.47			
	Middle/Highest	-0.49	-0.64	-0.34	-0.53	-0.76	-0.31			
English Spoken at Home	Always/Often	0.35	0.22	0.48	0.34	0.11	0.58	-0.14	-0.26	-0.01
	Always/(Sometimes/Never)	0.48	0.25	0.70	0.76	0.39	1.12	-0.33	-0.52	-0.13
	Often/(Sometimes/Never)	0.15	-0.08	0.39	0.42	0.03	0.80	-0.18	-0.40	0.04

1.5 Year 8/Year 4 All students: Subgroup means, standards deviations and sample sizes

Knowledge and Communication of Science Ideas				Nature of Science		Attitude to Science	
		Year 4	Year 8	Year 4	Year 8	Year 4	Year 8
All students	N	2076	1914	711	698	2054	1984
	Mean	88.3	111.7	86.3	113.7	107.7	92.3
	SD	20.7	19.2	19.9	20.1	21.8	17.9
		Year 4 - Boys	Year 8 - Boys	Year 4 - Boys	Year 8 - Boys	Year 4 - Boys	Year 8 - Boys
Gender - Boys	N	1035	958	366	345	1026	987
	Mean	86.8	112.3	86.8	113.5	107.3	94.9
	SD	20.9	19.7	18.8	20.8	23.5	18.3
		Year 4 - Girls	Year 8 - Girls	Year 4 - Girls	Year 8 - Girls	Year 4 - Girls	Year 8 - Girls
Gender - Girls	N	1041	956	345	353	1028	997
	Mean	89.8	111.1	85.7	114.0	108.1	89.8
	SD	20.5	18.6	21.0	19.4	20.1	17.2
		Year 4 - EuropeanNZ	Year 8 - NZ European				
Ethnicity - European	N	1334	1272				
	Mean	92.8	115.8				
	SD	18.7	17.4				
		Year 4 - Māori	Year 8 - Māori				
Ethnicity - Māori	N	423	353				
	Mean	81.1	101.8				
	SD	21.0	17.9				
		Year 4 - Pasifika	Year 8 - Pasifika				
Ethnicity - Pasifika	N	262	206				
	Mean	72.6	96.9				
	SD	21.7	19.7				
		Year 4 - Low	Year 8 - Low				
Decile - Low	N	440	345				
	Mean	74.4	97.5				
	SD	22.1	17.6				
		Year 4 - Mid	Year 8 - Mid				
Decile - Mid	N	789	829				
	Mean	89.0	110.9				
	SD	18.4	18.1				
		Year 4 - High	Year 8 - High				
Decile - High	N	847	740				
	Mean	94.8	119.3				
	SD	18.5	17.0				

1.6 Year 8/Year 4 All Students: Differences, effect sizes and confidence intervals

	Knowledge and Communication of Science Ideas				Nature of Science				Attitude to Science			
	Difference*	Effect Size	Lower	Upper	Difference*	Effect Size	Lower	Upper	Difference*	Effect Size	Lower	Upper
All Students	23.4	1.18	1.24	1.11	27.4	1.37	1.48	1.27	-15.4	-0.77	-0.71	-0.83
Gender												
Boys	25.5	1.26	1.35	1.17	26.7	1.35	1.49	1.20	-12.4	-0.60	-0.51	-0.68
Girls	21.3	1.09	1.18	1.00	28.3	1.40	1.54	1.25	-18.3	-0.98	-0.89	-1.07
Ethnicity												
European	23.0	1.27	1.35	1.20								
Māori	20.7	1.07	1.21	0.93								
Pasifika	24.3	1.17	1.35	-0.99								
School Decile												
Low	23.2	1.17	1.31	1.03								
Mid	21.9	1.20	1.30	1.10								
High	24.5	1.38	1.48	1.28								

* Mean (Year 8) – Mean (Year 4)

2. Māori Students

2.1 Year 4 Māori Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas			Nature of Science		
Variable		Boys	Girls		Boys	Girls	
Gender	N	233	190		85	63	
	Mean	79.4	83.2		80.7	82.9	
	SD	19.7	22.3		15.7	19.5	
		Low	Mid	High	Low	Mid	High
School Decile	N	175	166	82	73	50	25
	Mean	73.9	84.1	90.4	75.2	83.0	97.6
	SD	21.7	17.9	20.3	16.9	13.9	14.2
		Contributing	Full Primary		Contributing	Full Primary	
School Type	N	244	177		87	60	
	Mean	82.6	79.1		83.2	79.3	
	SD	18.7	23.8		17.3	17.4	

2.2 Year 4 Māori Students: Subgroup effect sizes and confidence intervals

		Knowledge and Communication of Ideas			Nature of Science		
Variable	Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Gender	Boys/Girls	-0.18	-0.37	0.01	-0.12	-0.46	0.21
School Decile	Low/Mid	-0.51	-0.73	-0.30	-0.51	-0.86	-0.15
	Low/High	-0.78	-1.04	-0.53	-1.44	-1.88	-1.00
	Mid/High	-0.33	-0.60	-0.06	-1.04	-1.52	-0.55
School Type	Contributing/Full Primary	0.16	-0.04	0.36	0.22	-0.11	0.55

2.3 Year 8 Māori Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas			Nature of Science		
Variable		Boys	Girls		Boys	Girls	
Gender	N	166	187		63	72	
	Mean	102.4	101.3		106.8	107.7	
	SD	18.4	17.4		17.9	17.2	
		Low	Mid	High	Low	Mid	High
School Decile	N	124	174	55	43	66	26
	Mean	94.5	103.9	111.8	96.9	110.2	117.2
	SD	17.6	16.8	15.2	17.1	15.4	14.9
		Full Primary	Intermediate	Secondary	Full Primary	Intermediate	Secondary
School Type	N	155	147	38	62	56	14
	Mean	99.1	102.5	108.7	103.6	108.8	117.3
	SD	17.1	17.8	17.04	17.8	17.2	13.55

2.4 Year 8 Māori Students: Subgroup effect sizes and confidence intervals

		Knowledge and Communication of Ideas			Nature of Science		
Variable	Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Gender	Boys/Girls	0.06	-0.15	0.27	-0.05	-0.39	0.29
School Decile	Low/Mid	-0.55	-0.78	-0.32	-0.82	-1.21	-0.43
	Low/High	-1.06	-1.36	-0.75	-1.27	-1.75	-0.79
	Mid/High	-0.49	-0.79	-0.20	-0.47	-0.92	-0.02
School Type	Full Primary/Intermediate	-0.20	-0.42	0.03	-0.29	-0.66	0.07
	Full Primary/Secondary	-0.56	-0.92	-0.21	-	-	-
	Intermediate/Secondary	-0.35	-0.71	0.00	-	-	-

2.5 Year 8/Year 4 Māori Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas		Nature of Science	
		Year 4	Year 8	Year 4	Year 8
All Students	N	423	353	148	135
	Mean	81.1	101.8	81.6	107.3
	SD	21.0	17.9	17.4	17.5
		Year 4 - Boys	Year 8 - Boys	Year 4 - Boys	Year 8 - Boys
Gender - Boys	N	233	166	85	63
	Mean	79.4	102.4	80.7	106.8
	SD	19.7	18.4	15.7	17.9
		Year 4 - Girls	Year 8 - Girls	Year 4 - Girls	Year 8 - Girls
Gender - Girls	N	190	187	63	72
	Mean	83.2	101.3	82.9	107.7
	SD	22.3	17.4	19.5	17.2

2.6 Year 8/Year 4 Māori Students: Differences, effect sizes and confidence intervals

	Knowledge and Communication of Science Ideas				Nature of Science			
	Difference*	Effect Size	Lower	Upper	Difference*	Effect Size	Lower	Upper
All students	20.7	1.07	1.21	0.93	25.7	1.47	1.71	1.24
Gender								
Boys	23.0	1.21	1.40	1.01	24.1	1.56	1.89	1.23
Girls	18.1	0.91	1.11	0.71	24.8	1.35	1.69	1.01

* Mean (Year 8) – Mean (Year 4)

3. Pasifika Students

3.1 Year 4 Pasifika Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas			Nature of Science		
Variable		Boys	Girls		Boys	Girls	
Gender	N	113	149		46	56	
	Mean	70.7	74.1		71.2	67.5	
	SD	23.0	20.5		16.4	24.8	
		Low	Mid	High	Low	Mid	High
School Decile	N	169	61	32	63	27	12
	Mean	67.8	81.0	81.7	63.3	75.3	85.8
	SD	21.2	16.9	24.8	20.4	17.3	23.3
		Contributing	Full Primary		Contributing	Full Primary	
School Type	N	151	109		52	49	
	Mean	71.8	73.6		70.0	68.1	
	SD	22.7	20.3		25.1	17.0	
		Always	Often	Sometimes/Never	Always	Often	Sometimes/Never
English Spoken at Home	N	114	67	81	40	24	38
	Mean	71.5	77.9	69.9	74.4	71.7	62.0
	SD	23.0	18.7	21.5	20.3	18.0	22.9

3.2 Year 4 Pasifika Students: Subgroup effect sizes and confidence intervals

		Knowledge and Communication of Ideas			Nature of Science		
Variable	Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Gender	Boys/Girls	-0.16	-0.40	0.09	0.18	-0.21	0.57
School Decile	Low/Mid	-0.69	-0.97	-0.41	-0.64	-1.08	-0.20
	Low/High	-0.60	-1.00	-0.20	-1.03	-1.68	-0.38
	Mid/High	-0.03	-0.49	0.43	-0.52	-1.24	0.21
School Type	Contributing/Full Primary	-0.08	-0.33	0.16	0.09	-0.31	0.49
English Spoken at Home	Always/Often	-0.31	-0.60	-0.01	0.14	-0.36	0.64
	Always/(Sometimes/Never)	0.07	-0.21	0.36	0.57	0.13	1.02
	Often/(Sometimes/Never)	0.40	0.08	0.72	0.47	-0.03	0.97

3.3 Year 8 Pasifika Students: Subgroup means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas			Nature of Science		
Variable		Boys	Girls		Boys	Girls	
Gender	N	92	114		32	37	
	Mean	96.5	97.2		98.0	98.6	
	SD	20.9	18.8		21.6	22.2	
		Low	Mid	High	Low	Mid	High
School Decile	N	125	53	28	46	13	10
	Mean	94.2	96.6	109.3	94.4	100.3	113.5
	SD	16.7	23.1	21.4	20.3	20.7	25.1
		Full Primary	Intermediate	Secondary	Full Primary	Intermediate	
School Type	N	115	77	12	41	24	
	Mean	94.8	97.2	112.2	95.8	100.3	
	SD	20.9	17.3	18.61	23.8	17.5	
		Always	Often	Sometimes/Never	Always	Often	Sometimes/Never
English Spoken at Home	N	103	71	32	31	24	14
	Mean	104.3	91.9	84.2	107.3	95.6	82.9
	SD	16.5	20.2	18.9	18.3	22.8	

3.4 Year 8 Pasifika Students: Subgroup effect sizes and confidence intervals

		Knowledge and Communication of Ideas			Nature of Science		
Variable	Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Gender	Boys/Girls	-0.03	-0.31	0.24	-0.03	-0.50	0.44
School Decile	Low/Mid	-0.12	-0.46	0.23	-0.29	-0.91	0.33
	Low/High	-0.79	-1.23	-0.35	-0.84	-1.57	-0.11
	Mid/High	-0.57	-1.02	-0.12	-0.58	-1.41	0.26
School Type	Full Primary/Intermediate	-0.12	-0.41	0.16	-0.22	-0.70	0.27
English Spoken at Home	Always/Often	0.68	0.37	0.99	0.57	0.03	1.11
	Always/(Sometimes/Never)	1.14	0.73	1.55	1.34	0.72	1.97
	Often/(Sometimes/Never)	0.39	-0.02	0.81	0.62	-0.02	1.26

3.5 Year 8/Year 4 Pasifika Students: Means, standards deviations and sample sizes

		Knowledge and Communication of Science Ideas		Nature of Science	
		Year 4	Year 8	Year 4	Year 8
All Students	N	262	206	102	69
	Mean	72.6	96.9	69.1	98.3
	SD	21.7	19.7	21.4	21.8
		Year 4 - Boys	Year 8 - Boys	Year 4 - Boys	Year 8 - Boys
Gender - Boys	N	113	92	46	32
	Mean	70.7	96.5	71.2	98.0
	SD	23.0	20.9	16.4	21.6
		Year 4 - Girls	Year 8 - Girls	Year 4 - Girls	Year 8 - Girls
Gender - Girls	N	149	114	56	37
	Mean	74.1	97.2	67.5	98.6
	SD	20.5	18.8	24.8	22.2

3.6 Year 8/Year 4 Pasifika Students: Differences, effect sizes and confidence intervals

	Knowledge and Communication of Science Ideas				Nature of Science			
	Difference*	Effect Size	Lower	Upper	Difference*	Effect Size	Lower	Upper
All Students	24.3	1.17	1.35	0.99	29.2	1.35	1.66	1.05
Gender								
Boys	25.8	1.18	1.42	0.93	26.8	1.41	1.88	0.94
Girls	23.1	1.17	1.42	0.93	31.1	1.33	1.74	0.91

* Mean (Year 8) – Mean (Year 4)

4. Special Education Needs (SEN) Students

4.1 Year 4 Special Education Needs Students: Means, standards deviations and sample sizes

	Knowledge and Communication of Science Ideas					Attitude to Science				
	High Needs	Moderate Needs	On Referral	No Needs	All Needs	High Needs	Moderate Needs	On Referral	No Needs	All Needs
N	8	162	74	1820	244	8	161	76	1799	245
Mean	57.8	68.5	91.1	90.1	75.0	102.7	104.8	111.3	107.8	106.8
SD	21.4	20.7	19.9	19.8	23.1	29.8	22.3	26.2	21.6	23.9

4.2 Year 4 Special Educaiton Needs Students: Subgroup effect sizes and confidence intervals

	Knowledge and Communication of Science Ideas			Attitude to Science		
Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Moderate/On Referral	-1.11	-1.38	-0.84	-0.27	-0.55	0.02
Moderate/No Needs	-1.06	-1.23	-0.90	-0.14	-0.30	0.03
On Referral/No Needs	0.05	-0.18	0.28	0.15	-0.10	0.40
All Needs/No Needs	-0.70	-0.84	-0.56	-0.05	-0.15	0.12

4.3 Year 8 Special Education Needs Students: Means, standards deviations and sample sizes

	Knowledge and Communication of Science Ideas					Attitude to Science				
	High Needs	Moderate Needs	On Referral	No Needs	All Needs	High Needs	Moderate Needs	On Referral	No Needs	All Needs
N	9	95	85	1716	189	11	100	87	1777	198
Mean	94.5	93.3	108.7	113.0	100.3	94.1	87.9	94.5	92.5	91.1
SD	27.2	19.0	21.6	18.4	21.9	21.1	19.7	20.4	17.7	20.3

4.4 Year 8 Special Education Needs Students: Subgroup effect sizes and confidence intervals

	Knowledge and Communication of Science Ideas			Attitude to Science		
Comparison	Effect Size	Lower	Upper	Effect Size	Lower	Upper
Moderate/On Referral	-0.76	-1.05	-0.46	-0.33	-0.62	-0.05
Moderate/No Needs	-1.05	-1.26	-0.84	-0.25	-0.46	-0.04
On Referral/No Needs	-0.22	-0.45	0.02	0.11	-0.12	0.34
All Needs/No Needs	-0.63	-0.79	-0.47	-0.07	-0.38	-0.10

4.5 Year 8/Year 4 Special Education Needs Students: Means, standard deviations and sample sizes

		Knowledge and Communication of Science Ideas		Attitude to Science	
		Year 4	Year 8	Year 4	Year 8
No Needs	N	1820	1716	1799	1777
	Mean	90.1	113.0	107.8	92.5
	SD	19.8	18.4	21.6	17.7
High Needs	N	8	9	8	11
	Mean	57.8	94.5	102.7	94.1
	SD	21.4	27.2	29.8	21.1
Moderate Needs	N	162	95	161	100
	Mean	68.5	93.3	104.8	87.9
	SD	20.7	19.0	22.3	19.7
On Referral	N	74	85	76	87
	Mean	91.1	108.7	111.3	94.5
	SD	19.9	21.6	26.2	20.4
All Needs	N	244	189	245	198
	Mean	75.0	100.3	106.8	91.1
	SD	23.1	21.9	23.9	20.3

4.6 Year 8/Year 4 Special Education Needs Students: Differences, effect sizes and confidence intervals

	Knowledge and Communication of Science Ideas				Attitude to Science			
	Difference*	Effect Size	Lower	Upper	Difference*	Effect Size	Lower	Upper
No Needs	22.9	1.20	1.27	1.14	-15.3	-0.78	-0.71	-0.85
Moderate Needs	24.8	1.25	1.50	1.00	-16.9	-0.81	-0.56	-1.05
On Referral	17.6	0.85	1.16	0.54	-16.8	-0.72	-0.41	-1.03
All Needs	25.3	1.12	1.31	0.94	-15.7	-0.71	-0.52	-0.89

* Mean (Year 8) – Mean (Year 4)APPENDIX 5:
Achievement by school decile and student ethnicity

APPENDIX 5:
Opportunities to learn in science for students with special education needs

Year 4 students

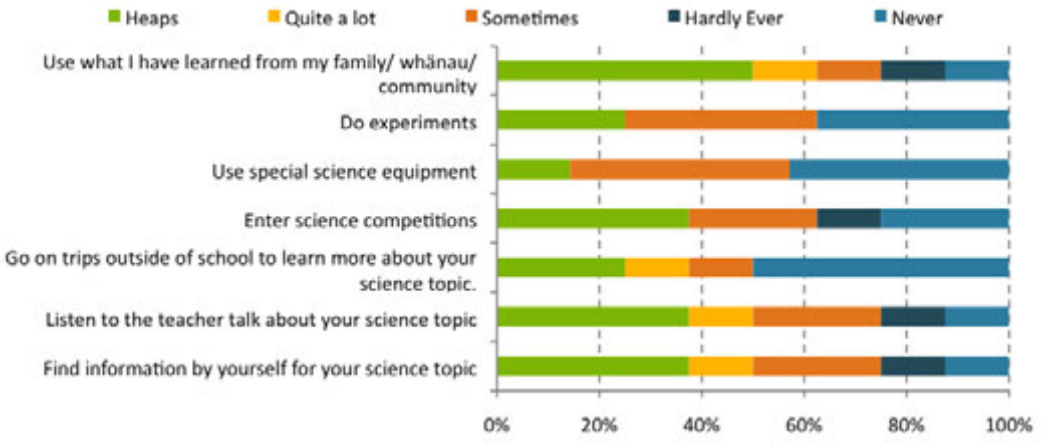


Fig A5.1 Year 4 Students: High special education needs

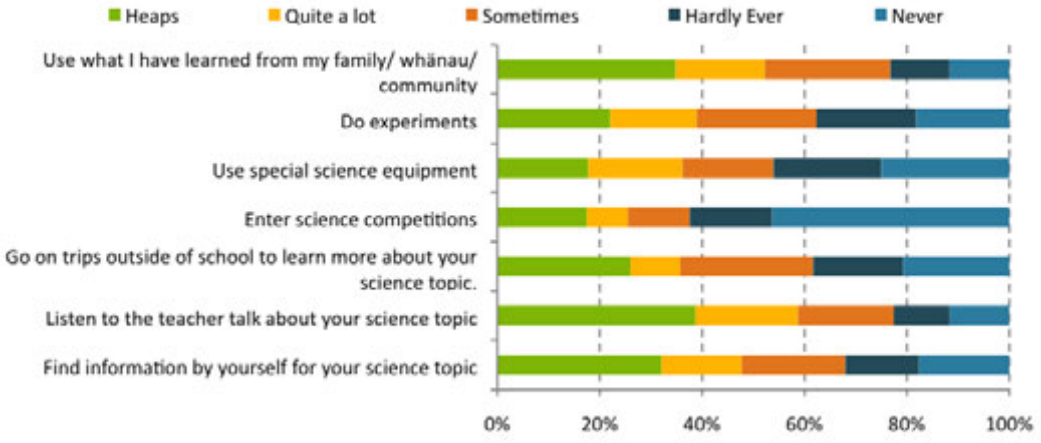


Fig A5.2 Year 4 Students: Moderate special education needs

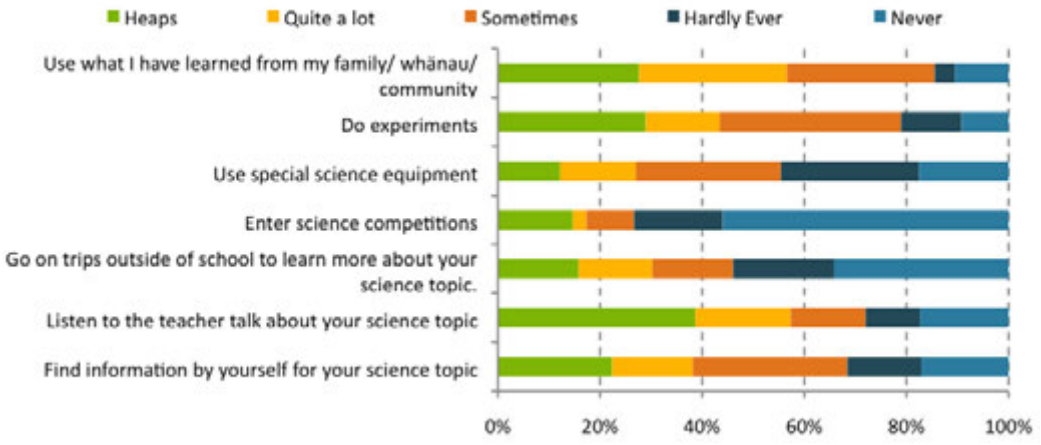


Fig A5.3 Year 4 Students: On referrral

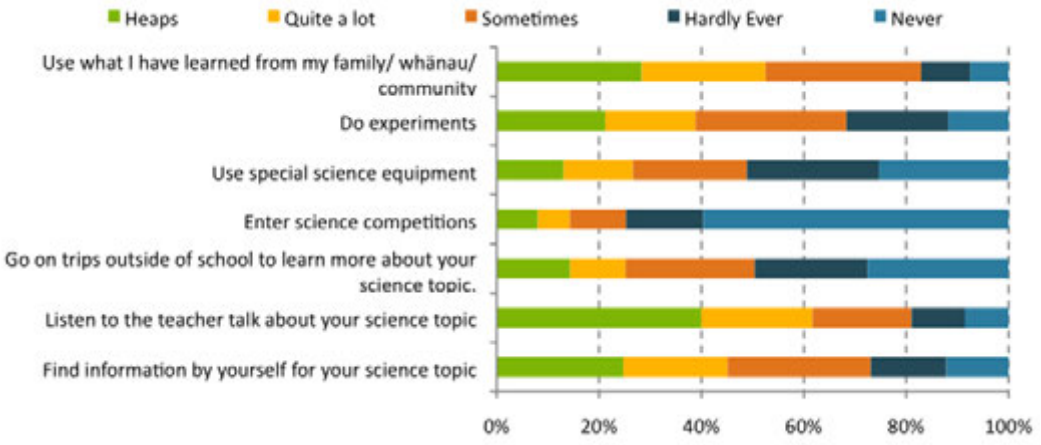


Fig A5.4 Year 4 Students: No special education needs

Year 8 students

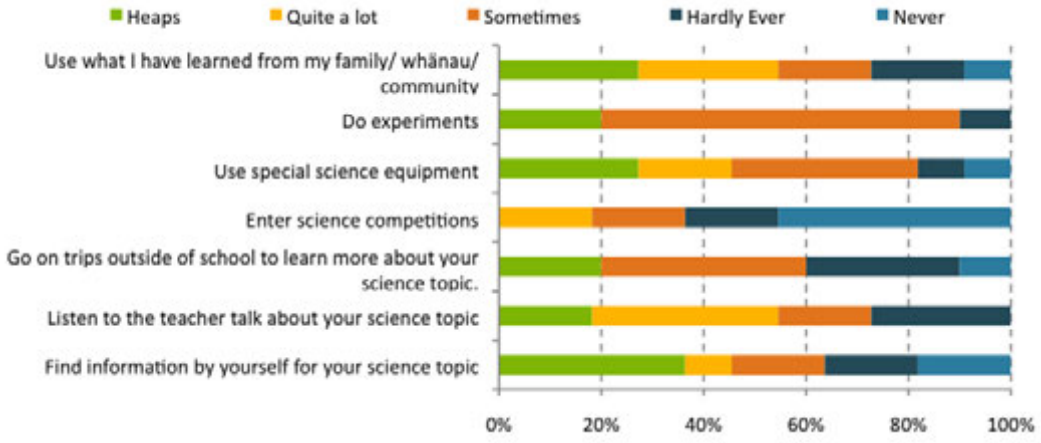


Fig A5.5 Year 8 Students: High special education needs

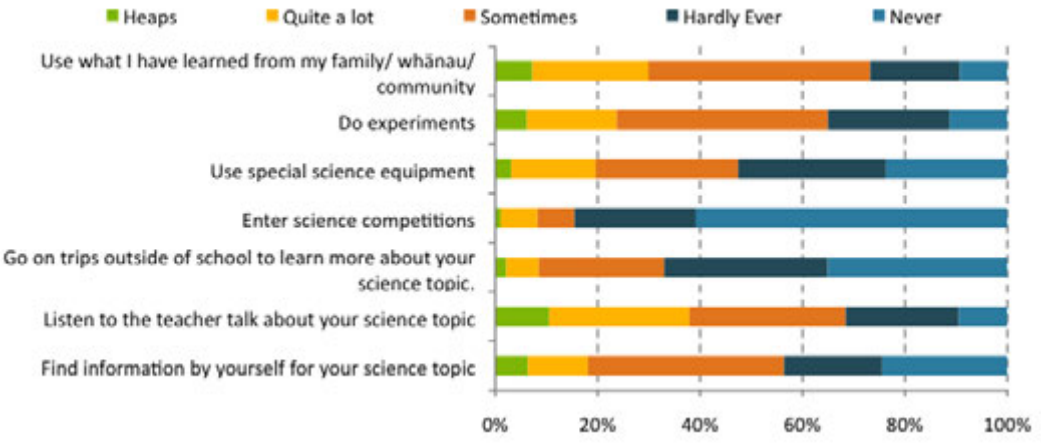


Fig A5.6 Year 8 Students: Moderate special education needs

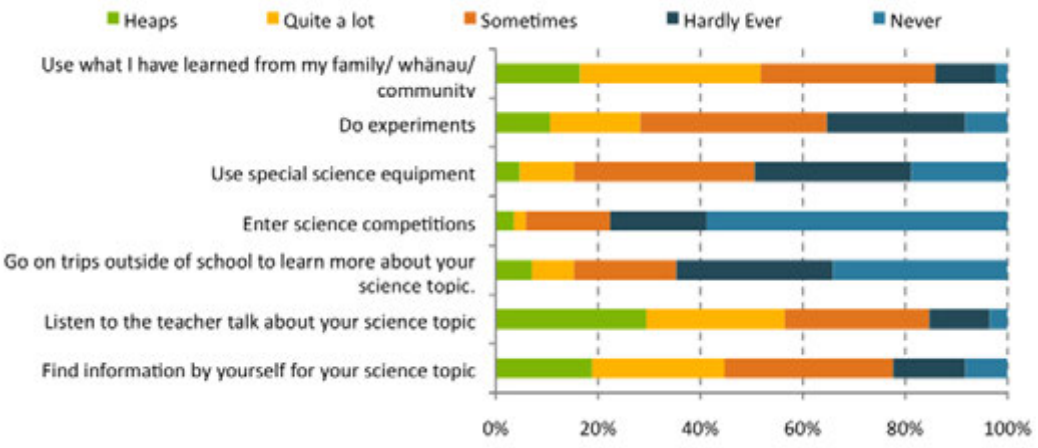


Fig A5.7 Year 8 Students: On referrral

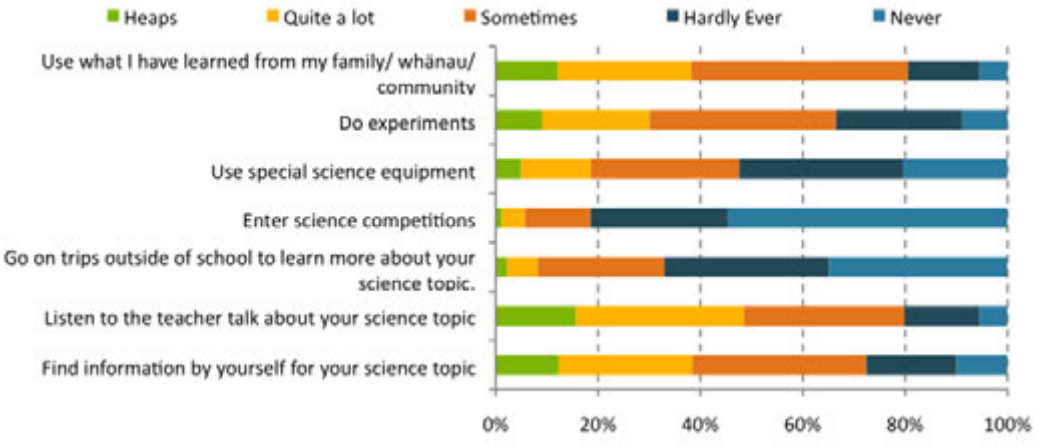


Fig A5.8 Year 8 Students: No special education needs

APPENDIX 6
Science achievement by school decile and student ethnicity

This appendix summarises science achievement by school decile and student ethnicity.

Part 1 presents the two-way analyses of variance (ANOVA) and post hoc comparisons for Year 4 and Year 8.

Part 2 presents the one-way ANOVA and post hoc comparisons for Year 4 and Year 8 students in low decile schools

Part 1 Science achievement by school decile and student ethnicity - two-way ANOVA

Year 4

Table 6.1 Two-way ANOVA Tables for Year 4 Science Achievement

Knowledge and Communication of Science Ideas					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	14379638.625	9	1597737.625	4434.877	.000
Ethnicity	27051.264	2	13525.632	37.543	.000
School decile	24943.400	2	12471.700	34.618	.000
Ethnicity * School decile	2567.383	4	641.846	1.782	.130
Error	658206.894	1827	360.266		
Total	15037845.519	1836			

Nature of Science					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	15417745.576	9	1713082.842	12382.551	.000
Ethnicity	5385.124	2	2692.562	19.462	.000
School decile	4718.802	2	2359.401	17.054	.000
Ethnicity * School decile	1718.480	4	429.620	3.105	.015
Error	252759.090	1827	138.347		
Total	15670504.665	1836			

Table 6.2 Means, standard deviations, sample sizes and statistically significant Scheffe post hoc comparisons

		Knowledge and Communication of Science Ideas		Nature of Science	
School decile			**Post hoc comparisons***		**Post hoc comparisons***
Low	Mean	74.5		86.1	
	SD	22.3		16.6	
	N	404		404	
			Low / Mid		Low / Mid
Mid	Mean	88.8		91.9	
	SD	18.5	Low / High	10.9	Low / High
	N	716		716	
			Mid / High		Mid / High
High	Mean	95.0		94.3	
	SD	18.5		9.5	
	N	716		716	
Ethnicity					
NZ European	Mean	93.3		93.5	
	SD	18.5		10.2	
	N	1206		1206	
			NZ Euro / Māori		NZ Euro / Māori
	Mean	80.6		89.8	
	SD	21.0	NZ Euro / Pasifika	11.9	NZ Euro / Pasifika
	N	402		402	
			Māori /Pasifika		Māori /Pasifika
	Mean	73.3		84.2	
	SD	21.6		18.6	
	N	228		228	

* All post hoc comparisons statistically significant at p>.01

Year 8

Table 6.3 Two-way ANOVA Tables for Year 8 Science Achievement

Knowledge and Communication of Science Ideas					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	21880917.479	9	2431213.053	8588.540	.000
Ethnicity	28969.087	2	14484.543	51.168	.000
School Decile	17598.866	2	8799.433	31.085	.000
Ethnicity * School Decile	1227.880	4	306.970	1.084	.363
Error	496232.936	1753	283.076		
Total	22377150.415	1762			
Nature of Science					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	18097615.776	9	2010846.197	9028.869	.000
School decile	3478.657	2	1739.328	7.810	.000
Ethnicity	3116.102	2	1558.051	6.996	.001
School decile * Ethnicity	1483.368	4	370.842	1.665	.155
Error	390415.849	1753	222.713		
Total	18488031.625	1762			

Table 6.4 Means, standard deviations, sample sizes and statistically significant Scheffe post hoc comparisons

		Knowledge and Communication of Science Ideas		Nature of Science	
School Decile			**Post hoc comparisons***		**Post hoc comparisons***
Low	Mean	97.4	Low / Mid Low / High Mid / High	96.4	Low / Mid Low / High Mid / High
	SD	17.2		12.4	
	N	325		325	
Mid	Mean	110.4		101.1	
	SD	17.9		14.2	
	N	783		783	
High	Mean	118.7		103.9	
	SD	16.9		17.0	
	N	654		654	
Ethnicity					
NZ European	Mean	115.9	NZ Euro / Māori NZ Euro / Pasifika Māori /Pasifika	102.8	NZ Euro / Māori NZ Euro / Pasifika
	SD	17.2		15.9	
	N	1237		1237	
Māori	Mean	101.9		98.9	
	SD	17.0		12.2	
	N	355		355	
Pasifika	Mean	95.3		95.3	
	SD	20.0		13.1	
	N	170		170	

* All comparisons listed statistically significant at p<.000 except ** p<.05

Part 2 Science achievement by student ethnicity for low decile schools - two-way ANOVA

Year 4

Table 6.5 One-way ANOVA Table for Year 4 Science Achievement

	Sum of Squares	df	Mean Square	F	Sig.
Knowledge and Communication of Science Ideas					
Between Groups	16111.551	2	8055.775	17.607	.000
Within Groups	183467.539	401	457.525		
Total	199579.090	403			
Nature of Science					
Between Groups	5417.127	2	2708.563	10.291	.000
Within Groups	105543.821	401	263.202		
Total	110960.948	403			

Table 6.6 Means, standard deviations, sample sizes and statistically significant Scheffe post hoc comparisons

		Knowledge and Communication of Science Ideas		Nature of Science	
Ethnicity			**Post hoc comparisons***		**Post hoc comparisons**
NZ European	Mean	86.4	NZ Euro / Māori* NZ Euro / Pasifika*	92.7	NZ Euro / Pasifika*
	SD	19.7		11.8	
	N	76		76	
Māori	Mean	74.4		86.5	
	SD	21.9		14.4	
	N	175		175	
Pasifika	Mean	68.6		82.4	
	SD	21.6		19.7	
	N	153		153	

* p<.05

Year 8

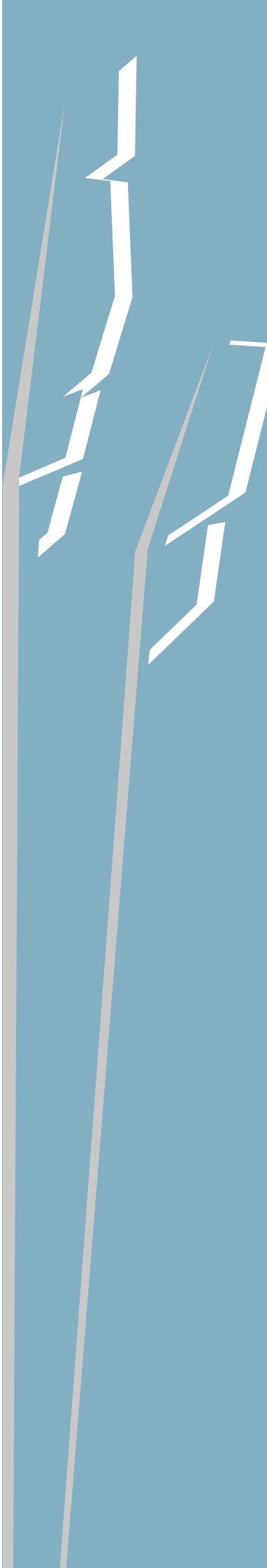
Table 6.7 One-way ANOVA Table for Year 8 Science Achievement

	Sum of Squares	df	Mean Square	F	Sig.
Knowledge and Communication of Science Ideas					
Between Groups	6869.885	2	3434.942	12.421	.000
Within Groups	89045.116	322	276.538		
Total	95915.001	324			
Nature of Science					
Between Groups	2748.562	2	1374.281	9.362	.000
Within Groups	47266.325	322	146.790		
Total	50014.887	324			

Table 6.8 Means, standard deviations, sample sizes and statistically significant Scheffe post hoc comparisons

		Knowledge and Communication of Science Ideas		Nature of Science	
Ethnicity			**Post hoc comparisons***		**Post hoc comparisons**
NZ European	Mean	104.7		101.1	
	SD	15.5		14.0	
	N	89		89	
Māori	Mean	95.3	NZ Euro / Māori**	95.0	NZ Euro / Māori*
	SD	16.9		9.8	
	N	128		128	
			NZ Euro / Pasifika**		NZ Euro / Pasifika**
Pasifika	Mean	93.6		94.2	
	SD	17.2		12.9	
	N	108		108	

* p<.001 **p<.000



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