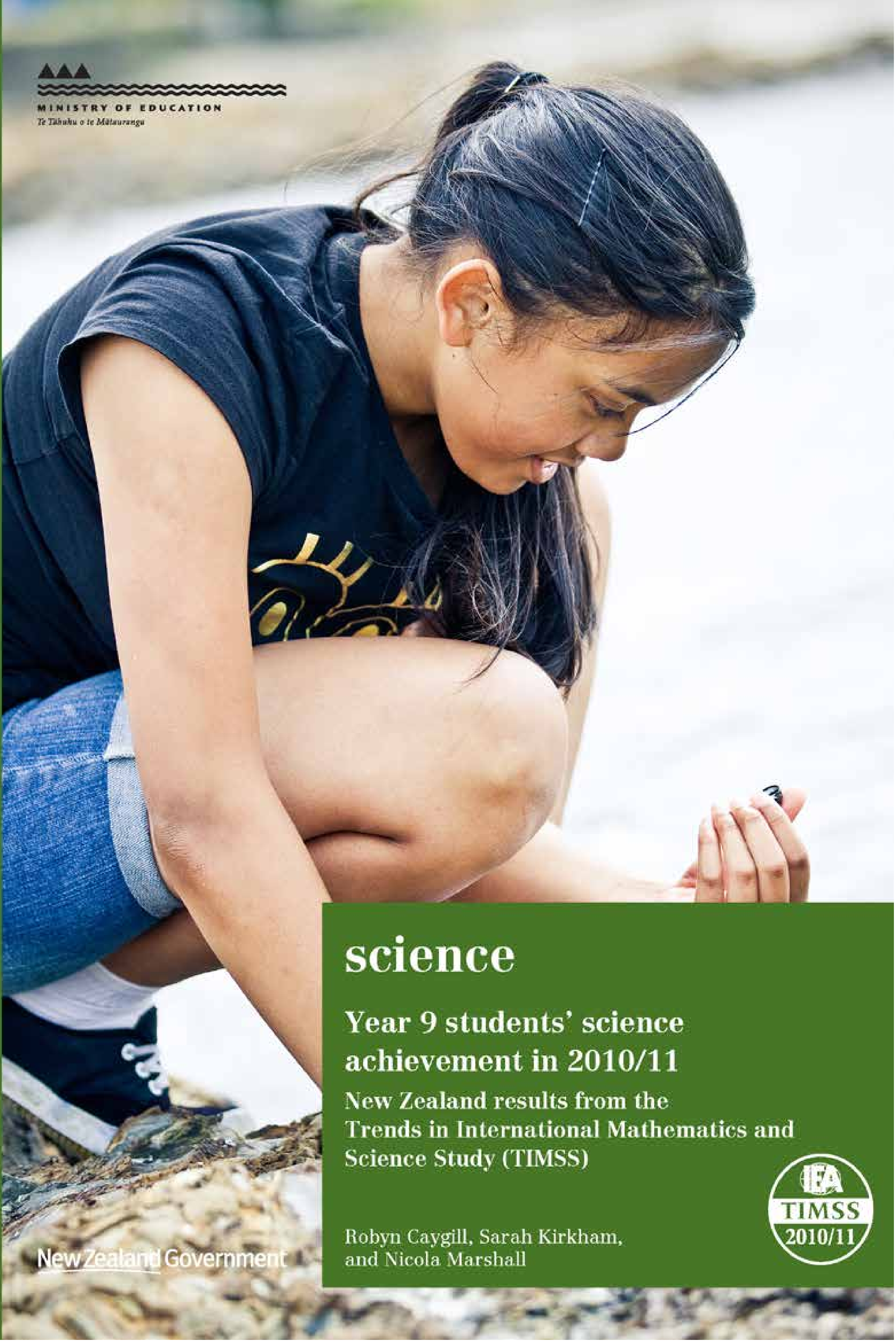

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

science

Year 9 students' science achievement in 2010/11

New Zealand results from the Trends in International Mathematics and Science Study (TIMSS)

IEA
TIMSS
2010/11

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New Zealand Government

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Acknowledgements

TIMSS is a collaborative effort internationally and nationally. There are many people that have been involved and it is not possible to thank all of them individually here. However, there are a few key people that I would like to acknowledge.

This study was made possible by the cooperation of the schools, teachers, students, and parents that participated. Thanks to these participants, large amounts of data have been collected about the teaching and learning of New Zealand Year 9 students.

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Robyn Caygill
TIMSS National Research Coordinator

Key Findings

Achievement in an international context

- New Zealand Year 9 students had higher science achievement than 25 participating countries, similar to 6, and lower than 10 countries.
- There has been no significant change in the mean science achievement of Year 9 students since the first cycle of TIMSS in 1994/95.
- In the international context, the range of achievement within New Zealand was moderate. This is in contrast to the 15-year-old students assessed in PISA where New Zealand has one of the widest ranges of achievement.
- There was a relatively high proportion of very low achievers (students who did not reach the low benchmark) in this cycle of TIMSS compared with countries with similar or higher mean science achievement.
- New Zealand lower secondary students performed relatively better on *Earth science* questions and relatively worse on *chemistry* questions. The cognitive aspect of *reasoning* was a relative strength for Year 9 students while *applying* was a relative weakness.

Equity in the New Zealand system

- Year 9 boys had higher science achievement, on average, than girls. Since the previous cycle of TIMSS (2002/03) there has been a significant decrease in achievement for Year 9 girls.
- There were advanced achievers and very low achievers in all ethnic groupings. However, there were proportionately more Pākehā/European and Asian advanced achievers compared with the Pasifika and Māori ethnic groupings. There were more very low achievers among Pasifika and Māori groupings than among Pākehā/European and Asian groupings. There has been a significant decrease in mean achievement among Pasifika and Māori students since 2002/03.
- Regardless of the measure used to assess socio-economic status (SES), students with lower SES had lower achievement than students with higher SES. In particular, on an international measure of the SES of the school attended, students in schools with a greater concentration of affluent students had higher achievement than students in schools with a greater concentration of disadvantaged students. On this measure New Zealand had one of the highest differences in achievement between these two groups.

Student attitudes

- Nearly all Year 9 students planned to get some form of qualification, some with expectations at the secondary level and some at tertiary.
- Year 9 students in New Zealand were generally positive about learning science. Compared to other countries, on average, fewer New Zealand Year 9 students liked science, were confident in their ability to do science, and valued science.
- Students who were more positive about learning science had, on average, higher achievement than those who were more negative. The self-confidence of students had a stronger relationship with science achievement than how much they liked or valued learning science.
- Year 9 boys' enjoyment, confidence and valuing of learning science were all higher than that of girls in New Zealand.

- A greater proportion of Asian students reported liking and valuing science than any of the other ethnic groupings. Asian and Pākehā/European students were slightly more likely to report high levels of confidence in learning science than Pasifika or Māori students.

Teaching

- More New Zealand lower secondary science teachers felt well prepared to teach topics in science and expressed high levels of confidence in their ability to teach science compared with their peers in other countries.
- New Zealand science teachers tended to place less emphasis on science investigations than their peers in other countries.
- New Zealand science teachers tended to use textbooks more as a supplement rather than as a basis for instruction. In contrast, teachers in other countries were more likely to use textbooks as a basis for instruction.
- New Zealand science classrooms were less likely to have computers available for instructional use compared with other countries.

School climate for learning

- Year 9 students generally perceived their school to be a good place to be. More than eight out of ten students agreed that they felt like they belonged at school and were safe there. A higher proportion of girls than boys were positive about school and Pasifika and Asian students were the most positive of the ethnic groupings.
- Fewer New Zealand Year 9 students liked being at school compared to the average student internationally.
- Teachers and principals were generally very positive about their school climate for learning, including having a safe environment, knowledgeable staff, supportive parents, and well-behaved students. However, principals tended to be slightly less positive about the teaching staff and more positive about parental support than the teachers.
- The proportion of New Zealand Year 9 students experiencing negative behaviours at school was similar to the average internationally. A higher proportion of boys than girls experienced these behaviours but no particular ethnic grouping experienced these negative behaviours more than would be expected based on their proportion of the population.
- Teachers of Year 9 students indicated that there were several factors that presented at least some limitations to their teaching of science, particularly having disruptive or uninterested students.
- More than half of the TIMSS Year 9 students had teachers who perceived various issues were at least a minor problem in their current school, particularly teachers having too many teaching hours or overcrowded classrooms. New Zealand teachers were relatively positive about their working conditions compared to most other TIMSS countries.
- A lack of computers and computer software for science instruction were the resources most commonly seen by principals as having an impact on instruction.

School leadership

- Principals of New Zealand schools with Year 9 students in them were, on average, less likely than their international counterparts to report spending a lot of time on any leadership activity.

Introduction

This report examines the science results for New Zealand Year 9 students from the Trends in International Mathematics and Science Study (TIMSS) in 2010/11.[1] Along with the reports on New Zealand's results for science at Year 5 (Caygill, Kirkham, and Marshall, 2013a) and on mathematics at Years 5 (Caygill, Kirkham, and Marshall, 2013b) and 9 (Caygill, Kirkham, and Marshall, 2013c), this report forms the beginning of a series of publications about New Zealand's participation in TIMSS 2010/11. International findings for science for TIMSS 2010/11 have been published by the IEA[2] (Martin, Mullis, Foy, & Stanco, 2012). A separate international report on mathematics was also published at this time (Mullis, Martin, Foy, & Arora, 2012).

This report begins by examining New Zealand's science achievement in relation to other countries that participated in the study. It then looks at trends in New Zealand science achievement at the Year 9 level from 1994 to 2011. An examination of the TIMSS assessment questions in relation to New Zealand's science curriculum is presented followed by analyses of achievement by sub-groupings (such as gender and ethnicity) and student background factors. Comprehensive coverage of background questions about teaching and learning as well as the school context for learning is also provided.

What is TIMSS?

The Trends in International Mathematics and Science Study (TIMSS) is a large-scale comparative study of mathematics and science achievement at the fourth and eighth grades (Years 5 and 9) around the world. As well as examining student achievement, it also monitors curricular implementation and aims to identify the most promising instructional practices from around the world.

Conducted on a regular four-year cycle, TIMSS has assessed mathematics and science in 1994/95[3], 1998/99, 2002/03, 2006/07, and 2010/11 with planning underway internationally for 2014/15.

What does TIMSS consist of?

TIMSS consists of assessments of students' achievements in mathematics and science along with questionnaires for students, teachers, and principals to gather background information. The background information provides a context within which the achievement can be examined.

The TIMSS assessments are organised around two dimensions: a content dimension specifying the domains or subject matter to be assessed within mathematics and science; and a cognitive dimension specifying the domains or thinking processes to be assessed. These domains are published in the *TIMSS 2011 assessment frameworks* (Mullis, Martin, Ruddock, O'Sullivan, Arora, and Preuschoff, 2009). To guide questionnaire development, the contextual factors associated with students' learning in mathematics and science are also included in the frameworks.

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[1] Internationally this cycle of the study is called TIMSS 2011. As New Zealand conducted TIMSS at the Year 9 level towards the end of 2010 and at the Year 5 level towards the end of 2011, it is referred to as TIMSS 2010/11 throughout this report.

[2] The International Association for the Evaluation of Educational Achievement (IEA) is an independent, international cooperative of national research institutions and governmental research agencies. It conducts large-scale comparative studies of educational achievement and other aspects of education.

[3] Note that this cycle of the study is called TIMSS 1995 internationally as most countries participated in 1995. However, southern hemisphere countries conducted the assessment towards the end of 1994 so in New Zealand reports the study is referred to as TIMSS 1994/95. Similarly for the subsequent cycles, the two years in which administrations occurred in participating countries are indicated.

Assessment framework for science in TIMSS

The four content dimensions for science at the lower secondary level (Year 9 level in New Zealand) are: *biology*, *chemistry*, *physics*, and *Earth science*. Briefly, each of the content areas is described in the frameworks (Mullis, Martin, et al., 2009) as follows.

> *"Biology includes students' understandings of the structure, life processes, diversity, and interdependence of living organisms." (p. 64).*
>
> *"In the area of chemistry, students will be assessed on their understanding of concepts related to the following topic areas: classification and composition of matter; properties of matter; and chemical change." (p. 69).*
>
> *"In physics, students' understandings of concepts related to physical processes and energy will be assessed in the following topic areas: physical states and changes in matter; energy transformations, heat, and temperature; light and sound; electricity and magnetism; and forces and magnetism." (p. 72).*
>
> *"Earth science is concerned with the study of Earth and its place in the solar system and the universe." (p. 76).*

In order to answer questions in the TIMSS test correctly, as well as being familiar with the science content, students need to draw on a range of cognitive skills. Also, in their lives outside and beyond school, students will need to do more than accurately recall a range of science facts. This is acknowledged in the framework with three aspects to the cognitive dimension entitled knowing, applying, and reasoning. Briefly, each cognitive dimension is described in the framework as follows.

> *"The first domain, knowing, covers science facts, procedures, and concepts students need to know, while the second domain, applying, focuses on the ability of the student to apply knowledge and conceptual understanding to a science problem. The third domain, reasoning, goes beyond the solution of routine science problems to encompass unfamiliar situations, complex contexts, and multi-step problems." (p. 80).*

How was TIMSS developed?

The TIMSS tests were developed cooperatively with representatives from participating countries. Questions were field-tested with a representative sample of students in these countries and the results generated were used to select and refine the questions for the final test. A similar process was used for the background questionnaires.

Who participated?

In TIMSS 2010/11, approximately 608,000 students in 63 countries and 14 economies (known as benchmarking participants) from all around the world took part. Participants included 301,603 students from 52 countries (three of which tested students at a higher grade) and seven benchmarking participants at the middle primary level, and 307,038 students from 44 countries (two of which tested students at a higher grade) and 14 benchmarking participants at the lower secondary level.[4] This cycle of TIMSS coincided with the third cycle of PIRLS (Progress in International Reading Literacy Study).

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[4] Some countries only tested students who were much older than the target population. For example, lower secondary students should be around 14 years old according to the design of TIMSS (in the eighth grade or the year level where the average age is closest to 14). However, in some countries these children have not covered enough of the material to achieve adequately on the TIMSS tests so the country has decided to test much older children. Throughout this report the countries that tested at a higher grade and the benchmarking participants are not discussed and do not appear in any totals or comparisons.

In this cycle of TIMSS, both Year 5 and Year 9 students participated in New Zealand. Schools in New Zealand were sampled so that there was no overlap between the samples: TIMSS Year 5, TIMSS Year 9, and PIRLS Year 5. In TIMSS in New Zealand, there were 5336 students from 158 schools assessed at the Year 9 level in November 2010 and 5572 students from 180 schools assessed at the Year 5 level in October 2011.

Participating countries and benchmarking participants

●	Armenia	◖	Ireland	◖	Poland
●	Australia	◗	Israel	◖	Portugal
◖	Austria	●	Italy	●	Qatar
◖	Azerbaijan	●	Japan	●	Romania
●	Bahrain	◗	Jordan	●	Russian Federation
◖	Belgium (Flemish)	●	Kazakhstan	●	Saudi Arabia
●	Chile	●	Korea, Rep. of	◖	Serbia
●	Chinese Taipei	◖	Kuwait	●	Singapore
◖	Croatia	◗	Lebanon	◖	Slovak Republic
◖	Czech Republic	●	Lithuania	●	Slovenia
◖	Denmark	◗	Macedonia, Rep. of	◖	Spain
●	England	◗	Malaysia	●	Sweden
●	Finland	◖	Malta	◗	Syrian Arab Republic
●	Georgia	●	Morocco	●	Thailand
◖	Germany	◖	Netherlands	●	Tunisia
◗	Ghana	●	New Zealand	●	Turkey
●	Hong Kong SAR	◖	Northern Ireland	◗	Ukraine
●	Hungary	●	Norway	●	United Arab Emirates
◗	Indonesia	●	Oman	●	United States
●	Iran, Islamic Rep. of	◗	Palestinian Nat'l Auth.	◖	Yemen
	Benchmarking participants				
●	Alberta, Canada	◗	Alabama, US	◗	Indiana, US
●	Ontario, Canada	◗	California, US	◗	Massachusetts, US
●	Quebec, Canada	◗	Colorado, US	◗	Minnesota, US
●	Abu Dhabi, UAE	◗	Connecticut, US	●	North Carolina, US
●	Dubai, UAE	●	Florida, US		
	Out of grade participants				
	Botswana (6,9)		Honduras (6,9)		South Africa (9)
	Yemen (6)				

Note: ● means the country participated at both middle primary and lower secondary level (usually Grade 4 and 8 equivalents).

◖ means the country participated at only the middle primary level (usually Grade 4 equivalent).

◗ means the country participated at only the lower secondary level (usually Grade 8 equivalent).

Who administered TIMSS?

A consortium was responsible for managing the international activities required for the project. This consortium was comprised of: the International Study Centre, Lynch School of Education at Boston College, (Massachusetts) United States; the IEA Secretariat in Amsterdam, the Netherlands; the IEA's Data Processing Centre in Hamburg, Germany; Statistics Canada in Ottawa, Canada; and the Educational Testing Service (ETS) in Princeton, New Jersey in the United States. In New Zealand the Comparative Education Research Unit in the Ministry of Education was responsible for carrying out TIMSS.

How was TIMSS administered?

Each lower secondary student was assessed in two timed sessions of 45 minutes, and answered a combination of mathematics and science questions. The assessment was a pencil-and-paper test containing both multiple-choice and constructed-response questions. Following this, students were given a questionnaire containing questions about themselves, their opinions about mathematics and science, interactions at home, their computer use, and their attitudes to school. Principals and teachers were also given questionnaires in order to gain further information about the context in which the science teaching and learning take place. In New Zealand, the assessments and questionnaires were conducted in English.

What procedures were used to ensure the quality of the data?

Members of the consortium ensured procedures were adhered to by all participating countries. TIMSS procedures are designed to ensure the reliability, validity, and comparability of the data through careful planning and documentation, cooperation among participating countries, standardised procedures, and attention to quality control throughout. Procedures included verification of translations and layout of booklets and questionnaires, monitoring of sampling activities, international and national quality control observers during test administration, checking of data, detailed manuals covering procedures, and rigorous training for all involved.

Technical information

A lot of information is gathered during the TIMSS administration and a number of techniques are applied when collecting and analysing the data. The *Methods and procedures in TIMSS and PIRLS 2011 report* (Martin, & Mullis (Eds.), 2012) contains a detailed account of the assessment framework and instrument development, sampling, translation of materials, survey operations, quality assurance, creating the international databases, and scaling the achievement data. In addition, the *TIMSS 2011 user guide for the international database* (Foy, Arora, & Stanco (Eds.), 2013) contains information on how to analyse the data. Brief details of the technical information are given in the Definitions and technical notes at the end of this report.

Why participate in TIMSS?

Although it is often assumed that the international studies are only useful for international benchmarking purposes, the real value of TIMSS lies in its ability to provide a rich picture of mathematics and science achievement within New Zealand over time.

TIMSS (along with other international assessment studies) can provide information about the performance of the New Zealand education system at the national level within a global context. The information from studies such as TIMSS is used in the development and review of policy frameworks and also to inform and improve teaching practice. Developments arising out of previous cycles of TIMSS include resource materials for schools and teachers along with teacher in-service training programmes.

The TIMSS encyclopaedia

In order to provide a context in which the TIMSS results can be examined, TIMSS also publishes the *TIMSS 2011 encyclopedia: a guide to mathematics and science education around the world* (Mullis, Martin, Minnich, Stanco, Arora, Centurino, & Castle (Eds.), 2012). This encyclopaedia contains short reports from each country describing mathematics and science education policies and practices in that country.

1. New Zealand science achievement in 2010/11 in an international context

In 2010 and 2011 63 countries participated in the fifth cycle of TIMSS, a large-scale assessment of the mathematics and science skills and knowledge of middle primary and early secondary students. In addition 14 economies took part as what are known as benchmarking participants. Of these countries and economies, 45 countries and 14 benchmarking participants assessed their lower secondary students. This chapter will examine the science achievement of New Zealand's Year 9 students in relation to that of other participating countries.

Science achievement in TIMSS 2010/11

The mean science score for New Zealand Year 9 students in 2011 was 512 scale score points. New Zealand's score was significantly higher than the TIMSS scale centre point, similar to Hungary (522), Australia (519), Israel (516), Lithuania (514), Sweden (509) and Ukraine (501) and higher than 25 countries (see Definitions and technical notes for details re the scales and the centre point). However, 512 is lower than the mean score of 10 countries including some of the other English-speaking countries who participated. Scotland, who also had a similar score to New Zealand in the 2002/03 cycle, did not participate in this cycle.

The highest achieving countries, Singapore, Chinese Taipei, the Republic of Korea, Japan, and Finland, all had average achievement among their Grade 8 students of over 550 scale score points. Of the countries that tested in English, Singapore had the highest mean score (590). The next highest mean scores among the countries testing in English were more than 50 scale score points lower: England (533) and the United States (525).

It is also useful to look at the range of achievement. The lowest outer limit of the bars presented in Figure 1.1 is called the 5th percentile, the score at which only five percent of students achieved a lower score. The upper-most limit presented is the 95th percentile, the score at which only five percent of students achieved a higher score. The range of achievement from the 5th percentile (365) to the 95th percentile (647) for New Zealand Year 9 students was 282 scale score points. New Zealand's range of achievement is narrower than Singapore (321) and similar to England (279) and Australia (277). Finland (212) had the narrowest range of achievement. Similar observations can be made based on the inter-quartile range.

Table 1.1 provides information to help put science achievement in context. Countries are presented in the same order as Figure 1.1. Information about economic conditions in each country is shown along with information about education for the students tested in TIMSS. Two versions of the Gross National Income (GNI) in U.S. dollars are given in the table. The first version of GNI is a measure of income that includes GDP plus other primary income (see World Bank, 2011 for details); the second version is an adjusted value that allows comparison of real levels of expenditure between countries and is calculated by simultaneously comparing prices of similar goods and services among a large number of countries.

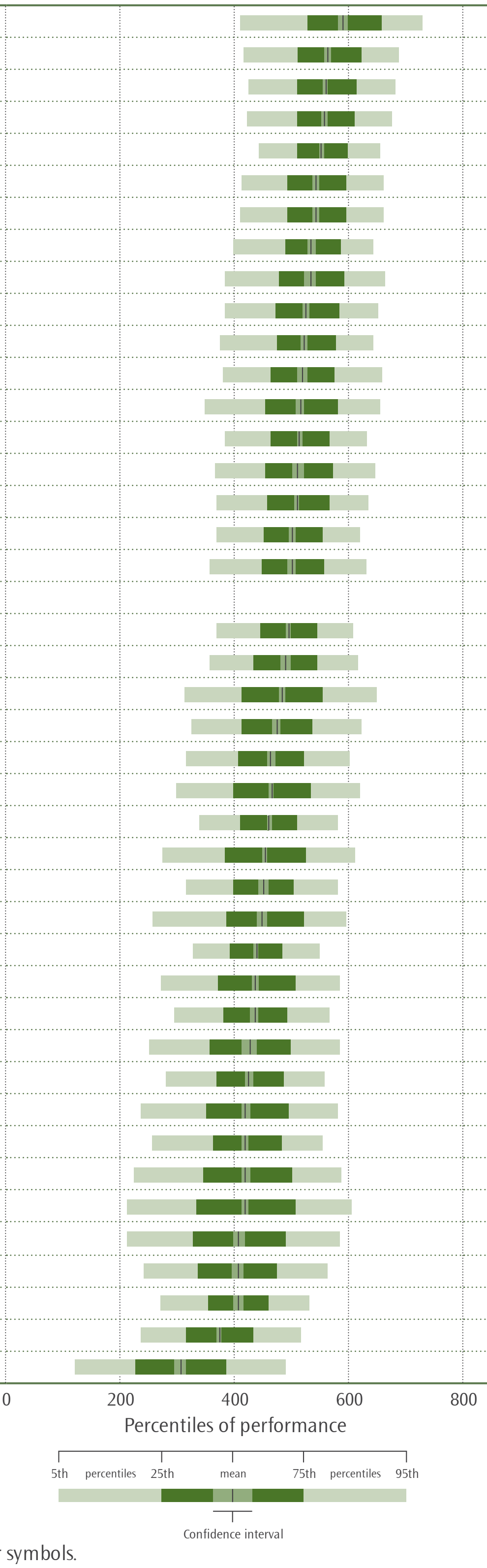
Many of the high-achieving countries had much higher income per capita than New Zealand, especially when purchasing power was taken into account. The exception was the Republic of Korea whose GNI was a bit smaller than that of New Zealand and a lot smaller than the other countries with high achievement. In terms of the countries that tested in English, all had higher income per capita than New Zealand.

Table 1.1 also shows the average age of students at the time of testing. Students from Scandinavian and Eastern European countries tended to be more than half a year older than New Zealand students were but were only in their eighth year of formal schooling. However, it is evident that some of these countries with older starting ages were teaching topics in their early childhood sectors that would be taught in our early years of schooling. Many countries had larger proportions of students beginning school knowing how to read some words or sentences compared with New Zealand (see Chamberlain, 2012 for details).

Compared to other countries, New Zealand students had lower than the average number of hours of science teaching per year (130 – lower than the international average 158). Among the English-speaking and high performing countries there was quite a variation in instructional hours for science (as shown in Table 1.1). For example, students in Slovenia had 251 hours of science instruction (on average) compared with 102 in England.

Figure 1.1: Distribution of lower secondary science achievement in TIMSS 2010/11

	Country	Mean science achievement			5th to 95th percentile	25th to 75th percentile
2	Singapore	590	(4.3)	▲	321	130
	Chinese Taipei	564	(2.3)	▲	274	113
	Korea, Rep. of	560	(2.0)	▲	256	104
	Japan	558	(2.4)	▲	252	99
	Finland	552	(2.5)	▲	212	88
	Slovenia	543	(2.7)	▲	249	101
2	Russian Federation	542	(3.2)	▲	251	103
	Hong Kong SAR	535	(3.4)	▲	245	95
‡	England	533	(4.9)	▲	279	117
2	United States	525	(2.6)	▲	267	112
	Hungary	522	(3.1)		269	104
	Australia	519	(4.8)		277	112
3	Israel	516	(4.0)		309	126
1	Lithuania	514	(2.6)		249	103
	New Zealand	**512**	**(4.6)**		**282**	**117**
	Sweden	509	(2.5)		265	108
	Italy	501	(2.5)	▼	249	102
	Ukraine	501	(3.4)		274	111
	TIMSS scale centre point	**500**		▼		
	Norway	494	(2.6)	▼	241	97
	Kazakhstan	490	(4.3)	▼	258	111
	Turkey	483	(3.4)	▼	336	141
	Iran, Islamic Rep. of	474	(4.0)	▼	296	125
	Romania	465	(3.5)	▼	285	115
	United Arab Emirates	465	(2.4)	▼	320	133
	Chile	461	(2.5)	▼	242	101
	Bahrain	452	(2.0)	▼	335	141
	Thailand	451	(3.9)	▼	264	107
	Jordan	449	(4.0)	▼	337	134
	Tunisia	439	(2.5)	▼	221	91
	Armenia	437	(3.1)	▼	312	133
	Saudi Arabia	436	(3.9)	▼	272	112
	Malaysia	426	(6.3)	▼	334	141
	Syrian Arab Republic	426	(3.9)	▼	276	118
	Palestinian Nat'l Auth.	420	(3.2)	▼	343	146
1	Georgia	420	(3.0)	▼	297	120
	Oman	420	(3.2)	▼	361	159
	Qatar	419	(3.4)	▼	394	173
	Macedonia, Rep. of	407	(5.4)	▼	372	165
	Lebanon	406	(4.9)	▼	319	138
	Indonesia	406	(4.5)	▼	258	108
	Morocco	376	(2.2)	▼	283	118
ψ	Ghana	306	(5.2)	▼	367	162



Note ▲ Country average significantly higher than New Zealand average
▼ Country average significantly lower than New Zealand average

See Appendices for notes explaining the other symbols.
Benchmarking participants and countries testing at a higher grade are not included in this table.

Source: Adapted from Exhibit 1.2, Martin, Mullis, Foy, and Stanco, 2012.

Table 1.1: Selected contextual factors for TIMSS 2010/11 countries

Country	Gross National Income per Capita (in $US)[1]	GNI per Capita (Purchasing Power Parity)[2]	Public Expenditure on Education (% of GDP)[3]	Average age at time of testing	Average hours of instructional time in science (teacher reports)[4]
Singapore	37,220	49,780	3	14.4	115 (2.1)
Chinese Taipei	16,471	34,520	4	14.2	157 (2.7)
Korea, Rep. of	19,830	27,240	4	14.3	126 (2.5)
Japan	38,080	33,440	4	14.5	128 (1.7)
Finland	45,940	35,280	6	14.8	190 (6.0)
Slovenia	23,520	26,470	6	13.9	251 (4.6)
Russian Federation	9,340	18,330	4	14.7	208 (1.6)
Hong Kong SAR	31,570	44,540	5	14.2	103 (4.6)
England	41,370	35,860	5	14.2	102 (3.1)
United States	46,360	45,640	6	14.2	x x
Hungary	12,980	19,090	5	14.7	236 (4.8)
Australia	43,770	38,510	5	14.0	131 (4.5)
Israel	25,790	27,010	6	14.0	132 (3.9)
Lithuania	11,410	17,310	5	14.7	251 (5.2)
New Zealand	**28,810**	**27,790**	**6**	**14.1**	**130 (2.6)**
Sweden	48,840	38,050	7	14.8	94 (3.1)
Italy	35,110	31,870	4	13.8	73 (1.0)
Ukraine	2,800	6,180	5	14.2	239 (4.0)
Norway	84,640	55,420	7	13.7	101 (3.3)
Kazakhstan	6,920	10,320	3	14.6	244 (4.8)
Turkey	8,720	13,500	4	14.0	99 (1.1)
Iran, Islamic Rep. of	4,530	11,470	5	14.3	120 (3.6)
Romania	8,330	14,540	4	14.9	281 (10.1)
United Arab Emirates	54,738	59,993	1	13.9	115 (2.7)
Chile	9,470	13,420	4	14.2	134 (3.8)
Bahrain	25,420	33,690	–	14.4	130 (2.8)
Thailand	3,760	7,640	4	14.3	119 (2.9)
Jordan	3,980	5,730	4	13.9	134 (3.1)
Tunisia	3,720	7,810	7	14.3	64 (1.9)
Armenia	3,100	5,410	3	14.6	240 (4.9)
Saudi Arabia	17,210	24,020	6	14.1	124 (6.8)
Malaysia	7,350	13,710	4	14.4	126 (3.6)
Syrian Arab Republic	2,410	4,620	5	13.9	150 (7.5)
Palestinian Nat'l Auth.	1,749	–	–	13.9	107 (3.4)
Georgia	2,530	4,700	3	14.2	198 (6.8)
Oman	17,890	24,530	4	14.1	161 (3.8)
Qatar	71,008	–	–	14.0	131 (6.9)
Macedonia, Rep. of	4,400	10,880	–	14.7	334 (14.7)
Lebanon	8,060	13,400	2	14.3	x x
Indonesia	2,050	3,720	3	14.3	190 (12.2)
Morocco	2,770	4,400	6	14.7	144 (2.0)
Ghana	1,190	1,530	6	15.8	148 (6.1)

Note: 1. GNI per capita in U.S. dollars is converted using the World Bank Atlas method (World Bank, 2011, pp. 10-13).

2. An international dollar has the same purchasing power over GNI as a U.S. dollar in the United States (World Bank, 2011, pp. 10-13).

3. Current and capital expenditures on education by local, regional, and national governments, including municipalities (World Bank, 2011, pp. 76-79).

4. Standard errors are presented in parentheses.

xx indicates data are available for less than 50% of students.

Source: Adapted from Exhibits C.1 and 8.7, Martin, Mullis, Foy, and Stanco, 2012 and from the encyclopaedia, Mullis, Martin, Minnich et al., 2012.

International trends in science achievement at the lower secondary level

There have now been five cycles of TIMSS internationally at the lower secondary level, 1994/95, 1998/99, 2002/03, 2006/07, and 2010/11. The design of TIMSS allows us to measure trends over time. Table 1.2 presents changes in mean science achievement for those countries that have participated in at least four cycles of TIMSS. Lithuania is the country with the largest increase in science achievement since the 1994/95 cycle (50 scale score points) although most of the change occurred prior to 2002/03. Slovenia (29), Hong Kong SAR (25), and the Russian Federation (20) have also had big increases since 1994/95. New Zealand has had no significant change over time. In contrast, Norway, Sweden, and Malaysia have had large significant decreases in mean science achievement across the cycles.

Table 1.2: Differences in mean science achievement across time for selected countries

Country	1994/95 to 2010/11 difference	1998/99 to 2010/11 difference	2002/03 to 2010/11 difference	2006/07 to 2010/11 difference
Lithuania	50 ▲	26 ▲	-6	-5
Slovenia	29 ▲		22 ▲	5
Hong Kong SAR	25 ▲	6	-21 ▼	5
Russian Federation	20 ▲	13	29 ▲	13 ▲
Korea, Rep. of	14 ▲	12 ▲	2	7 ▲
Iran, Islamic Rep. of	12 ▲	26 ▲	21 ▲	15 ▲
United States	12 ▲	10	-3	5
Singapore	10	22 ▲	12 ▲	23 ▲
Tunisia		9 ▲	35 ▲	-6
Italy		8	10 ▲	6
Australia	6		-8	4
Japan	3	8 ▲	6	4
New Zealand	**1**	**2**	**-8**	
England	0	-5	-11	-9
Jordan		-1	-26 ▼	-33 ▼
Chinese Taipei		-5	-7	3
Romania	-6	-7	-5	3
Hungary	-14 ▼	-30 ▼	-20 ▼	-17 ▼
Norway	-20 ▼		1	8 ▲
Sweden	-43 ▼		-15 ▼	-1
Malaysia		-66 ▼	-84 ▼	-44 ▼

Note: ▲ 2010/11 means that the mean score was significantly higher than other cycle

▼ 2010/11 means that the mean score was significantly lower than other cycle

A blank space indicates that the country did not participate in that cycle.

Source: Adapted from Exhibit 1.6 , Martin, Mullis, Foy, and Stanco, 2012.

In addition to those countries presented in the table, Ghana (51 scale score points) and Chile (41 scale score points) have also had a large increase in science achievement since previous cycles (2002/03 and 1998/99 respectively).

In order to help understand some of the larger country increases, information is presented below about changes in the education systems in Lithuania, Chile, Slovenia, Hong Kong SAR, and the Russian Federation.

Lithuania

Lithuania has been participating in TIMSS since the first cycle in 1994/95, when the educational system was just starting to see the effects of post-soviet reforms (Elijio, 2012). Mathematics education is heavily emphasised because many universities require good results on mathematics examinations for admission. Therefore, the majority of students in secondary school choose to study higher-level mathematics, but the same cannot be said of sciences.

According to Elijio (2012), reforms in science teaching and learning have been influenced by participation in TIMSS. Educational specialists have turned to the conceptual frameworks of other jurisdictions to help in their development of subject content.

From Grade 7, biology, chemistry and physics are taught as separate subjects. Beginning in Grade 5, there are specialist teachers for the sciences. Instructional time in the sciences in Grade 8 is 14 percent of total instructional time.

Chile

There is a national curriculum in Chile but schools are free to decide how it is implemented (Gubler, 2012). Based on the curriculum, the ministry develops study plans that specify the minimum number of instructional hours that should be devoted to each subject. The ministry also provides study programmes, which teachers are not required to use, but which provide a useful guide for teaching.

Chile first participated in TIMSS in 1998/99. From this assessment, it was evident that the curriculum of Chile was misaligned with what was considered necessary to learn and assess from an international perspective. Since then the Chilean curriculum has been revised after each cycle they participated in to take account of some of the differences between the curriculum and the TIMSS framework. Chile has also used the TIMSS methodological approaches of setting an assessment framework, providing scoring guides, and using Item Response Theory scoring methods in its own assessments.

Although not compulsory, most schools in Chile with Grade 1 students offer one year of preschool education. Some schools have specialist teachers at Grade 7 or 8, but all have specialist teachers at Grade 9. Instructional time in the sciences at Grade 8 is 10 percent of total instructional time (four periods of 45 minute duration).

Slovenia

Since the first cycle of TIMSS, the Slovenian education system has undergone some significant changes. Compulsory schooling now begins at age 6 rather than age 7 and the science curriculum was revised in 1998. Subsequent to the 2007 cycle of TIMSS, the 1998 curriculum has been re-evaluated. An improved version of the science curriculum was released in 2011 that introduced many topics earlier to students and emphasised abstract thinking (Japelj Pavesic & Svetlik, 2012).

TIMSS results also showed the need for improvement in students' explanatory and writing skills. In response to this need, the Ministry of Education, Science, Culture and Sport supported a series of teacher professional development programmes aimed at improving reading literacy in science and mathematics subjects. The main teaching resources for these courses were released TIMSS science items with written responses from students.

Grade 8 is considered part of compulsory elementary education in Slovenia. By this grade level, natural sciences are taught as separate subjects: biology, chemistry, and physics. All students have specialist teachers for the sciences. One-quarter of lesson time (25%) is devoted to the sciences.

Hong Kong SAR

Much of the improvement in science achievement for Hong Kong lower secondary students has occurred between 1994/95 and 2002/03. Based on results from these earlier cycles, professional development programmes were designed to enhance the quality of learning and teaching, as well as assessment skills of science teachers. Curriculum developers also used data from TIMSS to evaluate changes in the science curriculum.

The Hong Kong government has also increased its focus on teacher education and qualifications pre-service. Pre-service education has been upgraded so all new teachers must now receive professional training and hold a degree. Although there are no official requirements for on-going professional development for current teachers, the Advisory Committee on Teacher Education and Qualifications has set a target of 150 hours of professional development over a three–year period (Leung & Leung, 2012).

Emphasis at the lower secondary level in the science curriculum is to enhance students' scientific thinking through learning activities that involve planning, designing, measuring, observing, evaluating procedures, examining evidence, and analysing data. Through their learning activities, students should acquire scientific literacy and develop the necessary scientific knowledge and understanding, processing skills, values, and attitudes for their personal development to help them contribute to a scientific and technological world.

Specialist teachers usually teach science at the secondary level. Instructional time in the sciences at Grade 8 is 10 to 15 percent of total instructional time.

The Russian Federation

Since 1992, the Russian Federation has moved to a more decentralised education system with schools determining their programmes themselves based on documents recommended by central authorities (Kovaleva & Kranianskaia, 2012). Since 2004, the education system has undergone significant reform. Following the introduction of a new national curriculum in 2004, new national strategic goals were formulated in 2006. Beginning with primary schools in 2011, the new standards of general education are being developed and introduced gradually into schools. Emphasis has shifted in the system from rote learning to intelligent application in the solution of different kinds of learning and cognitive problems in familiar and unfamiliar situations.

In the last decade, changes in science education have included emphasising the nature of science and its methods, and using more inquiry, projects, and group methods oriented toward intellectual and personal development. Professional development has been realigned to change in emphasis from subject content to students' development, so that teachers have more training in active learning strategies and child development. Assessment practices have also changed slightly from assessment of science subject knowledge only to include assessment of scientific literacy and the nature of science knowledge and skills. Additionally, general education reform has included the introduction of a qualitative system of assessment without grades or marks in primary school and a shift in the orientation of assessment from absolute achievement to the dynamics of student achievement throughout primary school.

The majority of students in Russia have specialist teachers for science from Grade 5 onwards. At Grades 8 and 9, science is taught as four subjects – biology, geography, physics, and chemistry. Instructional time at Grade 8 level in the sciences is 26 percent of total instructional time or two lessons (45 minutes each) per week in each of the four subjects.

Relative rankings among countries

Many commentators on the international studies focus on New Zealand's ranking relative to other countries. In order to inform this commentary, Table 1.3 presents New Zealand's relative ranking in science achievement compared with the other countries who have participated in TIMSS in 1994/95, 2002/03, and 2010/11. Of all the 42 countries that participated in TIMSS 2010/11 at the lower secondary level, only 16 have participated in all these three cycles. In addition, standard errors are presented so that the reader can calculate whether apparent differences are real or not. For example, the score of 560 in the Republic of Korea (2010/11) is not significantly different from the score of 558 in Japan (see Definitions and technical notes for details of how significance can be calculated).

Table 1.3 shows that the mean science achievement in New Zealand has shifted downwards relative to the mean for the 16 countries in the later cycles compared with 1994/95. In number terms, New Zealand's mean achievement has not changed much over time, but the mean for the 16 countries has increased from 519 to 525. However, the relative ranking of New Zealand among the 16 countries is the same in 1994/95 and 2010/11.

Table 1.3: Relative rankings of selected countries participating in 3 cycles of TIMSS

1994/95 mean science score				2002/03 mean science score				2010/11 mean science score			
Singapore	580	(5.5)	▲	Singapore	578	(4.3)	▲	Singapore	590	(4.3)	▲
Japan	554	(1.8)	▲	Korea	558	(1.6)	▲	Korea	560	(2.0)	▲
Sweden	553	(4.4)	▲	Hong Kong SAR	556	(3.0)	▲	Japan	558	(2.4)	▲
Korea	546	(2.0)	▲	Japan	552	(1.7)	▲	Slovenia	543	(2.7)	▲
Hungary	537	(3.1)	▲	England	544	(4.1)	▲	Russian Federation	542	(3.2)	▲
England	533	(3.6)	▲	Hungary	543	(2.8)	▲	Hong Kong SAR	535	(3.4)	▲
Russian Federation	523	(4.5)		USA	527	(3.1)		England	533	(4.9)	
Norway	514	(2.4)		Australia	527	(3.8)		USA	525	(2.6)	
Slovenia	514	(2.7)		Sweden	524	(2.7)		Hungary	522	(3.1)	
Australia	514	(3.9)		Slovenia	520	(1.8)	▼	Australia	519	(4.8)	
USA	513	(5.6)		**New Zealand**	**520**	**(5.0)**	▼	Lithuania	514	(2.6)	▼
New Zealand	**511**	**(4.9)**		Lithuania	519	(2.1)	▼	**New Zealand**	**512**	**(4.6)**	▼
Hong Kong SAR	510	(5.8)		Russian Federation	514	(3.7)	▼	Sweden	509	(2.5)	▼
Romania	471	(5.1)	▼	Norway	494	(2.2)	▼	Norway	494	(2.6)	▼
Lithuania	464	(4.0)	▼	Romania	470	(4.9)	▼	Iran, Islamic Rep. of	474	(4.0)	▼
Iran, Islamic Rep. of	463	(3.6)	▼	Iran, Islamic Rep. of	453	(2.3)	▼	Romania	465	(3.5)	▼
Mean for all 16	**519**	**(1.0)**		**Mean for all 16**	**525**	**(0.9)**		**Mean for all 16**	**525**	**(1.1)**	

Note: ▲ means that the country mean score was significantly higher than the mean for all 16 countries
▼ means that the country mean score was significantly lower than the mean for all 16 countries

The mean for all 16 countries has been calculated by pooling all student results for the 16 countries and weighting so that each country contributes equally to the mean.

Standard errors are presented in parentheses.

International science benchmarks

In order to describe more fully what achievement on the science scale means, the TIMSS international researchers have developed benchmarks. These benchmarks link student performance on the TIMSS science scale to performance on science questions and describe what students can typically do at set points on the science achievement scale. The international benchmarks are four points on the science scale: the advanced benchmark (625), the high benchmark (550), the intermediate benchmark (475), and the low benchmark (400). The performance of students reaching each benchmark is described in relation to the types of questions they answered correctly. Table 1.4 presents the descriptions of the international benchmarks of science achievement for lower secondary students.

Table 1.4: Descriptions of TIMSS 2010/11 international benchmarks of science achievement

Advanced international benchmark— 625
Students communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and Earth science. Students demonstrate some conceptual knowledge about cells and the characteristics, classification, and life processes of organisms. They communicate an understanding of the complexity of ecosystems and adaptations of organisms, and apply an understanding of life cycles and heredity. Students also communicate an understanding of the structure of matter and physical and chemical properties and changes and apply knowledge of forces, pressure, motion, sound, and light. They reason about electrical circuits and properties of magnets. Students apply knowledge and communicate understanding of the solar system and Earth's processes, structures, and physical features. They understand basic features of scientific investigation. They also combine information from several sources to solve problems and draw conclusions, and they provide written explanations to communicate scientific knowledge.
High international benchmark — 550
Students demonstrate understanding of concepts related to science cycles, systems, and principles. They demonstrate understanding of aspects of human biology, and of the characteristics, classification, and life processes of organisms. Students communicate understanding of processes and relationships in ecosystems. They show an understanding of the classification and compositions of matter and chemical and physical properties and changes. They apply knowledge to situations related to light and sound, and demonstrate basic knowledge of heat and temperature, forces and motion, and electrical circuits and magnets. Students demonstrate an understanding of the solar system and of Earth's processes, physical features, and resources. They demonstrate some scientific inquiry skills. They also combine and interpret information from various types of diagrams, contour maps, graphs, and tables; select relevant information, analyse, and draw conclusions; and provide short explanations conveying scientific knowledge.
Intermediate international benchmark — 475
Students recognise and apply their understanding of basic scientific knowledge in various contexts. Students apply knowledge and communicate an understanding of human health, life cycles, adaptation, and heredity, and analyse information about ecosystems. They have some knowledge of chemistry in everyday life and elementary knowledge of properties of solutions and the concept of concentration. They are acquainted with some aspects of force, motion, and energy. They demonstrate an understanding of Earth's processes and physical features, including the water cycle and atmosphere. Students interpret information from tables, graphs, and pictorial diagrams and draw conclusions. They apply knowledge to practical situations and communicate their understanding through brief descriptive responses.
Low international benchmark — 400
Students can recognise some basic facts from the life and physical sciences. They have some knowledge of biology, and demonstrate some familiarity with physical phenomena. Students interpret simple pictorial diagrams, complete simple tables, and apply basic knowledge to practical situations.

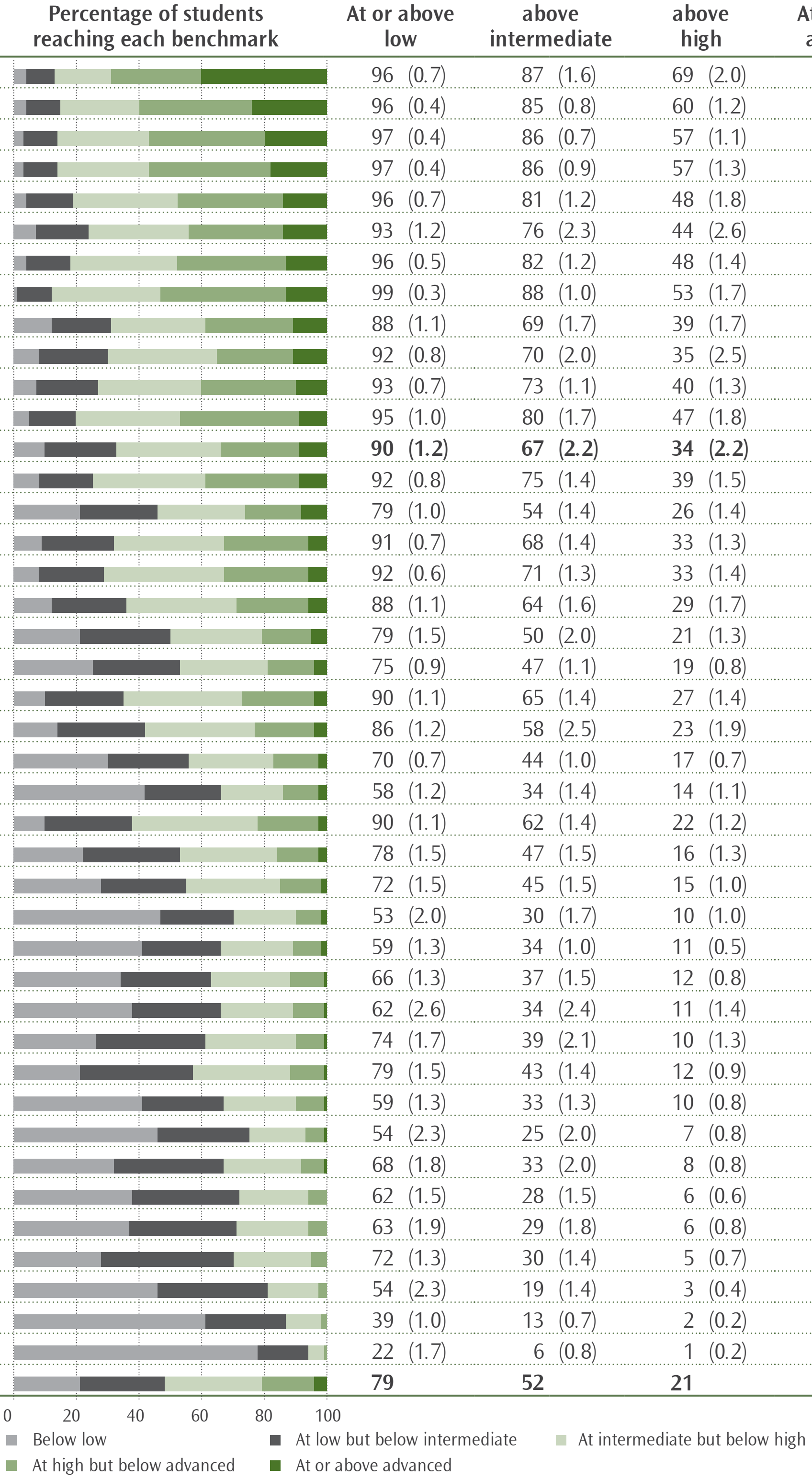
Source: Exhibit 2.17, Martin, Mullis, Foy, and Stanco, 2012.

Figure 1.2 presents two ways of looking at this data – those students achieving at each of the benchmarks (as shown in the graphical part) and those students achieving at or above each of the benchmarks (as shown in the table part). Nine percent of New Zealand lower secondary students reached the advanced benchmark, the point where students were deemed capable of *communicating an understanding of complex and abstract concepts in biology, chemistry, physics, and Earth science.* In comparison, 40 percent of students in Singapore reached this advanced level of science ability. There were also fewer advanced lower secondary scientists in New Zealand compared with England (14%). The proportions of students in Australia (11%) and the United States (10%) were similar to New Zealand.

There was 10 percent of lower secondary students in New Zealand who did not demonstrate the ability to consistently perform the simplest tasks TIMSS seeks to measure (they correctly completed less than half of the low benchmark tasks). In comparison there was five percent or less of students in the highest-performing countries below this low benchmark. There were also fewer really low performing lower secondary students (those who did not reach the low benchmark) in England (7%), the United States (7%), and Australia (8%).

Included in the figure is the international median percentage of students at each benchmark. The proportion of New Zealand students reaching each of the benchmarks was higher than the international median percentage.

Figure 1.2: Proportion of lower secondary students at each international benchmark



	Cumulative percentage of students:			
Country	At or above low	At or above intermediate	At or above high	At or above advanced
Singapore	96 (0.7)	87 (1.6)	69 (2.0)	40 (1.7)
Chinese Taipei	96 (0.4)	85 (0.8)	60 (1.2)	24 (1.4)
Korea, Rep. of	97 (0.4)	86 (0.7)	57 (1.1)	20 (0.9)
Japan	97 (0.4)	86 (0.9)	57 (1.3)	18 (1.1)
Russian Federation	96 (0.7)	81 (1.2)	48 (1.8)	14 (1.1)
England	93 (1.2)	76 (2.3)	44 (2.6)	14 (1.5)
Slovenia	96 (0.5)	82 (1.2)	48 (1.4)	13 (0.8)
Finland	99 (0.3)	88 (1.0)	53 (1.7)	13 (1.2)
Israel	88 (1.1)	69 (1.7)	39 (1.7)	11 (1.1)
Australia	92 (0.8)	70 (2.0)	35 (2.5)	11 (1.6)
United States	93 (0.7)	73 (1.1)	40 (1.3)	10 (0.7)
Hong Kong SAR	95 (1.0)	80 (1.7)	47 (1.8)	9 (1.1)
New Zealand	**90 (1.2)**	**67 (2.2)**	**34 (2.2)**	**9 (1.0)**
Hungary	92 (0.8)	75 (1.4)	39 (1.5)	9 (0.8)
Turkey	79 (1.0)	54 (1.4)	26 (1.4)	8 (0.9)
Sweden	91 (0.7)	68 (1.4)	33 (1.3)	6 (0.5)
Lithuania	92 (0.6)	71 (1.3)	33 (1.4)	6 (0.7)
Ukraine	88 (1.1)	64 (1.6)	29 (1.7)	6 (0.8)
Iran, Islamic Rep. of	79 (1.5)	50 (2.0)	21 (1.3)	5 (0.7)
United Arab Emirates	75 (0.9)	47 (1.1)	19 (0.8)	4 (0.4)
Italy	90 (1.1)	65 (1.4)	27 (1.4)	4 (0.5)
Kazakhstan	86 (1.2)	58 (2.5)	23 (1.9)	4 (0.6)
Bahrain	70 (0.7)	44 (1.0)	17 (0.7)	3 (0.3)
Qatar	58 (1.2)	34 (1.4)	14 (1.1)	3 (0.5)
Norway	90 (1.1)	62 (1.4)	22 (1.2)	3 (0.4)
Romania	78 (1.5)	47 (1.5)	16 (1.3)	3 (0.5)
Jordan	72 (1.5)	45 (1.5)	15 (1.0)	2 (0.3)
Macedonia, Rep. of	53 (2.0)	30 (1.7)	10 (1.0)	2 (0.4)
Oman	59 (1.3)	34 (1.0)	11 (0.5)	2 (0.2)
Armenia	66 (1.3)	37 (1.5)	12 (0.8)	1 (0.2)
Malaysia	62 (2.6)	34 (2.4)	11 (1.4)	1 (0.4)
Thailand	74 (1.7)	39 (2.1)	10 (1.3)	1 (0.5)
Chile	79 (1.5)	43 (1.4)	12 (0.9)	1 (0.2)
Palestinian Nat'l Auth.	59 (1.3)	33 (1.3)	10 (0.8)	1 (0.2)
Lebanon	54 (2.3)	25 (2.0)	7 (0.8)	1 (0.2)
Saudi Arabia	68 (1.8)	33 (2.0)	8 (0.8)	1 (0.2)
Georgia	62 (1.5)	28 (1.5)	6 (0.6)	0 (0.1)
Syrian Arab Republic	63 (1.9)	29 (1.8)	6 (0.8)	0 (0.1)
Tunisia	72 (1.3)	30 (1.4)	5 (0.7)	0 (0.1)
Indonesia	54 (2.3)	19 (1.4)	3 (0.4)	0 (0.1)
Morocco	39 (1.0)	13 (0.7)	2 (0.2)	0 (0.0)
Ghana	22 (1.7)	6 (0.8)	1 (0.2)	0 (0.1)
International Median	**79**	**52**	**21**	**4**

Note: Standard errors are presented in parentheses.

The proportion of students at the low benchmark includes those that achieved at higher benchmarks also.

Source: Exhibit 2.18, Martin, Mullis, Foy, and Stanco, 2012.

Figures 1.3 to 1.6 present examples of questions that Year 9 students achieving at or above the advanced (Figure 1.3), high (Figure 1.4), intermediate (Figure 1.5), and low (Figure 1.6) benchmarks were likely to have answered correctly. An example of a correct answer and a description of the intention of the question are presented. In addition, proportions of students successfully completing the question for a selection of countries, including the best performing country on that question, are shown. The international average is also presented as an indication of how students in all 42 countries performed on this question.

Figure 1.3: Example of a question students reaching the advanced benchmark are likely to have answered correctly

Content domain: chemistry
Cognitive domain: knowing
Description: describes two things that might be observed as a chemical reaction

Ahmet put some powder into a test tube. He then added liquid to the powder and shook the test tube. A chemical reaction took place.

Describe two things he might observe as the chemical reaction took place.

1. A temperature change

2. gas bubbles

Country	Percent full credit
England	59 (2.6)
New Zealand	**50 (2.5)**
United States	46 (1.5)
Chinese Taipei	44 (2.0)
Singapore	44 (1.9)
Australia	42 (2.3)
Finland	36 (2.3)
Hong Kong SAR	35 (1.9)
Norway	32 (2.5)
Japan	30 (2.1)
Slovenia	30 (2.1)
International Avg.	**24 (0.3)**
Korea, Rep. of	23 (1.6)

Note: Standard errors are presented in parentheses.

Source: Adapted from Exhibit 2.31, Martin, Mullis, Foy, and Stanco, 2012.

Figure 1.4: **Example of a question students reaching the high benchmark are likely to have answered correctly**

Content domain: physics
Cognitive domain: knowing
Description: recognises what happens to molecules of a liquid as the liquid cools

What happens to the molecules of a liquid when the liquid cools?

- ● They slow down.
- Ⓑ They speed up.
- Ⓒ They decrease in number.
- Ⓓ They decrease in size.

Country	Percent full credit	
Korea, Rep. of	82	(1.4)
Slovenia	80	(2.0)
Singapore	73	(1.8)
Finland	73	(2.0)
United States	73	(1.5)
New Zealand	**70**	**(2.3)**
Norway	68	(2.8)
England	65	(2.3)
Australia	62	(2.1)
International Avg.	**58**	**(0.3)**
Chinese Taipei	56	(1.9)
Hong Kong SAR	52	(2.2)
Japan	50	(2.3)

Note: Standard errors are presented in parentheses.

Source: Adapted from Exhibit 2.28, Martin, Mullis, Foy, and Stanco, 2012.

Figure 1.5: **Example of a question students reaching the intermediate benchmark are likely to have answered correctly**

Content domain: Earth science
Cognitive domain: applying
Description: given a starting point, orders the processes involved in the water cycle

The following five statements describe processes involved in the water cycle. Water evaporation from the sea is identified as a first step in the water cycle.

Number the other statements 2 through 5 in the order in which these processes take place.

2 Water vapour rises in warm air.
5 Water travels along a river to the sea.
1 Water evaporates from the sea.
3 Water vapour is cooled and forms clouds.
4 Clouds move and water falls on land as rain.

Country	Percent full credit	
Finland	92	(1.2)
Hong Kong SAR	85	(1.6)
Singapore	83	(1.5)
Chinese Taipei	82	(1.6)
Korea, Rep. of	81	(1.6)
England	79	(2.5)
Slovenia	76	(2.2)
New Zealand	**72**	**(2.3)**
Australia	71	(2.0)
United States	71	(1.4)
Japan	71	(2.2)
Norway	67	(2.2)
International Avg.	**63**	**(0.3)**

Note: Standard errors are presented in parentheses.

Source: Adapted from Exhibit 2.25, Martin, Mullis, Foy, and Stanco, 2012.

Figure 1.6: **Example of a question students reaching the low benchmark are likely to have answered correctly**

Content domain: biology
Cognitive domain: applying
Description: recognises that genetic material is inherited from both parents

Twins are born. One is a boy and one is a girl.

Which statement is correct about their genetic makeup?

Ⓐ The boy and girl inherit genetic material from the father only.
Ⓑ The boy and girl inherit genetic material from the mother only.
● The boy and girl inherit genetic material from both parents.
Ⓓ The boy inherits genetic material from the father only and the girl inherits it from the mother only.

Country	Percent full credit	
Japan	95	(0.9)
Finland	94	(1.0)
Korea, Rep. of	93	(0.9)
Singapore	92	(1.0)
Slovenia	91	(1.4)
United States	90	(0.8)
Chinese Taipei	89	(1.2)
England	88	(1.7)
Hong Kong SAR	88	(1.5)
Australia	86	(1.5)
New Zealand	**85**	**(1.6)**
International Avg.	**83**	**(0.2)**
Norway	82	(1.6)

Note: Standard errors are presented in parentheses.

Source: Adapted from Exhibit 2.21, Martin, Mullis, Foy, and Stanco, 2012.

Science content and cognitive domains

Questions for the TIMSS tests were written to assess the content and cognitive aspects as described in the *TIMSS 2011 assessment frameworks* (Mullis, Martin, et al., 2009). Scores were created for each of these domains so that they are comparable with each other. Note that in previous cycles of TIMSS a score of 500 on one domain was not directly comparable to 500 on another domain, but this new methodology ensures they are. The content domains describe the subject matter to be assessed. In science at the lower secondary level the content domains are *biology*, *chemistry*, *physics*, and *Earth science*. The cognitive domains describe the thinking processes to be assessed. They describe the sets of behaviours expected of students as they engage with the content. The cognitive domains are entitled *knowing*, *applying*, and *reasoning*.

When content domains were compared, two of the highest performing countries, the Republic of Korea and Singapore, had relatively higher performance on *physics* questions compared with the other domains. In contrast, students in Chinese Taipei had relatively higher performance on *chemistry* questions. For most of the other countries in this selection, *Earth science* was the category with the highest performance compared to the other three categories. New Zealand lower secondary students performed relatively better on *Earth science* and relatively worse on *chemistry* questions.

Table 1.5: Achievement in science content domains for selected countries

Country	Biology	Chemistry	Physics	Earth science
Singapore	594 (4.8)	590 (4.7)	602 (4.2)	566 (4.5)
Chinese Taipei	557 (2.5)	585 (3.9)	552 (3.4)	568 (2.9)
Korea, Rep. of	561 (2.4)	551 (2.2)	577 (2.8)	548 (3.2)
Japan	561 (2.3)	560 (2.6)	558 (2.7)	548 (2.8)
Finland	548 (2.9)	554 (2.5)	540 (2.7)	574 (3.0)
Slovenia	532 (2.7)	558 (3.2)	532 (2.8)	560 (3.2)
Hong Kong SAR	535 (3.5)	526 (3.6)	539 (3.6)	539 (3.7)
England	533 (4.9)	529 (5.2)	533 (4.6)	536 (5.3)
United States	530 (2.5)	520 (2.6)	513 (2.5)	533 (2.8)
Australia	527 (4.7)	501 (5.1)	511 (5.1)	533 (5.4)
New Zealand	**514 (4.7)**	**501 (5.1)**	**509 (4.6)**	**523 (4.8)**
Norway	491 (2.5)	488 (2.8)	481 (3.6)	516 (3.5)

Note: Standard errors are presented in parentheses.

Source: Adapted from Exhibit 3.2, Martin, Mullis, Foy, and Stanco, 2012.

There was no consistent pattern across countries when cognitive domains were compared (see Table 1.6). In New Zealand, *applying* was a relative weakness, with *reasoning* a relative strength.

Table 1.6: Achievement in science cognitive domains for selected countries

Country	Knowing	Applying	Reasoning
Singapore	588 (4.9)	589 (4.4)	592 (4.5)
Chinese Taipei	569 (2.7)	570 (2.7)	551 (2.9)
Korea, Rep. of	554 (2.9)	561 (2.0)	564 (2.2)
Japan	541 (2.7)	561 (2.4)	568 (2.3)
Finland	564 (3.0)	549 (2.5)	547 (3.4)
Slovenia	551 (2.7)	542 (2.6)	536 (2.7)
Hong Kong SAR	544 (3.3)	529 (3.5)	538 (4.1)
England	533 (5.1)	531 (4.7)	537 (4.8)
United States	527 (2.8)	522 (2.3)	524 (2.5)
Australia	514 (5.4)	517 (4.8)	526 (5.2)
New Zealand	**511 (5.0)**	**509 (4.3)**	**515 (4.7)**
Norway	490 (2.6)	496 (3.0)	494 (3.0)

Note: Standard errors are presented in parentheses.

Source: Adapted from Exhibit 3.4, Martin, Mullis, Foy, and Stanco, 2012.

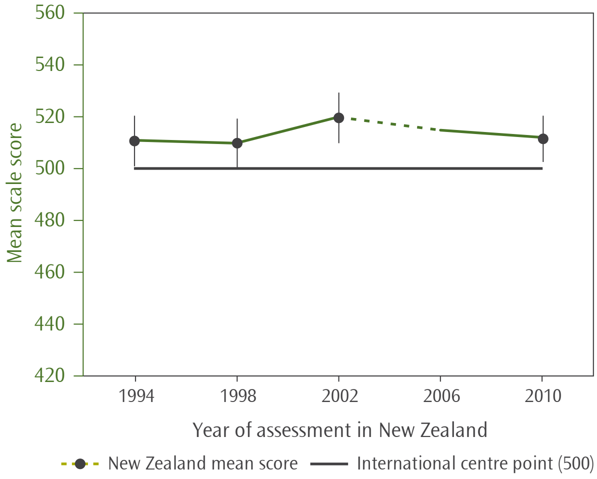
2. Trends in New Zealand science achievement 1994 to 2010

New Zealand has participated in TIMSS since its inception in 1994. However, in 2006 we opted not to participate at the Year 9 level. Therefore, we now have information from four assessments of science achievement. This chapter will present trends for New Zealand in means, distributions, benchmarks, item statistics, and the content and cognitive domains.

Trends in means and ranges since 1994

Mean science achievement has not changed significantly since 1994. However, achievement appears to be trending downwards in this latest cycle (see Figure 2.1). As mentioned in the previous chapter, New Zealand's mean score in 2010/11 (512) was significantly higher than the international scale centre point of 500.

Figure 2.1: Mean science achievement of New Zealand Year 9 students from 1994 to 2010

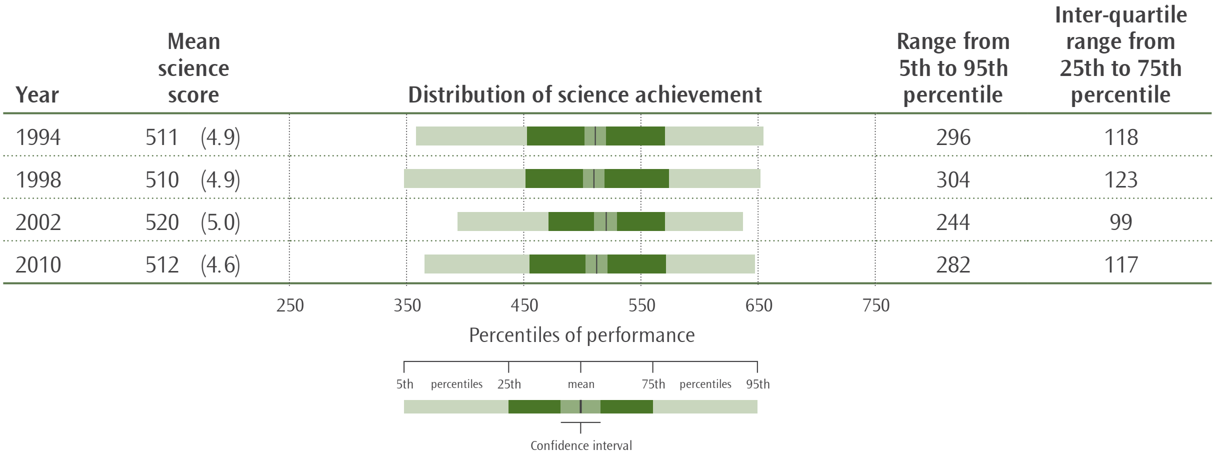


Note: New Zealand did not conduct the TIMSS assessment in 2006 so the dotted line indicates the possible location of mean achievement in that cycle.

In addition to looking at the mean achievement of students, it is useful to look at the range of achievement among the students. Considerable commentary on the 'tail of underachievement' has occurred in the last few years. Therefore, it is important to explore whether any changes have happened across the spectrum of achievement. Figure 2.2 presents achievement at the 5th, 25th, 75th, and 95th percentiles. The lower limit of achievement, the 5th percentile, is the score at which five percent of students achieved a lower score. The upper limit of achievement, the 95th percentile, is the score at which five percent of students achieved a higher score.

As shown in Figure 2.2, the range of achievement in 2010 was narrower than 1994 and 1998 but not as narrow as 2002. While there are fewer low achievers in 2010 compared with 1998, there are also fewer high achievers as shown by the 5th and 95th percentiles. However, when compared with 2002, there are more low achievers in 2010.

Figure 2.2: Distribution of science achievement of New Zealand Year 9 students from 1994 to 2010



Year	Mean science score		Distribution of science achievement	Range from 5th to 95th percentile	Inter-quartile range from 25th to 75th percentile
1994	511	(4.9)		296	118
1998	510	(4.9)		304	123
2002	520	(5.0)		244	99
2010	512	(4.6)		282	117

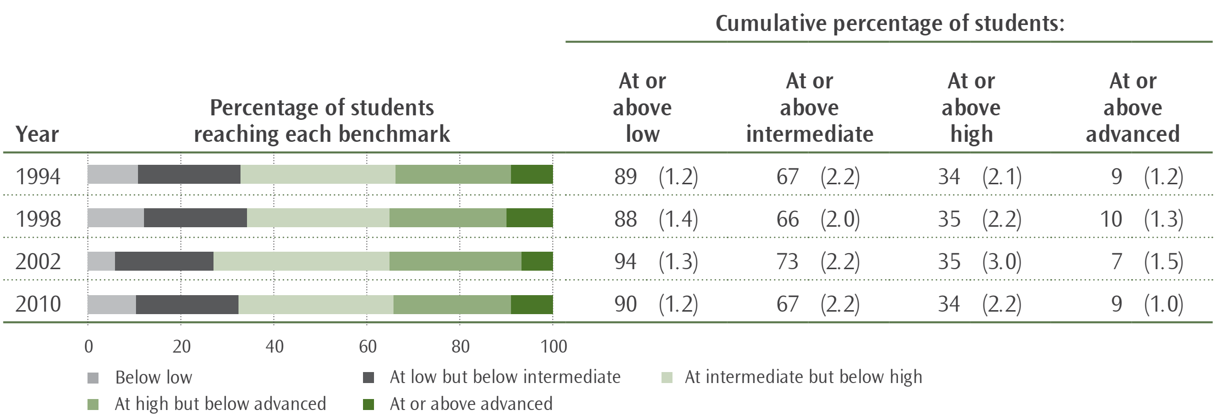
Note: Standard errors are presented in parentheses.

Trends in benchmarks for science

As mentioned earlier, in order to describe more fully what achievement on the science scale means, the TIMSS international researchers have developed benchmarks. These benchmarks link student performance on the TIMSS science scale to performance on science questions and describe what students can typically do at set points on the science achievement scale. Figure 2.3 presents those Year 9 students achieving at each of the benchmarks (as shown in the graphical part) and those students achieving at or above each of the benchmarks (as shown in the table part) in each cycle from 1994 to 2010.

As noted earlier when comparing the distributions of achievement in terms of percentiles, there were fewer high achievers and more low achievers than some of the previous cycles. An examination of the benchmark information shows there was little variation among the high and advanced benchmarks with the exception of 2002 when there were fewer students in the advanced benchmark (see Figure 2.3). However there were fewer low achieving students in 2002 than in 2010 as shown by both the low and intermediate benchmarks.

Figure 2.3: Trends in proportions of New Zealand Year 9 students at each benchmark from 1994 to 2011



		Cumulative percentage of students:							
Year	Percentage of students reaching each benchmark	At or above low		At or above intermediate		At or above high		At or above advanced	
1994		89	(1.2)	67	(2.2)	34	(2.1)	9	(1.2)
1998		88	(1.4)	66	(2.0)	35	(2.2)	10	(1.3)
2002		94	(1.3)	73	(2.2)	35	(3.0)	7	(1.5)
2010		90	(1.2)	67	(2.2)	34	(2.2)	9	(1.0)

Note: Standard errors are presented in parentheses.

"At or above" means that the proportion of students at the benchmark includes those that achieved at higher benchmarks also. For example, the 90% of students in 2010 that achieved at or above the low benchmark includes 22% who achieved at the low benchmark, 33% at the intermediate, 25% at the high, and 9% at the advanced benchmark.

Trends on the science test questions from 2002 to 2010

At the end of each cycle of TIMSS, test questions are released into the public domain. At the beginning of the next cycle, new questions are developed to replace released questions. In addition, each cycle of TIMSS includes some questions from previous cycles to provide a trend measure over time. This section presents an analysis of the trend questions included in both TIMSS 2002/03 and 2010/11.

There were 43 questions common to both 2002 and 2010. Of these 43 questions, five questions had similar proportions of New Zealand Year 9 students correctly answering them across the two cycles (as shown in Table 2.1). Less than one-sixth of the questions (7) showed a decline; that is they were correctly answered by fewer students in 2010 compared with 2002. In contrast, more than half of the questions showed an increase; that is they were correctly answered by more students in 2010 compared with 2002.

These item statistics show that despite the apparent downward trend, there were some improvements between 2002 and 2010. Note that the increases were spread across all content areas: *biology*, *chemistry*, *physics*, and *Earth science* but proportionately fewer questions increased in the *physics* content area.

Table 2.1: **Trends in proportions of New Zealand Year 9 students correctly answering science questions common to 2002 and 2010**

	Change between 2002 and 2010				
	decrease by 5% or more	decrease by between 1% and 5%	increase or decrease by 1% or less	increase by between 1% and 5%	increase by 5% or more
Number of questions	1	6	5	14	17

Trends in science content and cognitive domains from 2002 to 2010

As mentioned earlier, questions for the TIMSS tests were written to assess the content and cognitive aspects as described in the *TIMSS 2011 assessment frameworks* (Mullis, Martin, et al., 2009). Scores were created for each of these domains using a different methodology from previous cycles (see previous chapter and the Definitions and technical notes section for details). This new methodology was applied to the questions in the 2006/07 assessment to create revised domain scores for this cycle. Therefore, comparisons can be made between 2006 and 2010 but not with earlier cycles. Comparisons here only focus on relative strengths and weaknesses among the content domains as there was no attempt to describe cognitive domains in science in 2002. In terms of content, *Earth science* remains a relative strength in 2010 and *chemistry* remains a relative weakness within New Zealand.

3. TIMSS and the New Zealand science curriculum

The New Zealand curriculum guides teaching and learning. The alignment of curriculum levels with year levels is flexible. Teachers are expected to tailor lessons to meet students' individual needs. Students in the same year level may be working at different curriculum levels as appropriate to their abilities and pace of progression. As with previous cycles of TIMSS, teachers have given indications of what topics they have taught in the current school year to their Year 9 students and the curriculum level that the majority of their Year 9 students are working at. This section will examine what is implemented in terms of the curriculum as well as the match between the TIMSS test and the intended curriculum.

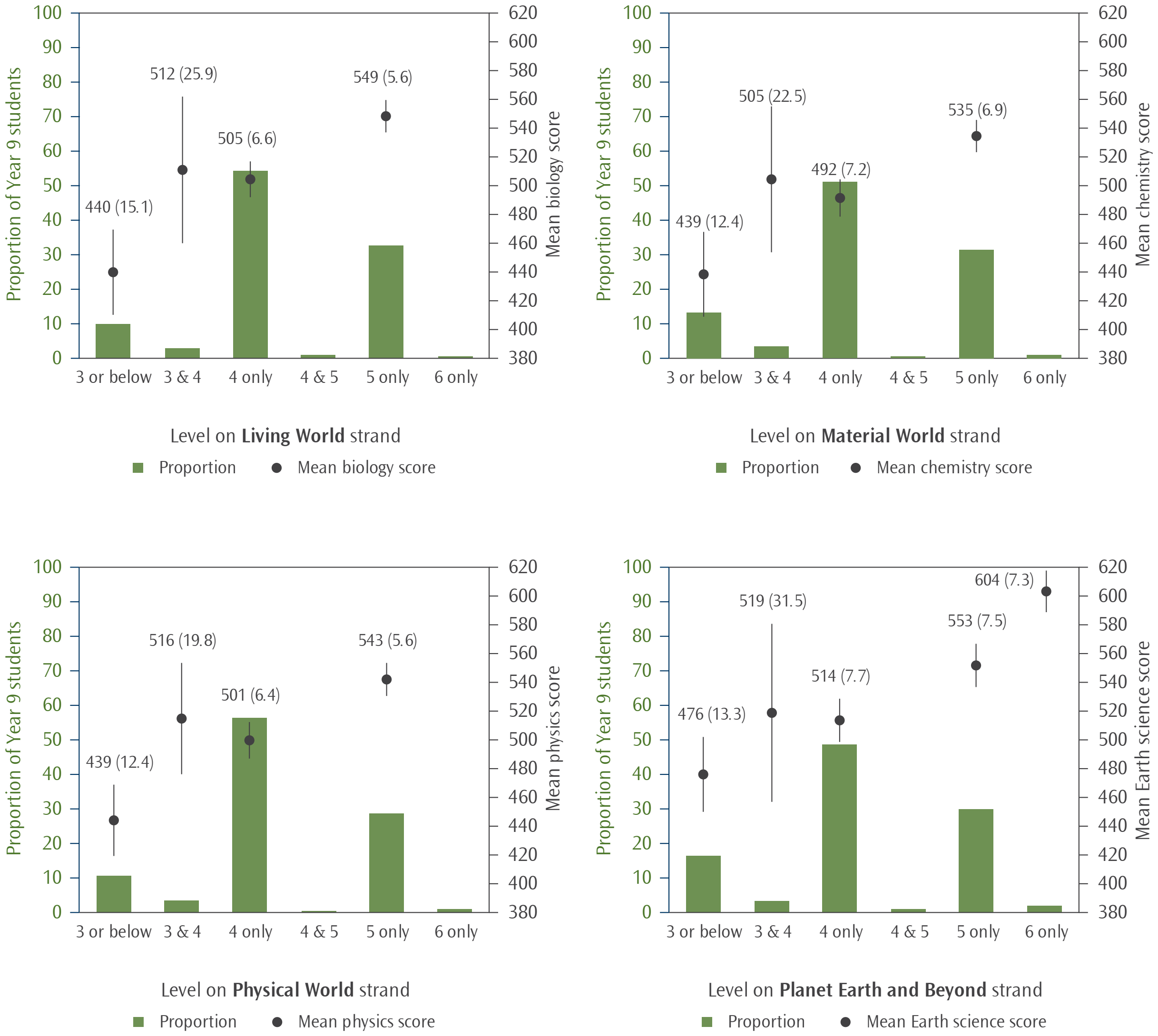
Science curriculum levels and the TIMSS content domains

New Zealand teachers were asked at which level(s) of Science in the New Zealand Curriculum were most of the Year 9 students in their class working for each of the strands: *nature of science*, *living world*, *physical world*, *material world*, and *planet Earth and beyond*. Figure 3.1 shows that the proportions of students working at level 5 of the curriculum were relatively low. The proportions varied across strands from one-third on the *living world* strand (33%) down to just over one-quarter (28%) on the *physical world* strand.

We can use the TIMSS content domains to examine attainment on the curriculum strands due to their similar science content. For example, the *chemistry* content domain for lower secondary in TIMSS consists of: classification and composition of matter, properties of matter, and chemical change (see Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009). Similarly, the *material world* strand at level 5 of the New Zealand curriculum consists of: properties and changes of matter, the structure of matter, and chemistry and society (Ministry of Education, 2007). Figure 3.1 shows that students whose classes are working at higher levels of the curriculum have higher achievement on the associated TIMSS content domain.

Examining these results in the international context shows that if we only included those Year 9 students working at level 5 of the curriculum in the TIMSS testing, New Zealand would still have a lower mean score than the high-performing countries (Singapore, Chinese Taipei, the Republic of Korea, and Japan). For example the average score for New Zealand students working at level 5 of the *living world* strand of the curriculum is still significantly lower on the *biology* content domain (549) than their Singaporean counterparts (594 scale score points). However for the *Earth science* content domain, New Zealand students working at level 5 (553) had a higher mean score than students in the Republic of Korea and Japan (both 548 scale score points).

Figure 3.1: Curriculum levels and New Zealand Year 9 student achievement on science content domains



Note: The bars on the graphs represent proportions of Year 9 students whose class were working at that level of the curriculum. The points represent mean scores on the appropriate content domain while the lines extending from those points represent the 95% confidence interval associated with estimating the mean of the population from the sample. No mean achievement is presented for groups smaller than two percent.

Curriculum match

Questions about international studies often focus on the appropriateness of the assessment questions for New Zealand students. New Zealand is not unique in asking this question; other countries are also concerned with appropriateness of the tests. The TIMSS assessment questions are developed through a collaborative process that begins with the development of an assessment framework. The *TIMSS 2011 assessment frameworks* (Mullis, Martin, et al., 2009) were designed to specify the important aspects of science that participating countries agreed should be the focus of an international assessment of science achievement. However it is inevitable that the tests included questions that were unfamiliar to some students in some countries. In order to investigate the extent to which the TIMSS 2010/11 assessment was relevant to each country's curriculum, TIMSS conducted a Test-Curriculum Matching Analysis (TCMA). The TCMA was also used to investigate the impact of selecting only appropriate questions on a country's performance.

For the TCMA, each assessment question was examined using the following two criteria:

- whether or not the topic of the question is in the intended curriculum for the majority (50 percent or more) of lower secondary students in the grade or school level tested (in our case Year 9); and
- whether or not the item topic was intended to be encountered by the students prior to the TIMSS testing (in our case November 2010).

While all questions, regardless of this analysis, were included in any overall results reported for TIMSS, this analysis was used to ascertain the level to which the results might change for New Zealand if only questions judged appropriate were included in the tests. The analysis also included an examination of how students in other countries would fare if given only the New Zealand-appropriate test.

Table 3.1 shows the proportion of questions considered appropriate to the New Zealand curriculum in each of the TIMSS content areas. However, it should be noted that New Zealand's science curriculum provides some challenges for deciding if at least half of Year 9 students are likely to have met the question topics in the TIMSS test. The curriculum is not prescriptive, instead providing some broad guidelines of science concepts and skills that schools can choose to cover. Schools are encouraged to design science programmes that are relevant to their students and communities. Consequently, when schools plan their science programmes there is considerable variation between them. Another challenge is that the broad achievement objectives are grouped in levels that cover approximately two years of schooling.

As shown in the previous section, New Zealand Year 9 students were generally working at levels 4 and 5 of the curriculum, so information from levels 4 and 5, but with a concentration on 5, was used to guide judgements on the TCMA. In addition, curriculum-matched resources available on http://scienceonline.tki.org.nz/ were used for further clarification.[5]

Table 3.1: Appropriateness of the TIMSS tests to the New Zealand Curriculum

TIMSS content domain	Number of score points judged appropriate for New Zealand curriculum	Number of score points in TIMSS assessment	Proportion of score points judged appropriate for New Zealand curriculum
Biology	73	87	84%
Chemistry	44	47	94%
Physics	50	58	86%
Earth Science	34	42	81%
Total	**201**	**234**	**86%**

Note: The TIMSS content area of biology corresponds to the living world strand in the curriculum, chemistry corresponds to the material world strand, physics corresponds to the physical world strand, and Earth science corresponds to the planet Earth and beyond strand.

As Table 3.1 shows 86 percent of the TIMSS questions were judged appropriate for New Zealand students in terms of the curriculum expectations. However, given that only about 30 percent of students were working at level 5 of the curriculum, this may be an over-estimation of the appropriateness of the test. The TCMA analysis shows that even if the TIMSS test was reduced to include only those questions considered appropriate to the New Zealand curriculum, the average New Zealand Year 9 student would have got less than half the items correct (see Table 3.2). In contrast, the average student in some of the high performing countries would have got nearly two-thirds of the items correct.

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[5] Thanks to Peter Saunders, Bernie Wills, Penelope de Boer, Margaret Vaka-Vivili, and Andrew Ball for their contributions to this work.

Table 3.2: **Performance of lower secondary students from selected countries on the New Zealand appropriate test in 2010/11**

Country	Average percent correct on New Zealand test
Singapore	65
Chinese Taipei	59
Korea, Rep. of	58
Japan	57
Finland	56
Russian Federation	54
Slovenia	54
Hong Kong SAR	53
England	53
United States	51
Australia	50
New Zealand	**49**
Norway	44
Kazakhstan	43

Source: Adapted from Exhibit F.2 in Martin, Mullis, Foy, and Stanco,2012.

Coverage of science topics

Teachers provided information on science topics taught to Year 9 students prior to or during the year of the TIMSS assessment. For each of 20 topics, teachers were asked if the topic was *mostly taught before this year*, *mostly taught this year*, or *not yet taught or just introduced*. Nearly half of students had been taught all these topics in 2010 or the preceding years (48% of students). In comparison, just under three-quarters of students (72%) on average across countries had been taught all these 20 topics (range from 39% in Norway to 98% in the Republic of Macedonia).

More New Zealand students had been taught *chemistry* and *physics* topics in 2010 or the preceding years (62% and 58% respectively) than *biology* topics (40%), or *Earth science* topics (38%). Note that this question was not about the proportion of time spent on these but rather the coverage of items in the *TIMSS 2011 assessment frameworks* (Mullis, Martin, et al., 2009). The TIMSS framework guided the writing of questions for the TIMSS assessment and the final formulation of the test. As mentioned earlier, *Earth science* is the area of TIMSS where New Zealand students show the best performance while the other areas were lower.

The science topics covered by fewer than one-third of all New Zealand students were:

- Reproduction (sexual and asexual) and heredity (passing on of traits, inherited versus acquired/learned characteristics) (20%);
- Reasons for increase in world's human population (e.g., advances in medicine, sanitation), and the effects of population growth on the environment (13%);
- Human health (causes of infectious diseases, methods of infection, prevention, immunity) and the importance of diet and exercise in maintaining health (22%);
- Properties and uses of common acids and bases (27%);

- Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets (14%);
- Earth's structure and physical features (Earth's crust, mantle and core; composition and relative distribution of water, and composition of air) (24%); and
- Earth's processes, cycles and history (rock cycle; water cycle; weather patterns; major geological events; formation of fossils and fossil fuels) (25%).

Table 3.3 shows a complete list of topics and coverage among New Zealand Year 9 students.

The relationship between coverage and achievement is complicated. New Zealand had one of the lowest coverage rates of all the participating countries but achieved quite well in comparison to many of them. Although higher than us, many of the high-achieving countries had relatively low coverage of the science topics. It is interesting to note that a lot of the high-performing countries had higher coverage of *physics* topics (e.g., Hong Kong SAR 76%, Republic of Korea 79%, Japan 76%, and Singapore 83%) than New Zealand (58%).

Table 3.3: Science topics taught to Year 9 students in New Zealand before or during 2010

Topic	Proportion of students in classes where the topic was taught before or during 2010
Biology	
Major organs and organ systems in humans and other organisms (structure/function, life processes that maintain stable bodily conditions)	41
Cells and their functions, including respiration and photosynthesis as cellular processes	74
Reproduction (sexual and asexual) and heredity (passing on of traits, inherited versus acquired/learned characteristics)	20
Role of variation and adaptation in survival/extinction of species in a changing environment	45
Interdependence of populations of organisms in an ecosystem (e.g., energy flow, food webs, competition, predation) and the impact of changes in the physical environment on populations (e.g., climate, water supply)	67
Reasons for increase in world's human population (e.g., advances in medicine, sanitation), and the effects of population growth on the environment	13
Human health (causes of infectious diseases, methods of infection, prevention, immunity) and the importance of diet and exercise in maintaining health	22
Chemistry	
Classification, composition, and particulate structure of matter (elements, compounds, mixtures, molecules, atoms, protons, neutrons, electrons)	91
Solutions (solvent, solute, concentration/dilution, effect of temperature on solubility)	79
Properties and uses of common acids and bases	27
Chemical change (transformation of reactants, evidence of chemical change, conservation of matter, common oxidation reactions – combustion, rusting, tarnishing)	51
Physics	
Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)	84
Energy forms, transformations, heat, and temperature	75
Basic properties/behaviours of light (reflection, refraction, light and colour, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)	73
Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets	14
Forces and motion (types of forces, basic description of motion, effects of density and pressure)	45
Earth Science	
Earth's structure and physical features (Earth's crust, mantle and core; composition and relative distribution of water, and composition of air)	24
Earth's processes, cycles and history (rock cycle; water cycle; weather patterns; major geological events; formation of fossils and fossil fuels)	25
Earth's resources, their use and conservation (e.g., renewable/nonrenewable resources, human use of land/soil, water resources)	40
Earth in the solar system and the universe (phenomena on Earth - day/night, tides, phases of moon, eclipses, seasons; physical features of Earth compared to other bodies; the Sun as a star)	61

4. Progress over time – Year 5 students in 2006 now Year 9 students in 2010

The cohort of New Zealand students who participated in TIMSS in 2006 as Year 5 students were in Year 9 in the 2010 cycle of TIMSS. Similarly, across other countries in TIMSS, the Grade 4 students in the fourth cycle of TIMSS were Grade 8 students in the fifth cycle. TIMSS was designed with a four-year cycle to allow a quasi-longitudinal study of mathematics and science achievement. Although the science achievement scales for the middle primary and lower secondary levels are not comparable, it is possible to look at the relative performance of countries in each assessment to examine the progress the younger cohort has made in four years.

Progress from 2006 to 2010

Nineteen countries that assessed their middle primary students in TIMSS 2006/07 also participated in TIMSS 2010/11 at the lower secondary level. The expectation, as demonstrated in the frameworks for TIMSS, was that students should be able to do much more difficult science questions in lower secondary school than in middle primary. For example at the middle primary level, items in the life science domain cover:

- characteristics and life processes of living things;
- life cycles, reproductions, and heredity;
- interaction with the environment;
- ecosystems; and
- human health.

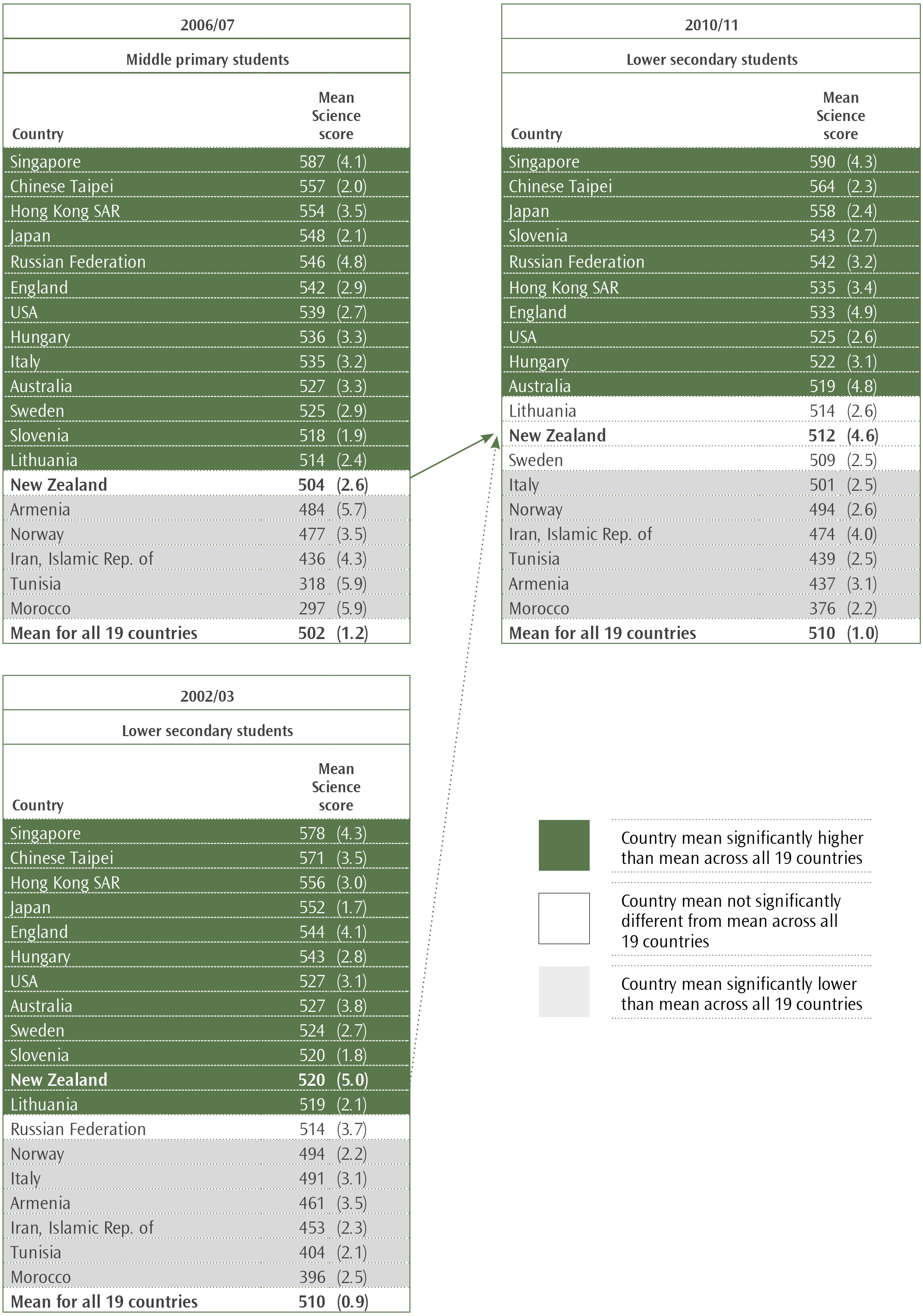
At the lower secondary level, the life science domain is titled 'biology' and is expanded to include:

- characteristics, classification, and life processes of organisms;
- cells and their functions;
- life cycles, reproductions, and heredity;
- diversity, adaptation, and natural selection;
- ecosystems; and
- human health.

The mean science achievement of New Zealand Year 5 students (504) was approximately the same as the mean of all 19 countries (502 scale score points) in the 2006/07 study. In 2010/11 the mean science achievement of this group as Year 9 students (512) was still approximately the same as the mean of all 19 countries (510 scale score points). However, New Zealand's relative ranking among these countries improved as these students matured so that there were more countries below New Zealand as shown in Figure 4.1.

Also shown in Figure 4.1 is the relative ranking among this group of countries for the previous Year 9 cohort of students, assessed in 2002/03. This group had a higher relative ranking, achieving significantly higher than the mean for all 19 countries.

Figure 4.1: Relative science performance of middle primary students in 2006/07 and again when they were lower secondary students in 2010/11 (and 2002/03 for comparison)



2006/07	
Middle primary students	
Country	Mean Science score
Singapore	587 (4.1)
Chinese Taipei	557 (2.0)
Hong Kong SAR	554 (3.5)
Japan	548 (2.1)
Russian Federation	546 (4.8)
England	542 (2.9)
USA	539 (2.7)
Hungary	536 (3.3)
Italy	535 (3.2)
Australia	527 (3.3)
Sweden	525 (2.9)
Slovenia	518 (1.9)
Lithuania	514 (2.4)
New Zealand	**504 (2.6)**
Armenia	484 (5.7)
Norway	477 (3.5)
Iran, Islamic Rep. of	436 (4.3)
Tunisia	318 (5.9)
Morocco	297 (5.9)
Mean for all 19 countries	**502 (1.2)**

2010/11	
Lower secondary students	
Country	Mean Science score
Singapore	590 (4.3)
Chinese Taipei	564 (2.3)
Japan	558 (2.4)
Slovenia	543 (2.7)
Russian Federation	542 (3.2)
Hong Kong SAR	535 (3.4)
England	533 (4.9)
USA	525 (2.6)
Hungary	522 (3.1)
Australia	519 (4.8)
Lithuania	514 (2.6)
New Zealand	**512 (4.6)**
Sweden	509 (2.5)
Italy	501 (2.5)
Norway	494 (2.6)
Iran, Islamic Rep. of	474 (4.0)
Tunisia	439 (2.5)
Armenia	437 (3.1)
Morocco	376 (2.2)
Mean for all 19 countries	**510 (1.0)**

2002/03	
Lower secondary students	
Country	Mean Science score
Singapore	578 (4.3)
Chinese Taipei	571 (3.5)
Hong Kong SAR	556 (3.0)
Japan	552 (1.7)
England	544 (4.1)
Hungary	543 (2.8)
USA	527 (3.1)
Australia	527 (3.8)
Sweden	524 (2.7)
Slovenia	520 (1.8)
New Zealand	**520 (5.0)**
Lithuania	519 (2.1)
Russian Federation	514 (3.7)
Norway	494 (2.2)
Italy	491 (3.1)
Armenia	461 (3.5)
Iran, Islamic Rep. of	453 (2.3)
Tunisia	404 (2.1)
Morocco	396 (2.5)
Mean for all 19 countries	**510 (0.9)**

🟩	Country mean significantly higher than mean across all 19 countries
⬜	Country mean not significantly different from mean across all 19 countries
▨	Country mean significantly lower than mean across all 19 countries

5. Science achievement of Year 9 boys and girls

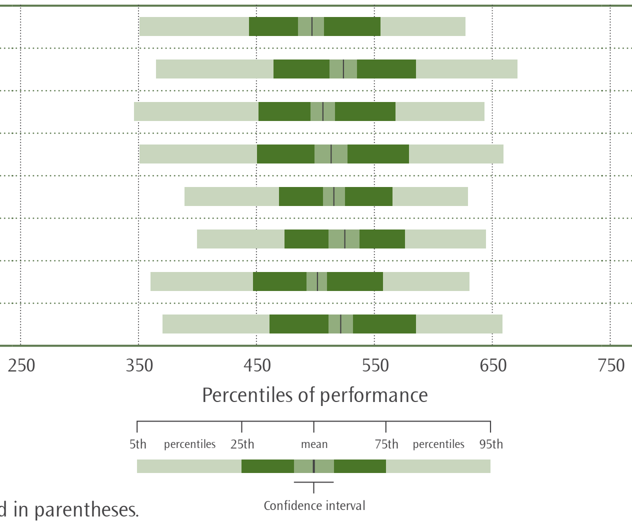
The Government sets the National Education Goals (NEGs) to recognise the fundamental importance of education to New Zealand. The first of these goals seeks to have "the highest standards of achievement, through programmes which enable all students to realise their full potential as individuals, and to develop the values needed to become full members of New Zealand's society" (Ministry of Education, 2009). Currently the focus is on the outcomes of boys in the New Zealand system rather than girls. Some New Zealand boys appear not to be reaching their full potential in our current education system (Ministry of Education, 2007). Qualification data shows different proportions of boys and girls having success (see for example http://www.educationcounts.govt.nz/statistics/schooling/ncea-attainment/ncea-achievement-data-roll-based/ncea-attainment). This chapter will examine the science achievement of Year 9 boys and girls in TIMSS in 2010 with some comparisons with previous cycles.

Science achievement of boys and girls

New Zealand boys had higher average science achievement (522) than girls (501 – 20 scale score points difference)[6] in 2010. However, the range of achievement for boys was wider than for girls (as shown in Figure 5.1). The last two cycles of TIMSS (2002 and 1998) had no significant gender difference so this is the first cycle since 1994 to show a significant difference in science achievement between the boys and the girls. This large increase in the difference is due to the large decrease in achievement for the girls from 2002 to 2010 (14 scale score points). There is no significant difference in mean achievement for boys between 2002 and 2010.

Figure 5.1: Trends in distributions of achievement for New Zealand girls and boys from 1994 to 2010

Year		Mean science score		Distribution of science achievement	Range from 5th to 95th percentile	Interquartile range from 25th to 75th percentile
1994	Girls	497	(5.6)		277	111
	Boys	524	(6.1)		307	121
1998	Girls	506	(5.4)		297	117
	Boys	513	(7.0)		308	129
2002	Girls	515	(4.8)		240	96
	Boys	525	(6.7)		246	102
2010	Girls	501	(4.6)		270	110
	Boys	522	(5.1)		287	123



Note: Standard errors are presented in parentheses.

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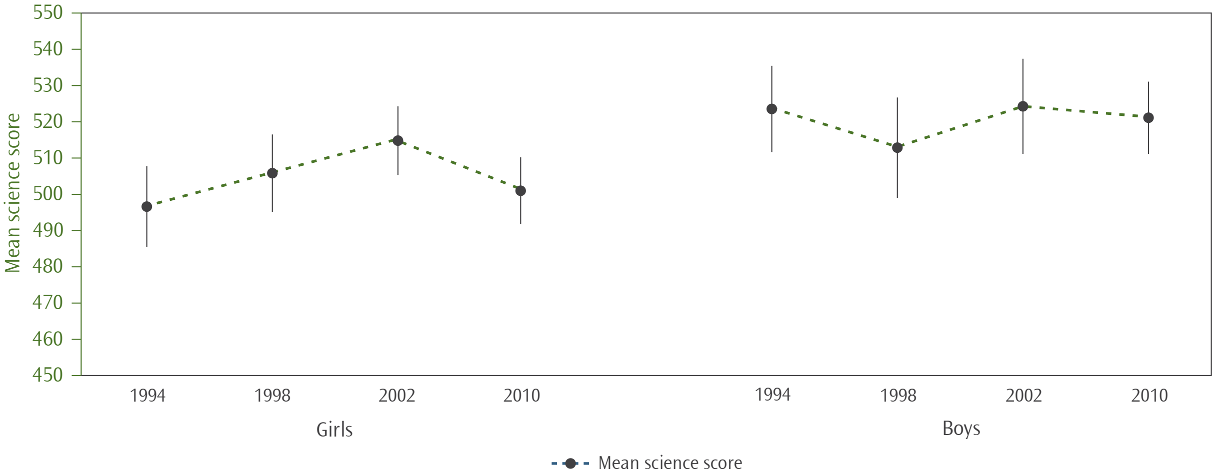
[6] Because results are rounded to the nearest whole number, this difference appears inconsistent.

In comparison with other countries, New Zealand really stands out for having nearly the largest gender difference in favour of boys. The other countries with large gender differences favouring boys were Ghana (30), Hungary (18), Tunisia (17), Australia (16), Chile (16), Italy (15), and the United States (11). With the exception of Japan and the Russian Federation, countries who were high-performing had no gender difference. Both Japan and the Russian Federation had small gender differences in favour of boys (8 and 7 scale score points difference respectively).

Figure 5.2 presents trends in mean science achievement for girls and boys. As Figure 5.2 shows, girls' science achievement was increasing from 1994 through to 2002, but dropped back to the 1994 level in 2010. In contrast, boys' achievement has not differed significantly across the four cycles of TIMSS. Note that although there appears to be a drop in mean achievement for boys between 1994 and 1998, due to relatively large standard errors, this is **not** significant.

Figure 5.2: Trends in mean achievement for New Zealand girls and boys from 1994 to 2010

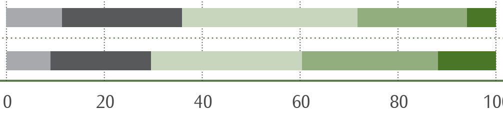


Note: The lines extending from the points represent the 95% confidence interval, i.e. the range in which we are 95 percent confident that the true population value lies.

Benchmarks for boys and girls

More boys reached the high and advanced benchmarks compared to girls as shown in Figure 5.3. There were significant proportions of both girls (11%) and boys (9%) who did not reach the low benchmark – these students did not demonstrate the ability to complete the basic science tasks that TIMSS seeks to measure.

Figure 5.3: Proportion of New Zealand boys and girls reaching each science international benchmark in 2010

	Percentage of students reaching each benchmark	Cumulative percentage of students: At or above low		At or above intermediate		At or above high		At or above advanced	
Girls		89	(1.8)	64	(2.4)	28	(2.0)	6	(1.0)
Boys		91	(1.1)	70	(2.5)	40	(2.6)	12	(1.2)

Note: Standard errors are presented in parentheses.

"At or above" means that the proportion of students at the benchmark includes those that achieved at higher benchmarks also. For example, the just under 89% of girls that achieved at or above the low benchmark includes 24% who achieved at the low benchmark, 36% at the intermediate, 22% at the high, and just under 6% at the advanced benchmark.

Although it appears there have been some small changes in the proportions of boys and girls reaching each of the benchmarks since 2002, only the changes in the proportions of girls reaching the intermediate and low benchmarks and boys reaching the low benchmark are statistically significant (see Table 5.1). There were more girls and boys with low achievement in 2010 compared with 2002. In particular, in 2002 there was only six percent of girls and five percent of boys who did not reach the low benchmark, but these proportions had grown to 11 percent and nine percent respectively by 2010.

Table 5.1: Proportion of New Zealand boys and girls reaching each science international benchmark in 2002

	Cumulative percentage of Year 9 students reaching each benchmark							
	Low		Intermediate		High		Advanced	
Girls	94	(1.3)	72	(2.5)	32	(3.0)	6	(1.2)
Boys	95	(1.6)	75	(2.8)	38	(3.8)	8	(2.2)

Note: Standard errors are presented in parentheses.

Achievement on the content and cognitive domains for boys and girls

As mentioned earlier, boys had higher average science achievement than girls. As shown below, this higher achievement was across all content and cognitive domains.

Table 5.2: New Zealand Year 9 mean science scores on the content and cognitive domains by gender

Content domain	Mean domain score			
	Girls		Boys	
Biology	509	(5.2)	519	(5.1) ▲
Chemistry	488	(5.9)	513	(5.2) ▲
Physics	494	(4.8)	522	(5.1) ▲
Earth Science	507	(5.2)	536	(5.2) ▲

Cognitive Domain	Mean domain score			
	Girls		Boys	
Knowing	498	(5.5)	524	(5.4) ▲
Applying	498	(4.5)	519	(4.8) ▲
Reasoning	507	(5.1)	522	(5.1) ▲

Note: ▲ mean domain score significantly higher than other gender.

Standard errors are presented in parentheses.

Source: Exhibits 3.10 & 3.12, Martin, Mullis, Foy, and Stanco, 2012.

6. Science achievement, ethnicity of students, and language of the home

The Ministry of Education is currently placing priority on improving outcomes for Māori learners and for Pasifika learners (as well as students with special needs and those with low socio-economic status). While this is not a new focus, with previous documents and programmes aimed in this direction, it is important to review our progress towards this goal. It is not the ethnicity of these groups per se that influences outcomes but rather ethnicity can be indicative of underlying social, cultural, educational, and economic influences. Thus the existence of a relationship between ethnicity and achievement demonstrated in this section does not infer that being classified in a particular ethnic group is a cause of poor or good achievement. This section will examine science achievement among ethnic groupings and language users.

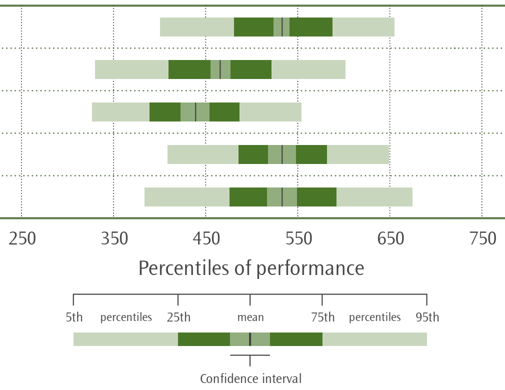
Science achievement among ethnic groupings

Five broad categories are used to describe ethnicity in this report: Pākehā/European, Māori, Pasifika, Asian, and 'Other'.[7] The majority of students were classified as Pākehā/European (58%) or Māori (20%). Of the remainder, eight percent were classified as Pasifika, ten percent as Asian and only four percent as 'Other'.

As shown in Figure 6.1, there was a range of achievement within each ethnic grouping, with the widest range among students in the 'Other' ethnic grouping. On average, Pākehā/European, Asian and 'Other' students had higher science achievement than Māori students. Māori students had higher science achievement, on average, than Pasifika students.

Figure 6.1: Distribution of New Zealand Year 9 science achievement for each ethnic grouping in TIMSS 2010

Ethnic grouping	Mean science score	Distribution of science achievement	Range from 5th to 95th percentile	Inter-quartile range from 25th to 75th percentile
Pākehā/European	533 (4.3)		255	107
Māori	466 (5.5)		272	111
Pasifika	439 (7.9)		227	98
Asian	533 (7.5)		240	97
Other	533 (8.3)		292	116



Note: Standard errors are presented in parentheses.

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[7] Note that information was collected from both schools and students and the data presented summarises this information. Also note, that although students were able to identify with more than one ethnic grouping, each student was assigned to only one group using prioritisation as per previous cycles. This allows groups to be compared with each other. See the appendix for the results of multiple categorisation of ethnicity.

In terms of trends over time, the average science achievement of Asian students has shown a significant increase since 1994. Between 2002 and 2010 there has been a significant decrease in the average science achievement of Māori and Pasifika students.

Table 6.1: **Trends in science achievement for Year 9 students in New Zealand over five cycles of TIMSS by ethnic grouping**

	Mean Science Achievement				
Ethnic grouping	**1994**	**1998**	**2002**	**2010**	**Change 1994 to 2010**
Pākehā/European	533 (4.4)	534 (4.5)	540 (5.4)	533 (4.3)	0 (6.2)
Māori	472 (5.6)	472 (6.0)	487 (5.6)	466 (5.5)	-6 (7.9)
Pasifika	430 (8.5)	430 (12.0)	465 (9.8)	439 (7.9)	9 (11.6)
Asian	498 (12.0)	515 (9.9)	543 (8.2)	533 (7.5)	35 (14.1)
Other	525 (14.6)	513 (17.3)	524 (12.9)	533 (8.3)	8 (16.8)

Note: Due to rounding some results may appear inconsistent.

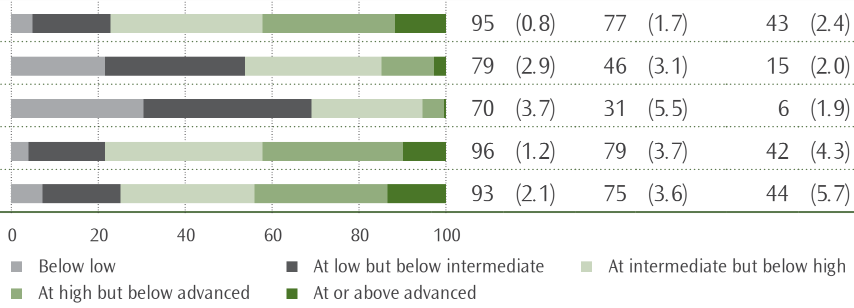
Standard errors are presented in parentheses.

Benchmarks of science achievement among ethnic groupings

The TIMSS benchmarks provide an understanding of achievement beyond mere averages and ranges (see Chapter 1 for details of these benchmarks). There were high achieving students in all ethnic groupings as measured by the high and advanced benchmarks. However, there were larger proportions of Asian, Pākehā/European and 'Other' students in these high achieving groups compared with Māori and Pasifika students. As shown in Figure 6.2 there were students in all ethnic groupings who did not demonstrate the ability to complete a reasonable number of the simplest science tasks that TIMSS seeks to measure (that is, they did not reach the low benchmark). However, there were larger proportions of Māori and Pasifika students in this low achieving group (below the low benchmark) compared with Asian and Pākehā/European students.

Figure 6.2: **Proportion of New Zealand Year 9 students reaching each international science benchmark by ethnic grouping in TIMSS 2010/11**

		Cumulative percentage of students:			
Ethnic grouping	**Percentage of students reaching each benchmark**	**At or above low**	**At or above intermediate**	**At or above high**	**At or above advanced**
Pākehā/European		95 (0.8)	77 (1.7)	43 (2.4)	12 (1.3)
Māori		79 (2.9)	46 (3.1)	15 (2.0)	3 (0.6)
Pasifika		70 (3.7)	31 (5.5)	6 (1.9)	1 (0.6)
Asian		96 (1.2)	79 (3.7)	42 (4.3)	10 (1.8)
Other		93 (2.1)	75 (3.6)	44 (5.7)	14 (3.3)



Note: Standard errors are presented in parentheses.

"At or above" means that the proportion of students at the benchmark includes those that achieved at higher benchmarks also. For example, the 95% of Pākehā/European students that achieved at or above the low benchmark includes 18% who achieved at the low benchmark, just under 35% at the intermediate, 31% at the high, and 12% at the advanced benchmark.

There were proportionately more low achieving Pākehā/European, Māori, and Pasifika students (not reaching the low benchmark) this cycle (2010) compared with the previous cycle (2002 – see Table 6.2). Although there appear to be increases at the advanced benchmark, none of these are statistically significant.

Table 6.2: Proportion of New Zealand Year 9 students reaching each international science benchmark in 2002, by ethnic grouping

	Cumulative percentage of Year 9 students at or above each benchmark			
Ethnic grouping	**Low**	**Intermediate**	**High**	**Advanced**
Pākehā/European	98 (1.0)	84 (1.9)	45 (3.4)	10 (2.1)
Māori	88 (2.4)	57 (3.8)	18 (2.3)	2 (0.7)
Pasifika	84 (5.4)	44 (6.6)	8 (2.8)	1 (1.0)
Asian	97 (1.9)	83 (4.3)	51 (6.1)	8 (3.1)

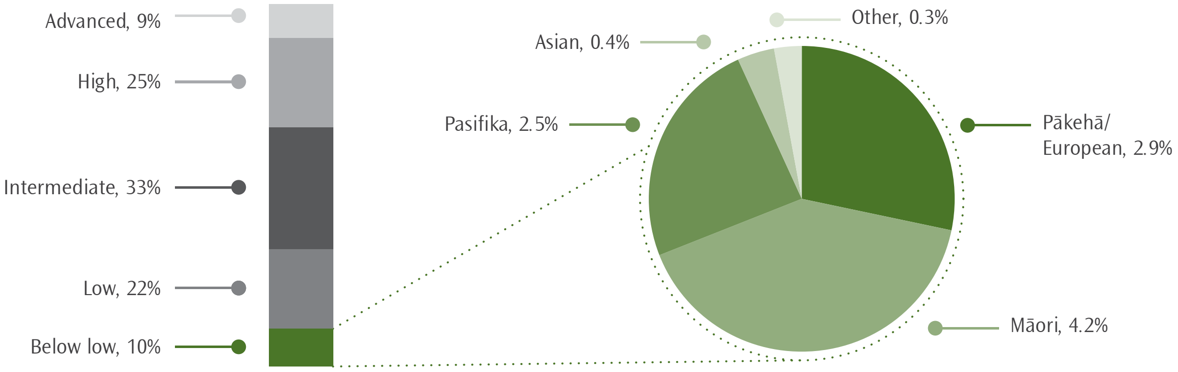
Note: Standard errors are presented in parentheses.

There were too few students in the 'Other' ethnic grouping in 2002 to report achievement.

Source: Table 3.8, Chamberlain, 2007.

We can also examine the composition of the group who did not reach the low benchmark (just over 10% of students over all New Zealand). The majority of these students were Māori or Pākehā/European as shown in Figure 6.3. However, both Māori and Pasifika students are over-represented in this lower achieving group compared to their proportion in the population.

Figure 6.3: Ethnic composition of New Zealand Year 9 students who did not reach the low benchmark



Note: The values presented in the pie chart are proportions of the whole population and add to just over 10% - the proportion of students in the 'below low' group.

Science achievement of boys and girls within ethnic groupings

As mentioned earlier, the science achievement of boys overall was higher than girls overall. This difference only occurred among the larger ethnic groupings: Pākehā/European boys and Māori boys had higher science achievement than their female counterparts.

Science achievement by language

Students were asked how often they spoke English at home. Most students (92%) indicated that they always or almost always spoke English at home. Nearly all of the rest of the students indicated that they sometimes spoke English and sometimes another language. Only one percent of students reported never speaking English at home. Of those who spoke another language, it was most common to speak an Asian language or Māori with a Pacific Islands language a close third.

Many studies point to the advantages of bilingualism (or indeed multilingualism) including greater flexibility of thinking (see for example Adesope, O. O., Lavin, T., Thompson, T., and Ungerleider, C., 2010). However, you might expect that by the time students began secondary school (providing all their education occurred in New Zealand) that they had learnt enough English that the language background of the home would not be a strong influence on achievement. Students who always or almost always spoke English at home had higher science achievement than those who sometimes did.[8] With only a few exceptions, this was also the pattern observed across many of the other countries who participated in TIMSS; students who nearly always used the language of the test at home often had higher achievement on average than those who only sometimes spoke it at home.

To provide further evidence about the relationship between language and achievement, principals were asked about the language composition of the school to ascertain if this affected science achievement. However, there was no difference in science achievement on average between those schools with many students (more than 90%) with English as their first language and those with few students (25% or less) nor with any of the categories in between.

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[8] Note that there were too few students regularly speaking other languages at home to examine their achievement by ethnic or language groupings.

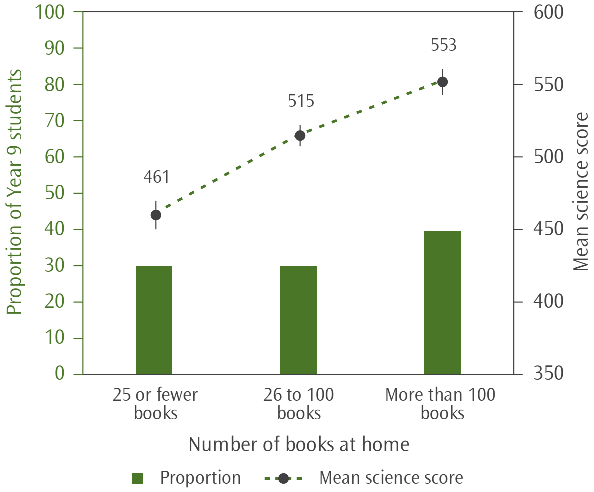
7. Science achievement and socio-economic status

The New Zealand education system recognises that students from homes poor in wealth and educational resources may need extra help to achieve at the same level as students from well-resourced homes. Schools with larger numbers of these students with low socio-economic status are provided with extra funding per student. TIMSS only provides a snap-shot measure of achievement so cannot provide a measure of value-adding that schools do for these students. Numerous studies, including previous TIMSS studies, have shown that students with fewer resources at home have lower achievement, on average, than those with more resources. Therefore, it is important to continue to measure the level of socio-economic status of students as well as the achievement of these students. This chapter will present details of some of the measures used to examine socio-economic status along with their association with achievement.

Home possessions and books as proxies for SES

Home possessions and books in the home can be used to give a measure of both the wealth of the home and the level of importance given to education and culture. The TIMSS questionnaires asked students about the presence in their home of five resources that could be used for educational purposes: a computer, a study desk or table for their use (presumably for learning activities at home), their own books, their own room (a quiet place for undertaking learning activities on their own), and an internet connection. Additionally, countries could specify their own list of resources that might be indicators of relative wealth – in New Zealand this list was: musical instruments, clothes dryer, dishwasher, two or more bathrooms, their own computer or laptop, and swimming or spa pool. Students were also asked about the number of books in their home. This next section will discuss the results of these questions.

Figure 7.1: Mean science achievement of New Zealand students by number of books in the home



Note: The bars on the graph represent proportions of Year 9 students. The points represent mean scores while the lines extending from those points represent the 95% confidence interval associated with estimating the mean of the population from the sample.

Books in the home

TIMSS has asked about the number of books in the home since 1994/95. Figure 7.1 shows proportions of students in three summarised categories of numbers of books in the home and their mean achievement.

Just under one-third of students (30%) reported that they had 25 or fewer books in their home. Just over one-third of students (40%) reported that they had more than 100 books in their home. This proportion of students with more than 100 books is a little lower than 2002/03 (47%) but much lower than in 1994 (66%).

As shown in Figure 7.1, students that reported more books in the home had higher science achievement than those with fewer books.

Educational resources in the home

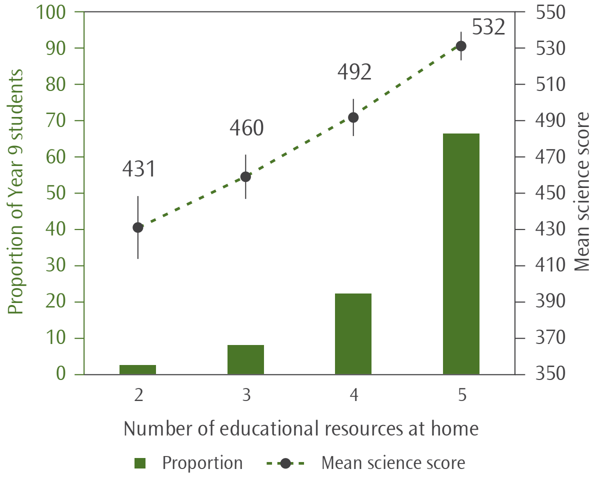
Table 7.1 shows the proportions of students that had each of the educational resources in their homes. Nearly all students reported having a computer in their home (97%) and the majority of students had an internet connection (91%). The least common resource students possessed was a study desk (86%).

Table 7.1: Proportions of New Zealand students with educational resources in their homes

Educational resource	Proportion of Year 9 students having resource
Computer	97
Study desk/table	86
Own books (do not count school books)	88
Own room	89
Internet connection	91

Nearly two-thirds of all students (66%) had all five educational resources; less than one percent had only one or none of the resources. Students with a greater number of these resources had higher achievement than those with fewer of the resources. Figure 7.2 shows the relationship between the number of these educational resources and science achievement.

Figure 7.2: Mean science achievement of New Zealand students by number of educational resources at home



Note: The bars on the graph represent proportions of Year 9 students. The points represent mean scores while the lines extending from those points represent the 95% confidence interval associated with estimating the mean of the population from the sample.

Less than one percent of students had one or none of the educational resources at home.

The relationship between educational resources in the home and achievement was evident among all ethnic groupings. However, far fewer Māori (47%) and Pasifika (41%) students had all five educational resources compared with Asian (74%) and Pākehā/European students (74%).

Number of items in the home

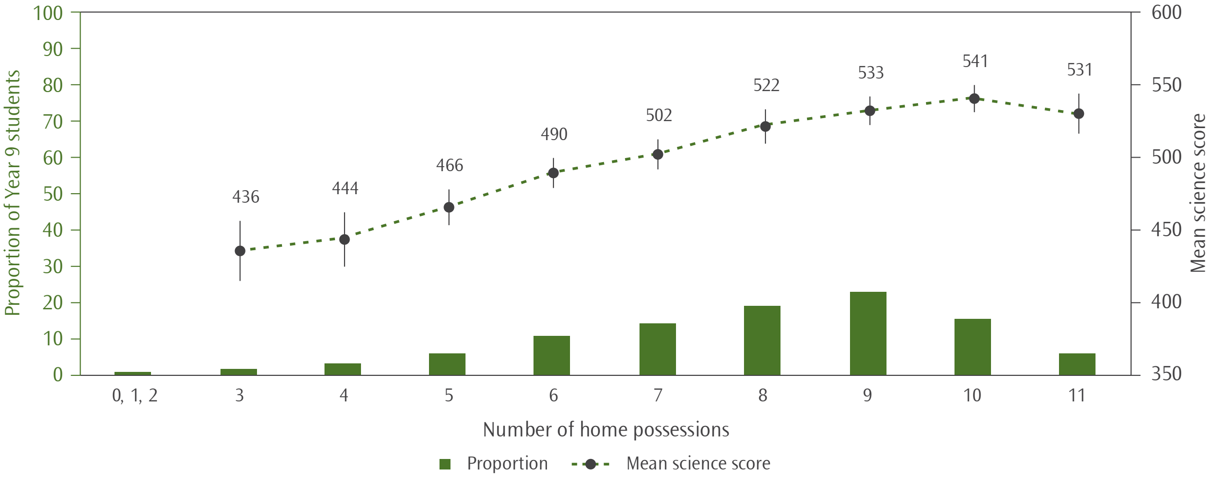
Table 7.2 shows the proportions of students that had each of the items in their homes used as an indicator of wealth. The majority of students reported having a clothes dryer in their home (82%) and many had a dishwasher (72%). The least common resources students possessed were their own computer or laptop (42%) and having a swimming or spa pool at home (22%). Among these items, in most cases, those students who reported having them at home had higher achievement than those who did not. The exceptions were swimming or spa pools, a clothes dryer, and own computer, and students who said they had these items had the same achievement as those who did not.

Table 7.2: **Proportions of New Zealand students with items in their homes**

Items used as a surrogate for SES	Proportion of Year 9 students having resource
Musical instruments (e.g., piano, violin, guitar)	67
Clothes dryer	82
Dishwasher	72
Two or more bathrooms	57
Your own computer or laptop	42
Swimming pool or spa pool	22

Generally, students who had more items in the home had higher achievement than those who had fewer. However, the differences between adjacent groupings are not necessarily statistically significant but the overall pattern is significant (see Figure 7.2).

Figure 7.3: **Mean science achievement of New Zealand students by number of home possessions**



Note: The bars on the graph represent proportions of Year 9 students. The points represent mean scores while the lines extending from those points represent the 95% confidence interval associated with estimating the mean of the population from the sample.

A higher proportion of Pākehā/European (53%) and Asian students (43%) had nine or more of the home possessions compared with Māori (29%) or Pasifika (18%) students. With home possessions used as a proxy for socio-economic status, we could conclude that more Pākehā/European and Asian students have higher socio-economic status compared with Māori or Pasifika students.

Socio-economic indicators of schools attended

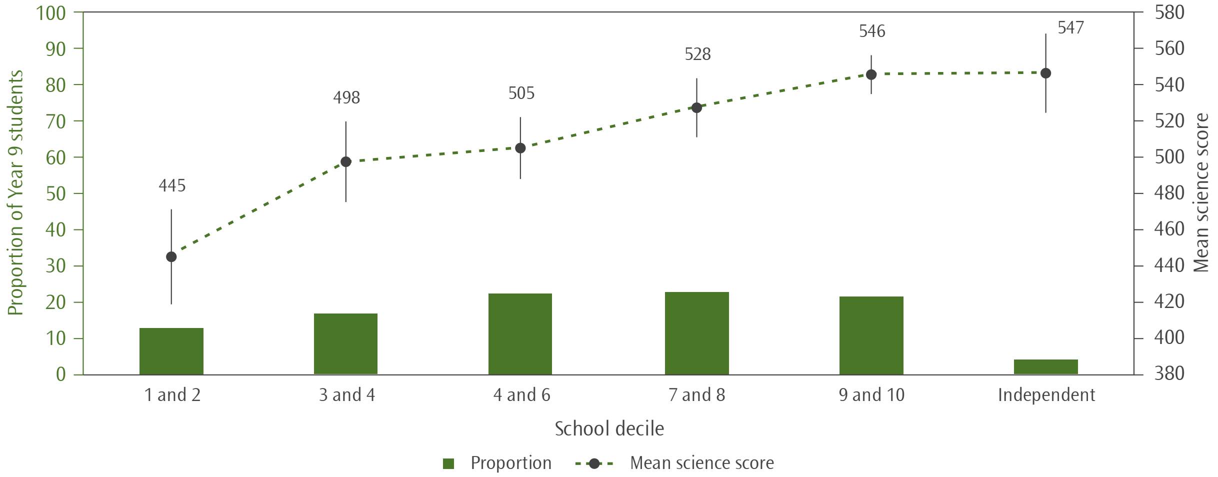
Schools with larger numbers of students from low socio-economic communities are provided with extra funding per student. The school decile indicator within New Zealand is used to allocate differentiated funding. Decile 1 schools are the schools with the highest proportion of students from socio-economically disadvantaged communities, while decile 10 schools have the lowest proportion of students from these communities.

Internationally, there was also information collected from principals that allows examination of the socio-economic status of the school intake. The School Questionnaire included two questions, one that asked about the approximate proportions of students in the school from economically disadvantaged homes and one that asked about approximate proportions from economically affluent homes. The responses to these two questions were combined to give a measure of school composition by student economic background. This measure allows us to compare the equity of our system with other countries. It is important to note that principals were providing estimates so this measure can provide only an approximate view of economic disadvantage.

Decile

Studies have shown that students attending schools with fewer students from lower socio-economic backgrounds (higher decile schools) had higher science achievement than those attending schools with more students from lower SES backgrounds (lower decile schools - see for example Caygill & Sok, 2008; Caygill, 2008). As shown in Figure 7.4, this is also true of the latest cycle of TIMSS, with students from higher decile schools (9 and 10; independent) having higher achievement (546 and 547 scale score points on average respectively) than those from the low decile schools (1 and 2 – 445 scale score points).

Figure 7.4: **Mean science achievement by decile of school attended**

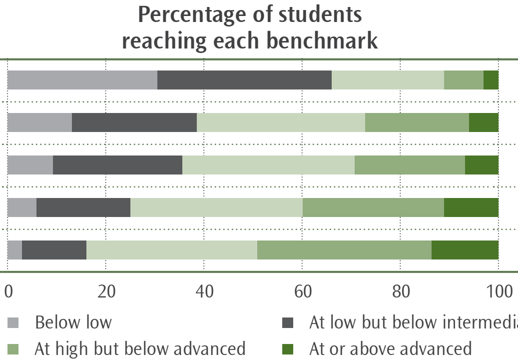


Note: The bars on the graph represent proportions of Year 9 students. The points represent mean scores while the lines extending from those points represent the 95% confidence interval associated with estimating the mean of the population from the sample.

The TIMSS benchmarks provide an understanding of achievement beyond mere averages and ranges (see Chapter 1 for details of these benchmarks). Figure 7.5 presents two different ways of looking at this data – those students achieving at each of the benchmarks (as shown in the graphical part) and those students achieving at or above each of the benchmarks (as shown in the table part). Presenting those students achieving at or above the benchmarks allows the reader to make comparisons with other countries' data as presented in the international reports.

There were high achieving students in all decile groupings as measured by the high and advanced benchmarks (see Figure 7.5). However, there were larger proportions of students in the higher decile schools achieving at or above the high benchmarks (49% in decile 9 and 10 schools) compared with the lower decile schools (11% in decile 1 and 2 schools). As shown in the figure there were students in all decile groupings who did not demonstrate the ability to complete a reasonable number of the simplest science tasks that TIMSS seeks to measure (that is they did not reach the low benchmark). However, there were larger proportions of students in the lower decile groupings in this low achieving group (30% of decile 1 and 2 students below low) compared with high decile groupings (3% of decile 9 and 10 students).

Figure 7.5: **Proportion of Year 9 students in each decile grouping at each international benchmark**



School decile grouping	Cumulative percentage of students: At or above low	At or above intermediate	At or above high	At or above advanced
1 and 2	70 (4.8)	34 (6.5)	11 (5.5)	3 (2.0)
3 and 4	87 (2.8)	62 (6.8)	27 (5.4)	6 (2.0)
5 and 6	91 (2.2)	64 (3.9)	29 (4.2)	7 (1.8)
7 and 8	94 (1.9)	75 (3.7)	40 (4.0)	11 (2.2)
9 and 10	97 (0.8)	84 (1.9)	49 (3.0)	14 (2.1)

Note: Standard errors are presented in parentheses.

"At or above" means that the proportion of students at the benchmark includes those that achieved at higher benchmarks also. For example, the 70% of students in deciles 1 and 2 schools that achieved at or above the low benchmark includes 36% who achieved at the low benchmark, 23% at the intermediate, just below 8% at the high, and just over 3% at the advanced benchmark.

School composition by student economic background

As mentioned earlier, there was also information collected from principals across the TIMSS countries that allows examination of the socio-economic status of the combined student population in the schools. Principals were asked to choose from four categories to estimate the percentage of students in their school that came from economically disadvantaged homes as well as the percentage from economically affluent homes. The international researchers combined the responses from these two questions into three categories: *schools with more affluent than disadvantaged students*, *schools with more disadvantaged than affluent students*, and *schools with neither more affluent nor more disadvantaged students.*[9]

As shown in Figure 7.6, just under one-third of New Zealand students were in schools with more affluent students (30%), while just under one-quarter were in schools with more disadvantaged students (24%). Science achievement was higher for students in schools with more affluent students (542 scale score points) than those in schools with more economically disadvantaged students (472 scale score points). The difference in science achievement between these two groupings within New Zealand (70 scale score points) was higher than many other countries in the TIMSS study. Only Singapore (93), Ghana (92), Turkey (87), Lebanon (79), and the Islamic Republic of Iran (71) had higher differences than New Zealand between the students in more affluent schools and those in more economically disadvantaged schools. On average internationally, this difference was 43 scale score points. In comparison, Australia (60), England (66), and the United States (55) all had relatively large differences between the students in more affluent schools and those in more economically disadvantaged schools.

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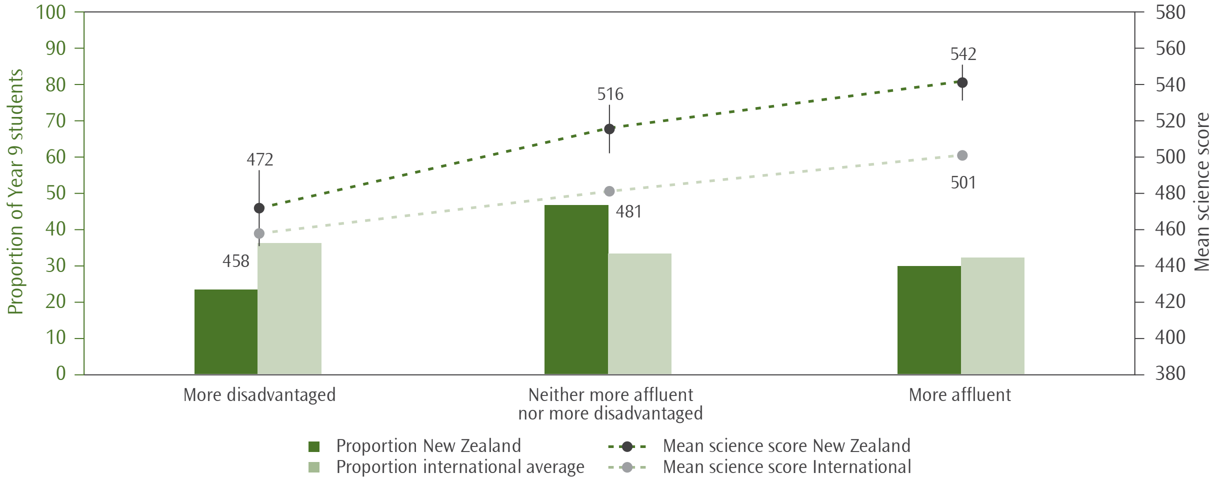
[9] Schools with more affluent than disadvantaged students are defined as those where the principal estimated that 25% or fewer came from economically disadvantaged homes and more than 25% came from affluent homes. Schools with more disadvantaged than affluent students are defined as those where the principal estimated that more than 25% came from economically disadvantaged homes and 25% or fewer came from affluent homes. All other students were assigned to the third category: schools with neither more affluent nor more disadvantaged students.

Figure 7.6: Mean science achievement of students by economic composition of school attended

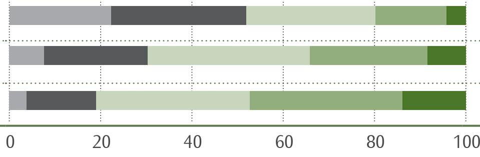


Source: Adapted from Exhibit 5.4, Martin, Mullis, Foy, and Stanco, 2012.

As with the measure of decile, the TIMSS benchmarks show that within each of these three categories of economic composition of the school population, there were high and low achievers. Figure 7.7 presents two different ways of looking at this data – those students achieving at each of the benchmarks (as shown in the graphical part) and those students achieving at or above each of the benchmarks (as shown in the table part).

There were larger proportions of students in the more affluent schools achieving at or above the high benchmarks (47% in schools with more affluent than economically disadvantaged students) compared with the economically disadvantaged schools (20% in schools with more economically disadvantaged than affluent students). As shown in the figure there were students in each of the three categories of school composition who did not demonstrate the ability to complete a reasonable number of the simplest science tasks which TIMSS seeks to measure (that is they did not reach the low benchmark). However, there were larger proportions of students in the economically disadvantaged schools in this low achieving group (22% in schools with more economically disadvantaged than affluent students) compared with affluent schools (4% in schools with more affluent than economically disadvantaged students).

Figure 7.7: Proportion of New Zealand Year 9 students at each international benchmark by economic composition of school attended



		Cumulative percentage of students:			
School composition grouping	Percentage of students reaching each benchmark	At or above low	At or above intermediate	At or above high	At or above advanced
Disadvantaged		78 (4.0)	48 (5.4)	20 (4.0)	5 (1.6)
Middle		93 (1.4)	70 (3.1)	34 (3.6)	8 (1.6)
Affluent		96 (1.1)	81 (2.2)	47 (2.9)	14 (1.7)

Note: Standard errors are presented in parentheses.

'Disadvantaged' refers to those schools with more economically disadvantaged than affluent students, 'Affluent' refers to those schools with more affluent than economically disadvantaged students, and 'Middle' refers to all other schools.

"At or above" means that the proportion of students at the benchmark includes those that achieved at higher benchmarks also. For example, the 78% of students in 'disadvantaged' schools that achieved at or above the low benchmark includes just under 30% who achieved at the low benchmark, 28% at the intermediate, just under 16% at the high, and just under 5% at the advanced benchmark.

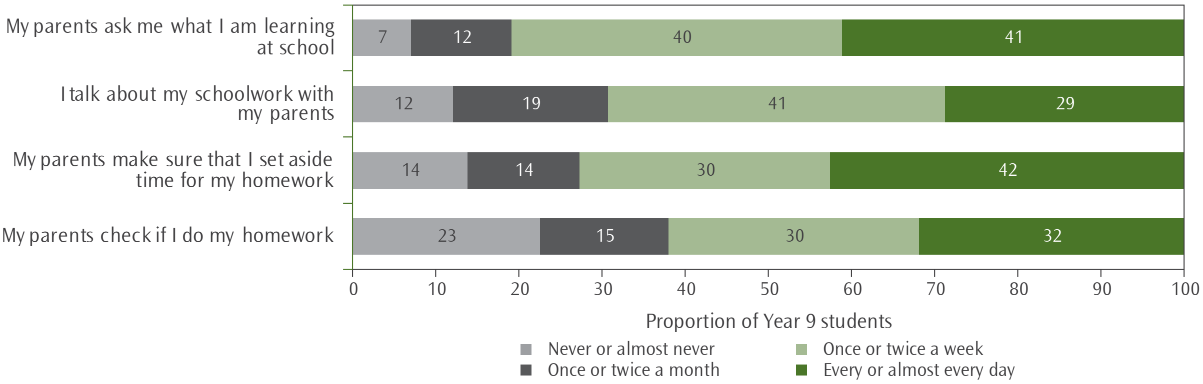
8. More about the home climate for learning science

As shown in the previous chapter, the home matters. Much of the information about the home of the students in the previous chapter focussed on socio-economic status. However, educational resources in the home were also discussed. This chapter will focus on interactions with parents about education, students' educational expectations, reading for enjoyment, and computer use.

Interactions with parents

Interactions with parents about school may be indicative of the importance placed on education in the home. However, there may be a lower frequency of interactions between parents and children if a child is highly self-motivated, or the parents have many interactions with the school directly. Students were asked four questions about the frequency of discussions about schoolwork and homework (shown in Figure 8.1). More than two-fifths of Year 9 students reported that their parents made sure that they set aside time for their homework each day and just over two-fifths had parents asking what they were learning at school each day. More than one-third of students were rarely asked by their parents if they had done their homework (23% *never or almost never* and 15% *once or twice a month*).

Figure 8.1: Frequency New Zealand Year 9 students reported interacting with parents about schoolwork and homework



Note: Results may appear inconsistent due to rounding.

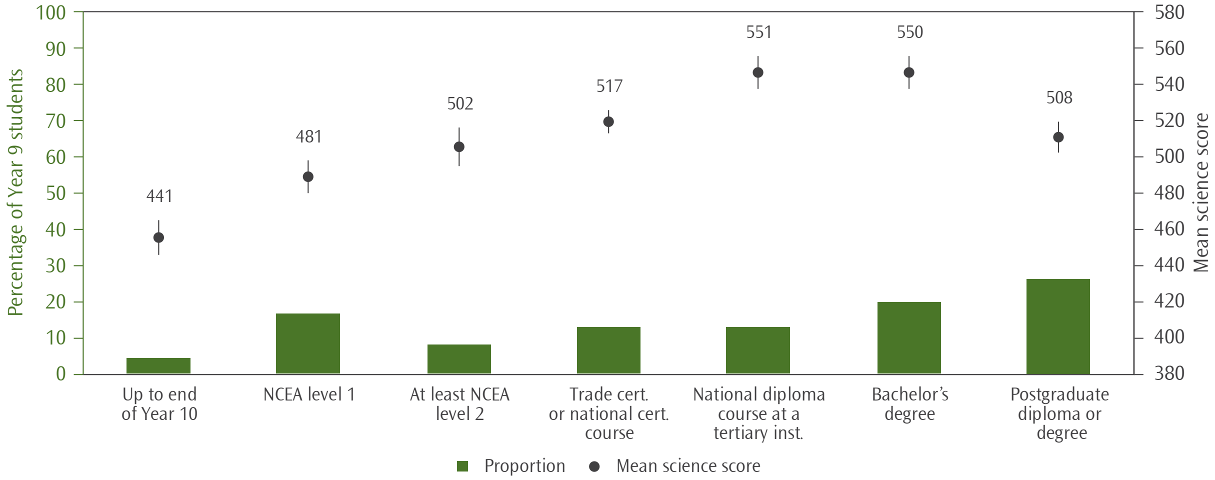
On average, those students with relatively regular interactions with their parents, about schoolwork or setting aside time for homework, had higher science achievement than those with few interactions. Those with more frequent checking of homework had similar achievement to those whose parents never checked if they had done their homework.

Education expectations

At the age of 14, many students will not yet have made the decision about their futures. However, students were asked about their intentions for further education. This can give an indication of the importance they place on education. Very few students expected that they would finish school without some form of qualification with only four percent saying they would only complete up to the end of Year 10. A further 17 percent expected to complete only Level 1 of NCEA. Most students expected to do some form of tertiary study and complete either a certificate, a diploma, or a degree (71%). Just over one-quarter of students (26%) expected to complete some form of post-graduate diploma or degree.

Generally, students with lower educational expectations had lower science achievement on average as shown in Figure 8.2. The exception to that general pattern of lower achievement for lower expectations is the group of students who expected to gain some form of post-graduate diploma or degree who had lower science achievement than other students with tertiary expectations.

Figure 8.2: Mean science achievement by educational expectations of New Zealand students

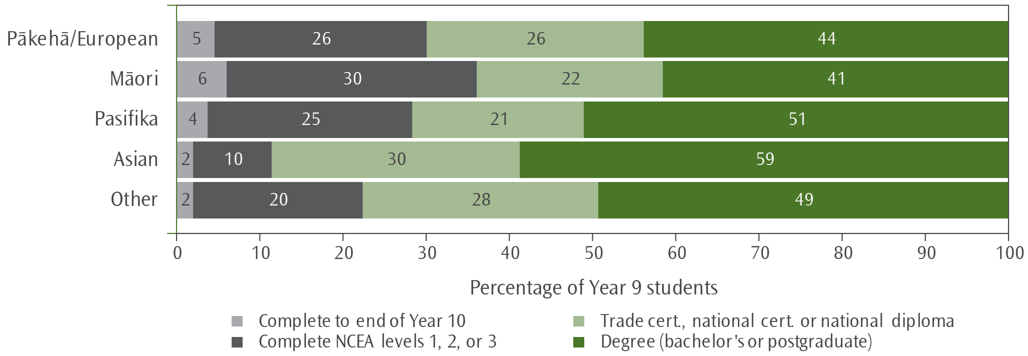


Note: Results may appear inconsistent due to rounding.

Figure 8.3 shows that more Asian students had expectations of tertiary education than any of the other ethnic groupings. Only 12 percent of Asian students expected to conclude their education at the secondary level without further study. A relatively high proportion of Pasifika students expected to complete a degree (51%).

Of all the ethnic groupings, Māori students had the largest proportion expecting to complete their education at secondary school. However, nearly two-thirds of Māori 14-year olds expected to complete some form of tertiary qualification (64%).

Figure 8.3: Educational expectations summarised by ethnic groupings in New Zealand

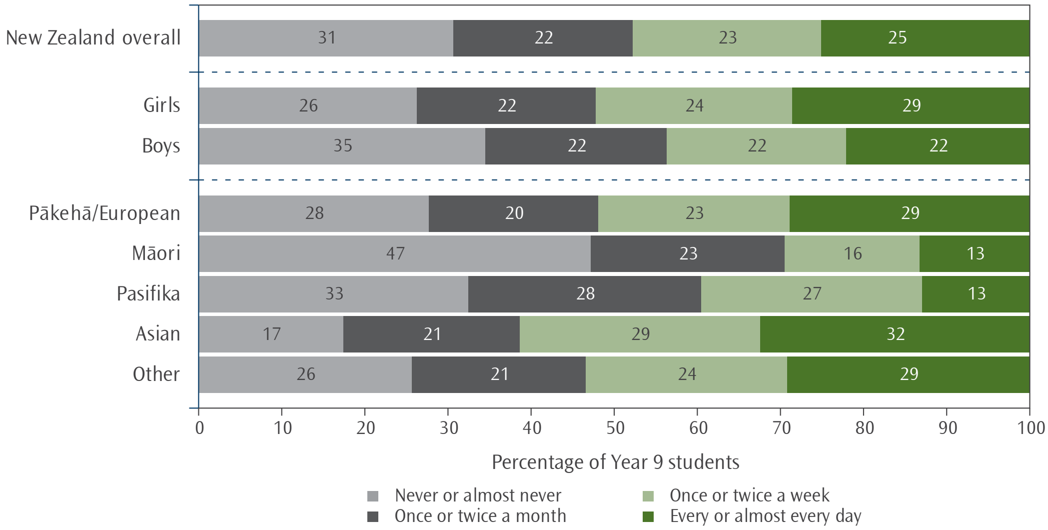


Note: Results may appear inconsistent due to rounding.

Reading for enjoyment

Just under one-third of students (30%) reported that they had 25 or fewer books in their home as mentioned in the previous chapter. However, most young people in New Zealand have access to libraries at school and many have libraries in their local community. Therefore, the lack of books in their home need not be an impediment to reading activities. In New Zealand we asked students how often they read a book for enjoyment. As shown in Figure 8.2, one-quarter of all students read a book daily for enjoyment. However, more girls (29%) read books for enjoyment daily compared with boys (22%). Fewer Māori and Pasifika students read for enjoyment daily compared with Pākehā/European students, Asian students, or students in the 'Other' ethnic grouping.

Figure 8.4: How regularly New Zealand Year 9 students read a book for enjoyment



Students who reported that they read a book for enjoyment daily had higher science achievement than those who did not. The more frequently a student read for enjoyment, the higher their science achievement, on average. Students who never read for enjoyment had the much lower science achievement (77 scale score points) than those who read for enjoyment daily.

Computer use

The digital age has given students access to more information and entertainment than they had in the first cycle of TIMSS. Although some of the information available online is of dubious quality, an inquisitive mind is an asset to a learner. Students were asked how often they used a computer at home, at school, or at some other place (not defined). Nearly all students had computers at home (97%). Of these students, many used the computer regularly (93% at least weekly). Of those that did not have one, most used a computer at school or some other place.

9. Student attitudes to and engagement with science

The vision of what we want for our young people, as presented in the New Zealand Curriculum, includes that they will be "confident, connected, actively involved, and lifelong learners" (Ministry of Education, 2007, p.8). In addition, the curriculum document notes that "Science is able to inform problem solving and decision making in many areas of life. Many of the major challenges and opportunities that confront our world need to be approached from a scientific perspective, taking into account social and ethical considerations." (Ministry of Education, 2007, p.28).

As a nation we want to maximise the contribution of education to the New Zealand economy (Ministry of Education, 2012). In particular, science, technology, engineering, and mathematics (STEM subjects), are seen by many as a means to increase innovation in society and have been identified as a priority area. The Tertiary Education Commission's guidance to tertiary education organisations includes eight priorities for new plans, one of which is that there will be "more learners engaged in study toward STEM qualifications...to better meet workforce demand" (Tertiary Education Commission, 2012, p.13).[10] Similarly, an education and skills survey in the United Kingdom found employers calling for action to improve the quantity and quality of STEM graduates, with almost half of firms still experiencing difficulties recruiting STEM skilled staff. The authors of the report on this survey asserted that "these skills will be vital if the UK is to harness opportunities in growth areas such as green technologies and creative industries" (CBI, 2010).

To meet these objectives we need more learners confident, engaged, and continuing in science beyond the compulsory years. This chapter will examine students' attitudes towards learning science – their enjoyment, confidence levels and the importance they attach to it.

Student attitudes toward science

To gauge their attitudes towards learning science, students were asked how much they agreed with a series of 23 statements. They were given four response options: *agree a lot*, *agree a little*, *disagree a little*, and *disagree a lot.* Positive and negative statements were interwoven in the questionnaire but are reordered in Figure 9.1 for ease of reading.

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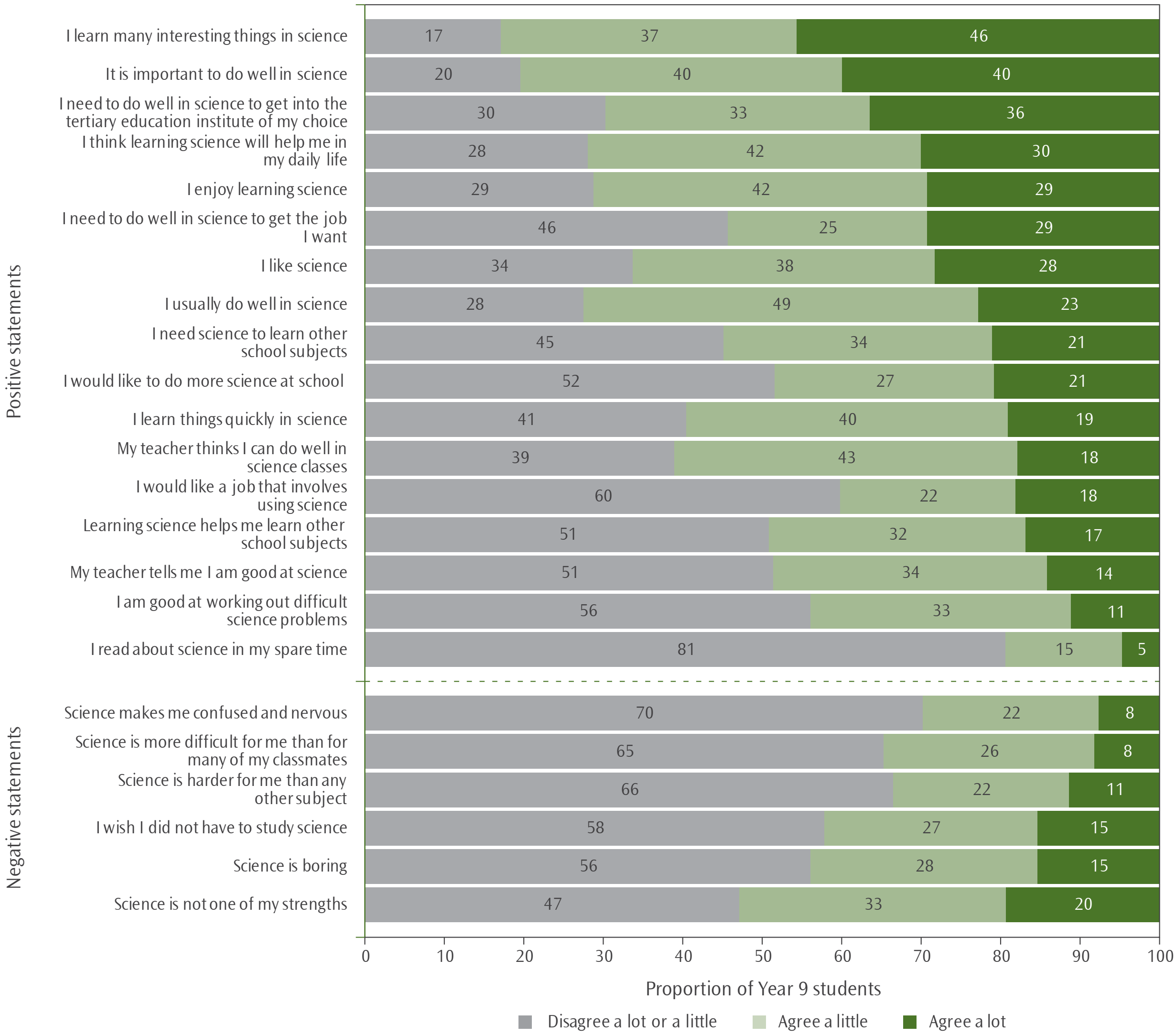
[10] Earle (2009) identified ongoing skill-shortages in New Zealand in engineering and related technologies, architecture and building, information technology and accounting; and ongoing demand in medical studies, nursing and health.

Of all the statements, New Zealand Year 9 students were most likely to agree that: *I learn many interesting things in science*, with 83 percent agreeing either a little or a lot. Eighty percent agreed that *it is important to do well in science*, a much smaller proportion than in 1994 or 1998 (92% and 93%).[11] Only 40 percent of students agreed that they would *like a job that involves using science*. However, around 70 percent agreed they need *to do well in science to get into the university, polytechnic, or other tertiary education institute of my choice* or that *learning science will help me in my daily life*. While 72 percent of the students agreed that they *usually do well in science*, a much smaller proportion (44%) agreed that they are *good at working out difficult science problems*. The proportion agreeing that they *usually do well in science* has decreased since 1994 (80%), and 1998 (78%). The proportion of Year 9 students agreeing that they *enjoy learning science* has been steady at around 71 percent over all four cycles of TIMSS in New Zealand.

Figure 9.1: **New Zealand Year 9 student attitudes to science**



Note: Due to rounding some results may appear inconsistent.

Positive and negative statements were interwoven in the questionnaire but are reordered here for ease of reading.

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[11] The context and wording of this item were slightly different in the earlier cycles of TIMSS: in 1994 and 1998 the full statement to which students were asked to give their level of agreement was *I think it is important to … a) do well in science at school*. It then also asked them about *mathematics* and *English*, *having time to have fun* and *being good at sports*. In 2010, the statements relating to mathematics and science were in separate questions. However, the proportion of students agreeing that *it is important to do well in mathematics* reduced only slightly from 97% in both 1994 and 1998 to 94% in 2010, suggesting that the comparatively large reduction in relation to science is not due simply to the change in question structure.

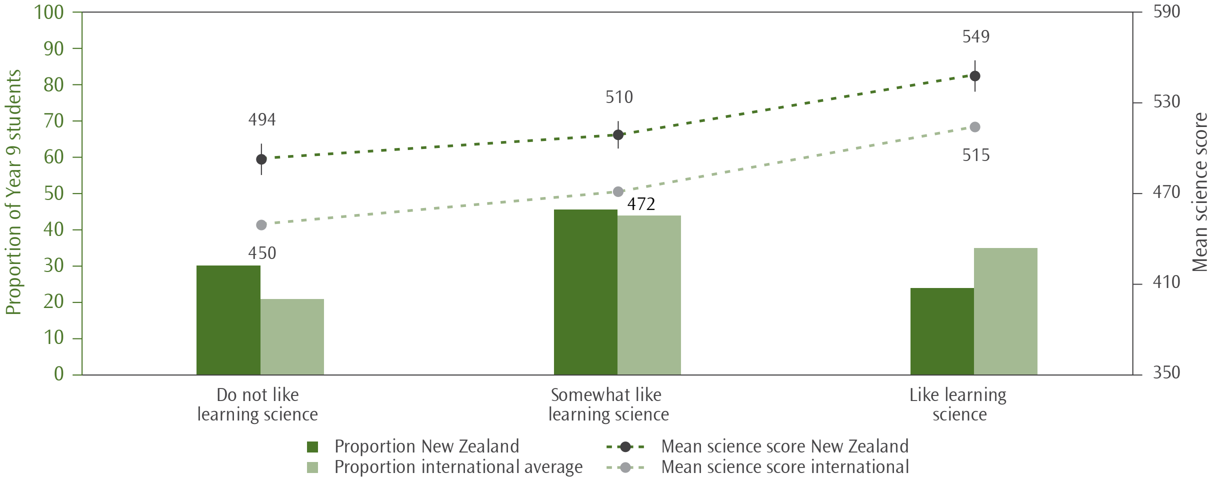
Generally, students with positive attitudes towards science had higher achievement than students with negative attitudes. To further examine the relationship with achievement the international researchers combined the data on three scales: the Students Like Learning Science (SLS) scale, the Students Value Science (SVS) scale and the Students Confident in Science (SCS) scale.[12] Each student's responses to a particular set of statements were used to generate a single score on a continuous scale.[13] For ease of interpretation, each scale was then divided into three categories.

Students like learning science

Students were put into one of three categories, *Like Learning Science*, *Somewhat Like Learning Science*, or *Do Not Like Learning Science,* according to their responses to five statements: *I enjoy learning science*; *I wish I did not have to learn science*; *Science is boring*; *I learn many interesting things in science*; and *I like science*.

Twenty-four percent of New Zealand Year 9 students *Like Learning Science*, 46 percent *Somewhat Like Learning Science*, while the remaining 30 percent *Do Not Like Learning Science*. As shown in Figure 9.2, students who were most positive about learning science had higher achievement than those in the middle group, who in turn performed better than those in the least positive group.

Figure 9.2: Proportion and mean science achievement of students in each category of the Students Like Learning Science (SLS) scale



Note: The bars on the graph represent the proportions of Year 9 students while the points represent the mean scores. Lines extending from the points represent the 95% confidence interval, i.e., the range within which we are 95 percent confident that the true population value lies.

Students who *Like Learning Science* had a score on the Students Like Learning Science (SLS) scale of at least 10.8, which corresponds to their "agreeing a lot" with three of the five statements and "agreeing a little" with the other two, on average. Students who *Do Not Like Learning Science* had a score no higher than 8.4, which corresponds to their "disagreeing a little" with three of the five statements and "agreeing a little" with the other two, on average. All other students *Somewhat Like Learning Science*. Negative statements were reverse coded.

Source: Adapted from Exhibit 8.2, Martin, Mullis, Foy, and Stanco, 2012.

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[12] The international average for these scales includes only those countries where students are enrolled in science as a single subject. Sixteen, mostly East European, countries are not included and instead have equivalent scales for *biology*, *chemistry*, *physics* and *Earth science*.

[13] See *Created scales for contextual variables* in the Definitions and technical notes for a brief description of the methodology

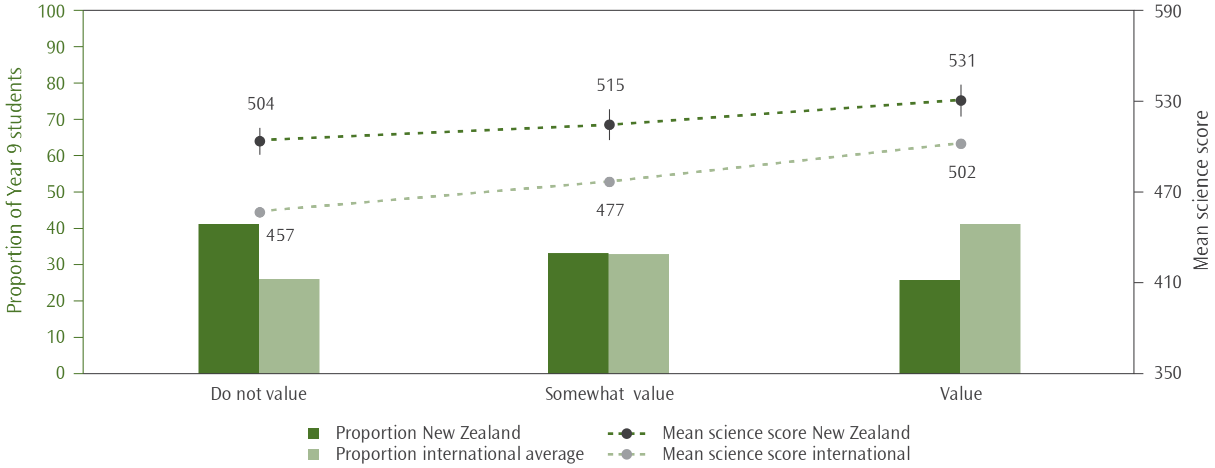
New Zealand had fewer Year 9 students who *Like Learning Science* than on average internationally (24% compared with 35%), and more who *Do Not Like Learning Science* (30% compared with 21%).[14] The mean difference internationally between students in these two categories was 65 scale score points, compared with a difference of 55 score points on average in New Zealand.

Students value science

Students were put into one of three categories, *Value*, *Somewhat Value*, or *Do Not Value* science according to their responses to six statements: *It is important to do well in science; I need to do well in science to get into the university, polytechnic, or other tertiary education institute of my choice*; *I think learning science will help me in my daily life; I need to do well in science to get the job I want*; *I need science to learn other school subjects*; and *I would like a job that involves using science*.

Twenty-six percent of New Zealand Year 9 students *Value* science, 33 percent *Somewhat Value* and 41 percent *Do Not Value* science. As shown in Figure 9.3, in New Zealand there was no significant difference in science achievement between those who *Do Not Value* and those who *Somewhat Value* science. Students in both these categories had lower achievement on average than those who *Value* science.

Figure 9.3: Proportion and mean science achievement of students in each category of the Students Value Science (SVS) scale



Note: The bars on the graph represent the proportions of Year 9 students while the points represent the mean scores. Lines extending from the points represent the 95% confidence interval, i.e., the range within which we are 95 percent confident that the true population value lies.

Students who *Value* science had a score on the Students Value Science (SVS) scale of at least 10.5, which corresponds to their "agreeing a lot" with three of the six statements and "agreeing a little" with the other three, on average. Students who *Do Not Value* science had a score no higher than 8.6, which corresponds to their "disagreeing a little" with three of the six statements and "agreeing a little" with the other three, on average. All other students *Somewhat Value* science.

Source: Adapted from Exhibit 8.3, Martin, Mullis, Foy, and Stanco, 2012.

New Zealand had fewer Year 9 students who *Value* science than on average internationally (26% compared with 41%), and more who *Do Not Value* science (41% compared with 26%).[15] Although in almost all countries students who *Value* science had somewhat higher achievement scores than those who *Do Not Value* science, the attitudes measured by this scale had a weaker relationship with science achievement, on average, than either students' enjoyment or their confidence in science.

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[14] The international average for these scales includes only those countries where students are enrolled in science as a single subject. Sixteen, mostly East European, countries are not included and instead have equivalent scales for *biology*, *chemistry*, *physics* and *Earth science*.

[15] The international average for these scales includes only those countries where students are enrolled in science as a single subject. Sixteen, mostly East European, countries are not included and instead have equivalent scales for *biology*, *chemistry*, *physics* and *Earth science*.

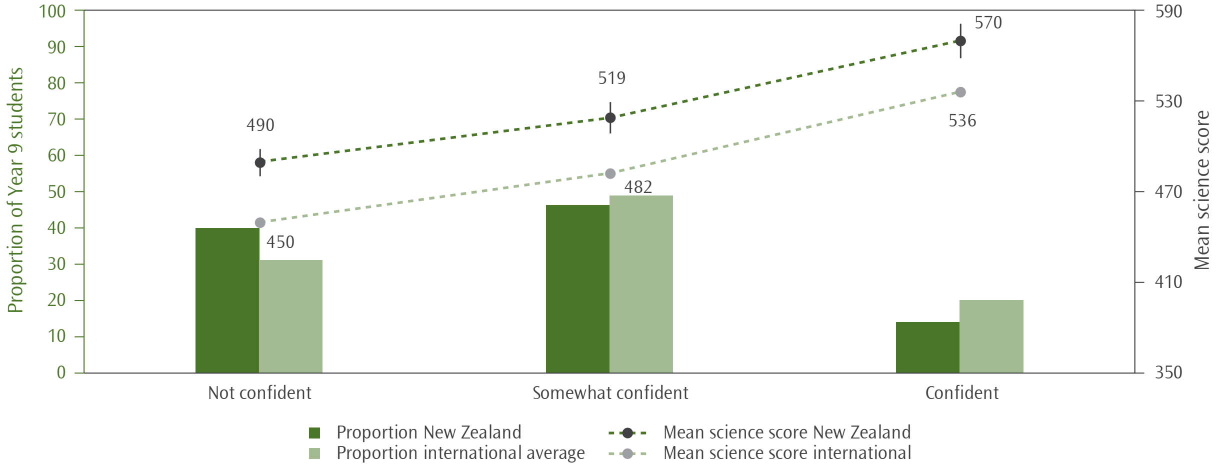
Students confident in science

Students were categorised as *Confident*, *Somewhat Confident,* or *Not Confident* in science according to their responses to nine statements: *I usually do well in science*; *Science is more difficult for me than for many of my classmates*; *Science is not one of my strengths*; *I learn things quickly in science*; *Science makes me confused and nervous*; *I am good at working out difficult science problems*; *My teacher thinks I can do well in science classes or lessons with difficult materials*; *My teacher tells me I am good at science*; and *Science is harder for me than any other subject*.

Fourteen percent of New Zealand Year 9 students were *Confident* in science, 46 percent were *Somewhat Confident* and the remaining 40 percent were *Not Confident* with science.

As shown in Figure 9.4, students who were more positive about their abilities to learn science (in the *Confident* category) had higher mean achievement than those who were more negative. Those students with the lowest self-confidence had the lowest science achievement on average. Note that the difference in mean science score between students who were *Confident* and those who were *Not Confident* (80 score points) is greater than between those in the corresponding groups on the Students Like Learning Science scale (55 score points) and the Students Value Science scale (27 score points). Thus the self-confidence of students had a stronger relationship with science achievement than how much they like or value learning science.

Figure 9.4: Proportion and mean science achievement of students in each category of the Students Confident in Science (SCS) scale



Note: The bars on the graph represent the proportions of Year 9 students while the points represent the mean scores. Lines extending from the points represent the 95% confidence interval, i.e., the range within which we are 95 percent confident that the true population value lies.

Students *Confident* with science had a score on the Students Confident in Science (SCS) scale of at least 11.5, which corresponds to their "agreeing a lot" with five of the nine statements and "agreeing a little" with the other four, on average. Students who were *Not Confident* had a score no higher than 9.0, which corresponds to their "disagreeing a little" with five of the nine statements and "agreeing a little" with the other four, on average. All other students were *Somewhat Confident* with science. Negative statements were reverse coded.

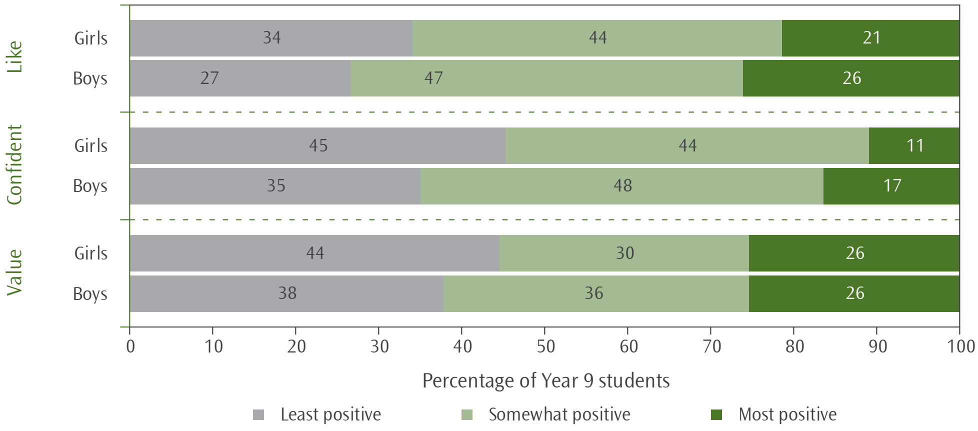
Source: Adapted from Exhibit 8.5, Martin, Mullis, Foy, and Stanco, 2012.

New Zealand had fewer *Confident* Year 9 students than the international average (14% compared with 20%), and more *Not Confident* students (40% compared with 31%).[16] Many of the high-performing countries had quite low proportions of *Confident* students (Hong Kong SAR 8%, Chinese Taipei 6%, Rep. of Korea 4% and Japan 3%). However, within each country, those students who had the highest levels of confidence in their science abilities had higher average achievement than those who were less confident. The international mean difference in science achievement between those in the most confident category and those in the least was 86 score points.

Attitudes to science by gender

Year 9 boys' enjoyment, confidence and valuing of learning science were all higher than that of girls in New Zealand. As shown in Figure 9.5, boys were more likely than girls to *Like Learning Science* (26% compared with 21%) and to be *Confident* with science (17% compared with 11%). Although a similar proportion of girls and boys *Value* science (26%), girls were more likely than boys to be in the least positive category on all three scales. The biggest difference was on the Students Confident in Science scale where 45 percent of girls were *Not Confident* in science, compared with 35 percent of boys. Students' degree of confidence had a stronger relationship with science achievement than either enjoyment or valuing of mathematics, for both boys and girls.

Figure 9.5: Proportion of New Zealand students in each category of the Students Like Learning Science (SLS), Students Confident in Science (SCS) and Students Value Science (SVS) scales, by gender



Attitudes to science by ethnicity

Some differences were evident among the ethnic groupings when attitudes to science were considered. As shown in Figure 9.6, a greater proportion of Asian students (35%) and a smaller proportion of Māori students (16%) *Like Learning Science* than Pasifika or Pākehā/European students (27% and 24%). A smaller proportion of Asian and Pasifika students (19% and 18%) *Do Not Like Learning Science* compared with Māori and Pākehā/European students (35% and 33%). Similarly, more Asian students (36%) and fewer Māori students (21%) *Value* science compared with Pasifika and Pākehā/European students (29% and 25%). A smaller proportion of Asian students (26%) *Do Not Value* science compared with the other ethnic groups (Pasifika 38%, Pākehā/European 43% and Māori 44%). On the Students Confident in Science scale, the proportions of students who were *Not Confident* were quite similar across ethnic groups. However, a greater proportion of Asian (15%) and Pākehā/European students (16%) reported high levels of confidence in learning science than students from the other ethnic groupings (Pasifika 7% and Māori 9%).

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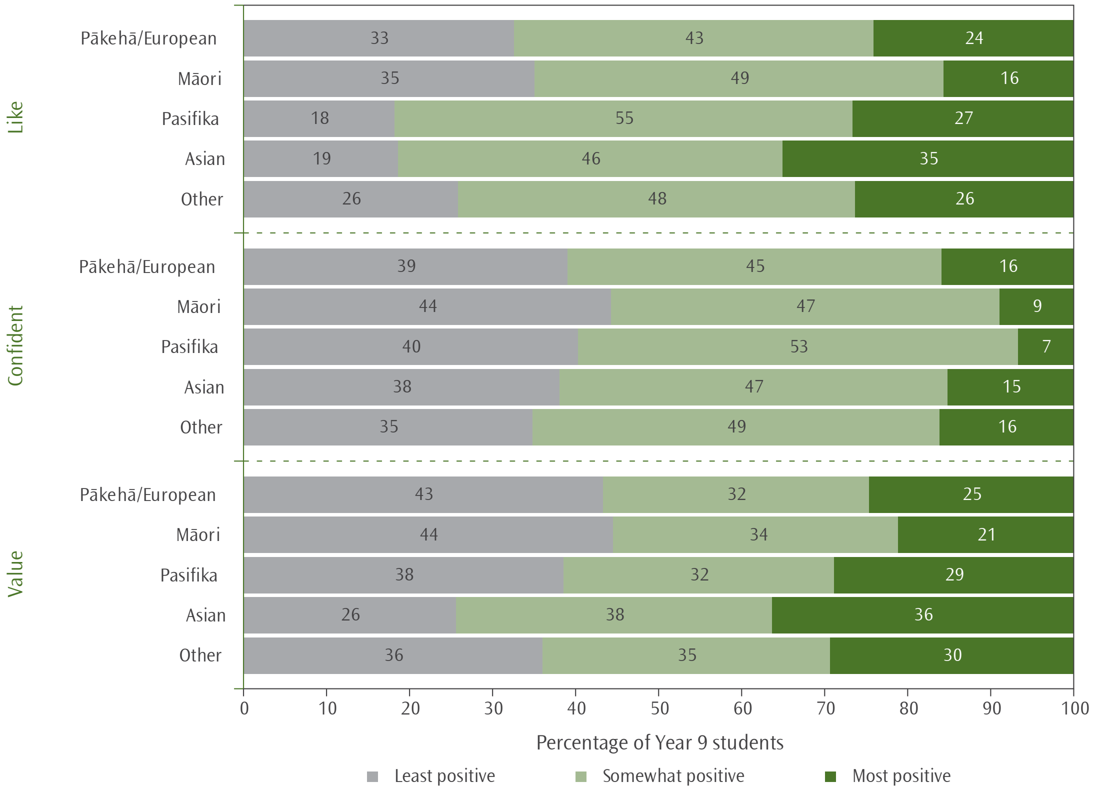
[16] The international average for these scales includes only those countries where students are enrolled in science as a single subject. Sixteen, mostly East European, countries are not included and instead have equivalent scales for *biology*, *chemistry*, *physics* and *Earth science*.

Figure 9.6: **Proportion of New Zealand students in each category of the Students Like Learning Science (SLS), Students Confident in Science (SCS) and Students Value Science (SVS) scales, by ethnicity**



The overall trend of students' degree of confidence in science having a stronger relationship with their average achievement than how much they reported liking or valuing science was reflected for the most part within ethnic groupings. However, the differences tended to be greater for Pākehā/European students than for students from the other ethnic groupings. The differences in *Confident* students' mean science scores compared with *Not Confident* ranged between 41 scale score points on average for Asian students up to 80 score points difference for Pākehā/European students. Pākehā/European students who *Value* science scored on average 39 score points higher than those who *Do Not Value* science, but the attitudes reported on this scale made no significant difference to the science achievement of students from the other ethnic groups. Within each ethnic group, students who *Like Learning Science* had higher average achievement than those who *Do Not Like Learning Science* – the differences in scale score points were: Asian 33, Pasifika 46, Māori 49 and Pākehā/European 60 score points.

10. Teaching science

Recent media coverage of education has focussed on the quality of teaching. 'Supporting improvement in teaching practice' is part of the current operating framework of the Ministry of Education (p. 14, Ministry of Education, 2012). One of the useful aspects of TIMSS is that it examines the context of student achievement, collecting information from students, teachers, and school leadership (usually principals). This section will report information collected about what happens in classrooms with a focus on science teaching.

Characteristics of secondary science teachers

It seems intuitive to believe that more experienced and better educated teachers will lead to higher achievement among students. However, it is difficult to examine this belief in a snapshot study like TIMSS, particularly because there are schools that assign the more experienced teachers to groups of students with the highest need. However, it is useful to know if well-educated people are being attracted into teaching and if they are being retained. TIMSS allows us to compare these rates of recruitment and retention with other countries. This section will look at these characteristics of experience and education.

Experience

Less than one-third of Year 9 students (29%) had science teachers who had 20 years or more teaching experience. One-fifth of students (20%) had teachers with less than five years teaching experience. On average, the New Zealand Year 9 science teachers had had 14 years teaching experience. As Table 10.1 shows, New Zealand teachers, on average, had similar amounts of teaching experience as on average across countries (15 years). On average internationally, 33 percent of lower secondary students had science teachers with 20 years or more teaching experience. Countries with similarly experienced teachers to New Zealand included Australia and the United States. England had more students whose teachers had less than five years teaching experience (32% of students).

Table 10.1: **Proportion of students by the years of experience of their science teacher**

	Years of experience of science teachers (percentage of students)				
	Less than 5 years	At least 5 but less than 10 years	At least 10 but less than 20 years	20 years or more	Average years of experience
New Zealand	20 (2.5)	25 (3.6)	27 (3.0)	29 (3.0)	14 (0.7)
International Avg.	20 (0.4)	19 (0.4)	29 (0.5)	33 (0.4)	15 (0.1)

Note: Standard errors are presented in parentheses.

Source: Exhibit 7.6, Martin, Mullis, Foy, and Stanco, 2012.

Education

Just over one-half of New Zealand Year 9 students (51%) had teachers with some form of postgraduate university education and just under one-half (47%) had teachers with a bachelor's degree or equivalent. As shown in Table 10.2, although the proportion with teachers qualified with degrees was similar in New Zealand to the international average, there were more New Zealand teachers with postgraduate qualifications and fewer with only bachelors' degrees. However, there were large variations in proportions across countries. For example, there were a few countries where a large proportion of teachers had postgraduate university degrees. These countries included the Russian Federation (99%), Armenia (94%), and Finland (89%). In contrast, there were also quite a few countries where the large majority of students had teachers with a bachelor's degree but no postgraduate qualification. These countries included Norway (97%), Ukraine (97%), Kazakhstan (95%), Saudi Arabia (94%) and Oman (93%).

Table 10.2: Proportion of students by education level of their science teacher

	Education levels of science teachers (percentage of students)			
	No further than upper-secondary education	Completed post-secondary education but not a bachelor's degree	Completed bachelor's degree or equivalent but not a postgraduate degree	Completed postgraduate university degree
New Zealand	0 (0.0)	2 (0.8)	47 (4.0)	51 (4.0)
International Avg.	2 (0.1)	8 (0.2)	63 (0.4)	27 (0.4)

Note: Standard errors are presented in parentheses.

Source: Exhibit 7.2, Martin, Mullis, Foy, and Stanco, 2012.

Few New Zealand students (6%) had science teachers who had majored in something other than science or science education. Two-fifths of students had teachers who had majored in science and science education. In contrast, on average across all countries, 28 percent of students had science teachers who had majored in both science and science education as shown in Table 10.3.

Table 10.3: Proportion of students by specialisation in education of their science teacher

	Specialisation in education of science teachers (percentage of students)				
	Major in science and science education	Major in science education but no major in science	Major in science but no major in science education	All other majors	No formal education beyond upper-secondary
New Zealand	40 (4.2)	3 (1.4)	51 (4.1)	6 (1.3)	0 (0.0)
International Avg.	28 (0.5)	11 (0.3)	51 (0.5)	8 (0.3)	2 (0.1)

Note: Standard errors are presented in parentheses.

Source: Exhibit 7.4, Martin, Mullis, Foy, and Stanco, 2012.

Preparation and confidence of secondary teachers

How well prepared do science teachers feel?

Teachers were asked how well prepared they felt to teach 20 topics in science based on the *TIMSS 2011 assessment frameworks* (Mullis, Martin, et al., 2009).[17] Of these 20 topics, seven were biology topics, four were chemistry topics, five were physics topics, and four Earth science topics. On average across all 20 topics, 80 percent of New Zealand students were taught science by teachers who felt very well prepared to teach the topics.[18] More New Zealand teachers felt very well prepared compared with the average internationally as shown in Table 10.4. In general, New Zealand teachers were more likely to say they felt very well prepared to teach the chemistry topics (92% of students) and to a lesser extent physics and biology topics (85% and 83% respectively) than Earth science topics (56%).

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[17] There were four options given: *not applicable*, *very well prepared*, *somewhat prepared*, and *not well prepared*.

[18] All analysis in this section calculates the percentage of students whose teachers felt very well prepared. However, for ease of reading, the text will often refer to 'teachers'.

While England had a larger proportions of teachers who felt very well prepared to teach the science topics (84% of students), New Zealand secondary science teachers generally felt well prepared compared to many of their peers in other countries. In comparison, fewer primary teachers, questioned as part of TIMSS at the Year 5 level, felt very well prepared to teach topics in science (42% - see Caygill, Kirkham, & Marshall, 2013a).

Table 10.4: Proportion of students whose science teacher felt very well prepared to teach topics

	Feel very well prepared to teach topics (percentage of students)				
	Overall science (20 topics)	Biology (7 topics)	Chemistry (4 topics)	Physics (5 topics)	Earth science (4 topics)
New Zealand	80 (1.3)	83 (2.0)	92 (1.5)	85 (2.1)	56 (2.7)
International Avg.	72 (0.3)	77 (0.4)	82 (0.4)	78 (0.4)	47 (0.5)

Note: Standard errors are presented in parentheses.

'Not applicable' responses were not included in the totals from which these percentages are calculated for biology, chemistry, and physics, but were internationally for Earth science topics. The New Zealand Earth science average excluding 'Not applicable' responses was 77%.

Source: Exhibit 7.10, Martin, Mullis, Foy, and Stanco, 2012.

Among the individual topics, there were five topics with far fewer New Zealand teachers feeling very well prepared to teach them.[19] *Reasons for increase in world's human population (e.g., advances in medicine, sanitation), and the effects of population growth on the environment* was the topic with the fewest teachers agreeing they were very well prepared (41% of students). *Human health (causes of infectious diseases, methods of infection, prevention, immunity) and the importance of diet and exercise in maintaining health* (51%) was the other biology topic that fewer teachers felt very well prepared to teach. In terms of physics topics, *electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets* had relatively fewer teachers feeling very well prepared to teach it (51%). *Earth's structure and physical features (Earth's crust, mantle and core; composition and relative distribution of water, and composition of air)* and *Earth's processes, cycles and history (rock cycle; water cycle; weather patterns; major geological events; formation of fossils and fossil fuels)* were the other two topics that fewer teachers felt very well prepared to teach (both 52%). Interestingly, the chemistry content domain was the topic area where New Zealand students also perform the least well (see section in this report in Chapter 1 entitled *Science content and cognitive domains* for details).

Confidence to teach science

Along with asking about preparedness to teach science content, TIMSS also asked teachers how confident they felt doing a range of teaching activities. The activities listed are shown in Table 10.5 and teachers were given the response categories: *very confident*, *somewhat confident*, and *not confident.* Most New Zealand students had science teachers who felt very confident to answer students' questions about science (90%). Fewer New Zealand teachers felt very confident to adapt their teaching to engage students' interest (59% of students) or provide challenging tasks for capable students (63% of students).

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[19] These five topics had high proportions of 'Not applicable' responses (around one-third of students had teachers who gave this response). The question told teachers to select 'Not applicable' if the topic was not in the curriculum or they were not responsible for teaching it.

Table 10.5: **Proportion of students whose science teacher felt very confident to do teaching activities**

Proportion of students whose science teachers felt very confident to:	Percentage of students	
	New Zealand	International Avg.
Answer students' questions about science	90 (2.1)	81 (0.4)
Explain science concepts or principles by doing science experiments	88 (2.0)	72 (0.5)
Provide challenging tasks for capable students	63 (3.5)	57 (0.5)
Adapt my teaching to engage students' interest	59 (3.8)	65 (0.5)
Help students appreciate the value of learning science	67 (3.5)	70 (0.5)

Note: Standard errors are presented in parentheses.

Source: Exhibit 7.14, Martin, Mullis, Foy, and Stanco, 2012.

As shown in Table 10.5, New Zealand teachers were less likely to express high confidence in some of the areas than many of their peers in other countries and more likely for others. In order to summarise comparisons between countries, the international researchers created a scale that combined teachers' responses to these five items and called it the Confidence in Teaching Science scale.

Proportions of students with very confident teachers ranged from 99 percent in Kazakhstan down to 33 percent in Japan (as shown in Table 10.6). On average across countries, just under three-quarters of students had very confident science teachers (73%). More New Zealand teachers were very confident (80% of students) using these techniques than their counterparts on average across countries, but similar to in the United States (84%) and England (84%).

Table 10.6: **Proportion of students whose science teachers felt very confident according to the Confidence in Teaching Science Scale for selected countries**

	Percentage of students	
Country	Teacher somewhat confident	Teacher very confident
Kazakhstan	1 (0.4)	99 (0.4)
Russian Federation	2 (0.5)	98 (0.5)
England	16 (2.0)	84 (2.0)
United States	16 (2.0)	84 (2.0)
New Zealand	**20 (2.9)**	**80 (2.9)**
Slovenia	22 (1.7)	78 (1.7)
Australia	23 (3.7)	77 (3.7)
Norway	33 (3.8)	67 (3.8)
Chinese Taipei	38 (4.0)	62 (4.0)
Singapore	40 (2.5)	60 (2.5)
Finland	44 (2.5)	56 (2.5)
Hong Kong SAR	52 (4.4)	48 (4.4)
Korea, Rep. of	60 (3.6)	40 (3.6)
Japan	67 (3.6)	33 (3.6)
International Avg.	**27 (0.4)**	**73 (0.4)**

Note: Standard errors are presented in parentheses.

A score for the five items combined was created using Item Response Theory. For any score 9.3 or greater, the teacher was assigned to the 'very confident' grouping, which corresponds to their teachers being 'very confident' in using three of the five instructional strategies and 'somewhat confident' in using the other two, on average. Otherwise, they were assigned to the 'somewhat confident' grouping.

Source: Exhibit 7.13, Martin, Mullis, Foy, and Stanco, 2012.

Professional development

Professional development has many purposes. It may be used to bring teachers up-to-date with the latest methodologies and understandings about the way students learn, or to demonstrate how new technology can be integrated into the classroom. Whatever the purpose, it may also help teachers gain confidence and gain the skills to help them feel better able to fulfil the needs of their students. Teachers were asked about the types of professional development they had participated in in the past two years. As shown in Table 10.7, more New Zealand teachers had participated in professional development in science than on average across countries. The most common area of professional development was around the curriculum (78% of students).

Table 10.7: Proportion of students whose science teachers had participated in professional development in the past two years

	Percentage of students			
Type of professional development:	**New Zealand**		**International Avg.**	
Science content	64	(3.3)	55	(0.5)
Science pedagogy / instruction	65	(4.3)	58	(0.5)
Science curriculum	78	(3.9)	53	(0.5)
Integrating information technology into science	53	(3.6)	49	(0.5)
Improving students' critical thinking or inquiry skills	53	(3.4)	43	(0.5)
Science assessment	45	(3.6)	48	(0.5)

Note: Standard errors are presented in parentheses.

Source: Exhibit 7.8, Martin, Mullis, Foy, and Stanco, 2012.

Science teaching and learning activities

A series of questions were asked of both teachers and students about the extent to which the teachers tried to engage students in the learning activities. Along with this, the teachers were also asked about the way they worked with the class (whole class teaching or getting students to explain their answers). This section will explore these questions.

Extent to which teachers engage students

Teachers were asked about the frequency with which they used certain instructional techniques for engaging the students (listed in Table 10.8). Most New Zealand students had science teachers who reported that they praised students for good effort every or almost every lesson (83% of students). Similarly, many New Zealand students were in classes where teachers reported encouraging all students to improve their performance every or almost every lesson (71% of students). Use questioning to elicit reasons and explanations was also a common technique among New Zealand teachers (80% of students in classes where this was used every or almost every lesson). Many students had teachers who regularly summarised what students should have learned in lessons (50% every or almost every lesson, 38% about half of lessons).

Table 10.8: Frequency with which New Zealand teachers used methods for engaging the students when teaching the class

	Percentage of students			
Methods for engaging the students when teaching the class:	**Never**	**Some lessons**	**About half the lessons**	**Every or almost every lesson**
Summarise what students should have learned from the lesson	0	13	38	50
Relate the lesson to students' daily lives	0	21	32	47
Use questioning to elicit reasons and explanations	1	4	15	80
Encourage all students to improve their performance	0	7	23	71
Praise students for good effort	0	6	10	83
Bring interesting materials to class	0	41	44	15

Note: Results may appear inconsistent due to rounding.

To summarise responses to this question, the international researchers created a scale that combined teachers' responses to four of these six items and called it the Instruction to Engage Students in Learning scale. The omitted items were *relate the lesson to students' daily lives*, and *bring interesting materials to class*.

As is shown in Table 10.9, on average, New Zealand teachers engaged students in learning with about the same frequency as on average internationally. However, the United States (88%) and England (93%) had higher proportions of students whose teachers attempted to engage them in learning *most lessons* while many of the high-achieving Asian countries had smaller proportions. Proportions of students ranged from 94 percent in the United Arab Emirates and the Palestinian National Authority down to 44 percent in Japan whose teachers tried to engage them in learning *most lessons*. This implies that there could be different cultural expectations for these types of instructional techniques.

Table 10.9: Frequency with which teachers engaged students in learning - Instruction to Engage Students in Learning Scale

	Percentage of students		
	Some lessons	**About half the lessons**	**Most lessons**
New Zealand	3 (1.4)	16 (3.3)	81 (3.5)
International Avg.	3 (0.2)	17 (0.4)	80 (0.4)

Note: Standard errors are presented in parentheses.

Results may appear inconsistent due to rounding.

A score for the four items combined was created using Item Response Theory. For any score 8.7 or greater, the teacher was assigned to the 'most lessons' grouping which corresponds to them using two of the four practices 'every or almost every lesson' and using the other two in 'about half the lessons', on average. For any score 5.7 or smaller, the teacher was assigned to the 'some lessons' grouping which corresponds to them using two of the four practices in 'some lessons' and using the other two in 'about half the lessons', on average. Otherwise, they were assigned to the 'about half the lessons' grouping.

Source: Exhibit 8.15, Martin, Mullis, Foy, and Stanco, 2012.

Students were asked their agreement with a series of five questions (shown in Table 10.10) to gauge their level of engagement with their science lessons. Most New Zealand Year 9 students (86%) agreed a little or a lot that they know what their teacher expects them to do in their science lessons. Nearly two-thirds of students (65%) admitted thinking of things not related to the lesson. Three-quarters of students found their teacher easy to understand (75%). Nearly three-quarters of students were interested in what their teacher said in lessons (70%) and thought that their teacher gave them interesting things to do (71%).

Table 10.10: Percentage of New Zealand students who agreed at least a little with statements about their engagement with their science lessons

Statements	Percentage of students who agreed at least a little with each statement	Is agreeing with the statement associated with higher science achievement?
I know what my teacher expects me to do	86 (1.0)	students agreeing higher
I think of things not related to the lesson	65 (0.9)	agreeing and disagreeing the same
My teacher is easy to understand	75 (1.5)	students agreeing higher
I am interested in what my teacher says	70 (1.4)	students agreeing higher
My teacher gives me interesting things to do	71 (1.4)	students agreeing higher

Note: Standard errors are presented in parentheses.

Students who agreed they were interested in what their teacher had to say or that their teacher gave them interesting things to do had higher science achievement than those who disagreed. Similarly, students who knew what their teacher expected them to do, and those who found their teacher easy to understand, had higher science achievement than those who did not. There was no difference in science achievement between those who agreed that they thought of things not related to the lesson and those who disagreed.

The international researchers created a scale that combined students' responses to these five items and called it the Students Engaged in Science Lessons scale. Fewer New Zealand students were engaged in science lessons according to this measure than on average internationally. New Zealand students who were engaged had higher science achievement than those who were only somewhat engaged (25 scale score points difference) or not engaged (39 scale score points lower than engaged). The same pattern was observed across nearly all other countries.

Table 10.11: Proportion of Students Engaged in Science Lessons

	Percentage of students		
	Not engaged	Somewhat engaged	Engaged
New Zealand	27 (1.6)	52 (0.9)	21 (1.2)
International Avg.	21 (0.2)	51 (0.2)	29 (0.2)

Note: Standard errors are presented in parentheses.

A score for the five items combined was created using Item Response Theory. For any score 11.2 or greater, the student was assigned to the 'engaged' grouping which corresponds to them "agreeing a lot" with three of the five statements and "agreeing a little" with the other two, on average. For any score 8.4 or smaller, the student was assigned to the 'not engaged' grouping which corresponds to them "disagreeing a little" with three of the five statements and "agreeing a little" with the other two, on average. Otherwise, they were assigned to the 'somewhat engaged' grouping.

Source: Exhibit 8.18, Martin, Mullis, Foy, and Stanco, 2012.

Emphasis on science investigation

Teachers were asked about their use of investigations in their science teaching along with asking students to give explanations or relate what they are learning to their own lives. New Zealand teachers most frequently asked students to give explanations about something they were studying or relate what they were learning to their lives (86% and 80% of students respectively were asked to do these about half the lessons or more often – see Table 10.12). Observe natural phenomena and describe what they see or conducting experiments or investigations were relatively commonplace science activities for nearly two-thirds of students.

Table 10.12: Frequency of doing investigations in science lessons in New Zealand

	Percentage of students		
	Never	Some lessons	About half the lessons or more often
Observe natural phenomena and describe what they see	0	38	62
Watch me demonstrate an experiment or investigation	3	67	31
Design or plan experiments or investigations	2	69	29
Conduct experiments or investigations	0	39	61
Use scientific formulas and laws to solve routine problems	7	60	33
Give explanations about something they are studying	0	14	86
Relate what they are learning in science to their daily lives	0	20	80

Note: Results may appear inconsistent due to rounding.

To summarise the use of these activities in classrooms the international researchers created a scale that combined teachers' responses to these seven items and called it the Teachers Emphasise Science Investigation scale. On average, New Zealand teachers emphasised science investigation less than their peers in other countries as shown in Table 10.13. With the exception of the United States (which was higher than New Zealand), all of the high-achieving and most of the English-speaking countries had similar or lower emphasis to New Zealand on science investigation during lessons.

Table 10.13: Proportion of students whose science teachers regularly conducted science investigations

	Level on the Teachers Emphasise Science Investigation scale (percentage of students)	
Country	Less than half the lessons	About half the lessons or more
New Zealand	65 (3.6)	35 (3.6)
International Avg.	52 (0.5)	48 (0.5)

Note: Standard errors are presented in parentheses.

A score for the seven items combined was created using Item Response Theory. For any score 10.2 or greater, the teacher was assigned to the 'about half the lessons or more' grouping which corresponds to their teachers using all seven activities at least about half the lessons, on average. Otherwise, they were assigned to the 'less than half the lessons' grouping.

Source: Exhibit 8.28, Martin, Mullis, Foy, and Stanco, 2012.

Use of resources

There is interesting variation around the world in the way resources are used for teaching science. Teachers were asked if their use of textbooks, workbooks or worksheets, science equipment and materials, and computer software was as a basis for instruction, as a supplement, or not used at all in their science lessons. As Table 10.14 shows, in New Zealand the most commonly used resources in terms of a basis for instruction were science equipment and materials (48% of students). Textbooks (77% of students) and workbooks or worksheets (74%) were most commonly used as a supplementary resource.

Table 10.14: Use of resources in New Zealand classrooms

	Percentage of students whose teacher used the resources as a:		
	Basis for instruction	Supplement	Not used
Textbooks	16	77	7
Workbooks or worksheets	23	74	3
Science equipment and materials	48	52	0
Computer software for science instruction	14	70	17

Note: Results may appear inconsistent due to rounding.

In comparison to New Zealand, textbooks were more commonly used as a basis for instruction in many of the countries. Table 10.15 shows the international average but there was quite a variation among countries. Countries like Armenia, Chinese Taipei, Georgia, the Islamic Republic of Iran, Jordan, Lithuania, and Norway had nearly all teachers using textbooks as a basis for instruction (92% of students or more). New Zealand had nearly the lowest proportion of students (16%) with science teachers using textbooks as a basis for instruction with only England having a lower proportion (8%).

Table 10.15: Use of resources in classrooms on average internationally

	Percentage of students on average internationally whose teacher used the resources as a:		
	Basis for instruction	Supplement	Not used
Textbooks	74	24	2
Workbooks or worksheets	35	60	5
Science equipment and materials	44	54	3
Computer software for science instruction	16	61	24

Note: Results may appear inconsistent due to rounding.

Source: Exhibit 8.26, Martin, Mullis, Foy, and Stanco, 2012.

Use of computers

As shown in Tables 10.14 and 10.15, more New Zealand teachers used computer software as a supplementary resource in their instruction than on average internationally. Nearly all New Zealand teachers used computers for preparation (99% of students), for administration purposes (100%) and most in their classroom instruction (93% - note this question was not about science instruction specifically so differs from the proportion in Table 10.14). Most of those who used computers in their classroom instruction agreed they felt comfortable using computers in their teaching (84% of students had teachers who agreed a lot and 16% agreed a little).

Specifically during science lessons, New Zealand had a relatively low proportion of students (39%) whose teachers responded that computers were available for use during lessons. In comparison, 46 percent of students on average internationally were in classes where computers were available for use during science lessons. New Zealand also had relatively low use of computers for doing scientific procedures or experiments, processing and analysing data, and practicing skills and procedures (see Table 10.16 for details).

Table 10.16: **Computer availability and use during science lessons**

	Percentage of students	
	New Zealand	International Avg.
Have computers available for science lessons	39 (4.1)	46 (0.5)
Computers used for:		
looking up ideas and information	37 (4.0)	39 (0.5)
doing scientific procedures or experiments	13 (2.5)	28 (0.5)
studying natural phenomena through simulations	25 (3.7)	30 (0.5)
processing and analysing data	21 (3.2)	31 (0.5)
practicing skills and procedures	23 (3.4)	33 (0.5)

Note: Standard errors are presented in parentheses.

Source: Exhibit 8.30, Martin, Mullis, Foy, and Stanco, 2012.

Monitoring student progress

According to the National Administration Guidelines schools in New Zealand are required to: "through a range of assessment practices, gather information that is sufficiently comprehensive to enable the progress and achievement of students to be evaluated" (Ministry of Education, 2012). Teachers were asked how much emphasis they placed on different sources to monitor students' progress in science (sources shown in Table 10.17). As shown in the table, more New Zealand teachers placed major emphasis on classroom tests (69% of students in such classes) than on evaluation of ongoing work.

On average internationally, proportions of students were much higher for the level of emphasis placed on evaluation of students' ongoing work (major emphasis 70% of students), and national or regional achievement tests (major emphasis 31%). The emphasis on classroom tests on average internationally (major emphasis 72% of students) was about the same as in New Zealand.

Table 10.17: **Emphasis New Zealand teachers placed on sources for monitoring students' progress**

	Emphasis placed by teachers (percentage of students)		
	Little or no emphasis	Some emphasis	Major emphasis
Evaluation of students' ongoing work	2	50	48
Classroom tests (for example, teacher-made or textbook tests)	2	29	69
National or regional achievement tests	64	30	6

Note: Results may appear inconsistent due to rounding.

On average internationally, giving tests frequently was a more common practice than in New Zealand as shown in Table 10.18. However, there was quite a large variation across countries with high use of tests in Chinese Taipei (98% of students tested fortnightly or more often) and low use in Slovenia (0%).

Table 10.18: Frequency of giving tests

	Frequency of giving tests (percentage of students)		
	A few times a year or less	About once a month	Every 2 weeks or more
New Zealand	23	69	8
International average	24	41	35

Note: Results may appear inconsistent due to rounding.

The most frequently used type of question in science tests, both in New Zealand and across many other countries, was questions involving application of knowledge and understanding (see Table 10.19). Fewer teachers frequently asked students to answer questions involving developing hypotheses and designing investigations – both internationally and in New Zealand.

Table 10.19: Types of questions used in tests

	New Zealand (percent of students)			International Average (percent of students)		
	Never or almost never	Sometimes	Always or almost always	Never or almost never	Sometimes	Always or almost always
Involving application of knowledge and understanding	0	26	74	1	22	78
Involving developing hypotheses and designing scientific investigations	9	67	23	17	62	21
Requiring explanations or justifications	1	31	68	3	42	54

Source: Exhibit 8.32, Martin, Mullis, Foy, and Stanco, 2012.

Monitoring teacher practice

The National Administration Guidelines for New Zealand schools require schools to maintain an on-going programme of self-review. Principals were asked what sources of information they used to evaluate the practice of Year 9 teachers. Student achievement was used by nearly all principals to evaluate the practice of teachers (98% of students in such schools). Similarly, nearly all principals reported that they or their senior staff observed the teachers to evaluate their practice (4% did not). Observations by people not part of the school staff were also used but not in as many schools (49% of students in such schools).

Table 10.20: Sources of information used to evaluate the practice of Year 9 teachers in New Zealand

	Percentage of students whose principal responded 'yes'
Student achievement	98 (1.4)
Observations by the principal or senior staff	96 (1.7)
Teacher peer review	89 (3.0)
Observations by inspectors or other persons external to the school	49 (3.7)

Note: Standard errors are presented in parentheses.

11. School climate

"Providing a caring, safe and respectful school environment in which learning can flourish is a key priority for educators…" (Boyd & Barwick, 2011). Student learning takes place for the individual within a classroom, situated in a school. It seems intuitive that a positive schooling environment would result in positive academic results for students.

In addition to data on achievement in mathematics and science, TIMSS collects a vast amount of contextual information, including responses to questions about the school gathered from teachers, school principals and students. This section examines student, teacher, and principals' perceptions of the climate for learning, teachers' beliefs on the limitations to science learning, and perceptions of school safety and student behaviour. This chapter also looks at the responses of teachers to the conditions in which they find themselves teaching and how they feel about their role as teacher. The relationships between some school context variables and science achievement are also examined and comparisons with previous cycles are presented where possible.

"…to bring about change we need to understand the contribution of, and relationship between, the different parts of the system." (Boyd & Barwick, 2011).

Student perceptions of climate for learning

Students in all countries were asked if they agreed with three statements about their schools: *I like being in school, I feel safe when I am at school,* and *I feel like I belong at this school*. They were able to respond with one of four options: *agree a lot, agree a little*, *disagree a little*, and *disagree a lot*. In addition, New Zealand students were asked if they agreed with a further statement: *I think that students at this school care about each other*.

Most New Zealand Year 9 students were positive about their schools and their teachers, with around eight out of every ten students agreeing with most of the statements as shown in Table 11.1. The statement with the lowest level of agreement was *I think that students at this school care about each other* with 24 percent disagreeing a little and nine percent disagreeing a lot – in total, 67 percent of students agreed with this statement. The statement with the highest level of agreement was *I feel safe when I am at school*, with 42 percent agreeing a lot and 44 percent agreeing a little.

Either higher or similar percentages of girls agreed with all four statements listed in Table 11.1 when compared to boys.

Table 11.1: New Zealand Year 9 student agreement with statements about their school

	Proportion of students agreeing (agreeing a little and a lot combined)		
Statements about the school	**Total**	**Girls**	**Boys**
I like being in school	79 (0.8)	81 (0.9)	77 (1.2)
I feel safe when I am at school	86 (0.6)	87 (0.6)	85 (0.9)
I feel like I belong at this school	83 (0.7)	82 (1.0)	84 (0.9)
I think that students at this school care about each other	67 (1.0)	70 (1.5)	64 (1.2)

Note: Standard errors are presented in parentheses.

All four ethnic groupings were generally positive about their schools, particularly Pasifika students, and a high proportion agreed with three of the four statements. Reflecting the pattern in the overall percentages, all ethnic groupings had fewer students agreeing that they think students at their school care about each other than they had agreeing with the other statements. Pākehā/European and Māori students reflected the general pattern of students, with those who agreed with the statements having higher science achievement than those within the group who disagreed. For Pasifika and Asian students, the size of the groups who disagreed was too small to draw valid conclusions about differences in achievement.

Table 11.2: New Zealand Year 9 student agreement with statements about their school by ethnic grouping

	Proportion of students agreeing (agreeing a little and a lot combined)			
Statements about the school	**Pākehā/European**	**Māori**	**Pasifika**	**Asian**
I like being in school	77 (1.1)	74 (1.5)	93 (1.1)	90 (1.9)
I feel safe when I am at school	85 (0.7)	85 (1.2)	90 (1.7)	84 (2.5)
I feel like I belong at this school	84 (1.0)	78 (1.4)	87 (2.2)	83 (2.3)
I think that students at this school care about each other	67 (1.2)	60 (2.1)	75 (3.6)	71 (2.2)

Note: Standard errors are presented in parentheses.

There were too few students in the 'Other' ethnic grouping to include that grouping in the table.

All of the four statements showed a significant relationship with achievement for New Zealand overall. The students who disagreed with the statements had lower achievement than their counterparts who agreed with the statements.

There is not a consistent pattern across TIMSS countries in terms of the relationship between student achievement and to what degree students agreed with the statement *I like being in school* (see Table 11.3). However, it seems that for many countries, those who answered with *agree a little* or *disagree a littl*e scored higher than those who responded at the extremes with *agree a lot* or *disagree a lot*. Those countries that had the highest number of students agreeing with the statement (Indonesia, Morocco, and Ghana; with 99%, 97% and 97% agreeing either a little or a lot respectively) all tended to have lower achievement than New Zealand while the countries with higher proportions of students who disagreed with this statement tended to have higher achievement. So while within a country there may be some pattern with achievement being better amongst students who agreed that they liked school, higher proportions of students agreeing with this statement did not necessarily mean the country as a whole achieved better.

Table 11.3: **Student agreement with the statement "I like being in school" for selected countries in TIMSS 2010/11**

Country	Proportion of students agreeing (agreeing a little and a lot combined)
Indonesia	99
Morocco	97
Ghana	97
Kazakhstan	95
Syrian Arab Republic	95
Thailand	95
Singapore	90
Hong Kong SAR	81
New Zealand	**79**
Korea, Rep. of	78
Australia	77
England	76
United States	73
Chinese Taipei	72
International Avg.	**84**

Note: The order of this table is based on percentage of students agreeing.

Trends in student perceptions

The first statement listed in Table 11.1 was also posed to TIMSS students in 2002/03. The proportions of New Zealand students agreeing with the statement *I like being in school* was similar in 2002/03 (78%) to the proportions agreeing in 2010/11 (79%). As in 2010/11, this statement had a significant relationship with science achievement in 2002/03.

Teacher perceptions of climate for learning

Teachers of Year 9 students were asked how they would characterise eight aspects of life at their school from teachers' job satisfaction to students' desire to do well in school, as listed in Table 11.4. They were given five response options: *very high*, *high*, *medium*, *low*, and *very low*.

Of all the statements listed, teachers were most positive about other teachers in their schools. Additionally, 85 percent of students had science teachers that felt their expectations for student achievement were *very high* or *high*, with a small percentage having teachers who characterised this as being *low* or *very low*. Around 80 percent of students also had science teachers that characterised the teachers' understanding of the school's curricular goals as being *very high* or *high*, with around one percent of students having teachers who rated this as *low* or *very low*.

Conversely, teachers were less enthusiastic about the parental support and involvement and student attitudes asked about. Parental involvement in school activities had the lowest percentages of students with teachers who rated this statement as *high/very high* (25% for science) and highest percentages of students whose teachers rated the statement as *low/very low* (35% for science). Teachers were also less enthusiastic about students' regard for school property, with around 30 percent of students having teachers who indicated this aspect was *very high* or *high* and around a quarter of students having science teachers who characterised this as *low* or *very low* in their school.

Table 11.4: **Extent to which science teachers characterised aspects of school climate in New Zealand in TIMSS 2010/11**

	Proportion of Year 9 students					
Statements on aspects of school climate	Very low or Low		Medium		Very high or High	
Teachers' job satisfaction	6	(1.9)	31	(3.6)	63	(4.0)
Teachers' understanding of the school's curricular goals	<1	(0.2)	20	(2.9)	80	(2.9)
Teachers' degree of success in implementing the school's curriculum	3	(1.5)	20	(3.0)	77	(3.4)
Teachers' expectations for student achievement	1	(0.9)	14	(2.5)	85	(2.7)
Parental support for student achievement	16	(2.6)	44	(3.8)	41	(3.3)
Parental involvement in school activities	35	(3.5)	40	(3.2)	25	(3.3)
Students' regard for school property	26	(3.4)	45	(4.2)	29	(3.5)
Students' desire to do well at school	10	(2.3)	53	(4.6)	37	(3.9)

Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

Out of the statements in Table 11.4, students' desire to do well in school was the only statement for which there was a significant difference between all three categories (*very high/high*, *medium*, *low/very low*) for science achievement. The higher this statement was regarded by the teachers, the higher the students' achievement was, on average, showing student attitude, perhaps unsurprisingly, has a particular impact on achievement.

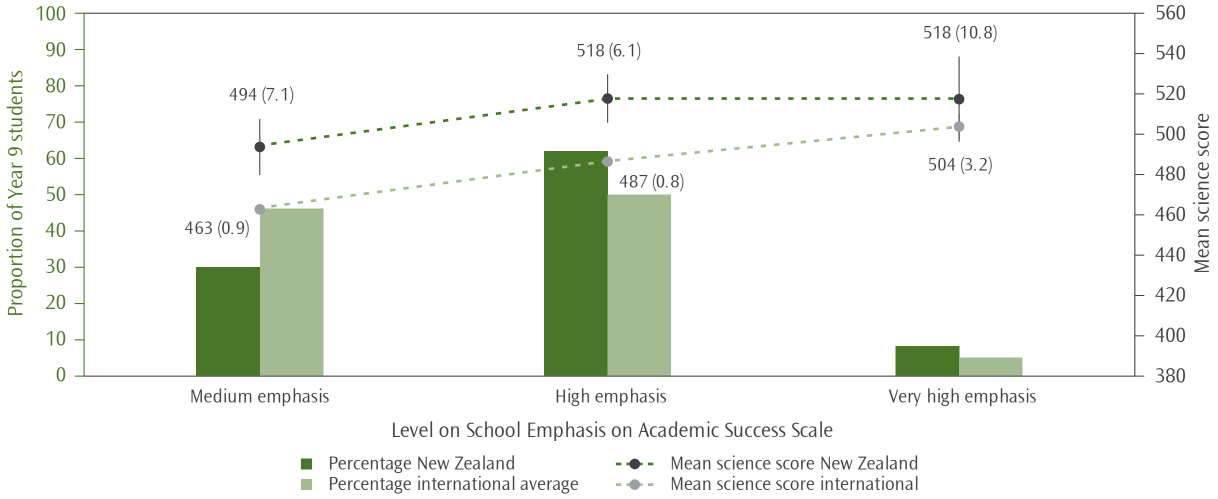
The effect of parental support and involvement on science achievement was more varied. Students whose teachers characterised parental support for achievement as *low* or *very low*, had lower science achievement than those whose teachers characterised this as *medium*, *high*, or *very high*. There were no significant differences in science achievement across the categories for parental involvement in school activities. There was little difference in science achievement across the categories for the statements pertaining to teachers.

Principals were also asked how they would characterise the same eight aspects of life at their school (refer to section *Principal perceptions of climate for learning* later in this chapter). Responses to five out of these eight statements, intended to represent academic optimism in schools, were summarised into two continuous scales, one for teachers' responses and one for principals, referred to as the School Emphasis on Academic Success scale. The statements that did not go into the creation of this scale were: *Teachers' job satisfaction*, *Parental involvement in school activities*, and *Students' regard for school property*. To report the scale in a meaningful way, values were grouped into three categories, *Very high*, *High*, and *Medium* emphasis. As teachers had responded very positively to these statements, there was no *Low* or *Very low* category in the scale.

The general pattern, as shown by the international average, indicated that the higher the emphasis by the teacher on the scale, the higher the associated achievement scores in TIMSS for science (see Table B.1 in the Appendix), however the general pattern was not consistent across all countries. For New Zealand schools, there was a difference between science achievement for those at the lower end of the scale and those at the upper end, but there was no difference for the two upper categories (*High* and *Very high*) (see Figure 11.1).

In some countries, such as Indonesia, there was no significant difference in science achievement across the three categories. For Kazakhstan in science, achievement was higher in the *Medium* category than it was in the *High* category.

Figure 11.1: Levels on the School Emphasis on Academic Success scale (based on teachers' reports) by mean science achievement in TIMSS 2010/11



Note: A classification as Very high meant that students in a school had teachers who responded with very high for an average of three of the five statements and high for the other two. Medium meant students in the school had teachers who responded to an average of no more than three of the five statements as medium and the others as high. Those left over were classified as High.

Source: Adapted from Exhibit 6.4, Martin, Mullis, Foy, and Stanco, 2012.

For the first time in TIMSS, teachers were also asked about their feelings about being a teacher. See Table 11.5 for the six statements with which teachers could *agree a lot*, *agree a little*, *disagree a little*, or *disagree a lot*. There was almost complete agreement amongst the teachers who responded to the questionnaire that the work they do is important and 90 percent said they were content with their profession, 90 percent were satisfied with being a teacher at their school, and 81 percent planned to continue as a teacher for as long as they could. Despite a number of teachers being positive about their role and school, almost 50 percent of teachers agreed that they had more enthusiasm when they started teaching than they had when they completed the questionnaire and 44 percent were frustrated as a teacher.

Table 11.5: New Zealand science teachers' agreement with statements about teaching in TIMSS 2010/11

Statements about teaching	Proportion of students with teachers agreeing (agreeing a little and a lot combined)
I am content with my profession as a teacher	90 (2.6)
I am satisfied with being a teacher at this school	90 (2.2)
I had more enthusiasm when I began teaching than I have now	48 (4.0)
I do important work as a teacher	97 (1.1)
I plan to continue as a teacher for as long as I can	81 (2.8)
I am frustrated as a teacher	44 (4.0)

Note: Standard errors are presented in parentheses.

Students in the selection of English speaking and high achieving countries shown in Table 11.6 have teachers who agreed with high levels of accordance that they do important work as teachers. There were also high levels of agreement that teachers were content with their profession. There was a larger range however for the two statements about enthusiasm and frustration. Out of the countries listed in Table 11.6, the Asian countries tended to have higher proportions of students with teachers who agreed that they had more enthusiasm when they began teaching. The exception to this is Japan who actually had the lowest level of agreement out of those listed, and also had the lowest proportion of students with teachers who were frustrated as teachers.

Table 11.6: Lower secondary science teacher agreement with statements about their role as teachers for selected countries in TIMSS 2010/11

	Proportion of students with teachers agreeing (agreeing a little and a lot combined)			
Country	**Contentment with profession as teacher**	**More enthusiasm when began teaching**	**Do important work as a teacher**	**Frustrated as a teacher**
Singapore	93	71	96	39
Chinese Taipei	97	62	99	33
Korea, Rep. of	90	71	97	37
Japan	91	47	92	24
Hong Kong SAR	94	67	99	31
England	84	54	99	47
United States	89	52	100	60
Australia	89	53	100	49
New Zealand	**90**	**48**	**98**	**44**
International Avg.	**94**	**60**	**99**	**25**

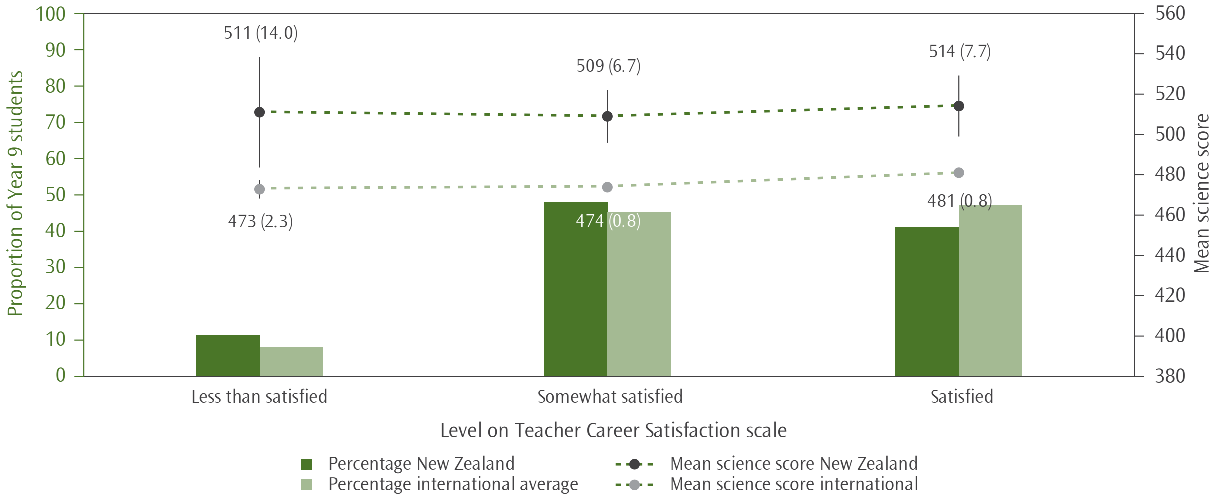
Note: The order of this table is based on achievement order in science.

The international TIMSS team also constructed a Teachers' Career Satisfaction scale, based on how much teachers agreed with the six statements about their role as a teacher. Teachers' responses were combined into a continuous scale to describe the extent to which they agreed with the statements and the scale values were then grouped into three categories, *Satisfied*, *Somewhat satisfied*, and *Less than satisfied*, to report the scale in a meaningful way.

The proportion of New Zealand Year 9 students taught by teachers who were satisfied with their career (i.e., in the *Satisfied* category) was lower than the international average for science (41% versus 47% – see Figure 11.2). New Zealand also had similar rates of students with satisfied science teachers to most of the other English speaking countries who took part in TIMSS at Year 9 (see Table B.2 in the Appendix).

On average internationally, those students with teachers in the *Satisfied* category had higher achievement than those with teachers who were *Less than satisfied*. For New Zealand however, achievement does not appear to be related to how teachers rated on the career satisfaction scale as science achievement was not significantly different across the three categories. New Zealand was not the only country that deviated from the overall pattern; Chinese Taipei had a similar lack of relationship with science achievement as New Zealand for example, as did Korea.

Figure 11.2: Levels on the Teacher Career Satisfaction scale by mean science achievement in TIMSS 2010/11



Note: The category Satisfied covers the proportion of students who had teachers that marked at least agree a lot for three out of the six statements and agree a little with the other three, on average. Less than satisfied teachers at most disagreed a little with three of the six statements and agreed a little with the other three, on average. The rest of students were classified as having Somewhat satisfied teachers.

Source: Adapted from Exhibit 7.16, Martin, Mullis, Foy, and Stanco, 2012.

Trends in teacher perceptions

Teachers' feelings about their own role as a teacher were asked about for the first time in the 2010/11 cycle but the questions given to teachers about school climate were introduced in 2002/03. The proportions of students whose teachers gave positive responses have not changed significantly for a number of the questions between 2002/03 and the 2010/11 cycle. The three questions that have significantly increased for science are characterisation of: *teachers' job satisfaction within the school*, *students' regard for school property within the school* and *teachers' expectations for student achievement within the school*.

Principal perceptions of climate for learning

Principals of Year 9 students were asked how they would characterise the same eight aspects of life at their school as the teachers, and these are listed in Table 11.7. They were given the same five options as the teachers: *very high, high*, *medium*, *low*, and *very low*.

While percentages were different, the pattern was similar when teachers' responses and principals' responses to these questions were compared. The statements where principals were most positive were the four statements relating to teachers with more than three-quarters of students having principals who indicated these aspects were *very high* or *high*; these proportions were similar or higher than those for the responses from the teachers themselves. Principals were much more positive than teachers about students' regard for school property and students' desire to do well at school (56% versus 29% for the former and 68% versus 37% for the latter in the *very high/high* category). Principals were also more positive about parental support for student achievement than teachers were, with 63 percent of students having principals who indicated this was *very high* or *high*, compared to 41 percent of students with teachers rating parental support at this level.

Table 11.7: Extent to which principals characterised aspects of school climate in New Zealand in TIMSS 2010/11

	Proportion of Year 9 students		
Statements on aspects of school climate	**Very low or Low**	**Medium**	**Very high or High**
Teachers' job satisfaction	0 (0.0)	22 (3.1)	78 (3.1)
Teachers' understanding of the school's curricular goals	0 (0.0)	13 (3.1)	87 (3.1)
Teachers' degree of success in implementing the school's curriculum	0 (0.0)	20 (3.2)	80 (3.2)
Teachers' expectations for student achievement	1 (0.4)	23 (3.9)	76 (3.8)
Parental support for student achievement	4 (1.2)	33 (3.9)	63 (3.8)
Parental involvement in school activities	30 (4.1)	43 (4.4)	27 (4.5)
Students' regard for school property	4 (1.8)	40 (4.5)	56 (4.4)
Students' desire to do well at school	1 (0.7)	31 (3.9)	68 (4.0)

Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

The responses of the principals across these eight statements and their relationship with achievement differed in several ways from the relationship between the teachers' responses and achievement scores. With the principals' responses, there was a significant difference between the *very high/high* group and the *medium* group for science for *teachers' job satisfaction,* a difference that was not present with the teachers' responses. There were no students whose principals replied with *low* or *very low* to this question. *Teachers' understanding of the school's curricular goals*, as viewed by principals, did not have a relationship with science achievement while teachers' expectations for student achievement did relate to achievement with higher levels of expectations being associated with higher achievement.

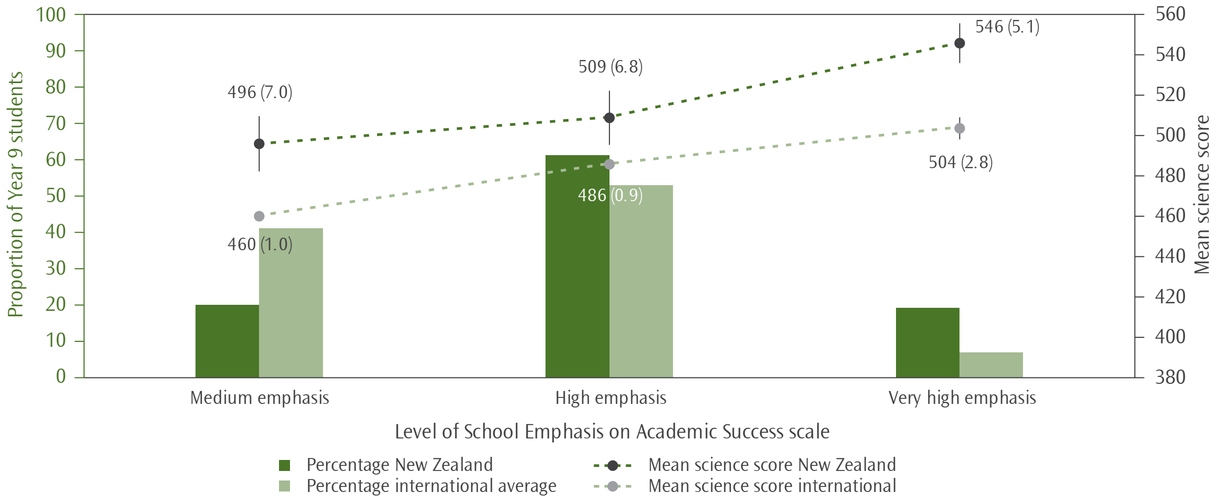
For teachers, there was no relationship between parental involvement and science achievement, but there was a significant relationship between principals' responses to this question and science achievement. The higher the principal rated parental involvement in their school, the higher the average science achievement of their students.

The statements relating to students as responded to by principals seem to have a similar relationship with science achievement to the responses from teachers. Those students who came from schools where the principals rated *students' regard for school property* as being *very high* or *high* scored significantly higher than those in the lower categories and there were differences in science achievement across all three categories for *students' desire to do well in school*.

Responses to five out of these eight statements, intended to represent academic optimism in schools, were summarised into two scales, one for teachers and one for principals, referred to as the School Emphasis on Academic Success scale (the results for teachers can be found in Figure 11.1 earlier in this chapter). As mentioned earlier, the statements that did not go into the creation of this index were: *Teachers' job satisfaction*, *Parental involvement in school activities*, and *Students' regard for school property*. To report the scale in a meaningful way, values were grouped into three categories, *Very high*, *High*, and *Medium* emphasis. As principals had responded very positively to these statements, there was no *low* or *very low* category on this scale.

The general pattern, as shown by the international average, was that the higher on the scale the emphasis by the principal, the higher the associated achievement scores in TIMSS for science (see Table B.3 in the Appendix). New Zealand follows a similar pattern with respect to the difference between achievement at the top and the bottom categories on this scale. The pattern was not consistent across all countries (see Table B.3 in the Appendix). Indonesia and the Palestinian National Authority for example had no statistical difference across the three categories when it came to science achievement.

Figure 11.3: Levels on the School Emphasis on Academic Success scale (based on principals' reports) by mean science achievement in TIMSS 2010/11



Note: A classification as Very high meant that students in a school had a principal who responded with very high for an average of three of the five statements and high for the other two. Medium meant students in the school had a principal who responded to an average of no more than three of the five statements as medium and the others as high. Those left over were classified as High.

Source: Adapted from Exhibit 6.2, Martin, Mullis, Foy, and Stanco, 2012.

For New Zealand, the overall pattern of those students in schools with higher ratings on the scale having higher average achievement appears to be the same, regardless of whether it was teachers or principals reporting it.

Trends in principal perceptions

The questions given to principals about school climate were first introduced in 2002/03. Between 2002/03 and 2010/11 there were changes for several of the statements regarding school climate and little to no change for the rest. For those statements where there had been change since 2002/03 (*teachers' job satisfaction*, *teachers' expectations for student achievement*, and *students' desire to do well at school*), these were all more positive than they had been in 2002/03.

Student perceptions of school safety and student behaviours

Year 9 students were asked how often they had experienced negative behaviours during the year (behaviours are listed in Table 11.8). They were given the response options *never*, *a few times a year*, *once or twice a month*, and *at least once a week*.

The most commonly reported negative behaviour was being made fun of or called names (35%). The least commonly reported behaviour was being made to do things they didn't want to by other students (7%). The proportions of students in 2010/11 that indicated they had experienced these behaviours at least once a month, meaning they indicated it had happened *at least once a week* or *once or twice a month*, are shown in Table 11.8.

Table 11.8: New Zealand Year 9 students' agreement with statements about other students' behaviour

Statements	Proportion of Year 9 students that replied once a month or more frequently
I was made fun of or called names	35 (0.8)
I was left out of games or activities by other students	14 (0.6)
Someone spread lies about me	19 (0.7)
Something was stolen from me	13 (0.6)
I was hit or hurt by other student(s)	13 (0.7)
I was made to do things I didn't want to do by other students.	7 (0.4)

Note: Standard errors are presented in parentheses.

For three of the statements in Table 11.8 (*someone spread lies about me*, *something was stolen from me*, and *I was made to do things I didn't want to do by other students*), achievement in science was higher for those students who experienced these behaviours less frequently (*a few times a year* or *never*) than for those students who experienced it more frequently. There was no significant difference in science achievement between those students who were made fun of or called names or those who were hit or hurt by other student(s) at least monthly and those who reported it happening more infrequently or never. There was also no difference in science achievement depending on frequency of experiencing *I was left out of games or activities by other students*.

Students' responses to these statements were combined into a continuous scale, the Students Bullied at School scale, to describe the extent to which they experienced bullying behaviours at school. To report the scale in a meaningful way, values on the scale were grouped into three categories. *Almost never* on the scale meant that at most the student responded with *never* to three of the six statements and *a few times a year* to the other three, on average. Students who were categorised as experiencing these behaviours *About weekly* on the scale experienced at least each of three of the six behaviours *once or twice a month* and the other three *a few times a year*, on average. All other students were classified as being bullied *About monthly.*[20]

Note that the titles for these categories, as used internationally, may overstate the frequency of the bullying behaviours as can be seen from these descriptors. This data should be read with caution as the reader could assume that 12 percent of students had reported that they were bullied about weekly. However, the scale is based on individual behaviours and could range from a repeated behaviour on a weekly basis from a group of individuals to three different behaviours, with each behaviour happening on separate occasions only once a month and instigated by different perpetrators.

New Zealand had the same proportion of students in the *About weekly* category as the international average and slightly fewer in the *Almost never* category (55% versus 59% - see Figure 11.4).

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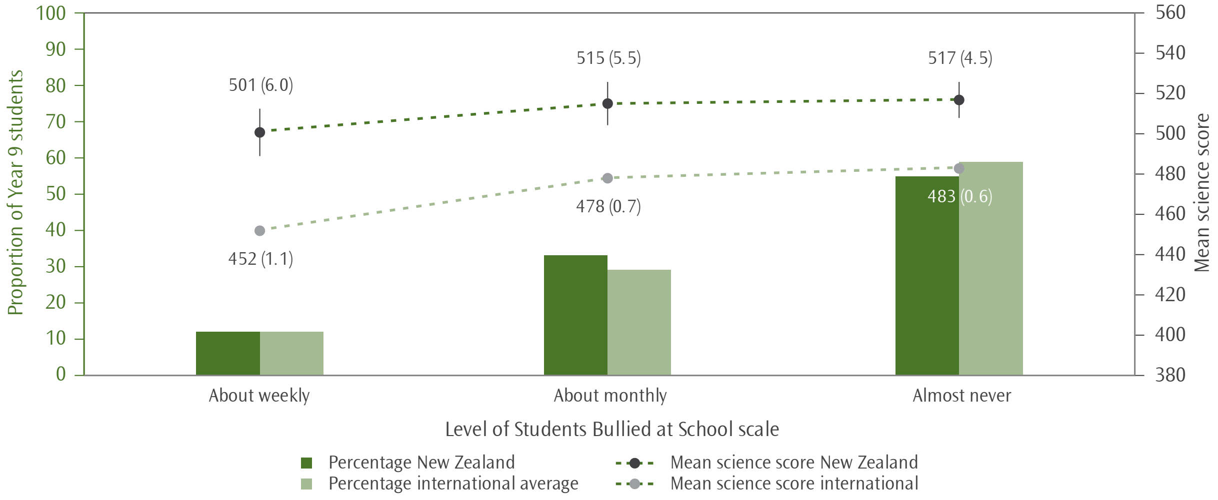
[20] The descriptions here explain the cut points for the category, not the categories themselves. That is, the cut point represents the maximum score that a student could get, on average, and still be assigned to a category. For example, for the *About weekly* category, the maximum cut score of 7.7 corresponds to students experiencing each of three bullying behaviours *once or twice a month* and each of the other three *a few times a year*, on average. Any response corresponding to more frequent bullying behaviour than this will also fall into the *About weekly* category. Students with a score higher than 9.6 were assigned to the *Almost never* category.

Looking at achievement across the levels of the scale, there was a general pattern of students who were categorised as being bullied less having higher achievement than those who were categorised as being bullied more, as shown by the international average for science (see Figure 11.4). The biggest difference tended to be between those who were categorised as almost never bullied and those who were categorised as being bullied at school about weekly. For a number of countries, including New Zealand, the only significant difference was between the most frequent category *About weekly*, and the least frequent category, *Almost never* (see Table B.4 in the Appendix). There were also some countries, such as Thailand and Hong Kong SAR, where there was no significant difference in science achievement across the three categories.

Figure 11.4: Percentages of students on the Students Bullied at School scale by mean science achievement in TIMSS 2010/11



Source: Adapted from Exhibit 6.12, Martin, Mullis, Foy, and Stanco, 2012.

Different experiences of bullying behaviours within New Zealand

Bullying behaviours can affect different groups in different ways. Consequently, the analysis below is broken down into gender differences, differences amongst socio-economic groups, and differences amongst ethnic groupings.

For the Students Bullied at School scale, the proportion of boys who experienced the bullying behaviours about weekly was higher than the proportion of girls for the same category. For both genders, those in the most frequent category (*About weekly*) had significantly lower science achievement than those in the other two categories (*Almost never* and *About monthly*), although for girls, the gap in achievement was greater than it was for boys.

Generally, for the individual items by gender, a higher proportion of boys indicated that they had experienced the behaviours monthly or more frequently (versus less frequently) when compared to the proportion of girls who indicated the same (versus less frequently). The biggest differences were for *I was made fun of or called names* and *I was hit or hurt by other students*, with 42 percent and 18 percent of boys respectively responding that they had experienced these behaviours once or twice a month or more frequently, compared with 27 percent and seven percent of girls.

For girls, those who did indicate this level of frequency had significantly lower science achievement than those girls who indicated that they experienced these behaviours less frequently or never. For boys however, achievement was not significantly different for those who responded that they experienced these behaviours with greater frequency for most of the statements.[21]

As mentioned previously, the socio-economic status of students has been found to have a strong relationship with achievement and TIMSS asked school principals to report on the economic composition of their school by estimating the proportion of students in their school from economically disadvantaged homes and economically affluent homes. Schools were categorised as being advantaged if more than a quarter of their students were from affluent homes and one quarter or fewer were from disadvantaged homes. Schools that were categorised as disadvantaged had the opposite situation and those schools remaining were classified as neither advantaged nor disadvantaged.

Within each category of the Students Bullied at School scale, the proportions of students from each of the socio-economic groups (economically disadvantaged, neither advantaged or disadvantaged, and economically affluent) were reflective of their proportion of the population as a whole. In other words, none of the socio-economic groupings were over- or under-represented at each level of the scale. This is further supported by looking at the scale by decile grouping.

The Students Bullied at School scale was also examined by ethnicity. The only ethnic grouping over-represented in the *About weekly* end of the scale was the Pākehā/European grouping, although their average achievement was still higher than or similar to those other ethnic groupings at this end of the Students Bullied at School scale. Each ethnic grouping had similar proportions of students who said they almost never experienced the bullying behaviours.

Trends in student perceptions about school safety

Questions given to students about school safety have changed since TIMSS was first implemented in 1994. One question from the 1994 cycle remained through to the 2002/03 assessment; a variation on *something was stolen from m*e. Five out of the six questions asked in 2002/03 were also asked in the 2010/11 cycle but the response options were changed between the two cycles. In 2002/03, students were asked to indicate by ticking yes or no if the behaviours listed had happened to them at school during the last month. In the 2010/11 cycle, they were given options for how often the behaviours happened to them at school. To compare the two cycles, Table 11.8 earlier in this chapter shows combined categories *at least once a week* and *once or twice a month* as an approximation to the proportions of students who ticked yes for the various behaviours in 2002/03. While the proportions can be compared across the two cycles, it should be viewed with caution, as it is not clear to what degree differences are due to actual changes amongst the students and how much is due to the rephrasing of the questions. For all five behaviours, there were similar or lower proportions in TIMSS 2010/11 (refer to Table 11.9 for details of the 2002/03 percentages). *Something of mine was stolen* and *I was hit or hurt by other students* had the largest drops, with a 25 percent reduction for the former and 14 percent for the latter.

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[21] The exceptions were *Someone spread lies about me* and *I was made to do things I didn't want to by other students*, where the achievement for boys was either borderline significant or statistically lower for those who indicated that they experienced these once or twice a month or more frequently.

Table 11.9: Proportion of students that experienced each of these behaviours during the last month in New Zealand in TIMSS 2002/03

Statements	Proportion of Year 9 students
Something of mine was stolen	38 (1.2)
I was hit or hurt by other students (e.g., shoved, punched or kicked)	27 (1.3)
I was made to do things I didn't want to do by other students	13 (0.7)
I was made fun of or called names	34 (1.4)
I was left out of activities by other students	15 (0.8)

Note: Standard errors are presented in parentheses

Teacher perceptions of school safety and student behaviours

Teachers of Year 9 students were asked to indicate the extent to which they agreed or disagreed with three statements on the general levels of safety they experienced at their schools. The statements listed are shown in Table 11.10. There were four possible response options given: *agree a lot, agree*, *disagree*, and *disagree a lot*.

Almost all students in TIMSS were taught by teachers who agreed their school was a safe place, with 97 percent agreeing with the statement *I feel safe at this school*, as shown in Table 11.10. There was least agreement with the statements *the students are well behaved* and *the students are respectful of the teachers* with 21 to 22 percent of students having teachers who disagreed to some extent.

Table 11.10: Extent to which teachers agreed with statements on school safety in New Zealand in TIMSS 2010/11

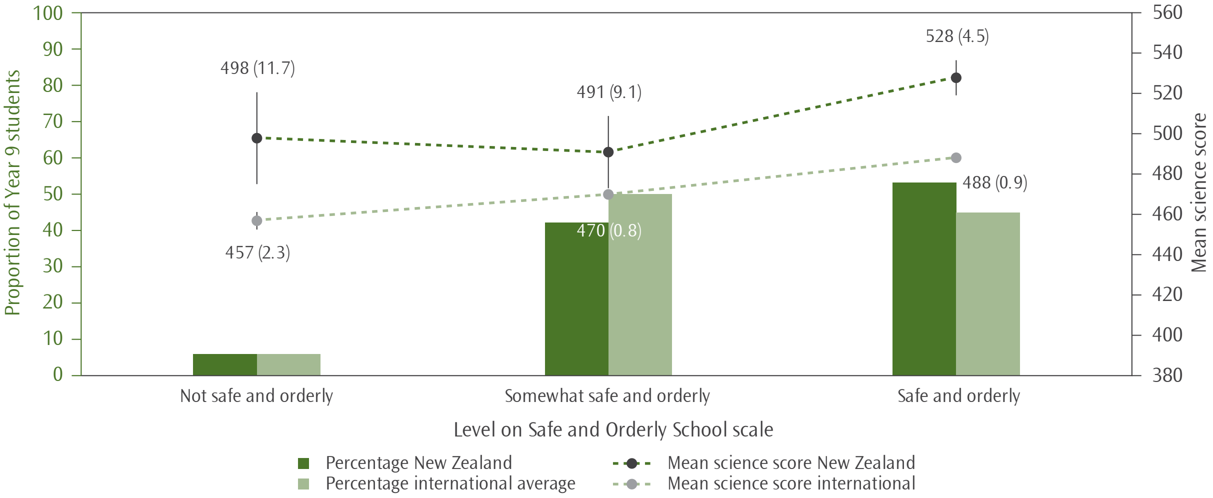
Statements on school safety	Proportion of students with teachers agreeing (agreeing a little and a lot combined)
This school is located in a safe neighbourhood	91 (1.4)
I feel safe at this school	97 (1.5)
This school's security policies and practices are sufficient	92 (2.2)
The students are well behaved	78 (3.0)
The students are respectful of the teachers	79 (3.2)

Note: Standard errors are presented in parentheses.

Teachers' responses to these statements were summarised into a continuous scale, the Safe and Orderly School scale, to describe the extent to which they felt their school was a safe and orderly environment. To report the scale in a meaningful way, values on the scale were grouped into three categories; *Safe and orderly*, *Somewhat safe and orderly*, and *Not safe and orderly*.

Fifty-three percent of New Zealand Year 9 students had science teachers who agreed that their school was a safe and orderly place, which was higher than the international average of 45 percent. The general pattern relating achievement to rating on this scale, as shown by the international average, seems to indicate that the more safe and orderly a school is, the higher the average science achievement of the students. For some countries such as Turkey and Chile, this meant a discernible difference between all three categories for science achievement (see Table B.5 in the Appendix). There was also a number of countries where there was a difference between the top and bottom categories but achievement for *Somewhat orderly* was not significantly different from *Not safe and orderly* (in Chinese Taipei for example). For some countries, there was no statistically significant difference between the science achievement for all three categories, such as was the case for Tunisia and Slovenia.

Figure 11.5: **Levels on the Safe and Orderly School scale by mean science achievement in TIMSS 2010/11**



Note: Those students whose teachers agreed a lot with three out of the five statements and agreed a little with the other two, on average, were classified in the Safe and orderly school category. Teachers disagreed a little with at least three of the five statements and agreed a little with the other two, on average, for students to be classified as being in schools that were Not safe and orderly. All others were allocated to Somewhat safe and orderly.

Source: Adapted from Exhibit 6.8, Martin, Mullis, Foy, and Stanco, 2012.

Trends in teacher perceptions

The first three questions about school safety in Table 11.10 were given to teachers for the first time in 2002/03. Comparisons between that cycle and 2010/11 show no significant change in the proportions of students whose teachers gave positive responses to the individual questions. The other two questions in the table were asked for the first time in 2010/11.

Principal perceptions of school safety and student behaviours

To help foster a healthy learning environment, minimal or no disruption to learning is desirable. In previous cycles, principals were asked how frequently a series of problem behaviours occurred in their school and the severity of the problem. In 2010/11, these were combined to ask how much of a problem these behaviours (listed in Table 11.11) were in the school.

Principals expressed the extent to which these behaviours were a problem amongst Year 9 students in their school with one of the following response options: *not a problem*, *minor problem*, *moderate problem*, or *serious problem*. The majority of Year 9 students attended schools where these behaviours were perceived by the principal to be a minor problem at the most. Few students had principals that acknowledged any of these behaviours as posing a serious problem in their school. *Absenteeism* was the behaviour with the highest proportions in the moderate and serious problem categories combined (24%), followed by *intimidation or verbal abuse among students* (20%), *arriving late at school* (19%), and *classroom disturbance* (19%).

Table 11.11: Extent to which principals classified behaviours of New Zealand Year 9 students as a problem in TIMSS 2010/11

	Proportion of Year 9 students in each category of severity of behaviours			
Behaviours	**Serious problem**	**Moderate problem**	**Minor problem**	**Not a problem**
Arriving late at school	2 (1.1)	17 (4.4)	60 (4.5)	21 (3.6)
Absenteeism	5 (2.1)	19 (3.8)	62 (4.2)	15 (1.9)
Classroom disturbance	<1 (0.4)	19 (3.5)	69 (4.6)	12 (3.2)
Cheating	0 (0.0)	0 (0.0)	47 (4.1)	53 (4.1)
Profanity	1 (1.0)	15 (2.6)	64 (4.0)	20 (3.5)
Vandalism	1 (0.5)	5 (2.0)	65 (4.5)	29 (4.1)
Theft	<1 (0.4)	10 (3.1)	70 (4.1)	19 (2.9)
Intimidation or verbal abuse among students	1 (0.7)	19 (3.6)	73 (3.8)	6 (1.5)
Physical injury to other students	<1 (0.4)	2 (1.4)	57 (4.6)	40 (4.6)
Intimidation or verbal abuse of teachers or staff	<1 (0.4)	6 (2.2)	56 (4.9)	38 (4.6)
Physical injury to teachers or staff	0 (0.0)	1 (0.7)	6 (2.6)	93 (2.7)

Note: Standard errors are presented in parentheses.

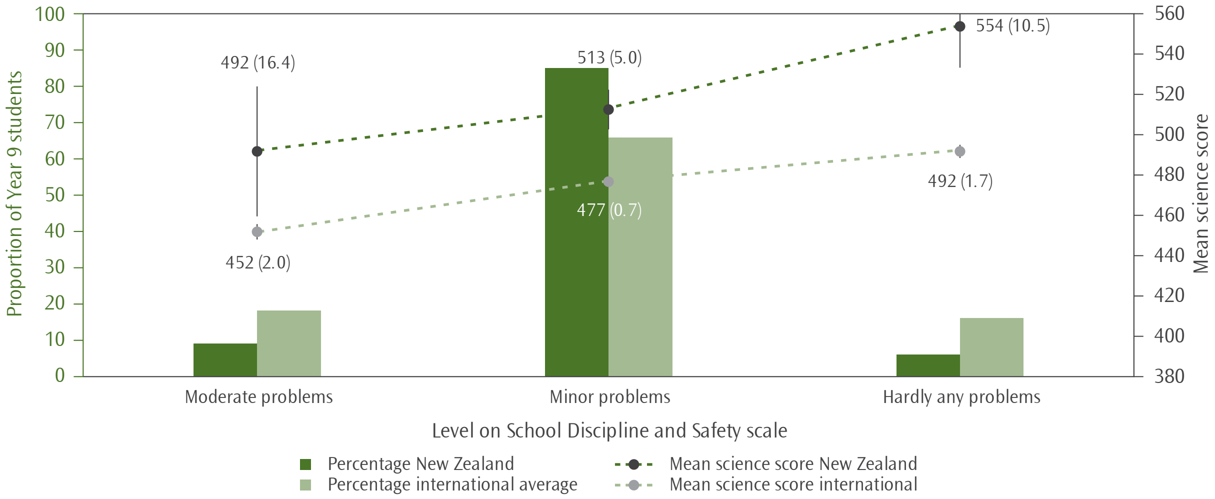
Proportions in each row should add to 100%; inconsistencies are due to rounding.

Generally, being in a school with less of a problem with the behaviours listed above was associated with higher achievement in science, although this often meant a difference between the top two categories versus the bottom two rather than a difference between each category. There were four exceptions to this, *cheating*, *profanity*, *vandalism* and *physical injury to teachers or staff* where there were no significant differences across the categories. However, for *cheating*, there were only responses for the top two categories anyway.

To summarise the extent to which school discipline and safety affects student learning, the TIMSS international team created a continuous scale, the School Discipline and Safety scale, based on principals' views on the extent to which the ten behaviours listed above occurred among lower secondary students in their schools. To report the scale in a meaningful way, values on the scale were grouped into three categories: *Moderate problems*, *Minor problems*, and *Hardly any problems*.

A number of the higher achieving countries had proportions in the *Hardly any problems* category that were higher than the international average (refer Table B.6 in the Appendix). Kazakhstan had the highest proportion in this category, with 44 percent of students going to schools deemed to have hardly any problems with school discipline and safety. A small proportion of Year 9 students in New Zealand (6%) attended schools whose principals indicated that there were hardly any problems with school discipline and safety and a small minority (9%) attended schools where there were moderate problems. The majority of students were in schools with minor problems.

Figure 11.6: Levels on the School Discipline and Safety scale by mean science achievement in TIMSS 2010/11



Note: Students whose principals reported not a problem on average for five out of the ten statements and only minor problems for the other five rated as having Hardly any problems on the scale. A rating of Moderate problems corresponded to students whose principals responded with moderate problem for, at most, five of the ten statements and minor problem for the other five, on average.

Source: Adapted from Exhibit 6.10, Martin, Mullis, Foy, and Stanco, 2012.

The overall pattern shown by the international average (see Figure 11.6) is that higher achievement is related to higher safety and order ratings on the scale. Several countries show little variation in achievement scores for science across the categories however, Slovenia and Armenia for example.

Trends in principals' perceptions

The behaviours in Table 11.11 were asked about in the 2002/03 cycle. The question was phrased in a slightly different way in these previous cycles however, asking for the frequency of occurrence of the problems in the school and then how severe they were. Comparing the proportions for the *Not a problem* column, most of the items were not significantly different between the two cycles, seeming to indicate these things were not any more of a problem than previously. For the three items where there was a difference, the greatest change was for *cheating*, dropping from 71 percent of students having principals who indicated this was not a problem in 2002/03 to 53 percent in 2010/11, followed by *vandalism* dropping from 44 percent to 29 percent and *theft* from 33 percent to 19 percent between 2002/03 and 2010/11.

Relationship between home and school

In *The Complexity of Community and Family Influences on Children's Achievement in New Zealand: Best Evidence Synthesis*, Biddulph, Biddulph, and Biddulph (2003) state that "A key message emerging from the New Zealand and international research is that effective centre/school-home partnerships can strengthen supports for children's learning in both home and centre/school settings. What is remarkable about such partnerships is that when they work the magnitude of the positive impacts on children can be so substantial, compared to traditional institutionally-based educational interventions."[22]

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[22] This BES contains an extensive synthesis on the effect of community and family on student achievement, as well as the effect of partnerships between these groups and schools/centres, supporting the results that have come from TIMSS.

In New Zealand, Boards of Trustees are required under the National Administrative Guidelines (Ministry of Education) to report to students, parents and the school's community on individual student achievement, on the achievement of students as a whole, and on groups such as Māori students, evaluating these against established targets.[23] Ka Hikitia, the Māori Education Strategy, also has a strong emphasis on the involvement of parents, families and whānau in students' learning and engagement. Similarly, the Pasifika Education Plan puts Pasifika learners, their parents, families, and communities at the centre of the education system (Ministry of Education, 2012).

Given the important role that parents, and the interface between parents and teachers/schools, play in enriching their child's education, the TIMSS study examined parental involvement in various school activities. In TIMSS 2010/11, teachers were asked about their face-to-face interactions with parents and principals were asked if their school had asked parents to be involved in various school activities such as school projects programmes and trips, school committees, and raising funds for the school.

Over 80 percent of students had science teachers who reported that they met or talked individually with parents about students' progress one to three times a year (see Table 11.12), which probably refers to the standard school practice of parent-teacher interviews. Just under 80 percent of students had science teachers who sent home progress reports on students' learning one to three times a year; this is likely to correspond with the usual practice of issuing regular student reports.

Table 11.12: Frequency of teachers' interactions with parents, reported by New Zealand Year 9 science teachers

	Proportion of Year 9 students whose science teachers indicated how often the interactions with parents occurred				
Teacher-parent interaction	**Never**	**1-3 times a year**	**4-6 times a year**	**Once or twice a month**	**At least once a week**
Meet or talk individually with the students' parents to discuss his/her learning progress	2 (0.7)	83 (3.2)	13 (2.9)	2 (1.0)	1 (0.5)
Send home a progress report on the student's learning	1 (1.0)	78 (3.6)	17 (3.4)	3 (1.2)	2 (1.2)

Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

In terms of interactions about education, the most frequent interaction reported on in TIMSS between schools and parents about the school was informing parents about school accomplishments, with all New Zealand Year 9 students having principals who said they did this at least two to three times a year (*2 to 3 times a year* and *more than 3 times a year* combined). The next most frequent interaction was informing parents about the overall achievement of the school, with more than three-quarters of students having principals who indicated they did this at least two to three times a year. Of the list of general school interactions in TIMSS, these two would be the most likely to be covered by sending out regular newsletters from schools to parents about the notable activities and achievements happening in the school, a practice that seems to be quite common for New Zealand schools.

For interactions regarding individual students, all Year 9 students had principals who indicated that they informed parents about their child's learning progress at least twice a year and almost all had principals who indicated that they informed parents about the behaviour and well-being of their child with similar frequency. These two interactions, as discussed earlier in relation to the teachers' responses, along with discussing parents concerns or

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[23] National Administration Guidelines 2c.

wishes about their child's learning (93% at least 2 to 3 times a year) could be covered by issuing student reports three to four times a year, and the interviews between teachers and parents, which normally occur one to two times a year in New Zealand schools.

Table 11.13: Frequency of schools' interactions with parents, as indicated by the New Zealand principals

	Proportion of Year 9 students whose principals indicated they interacted with parents:							
School-parent interaction	**Never**		**Once a year**		**2 to 3 times a year**		**More than 3 times a year**	
In general								
Inform parents about the overall academic achievement of the school	1	(0.6)	24	(4.7)	49	(4.7)	27	(4.3)
Inform parents about school accomplishments	0	(0.0)	0	(0.0)	7	(2.8)	93	(2.8)
Inform parents about the educational goals and pedagogic principles of the school	<1	(0.3)	28	(4.5)	40	(4.1)	31	(4.8)
Inform parents about the rules of the school	<1	(0.3)	36	(5.2)	37	(5.0)	27	(4.8)
Discuss parents' concerns or wishes about the school's organisation	1	(0.7)	40	(5.7)	27	(4.7)	32	(5.1)
Provide parents with additional learning materials for their child to use at home	49	(5.3)	15	(3.4)	20	(4.5)	16	(3.8)
Organise workshops or seminars for parents on learning or pedagogical issues	20	(4.8)	34	(4.2)	36	(4.6)	9	(3.6)
For individual students								
Inform parents about their child's learning progress	0	(0.0)	0	(0.0)	58	(5.0)	42	(5.0)
Inform parents about the behaviour and well-being of their child at school	2	(2.0)	1	(0.7)	50	(5.7)	47	(5.9)
Discuss parents' concerns or wishes about their child's learning	2	(2.0)	5	(2.2)	61	(5.4)	32	(4.9)
Support individual parents in helping their child with schoolwork	6	(2.3)	19	(4.3)	34	(5.1)	41	(5.4)

Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

As well as eliciting information on the way schools interact with parents, TIMSS also asked about ways in which schools try to get parents involved with the schools (see Table 11.13). For two out of the three activities, *volunteer for school projects, programmes and trips*, and *raise funds for the school*, around 50 percent of students were in schools where the principal asked parents to be involved at least two to three times a year.

Table 11.14: New Zealand schools' encouragement of parental involvement in TIMSS 2010/11

	Proportion of Year 9 students whose principals reported they asked parents:							
Activity	**Never**		**Once a year**		**2 to 3 times a year**		**More than 3 times a year**	
Volunteer for school projects, programmes and trips	12	(4.1)	36	(5.0)	31	(4.4)	21	(3.9)
Serve on school committees	9	(2.9)	48	(5.0)	31	(4.9)	12	(2.7)
Raise funds for the school	17	(3.4)	32	(4.6)	33	(3.9)	18	(3.6)

Note: Standard errors are presented in parentheses.

These were lower proportions than those found for the 2002/03 cycle, although the phrasing of the question was changed between the two cycles. In the 2002/03 cycle, principals were asked "Does your school ask parents to do the following…" and given five different school-related activities to respond to. In 2010/11, they were asked for the frequency with which they asked parents and given three activities. In 2002/03, 67 percent of students had principals who responded in the affirmative when asked if they requested parents volunteer for school projects, programmes and trips, 72 percent for requesting parents to serve on school committees, and 53 percent for help to raise funds for the school.

Interactions between teachers

Teachers as professionals spend time learning and improving their practice throughout their careers. An excellent way to learn is through interactions and collaborations with other teachers. TIMSS asked teachers how often they interact with other teachers, with five types of interaction provided in the questionnaire, as shown in Table 11.15. Four possible response options for the frequency of interactions were: *never or almost never*, *2 or 3 times a month*, *1 to 3 times per week*, and *daily or almost daily*. Teachers' most common interaction was discussing how to teach a particular topic, with half of students having science teachers who reported doing this at least weekly. The other most common activity was sharing what they have learned about teaching experiences at least weekly (51% at least weekly). Visiting another classroom to learn more about teaching was the least common interaction by a considerable margin.

Table 11.15: Frequency of interactions among New Zealand Year 9 science teachers in TIMSS 2010/11

	Proportion of Year 9 students whose science teachers interacted with other teachers:			
Types of interactions	**Never or almost never**	**2 or 3 times a month**	**1 to 3 times a week**	**Daily or almost daily**
Discuss how to teach a particular topic	8 (1.9)	42 (3.7)	33 (3.8)	17 (2.7)
Collaborate in planning and preparing instructional materials	16 (3.2)	53 (4.3)	24 (3.2)	7 (1.6)
Share what I have learned about my teaching experiences	11 (2.5)	37 (3.7)	36 (3.3)	15 (2.7)
Visit another classroom to learn more about teaching	63 (3.4)	31 (3.5)	4 (1.3)	2 (0.9)
Work together to try out new ideas	28 (3.3)	51 (3.8)	16 (2.8)	5 (1.7)

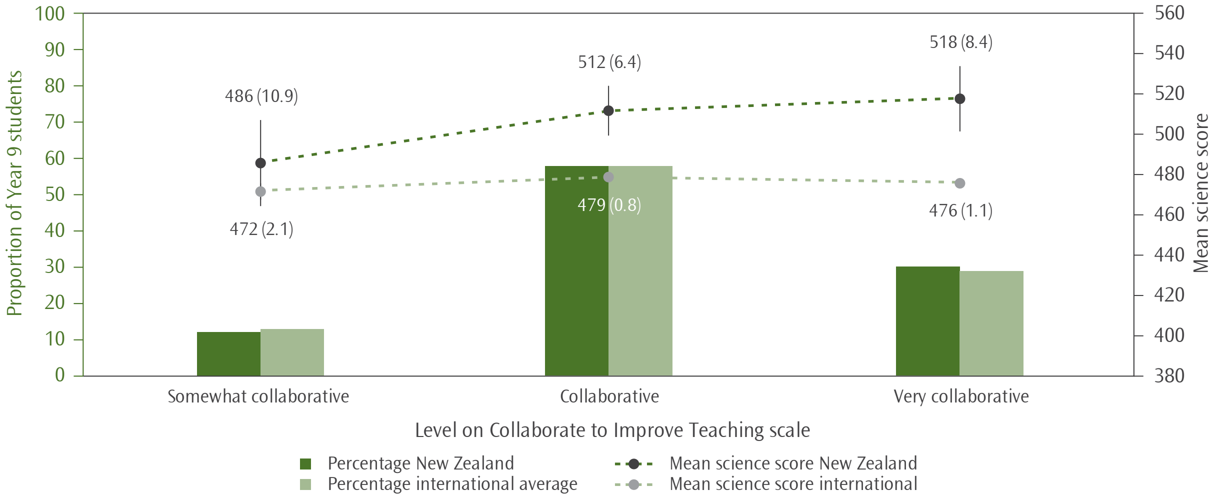
Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

Most of the different interactions did not seem to have particular relationships with achievement but there were a few exceptions. Those students whose science teachers said that they never or almost never discussed how to teach a particular topic had lower achievement than those who had teachers who did this daily or almost daily, but the differences were not significant between all the frequency categories.

Teachers' responses to the questions about the frequency of their interactions with other teachers were combined into a continuous scale, the Collaborate to Improve Teaching scale. To report the scale in a meaningful way, values on the scale were grouped into three categories; *Very collaborative*, *Collaborative*, and *Somewhat collaborative*.

Figure 11.7: **Levels on the Collaborate to Improve Teaching scale by mean science achievement in TIMSS 2010/11**



Note: Students who were classified in the Very collaborative portion of the scale had teachers who answered at least three of the five statements with one to three times a week and two or three times per month for the other two, on average. Those in the Somewhat collaborative category had teachers who responded with never or almost never to three of the five statements and two or three times per month to the other two, on average. All others were classified as Collaborative.

Source: Adapted from Exhibit 8.13, Martin, Mullis, Foy, and Stanco, 2012.

Thirty percent of Year 9 students in New Zealand had science teachers who said they were *Very collaborative*, similar to the international average of 29 percent.

For science internationally, there was not a great difference between science achievement across the levels of the scale but for the students internationally who had teachers who were *Somewhat collaborative*, their science achievement was higher than for the other two categories on the scale. For New Zealand, students whose teachers were characterised as *Somewhat collaborative* had significantly lower achievement than those in the other two categories and we were the only country to exhibit this particular pattern (see Table B.7 in the Appendix).

Trends in interactions with other teachers

Questions about interactions with other teachers were first introduced in the 2002/03 cycle. However, the questions asked in previous cycles were too different to those asked in 2010/11 to analyse trend data.

Vacancies

Principals were also asked how difficult it was to fill Year 9 teaching vacancies in the two TIMSS subjects as well as any other subjects (in a general category called "other"). They were given the four response options: *no vacancies in this subject*, *easy to fill vacancies*, *somewhat difficult*, and *very difficult*.

For science, 23 percent of New Zealand students had principals that identified filling science teaching vacancies as somewhat or very difficult and 47 percent who said it was easy to fill vacancies in this subject. Internationally, these figures were 19 percent for somewhat or very difficult and 25 percent for easy. Thirty-one percent of students had principals who said there were no vacancies in science – internationally, 56 percent of students had principals who said this.

Vacancies for mathematics were more of an issue, with 43 percent of students in schools where the principal said they were somewhat or very difficult to fill.

When it came to other subjects (not further specified in the questionnaire), 35 percent of New Zealand students had principals that identified filling teaching vacancies as somewhat or very difficult.

Principals were also asked if they used any incentives to recruit or retain Year 9 teachers for science or other subjects. Suggestions for possible incentives included pay, housing, a signing bonus, and/or smaller classes. Less than ten percent of students attended schools where the principal indicated this incentivising happened for recruitment or retention of Year 9 teachers of any subject (8% for science, 9% for mathematics, and 8% for other subjects). This compares to around 20 percent of students internationally (19% for science, 20% for mathematics, and 20% for other subjects).

School and classroom size

School size

The total enrolment of the New Zealand schools that participated in TIMSS 2010/11 at the Year 9 level ranged from 36 to 2,586 students, with an average of 1128. Forty-two percent of all New Zealand Year 9 students attended mid-size schools with between 601 and 1200 students, an increase of almost 10 percentage points since 2002/03 (33%). More than a third of students attended large schools with 1201 students or more (38%), and 19 percent were in small schools with fewer than 600 students.

Table 11.16: Proportion of New Zealand Year 9 students and mean science achievement scores by size of school band in TIMSS 2010/11

School size band	Proportion of students	Mean science achievement score	
Small (600 or fewer students)	19	488	(7.0)
Small to Medium (601 to 900 students)	24	505	(8.6)
Medium to Large (901 to 1200 students)	18	515	(10.2)
Large (1201 students or more)	38	533	(9.6)
New Zealand	**100**	**512**	**(4.6)**

Note: Standard errors are presented in parentheses.

Proportions in the 'Proportion of students' column should add to 100%; inconsistencies are due to rounding.

New Zealand secondary schools have increased in size since the first cycle of TIMSS in 1994. Forty-seven percent of students taking part in TIMSS at the Year 9 level were in schools with 900 students or more in 1994, compared with 56 percent in 2010/11. The proportion of students in small schools of fewer than 600 students was less in 2010/11 than what it was in 1994 (25%).

Students in small schools had significantly lower achievement in science, on average, than those in the two largest size groups but otherwise there were not significant differences between groups in either 2010/11 or 1994/95.

Classroom size

TIMSS asked teachers about the size of their science classes, as larger or smaller classes can influence how the teacher chooses to teach science topics. The average TIMSS class size in New Zealand for science was 26 students in 2010/11, similar to the international average of 29. In the majority of countries, students were in classes with between 20 and 35 students, with the exception of Finland, which had 17 students per class on average, and Indonesia, Morocco, Singapore, Hong Kong SAR, Thailand and Ghana, which had average class sizes of between 36 and 44 students.

It is difficult to disentangle the relationship between class size and achievement. For example, in some countries smaller classes tend to be in rural areas where there are fewer resources, and larger classes in urban areas with more resources. Remedial classes may also be smaller. However, TIMSS studies repeatedly show that high performing Asian countries, such as Singapore and Hong Kong SAR, have some of the largest class sizes. On the other hand, most non-Asian top performing countries tend to have class sizes of fewer than 25 students.

Class sizes in New Zealand have not changed significantly since the first cycle of TIMSS; in 1994, the average class size was 25 for science, not significantly different to the 26 students for science in 2010/11.

Limitations to teaching

Science teachers of Year 9 TIMSS classes were asked to what extent certain factors (listed in Table 11.17) limited science teaching in their classes. Responses were given on a four-point scale; *not applicable*, *not at all*, *some*, and *a lot*. The *not applicable* category is likely to mean there are no students in the class that meet the criteria. Table 11.17 shows the proportions of students whose teachers indicated that some or all of these factors limited how they taught science to their Year 9 students. *Not applicable* and *not at all* were grouped into one category *no limitations*. In general, around three quarters of students had teachers who thought that having students in the class with a lack of prerequisite knowledge or skills put some or a lot of limitations on teaching science, followed by uninterested or disruptive students (82% and 77% respectively). The factor that seemed to be the least likely to place limitations on teaching was lack of basic nutrition (27%).

Table 11.17: Extent to which New Zealand science teachers indicated these factors limited their teaching in TIMSS 2010/11

	Proportion of Year 9 students whose teachers indicated the factors presented:		
Factors	**A lot of limitations**	**Some limitations**	**No limitations**
Lack of prerequisite knowledge or skills	19 (2.4)	55 (2.9)	27 (2.9)
Lack of basic nutrition	2 (1.0)	27 (2.8)	71 (3.0)
Not enough sleep	8 (1.7)	55 (3.8)	37 (3.8)
Special needs	3 (1.0)	36 (3.0)	61 (3.1)
Disruptive	18 (2.6)	59 (3.8)	23 (3.0)
Uninterested	14 (2.5)	68 (3.8)	18 (2.9)

Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

Quality and availability of school buildings and resources

Teachers in TIMSS 2010/11 were asked how much of a problem various issues were in their current school. These issues are listed in Table 11.18. Classrooms being overcrowded and teachers having too many teaching hours had the highest percentages of students with science teachers indicating that these were moderate to serious problems (40% and 33% respectively). The least problematic of these five issues in the opinions of the science teachers were *not having adequate instructional materials and supplies*, and *teachers not having adequate workspace*, with 46 percent and 37 percent of students respectively having science teachers who indicated these were not problems at all.

Table 11.18: How much science teachers perceived various issues were problems in their current schools in New Zealand in TIMSS 2010/11

	Proportion of Year 9 students with science teachers who indicated these issues were:		
Issues	Not a problem	Minor problem	Moderate to serious problem
The school building needs significant repair	34 (3.5)	39 (3.4)	27 (3.3)
Classrooms are overcrowded	23 (3.0)	37 (3.6)	40 (4.2)
Teachers have too many teaching hours	32 (3.8)	35 (3.9)	33 (4.1)
Teachers do not have adequate workspace	37 (3.7)	36 (3.5)	28 (3.6)
Teachers do not have adequate instructional materials and supplies	46 (3.3)	32 (3.4)	22 (2.7)

Note: Standard errors are presented in parentheses.

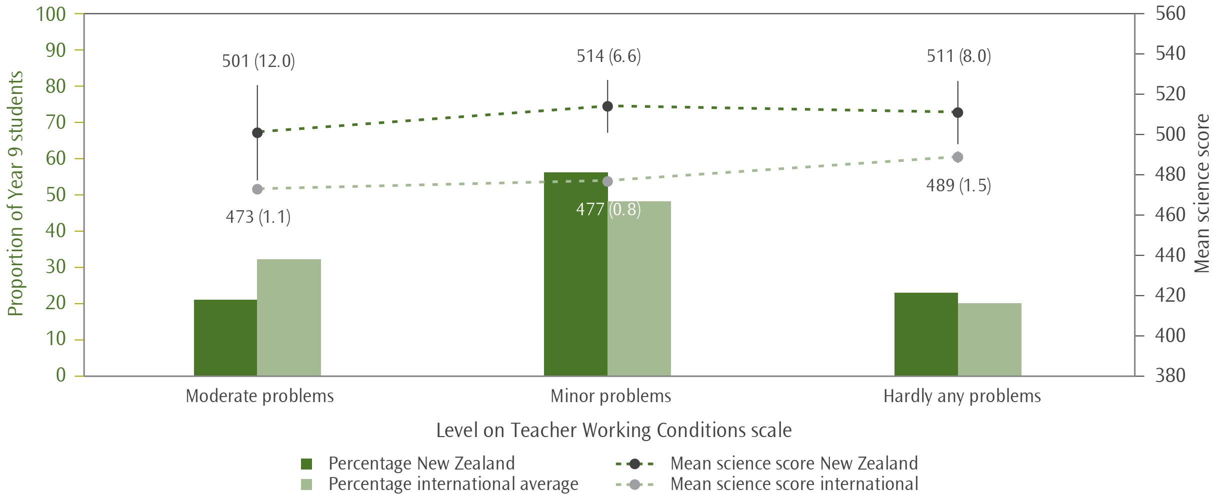
Proportions in each row should add to 100%; inconsistencies are due to rounding.

Science teachers' responses to these questions were combined into a continuous scale, the Teacher Working Conditions scale, to describe the extent to which various issues created problems for them. To report the scale in a meaningful way, values on the scale were grouped into three categories; *Moderate problems*, *Minor problems*, and *Hardly any problems*.

New Zealand science teachers were relatively positive about their working conditions compared with teachers from other countries, although not as positive as teachers from the United States (see Table B.8 in the Appendix).

In general, the international average indicates that the more positive teachers were on the scale, the higher the average achievement of their students in science (see Figure 11.8). However, New Zealand was one of a group of countries, including Japan and Australia, where there was no significant difference in science achievement across the different levels of positivity. Hungary was a particular exception to the international trend as those students whose teachers were less positive had higher average achievement in science than those with the most positive teachers did.

Figure 11.8: Levels on the Teacher Working Conditions scale by mean science achievement in TIMSS 2010/11



Note: The students who had teachers who selected at most not a problem for three out of the five statements and only minor problems for the other two, on average, were classified under the Hardly any problems category. Those classified under Moderate problems had teachers who selected at least moderate problem for three out of the five statements and minor problem for the other two, on average. All the rest were classified under Minor problems.

Source: Adapted from Exhibit 5.10, Martin, Mullis, Foy, and Stanco, 2012.

Impact of shortages of resources

Principals were asked to rate if their school's capacity to provide instruction was affected by a shortage or inadequacy of any of 13 selected resources using a four-point scale, the response options being *none*, *a little*, *some*, or *a lot*. The 13 resources are listed in Table 11.19. Of the resources listed, the one most commonly seen as having an impact on science instructional capability by New Zealand principals was a lack of computers for science instruction (70% impacted at least a little). Thirty percent of students attended schools where their principal did not see the lack of computers as a hindrance to science instruction. A lack of computer software for science instruction was the next most common resource indicated as hindering science instruction (68% impacted at least a little).

Table 11.19: How much principals perceived instructional capability was limited by lack of resources in New Zealand in TIMSS 2010/11

Resources	Proportion of Year 9 students whose principals indicated instruction was limited: A lot		Some		A little		None	
General								
Instructional materials	3	(1.9)	11	(2.7)	33	(4.8)	54	(4.7)
Supplies	4	(2.0)	8	(2.3)	15	(3.2)	74	(4.2)
School buildings and grounds	7	(2.7)	12	(3.3)	34	(4.2)	48	(4.1)
Heating/cooling and lighting systems	5	(2.4)	7	(1.7)	17	(3.4)	72	(4.2)
Instructional space	8	(2.9)	14	(3.8)	27	(4.1)	51	(3.9)
Technologically competent staff	3	(1.4)	17	(3.4)	41	(4.5)	39	(4.7)
For science instruction								
Teachers with a specialisation in science	1	(0.7)	5	(2.5)	21	(3.5)	72	(4.3)
Computers for science instruction	6	(2.4)	26	(4.2)	38	(5.4)	30	(4.8)
Computer software for science instruction	3	(1.5)	21	(3.3)	44	(4.8)	32	(3.8)
Library materials relevant to science instruction	2	(1.0)	14	(3.6)	38	(5.3)	46	(4.3)
Audio-visual resources for science instruction	2	(1.1)	13	(2.9)	39	(4.3)	47	(4.0)
Calculators for science instruction	2	(1.2)	8	(2.8)	23	(3.2)	67	(4.2)
Science equipment and materials	4	(1.7)	9	(2.8)	40	(4.5)	47	(4.4)

Note: Standard errors are presented in parentheses.

Proportions in each row should add to 100%; inconsistencies are due to rounding.

This table is based on a selection of resources from the School Questionnaire. Principals were also asked about resources for mathematics instruction.

Most of the general school resources and the resources for science instruction were also asked about in previous cycles of TIMSS. Where there were differences between the proportions in 2002/03 versus 2010/11, these had not changed by much.

Computers and software

As shown in Table 11.19, 70 percent of New Zealand Year 9 students were in schools where their principal reported that a lack of computers hindered the school's capacity to provide science instruction at least a little. A lack of computer software for science instruction was also indicated as at least a little hindrance in the schools of just over two-thirds of the students. To supplement the questions on computer resources, principals were asked specifically about the number of computers that could be used for instructional purposes (in general, not science specifically) by Year 9 students. Most New Zealand students (88%) were in schools where the number of computers available for use by Year 9 students was large enough that the ratio could be described as one computer for every one to two Year 9 student. However, it should be noted that these may well have to be shared with other year levels.

Teachers and support staff

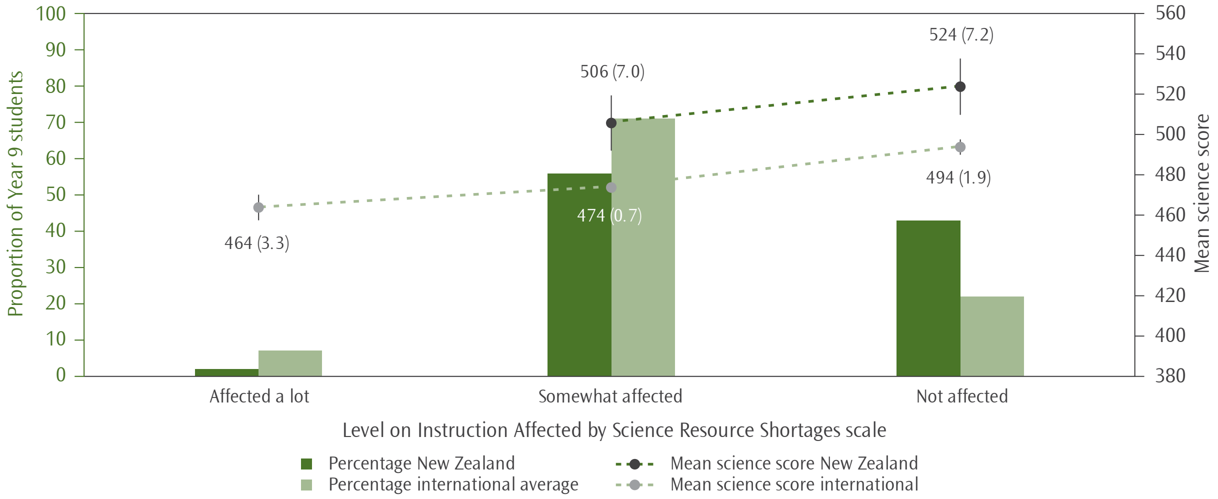
As shown in Table 11.19, a lack of specialist science teachers was indicated as at least a little hindrance to the school's capacity to provide instruction for the schools of more than a quarter of the students. Around 60 percent of students attended schools where the principal perceived that a lack of technologically competent staff hindered the school's capacity to provide instruction at least a little.

Instruction affected by resource shortages

Principals' responses about how lack of some of the resources listed in Table 11.19 affect schools' capacity to provide instruction were combined into a continuous scale, the Instruction Affected by Science Resources Shortages scale. The scale used the six general school resources and the seven science-specific resources. To report the scale in a meaningful way, values were grouped into three categories; *Not affected*, *Somewhat affected*, and *Affected a lot*.

As shown in Figure 11.9, 43 percent of New Zealand Year 9 students were at schools where the principals indicated that science resource shortages had not affected instruction. Fifty-six percent of students were in schools where science resource shortages somewhat affected instruction. Internationally, the percentage of students in schools where the principal felt that science resource shortages had no impact on instruction (22%) was quite a lot smaller than the percentage in New Zealand.

Figure 11.9: Proportions of students on the Science Instruction Affected by Resource Shortages scale by achievement in TIMSS 2010/11



Note: The proportion of students with principals who responded with at most not at all for six of the twelve resources and a little for the other six on average were categorised under Not affected. The proportions of students in schools where the principals reported that shortages in at least six out of the twelve resources affected instruction a lot and some for the other six, on average, are at schools classified as having instruction Affected a lot. All others were in the Somewhat affected category.

There were too few New Zealand students whose schools were Affected a lot by science resource shortages to report achievement.

Source: Adapted from Exhibit 5.8, Martin, Mullis, Foy, and Stanco, 2012.

The general pattern of science achievement for the scale across the three categories, as exhibited by the international average, is that the less affected the principal reported the school as being by a shortage of science resources, the higher the achievement scores. It is worth noting however that around a third of countries (New Zealand included) had such small proportions of students in the *Not at all* category that calculating a viable average was not possible and so there was not a third data point to help gauge a trend for those countries. A number of those countries that did have three data points were not significantly different across at least two of the categories and others, such as Indonesia, had a different pattern altogether as the highest achievement was in the *Affected a lot* category.

Even when broken down by decile groupings[24], size, and area (rural versus urban) at a national level, the proportion of New Zealand students with principals who reported that science instruction was affected a lot by resource shortages was so small that statistically viable analyses on the science achievement of this group are not possible. However, it is possible to say that those who did indicate that their science instruction was affected a lot by lack of resources came from lower decile, urban schools, and were a mixture of large and small schools.

Science laboratories

As mentioned in Table 11.19, principals were asked about the impact on instructional capability of a lack of science equipment and materials. Principals were also asked specifically if the school had a science laboratory that could be used by Year 9 students and if teachers had assistance available when students were conducting experiments. No definition was given in the question of what was meant by a science laboratory. All students in New Zealand attended schools with a science laboratory that could be used by Year 9 students, compared to the international average of 80 percent

On average internationally, the science achievement of students in schools where there were science laboratories available for Year 9 students was higher than those in schools without (see Table 11.20). Like all resources, having a science laboratory may not make any different to achievement unless it is used to enhance the teaching that happens outside the laboratory. Principals were also asked if teachers had assistance available when students conduct science experiments. Thirty-seven percent of New Zealand students were in schools where the principal said this was the case, versus 57 percent internationally. In New Zealand, science achievement did not significantly vary based on whether a school had this assistance available or not but internationally, schools with this assistance had students who achieved higher, on average, than students in schools that did not. The relationship between achievement and assistance for science teachers may be a bit more complex than just a question of resourcing. It may be dependent on the purpose for the assistance; whether it was to help teachers who were less confident in the laboratory or more related to having specific laboratory staff as a matter of course.

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[24] The deciles were grouped as follows: 1 and 2, 3 and 4, 5 and 6, 7 and 8, 9 and 10, and Independent schools were included as a separate classification.

Table 11.20: Proportion of students in schools with a science laboratory for selected countries in TIMSS 2010/11

	Have science laboratory in school		Do not have science laboratory in school	
Country	Proportion of students	Mean science score	Proportion of students	Mean science score
Bahrain	100 (0.0)	452 (2.0)	0 (0.0)	~ ~
England	100 (0.0)	534 (5.2)	0 (0.0)	~ ~
Japan	100 (0.0)	558 (2.4)	0 (0.0)	~ ~
Korea, Rep. of	100 (0.0)	560 (2.0)	0 (0.0)	~ ~
Singapore	100 (0.0)	590 (4.4)	0 (0.0)	~ ~
New Zealand	**100 (0.0)**	**514 (4.7)**	**0 (0.0)**	~ ~
Australia	100 (0.1)	521 (5.0)	0 (0.1)	~ ~
Hong Kong SAR	99 (0.8)	533 (3.7)	1 (0.0)	~ ~
Chinese Taipei	99 (1.0)	564 (2.3)	1 (1.0)	~ ~
Finland	91 (2.2)	552 (2.5)	9 (2.2)	555 (8.2)
United States	81 (2.0)	531 (3.0)	19 (2.0)	504 (8.5)
Slovenia	48 (3.6)	545 (4.6)	52 (3.6)	542 (3.3)
International Avg.	**80 (0.4)**	**485 (0.7)**	**20 (0.4)**	**451 (1.9)**

Note: Standard errors are presented in parentheses.

Tilde (~) indicates insufficient data to report achievement.

Source: Adapted from Exhibit 5.16, Martin, Mullis, Foy, and Stanco, 2012.

Table 11.21: Proportion of students in schools where teachers have assistance when students conduct science experiments for selected countries in TIMSS 2010/11

	Teachers have assistance available when students are conducting experiments		Teachers do not have assistance available when students are conducting experiments	
Country	Proportion of students	Mean science score	Proportion of students	Mean science score
Bahrain	93 (0.1)	452 (2.1)	7 (0.1)	465 (4.8)
England	75 (4.6)	532 (5.9)	25 (4.6)	546 (12.3)
Japan	34 (4.1)	559 (4.1)	66 (4.1)	557 (3.3)
Korea, Rep. of	63 (3.2)	562 (2.7)	37 (3.2)	557 (3.2)
Singapore	89 (0.0)	590 (4.7)	11 (0.0)	591 (13.8)
New Zealand	**37 (4.8)**	**517 (7.4)**	**63 (4.8)**	**512 (6.6)**
Australia	66 (3.6)	525 (6.4)	34 (3.6)	514 (7.1)
Hong Kong SAR	99 (1.0)	534 (3.7)	1 (1.0)	~ ~
Chinese Taipei	88 (2.7)	567 (2.5)	12 (2.7)	540 (10.2)
Finland	10 (2.9)	550 (5.2)	90 (2.9)	552 (2.6)
United States	32 (2.5)	529 (6.3)	68 (2.5)	524 (2.9)
Slovenia	76 (3.2)	546 (2.7)	24 (3.2)	537 (7.3)
International Avg.	**57 (0.5)**	**480 (1.1)**	**43 (0.5)**	**472 (1.3)**

Note: Standard errors are presented in parentheses.

Tilde (~) indicates insufficient data to report achievement.

Country order is based on the order in Table 11.20.

Source: Adapted from Exhibit 5.16, Martin, Mullis, Foy, and Stanco, 2012.

12. School Leadership

Leaders in schools, through a multitude of possible actions, have the opportunity to influence the learning that takes place there. Recent research has proposed a variety of approaches for exercising school leadership. Davies (2009) offers no less than ten different possibilities including Leithwood and Jantzi's model of *Transformational leadership*. This model identifies three categories of leadership practices: *setting directions*; *developing people*; and *redesigning the organisation*.

With a particular focus on the New Zealand context, but drawing on a range of international studies, Robinson, Hohepa and Lloyd (2009) identified five dimensions of school leadership that all have some effect on student achievement: *establishing goals and expectations*; *strategic resourcing*; *planning, coordinating and evaluating teaching and the curriculum*; *promoting and participating in teacher learning and development*; and *ensuring an orderly and supportive environment*. The fourth of these dimensions was found to have the biggest effect, and the key finding from this Best Evidence Synthesis was that "the closer educational leaders get to the core business of teaching and learning, the more likely they are to have a positive impact on students" (Robinson et al., 2009, p.47).

This chapter examines a question in TIMSS that collected estimates of the relative time principals spent on a range of activities. The components of the question were defined using research from a variety of sources in response to findings that the school leadership style has an indirect effect on student achievement (Mullis, Martin, et al. 2009). It should be noted that the responses to the question relate only to time spent by principals and so will not reflect tasks that may be taken on by other staff in some schools.

Time spent by principals on leadership activities

In TIMSS 2010/11, principals were asked how much time they had spent on a range of leadership activities in their role as a school principal, ticking either *no time, some time* or *a lot of time* for each activity. The leadership activities identified are shown in Table 12.1 and can be grouped into three broad dimensions: establishing and monitoring the attainment of educational goals; dealing with student behaviour; and developing self and teachers.

The principals of schools with Year 9 students in New Zealand were, on average, less likely than their international counterparts to report spending *a lot of time* on any of the leadership activities. Those activities where the difference was most pronounced were:

- monitoring teachers' implementation of the school's educational goals in their teaching;
- monitoring students' learning progress to ensure that the school's educational goals are reached;
- all of the activities dealing with student behaviour;
- initiating a discussion to help teachers who have problems in the classroom; and
- advising teachers who have questions or problems with their teaching.

Table 12.1: **Principals' time spent on leadership activities**

	Percentage of students whose principals spent a lot of time	
	New Zealand	International Average
Goals		
Promoting the school's educational vision or goals	57	64
Developing the school's curricular and educational goals	59	62
Monitoring teachers' implementation of the school's educational goals in their teaching	30	62
Monitoring students' learning progress to ensure that the school's educational goals are reached	42	65
Student Behaviour		
Keeping an orderly atmosphere in the school	54	75
Ensuring that there are clear rules for student behaviour	41	66
Addressing disruptive student behaviour	31	54
Development		
Creating a climate of trust among teachers	46	61
Initiating a discussion to help teachers who have problems in the classroom	17	43
Advising teachers who have questions or problems with their teaching	16	44
Visiting other schools or attending educational conferences for new ideas	16	25
Initiating educational projects or improvements	37	41
Participating in professional development activities specifically for school principals	20	40

TIMSS 2010/11 reveals some clear variations in the way principals report spending their time in different countries. For example, in Japan the average percentages for principals spending *a lot of time* on each leadership activity ranged between eight and 48 percent, while in Korea, which was similarly high-performing, the range was 56 to 89 percent. However, it is not so obvious what the source of this difference might be – does it reflect different expectations of principals or simply different perceptions of what constitutes *a lot of time*? While acknowledging this subjectivity in the data, the lower than average frequency of principal time spent on addressing student behaviour issues in New Zealand is reassuring.

Time spent on leadership activities and school characteristics

Within New Zealand, neither the socio-economic status nor the size of schools had a particular impact on the time spent by principals on particular leadership activities.

There was no significant difference in the likelihood of reporting *a lot of time* spent on most of the leadership activities when examined by decile or size of school. There were some differences evident on activities related to student behaviour and to professional development but the groups involved were either too small to draw a valid conclusion or a consistent pattern was not evident.

Time spent on leadership activities and student achievement

For two activities, there were differences observed in achievement between New Zealand students whose principals reported spending *no time* and those who reported spending *some time* or *a lot of time*. However, in each case, there were too few principals in the *no time* group to reliably compare achievement between these subgroups.

School leaders' engagement with the core educational activities of their school will take a variety of forms depending on the context. The focus of TIMSS on the amount of time spent offers some insights into the relative priority accorded to various activities by New Zealand principals. It is less useful in judging how well those choices might match the needs of each school, and hence the effectiveness of any particular leadership model.

Conclusion

This report has examined New Zealand's science achievement in relation to other countries that participated in the study. It looked at trends in New Zealand science achievement at the Year 9 level from 1994 to 2010. An examination of the TIMSS assessment questions in relation to New Zealand's science curriculum was presented followed by analyses of achievement by sub-groupings (such as gender and ethnicity) and student background factors. Comprehensive coverage of background questions about teaching and learning as well as the school context for learning was also provided. This section will recap these results and pose questions to reflect on them.

Achievement in an international context

New Zealand Year 9 students had higher science achievement than 25 participating countries, similar to six, and lower than 10 countries. There has been no significant change in the mean science achievement of Year 9 students since the first cycle of TIMSS in 1994/95.

New Zealand lower secondary students performed relatively better on Earth science questions and relatively worse on chemistry questions. The cognitive aspect of reasoning was a relative strength for Year 9 students while applying was a relative weakness.

When compared with other countries, the range of achievement within New Zealand was moderate. This is in contrast to the 15-year-old students assessed in PISA where New Zealand has one of the widest ranges of achievement. There was a relatively high proportion of very low achievers (students who did not reach the low benchmark) in this cycle of TIMSS compared with countries with similar or higher mean science achievement.

Clearly there are strengths and weaknesses reflected in these results. The advantage of this large-scale international assessment is that we can see what other countries have done to improve their systems and learn from them. The TIMSS encyclopaedia (Mullis, Martin, Minnich, et al., 2012) has articles from participating countries, giving summaries of curriculum expectations and details of changes they have made in their system since the beginning of TIMSS in 1994/95. For example, Lithuania, the country with the largest increase in science achievement at Grade 8 since the first cycle of TIMSS, has specialist teachers for science from Grade 5.

Equity in the New Zealand system

This report has raised some concerns about equity in the New Zealand education system. Year 9 boys had higher science achievement, on average, than girls. Since the previous cycle of TIMSS (2002/03) there has been a significant decrease in achievement for Year 9 girls.

There were advanced achievers and very low achievers in all ethnic groupings. However, there were proportionately more Pākehā/European and Asian advanced achievers compared with the Pasifika and Māori ethnic groupings. There were also more very low achievers among Pasifika and Māori groupings than among Pākehā/European and Asian groupings. There has been a significant decrease in mean achievement among Pasifika and Māori students since 2002/03.

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[25] SES measures included collection of proxy information from students such as the number of books at home and home possessions as well as measures of the SES of the school such as decile and principals' estimates of the level of affluence and disadvantage among the school population.

Regardless of the measure[25] used to assess socio-economic status (SES), students with lower SES had lower achievement than students with higher SES. In particular, on an international measure of the SES of the school attended, students in schools with a greater concentration of affluent students had higher achievement than students in schools with a greater concentration of disadvantaged students. On this measure, New Zealand had one of the largest differences in achievement between these two groups.

The Ministry has, as one of its highest priorities, a focus on raising achievement for priority learners (Māori learners, Pasifika learners, learners with special needs, and learners from poor socio-economic backgrounds). The findings from the latest cycle of TIMSS are consistent with those from earlier cycles and from other studies (e.g., PISA and NEMP) and show that the education system is not delivering equitable outcomes for these students. The challenges for all involved in education is how we are going to support these learners to reach their potential. For example, two things the evidence demonstrates are critical for priority learners are the importance of early learning before a child reaches school age and the quality of relationships between the school and parents and whānau.

Student attitudes

Nearly all Year 9 students planned to get some form of qualification, some with expectations at the secondary level and some at tertiary.

Year 9 students in New Zealand were generally positive about learning science. Compared to other countries, on average, fewer New Zealand Year 9 students liked science, were confident in their ability to do science, and valued science. Students who were more positive about learning science had, on average, higher achievement than those who were more negative. The self-confidence of students had a stronger relationship with science achievement than how much they liked or valued learning science.

Year 9 boys' enjoyment, confidence and valuing of learning science were all higher than those of girls in New Zealand. A greater proportion of Asian students reported liking and valuing science than any of the other ethnic groupings. Asian and Pākehā/European students were slightly more likely to report high levels of confidence in learning science than Pasifika or Māori students.

Teaching

As with previous cycles, in this cycle of TIMSS, many students were in classes working at a lower level of the curriculum than was intended. For example, most Year 9 students are expected to be working at level 5 by the end of the year. One of the issues this raises is whether or not the expectations for learners in Year 9 science are set too low and what that means for teaching and learning at the lower secondary level.

More New Zealand lower secondary teachers felt well prepared to teach topics in science and expressed high levels of confidence in their ability to teach science compared with their peers in other countries. As mentioned earlier, fewer New Zealand Year 9 students liked science, were confident in their ability to do science, and valued science.

New Zealand teachers tended to place less emphasis on science investigations than their peers in other countries. New Zealand science classrooms were less likely to have computers available for instructional use compared with other countries. New Zealand science teachers tended to use textbooks more as a supplement rather than as a basis for instruction. In contrast, teachers in other countries were more likely to use textbooks as a basis for instruction.

School climate for learning

Year 9 students generally perceived their school to be a good place to be. More than eight out of ten students agreed that they felt like they belonged at school and were safe there. A higher proportion of girls than boys were positive about school and Pasifika and Asian students were the most positive of the ethnic groupings. However, fewer New Zealand Year 9 students liked being at school compared to the average student internationally.

The proportion of New Zealand Year 9 students experiencing negative behaviours at school was similar to the average internationally. A higher proportion of boys than girls experienced these behaviours but no particular ethnic grouping experienced these negative behaviours more than would be expected based on their proportion of the population.

Teachers and principals were generally very positive about their school climate for learning, including having a safe environment, knowledgeable staff, supportive parents, and well-behaved students. However, principals tended to be slightly less positive about the teaching staff (more likely to say *high* than *very high*) and more positive about parental support (more likely to say *very high* than *high*) than the teachers.

Science teachers of Year 9 students indicated that there were several factors that presented at least some limitations to their teaching, particularly having disruptive or uninterested students. More than half of the TIMSS Year 9 students had teachers who perceived various issues were at least a minor problem in their current school, particularly teachers having too many teaching hours or overcrowded classrooms. New Zealand teachers were relatively positive about their working conditions compared to most other TIMSS countries.

A lack of computers and computer software for science instruction were the resources most commonly seen by principals as having an impact on instruction.

School leadership

Principals of New Zealand schools with Year 9 students in them were, on average, less likely than their international counterparts to report spending a lot of time on any leadership activity. Previous cycles of TIMSS have shown that New Zealand principals spend more of their time on administrative tasks than nearly all other countries.

Final comment

Although Year 9 science is not as concerning as Year 5 science in terms of comparisons with other cycles or other countries, New Zealand Year 5 students will soon be in Year 9. The lower confidence, enjoyment, and valuing of science among Year 9 students compared to other countries may have implications further down the track for recruitment of a workforce capable in the STEM subjects.

Vannier (2012) in his review of science education in New Zealand, recommended that as a country we agree that science education is important and requires attention. In particular, he recommended to the Ministry of Education that it:

- provides schools with consistent, tailored support for science,
- enables collaboration and strong leadership within schools, and
- includes science in formulating current polices on teacher preparation.

As well as providing us with a snapshot of student achievement in science at middle primary and lower secondary schooling, TIMSS also provides us with valuable information about how the New Zealand education system changes – or does not – over time and in an international context. This allows education stakeholders at all levels of the education system to reflect on the different aspects examined in TIMSS as part of a review of their policies and practices.

Appendices

Sampling Notes for Figure 1.1.

1. National Target Population does not include all of the International Target Population.
2. National Defined Population covers 90% to 95% of National Target Population.
3. National Defined population covers less than 90% of National Target population (but at least 77%)

° Did not satisfy guidelines for sample participation rates.

‡ Nearly satisfied guidelines for sample participation rates after replacement schools were included.

ψ Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%.

Results of multiple classifications of ethnicity

Students were asked to identify their ethnicity using 12 categories, the 12th one being 'Other' group. In order to have groupings large enough to make reasonable predictions among the population, these twelve categories were summarised into five broad ethnic groupings, Pākehā/European, Māori, Pasifika, Asian, and 'Other'. Students were able to select more than one ethnic group so students categorised here as Pākehā/European may also be in one of the other four ethnic groupings. As a result of these overlapping groupings, achievement cannot be compared across ethnic groupings or against an overall New Zealand average.

Table A.1: New Zealand Year 9 science achievement for overlapping ethnic groupings (multiple classification of ethnicity)

Overlapping ethnic grouping – student ticked the listed group and may also have ticked another group	Mean science score	
Student ticked Pākehā/European or Other European	529	(4.2)
Student ticked Māori	473	(4.9)
Student ticked at least one of the Pacific Islands groups	453	(6.9)
Student ticked at least one of the Asian groups	529	(6.7)
Student ticked 'Other' ethnic group	512	(10.9)

Note: Standard errors are presented in parentheses.

International comparisons for school climate

Table B.1: Proportion of students at each level of the School Emphasis on Academic Success (teachers' reports) scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the School Emphasis on Academic Success (teachers' reports) scale					
	Medium emphasis		High emphasis		Very high emphasis	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
England	24 (3.2)	514 (12.0)	60 (3.6)	533 (5.9)	16 (2.5)	554 (14.5)
United States	36 (2.1)	503 (4.5)	54 (2.5)	536 (3.3)	10 (1.6)	563 (10.2)
Australia	39 (3.6)	501 (6.9)	51 (3.5)	535 (8.7)	10 (2.2)	570 (11.1)
Chinese Taipei	26 (3.4)	551 (5.2)	66 (3.7)	567 (3.2)	8 (2.2)	582 (9.3)
New Zealand	**30 (3.4)**	**494 (7.1)**	**62 (3.8)**	**518 (6.1)**	**8 (2.2)**	**518 (10.8)**
Korea, Rep of	39 (3.9)	554 (3.3)	56 (4.2)	564 (2.7)	5 (1.7)	569 (6.0)
Hong Kong SAR	46 (4.5)	514 (6.7)	50 (4.5)	553 (5.2)	4 (1.9)	559 (21.3)
Japan	54 (4.1)	547 (2.9)	43 (4.2)	569 (3.3)	3 (1.5)	584 (23.1)
Singapore	43 (2.2)	554 (7.6)	54 (2.3)	616 (5.9)	3 (0.9)	624 (37.9)
Finland	46 (2.6)	546 (3.0)	52 (2.6)	557 (3.0)	2 (0.6)	~ ~
International Avg.	**46 (0.5)**	**463 (0.9)**	**50 (0.5)**	**487 (0.8)**	**5 (0.2)**	**504 (3.2)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Very high emphasis category.

Source: Adapted from Exhibit 6.4, Martin, Mullis, Foy, and Stanco, 2012.

Table B.2: Proportion of students at each level of the Teachers Career Satisfaction scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the Teachers Career Satisfaction scale					
	Less than satisfied		Somewhat satisfied		Satisfied	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
New Zealand	**11 (2.9)**	**511 (14.0)**	**48 (4.3)**	**509 (6.7)**	**41 (3.7)**	**514 (7.7)**
United States	10 (1.4)	500 (8.3)	51 (2.9)	527 (4.5)	40 (2.6)	533 (4.9)
England	15 (2.4)	542 (8.4)	46 (3.1)	533 (6.7)	39 (2.8)	526 (8.6)
Australia	10 (2.3)	522 (13.5)	52 (4.3)	526 (6.1)	38 (3.9)	525 (7.8)
Hong Kong SAR	9 (2.7)	508 (23.5)	53 (4.3)	534 (4.9)	38 (4.4)	542 (6.9)
Chinese Taipei	5 (1.8)	555 (9.4)	62 (3.8)	564 (3.2)	32 (3.6)	565 (4.7)
Singapore	13 (1.8)	576 (11.5)	59 (2.7)	592 (5.4)	28 (2.3)	592 (8.6)
Japan	13 (2.9)	557 (4.9)	65 (4.1)	557 (3.3)	22 (3.4)	559 (5.0)
Korea, Rep of	24 (3.6)	558 (4.2)	63 (3.6)	559 (2.3)	13 (2.0)	567 (5.2)
International Avg.	**8 (0.3)**	**473 (2.3)**	**45 (0.5)**	**474 (0.8)**	**47 (0.5)**	**481 (0.8)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Satisfied category.

A tilde (~) indicates insufficient data to report achievement.

Source: Adapted from Exhibit 7.16, Martin, Mullis, Foy, and Stanco, 2012.

Table B.3: Proportion of students at each level of the School Emphasis on Academic Success (principals' reports) scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the School Emphasis on Academic Success (principals' reports) scale					
	Medium emphasis		High emphasis		Very high emphasis	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
England	19 (3.4)	506 (14.1)	56 (4.7)	534 (7.7)	26 (3.5)	553 (11.3)
Australia	32 (3.1)	495 (8.0)	48 (3.8)	522 (5.6)	20 (2.7)	567 (12.6)
New Zealand	**20 (3.3)**	**496 (7.0)**	**61 (4.9)**	**509 (6.8)**	**19 (3.8)**	**546 (5.1)**
Korea, Rep of	28 (3.6)	550 (2.8)	56 (4.3)	560 (2.7)	16 (3.2)	577 (5.4)
United States	24 (2.1)	500 (5.6)	61 (2.7)	531 (3.8)	15 (2.0)	546 (7.4)
Chinese Taipei	7 (1.7)	543 (7.2)	81 (3.3)	560 (2.9)	12 (2.8)	598 (10.8)
Singapore	29 (0.0)	560 (9.0)	60 (0.0)	594 (4.8)	11 (0.0)	638 (13.7)
Indonesia	32 (4.4)	398 (6.1)	60 (4.8)	407 (6.8)	8 (2.2)	430 (17.7)
Hong Kong SAR	47 (4.3)	512 (6.6)	51 (4.1)	552 (5.1)	3 (1.6)	590 (31.2)
Palestinian National Authority	46 (4.2)	418 (6.3)	52 (4.1)	423 (5.1)	3 (1.4)	410 (9.7)
Japan	47 (4.3)	548 (3.2)	52 (4.4)	566 (3.3)	2 (1.1)	~ ~
International Avg.	**41 (0.5)**	**460 (1.0)**	**53 (0.6)**	**486 (0.9)**	**7 (0.3)**	**504 (2.8)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Very high emphasis category.

Source: Adapted from Exhibit 6.2, Martin, Mullis, Foy, and Stanco, 2012.

Table B.4: Proportion of students at each level of the Students Bullied at School scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the Students Bullied at School scale					
	About weekly		About monthly		Almost never	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
England	7 (0.6)	515 (10.9)	24 (0.7)	537 (5.5)	68 (1.1)	535 (5.1)
Chinese Taipei	7 (0.4)	547 (4.8)	26 (0.8)	567 (3.1)	67 (1.0)	565 (2.7)
Korea, Rep of	7 (0.5)	555 (4.5)	28 (0.9)	564 (2.8)	65 (1.1)	559 (2.2)
Japan	9 (0.6)	559 (5.2)	28 (0.8)	563 (3.3)	63 (1.2)	555 (2.7)
United States	9 (0.3)	518 (3.1)	28 (0.6)	526 (3.6)	63 (0.7)	527 (2.7)
Australia	11 (0.7)	502 (6.7)	31 (1.0)	521 (5.1)	58 (1.1)	523 (5.0)
New Zealand	**12 (0.5)**	**501 (6.0)**	**33 (0.7)**	**515 (5.5)**	**55 (0.9)**	**517 (4.5)**
Hong Kong SAR	10 (0.7)	531 (8.6)	36 (1.0)	536 (3.2)	54 (1.3)	536 (3.6)
Singapore	12 (0.5)	566 (6.4)	36 (0.6)	590 (4.6)	52 (0.8)	596 (4.6)
Thailand	27 (0.8)	449 (4.3)	43 (0.7)	454 (4.4)	30 (0.8)	451 (4.4)
International Avg	**12 (0.1)**	**452 (1.1)**	**29 (0.1)**	**478 (0.7)**	**59 (0.2)**	**483 (0.6)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Almost never category.

Source: Adapted from Exhibit 6.12, Martin, Mullis, Foy, and Stanco, 2012.

Table B.5: Proportion of students at each level of the Safe and Orderly School scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the Safe and Orderly School scale					
	Not safe and orderly		Somewhat safe and orderly		Safe and orderly	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
Singapore	5 (0.9)	558 (21.0)	35 (2.8)	572 (8.2)	61 (2.8)	603 (5.7)
Australia	9 (2.8)	488 (13.8)	38 (3.2)	510 (7.1)	53 (3.8)	542 (8.4)
New Zealand	**6 (1.8)**	**498 (11.7)**	**42 (4.0)**	**491 (9.1)**	**53 (3.7)**	**528 (4.5)**
United States	7 (1.3)	493 (8.8)	44 (2.1)	511 (4.1)	49 (2.1)	545 (4.2)
Hong Kong SAR	2 (0.7)	~ ~	48 (4.2)	524 (6.2)	49 (4.1)	550 (6.1)
England	8 (1.6)	516 (15.1)	46 (3.0)	522 (7.1)	46 (3.0)	544 (7.3)
Turkey	12 (2.1)	440 (8.6)	50 (3.4)	479 (4.6)	38 (3.3)	501 (7.6)
Chile	18 (3.7)	428 (6.1)	52 (4.1)	456 (4.0)	30 (3.0)	490 (4.8)
Chinese Taipei	8 (2.2)	548 (8.6)	68 (3.8)	559 (3.2)	25 (3.0)	581 (6.2)
Tunisia	18 (3.3)	435 (6.6)	59 (4.1)	437 (3.1)	22 (3.3)	447 (7.2)
Slovenia	8 (1.3)	540 (5.0)	72 (2.1)	542 (2.9)	20 (1.9)	546 (3.6)
Korea, Rep of	11 (2.6)	565 (6.3)	75 (3.4)	558 (2.2)	13 (2.6)	568 (5.4)
Japan	17 (3.1)	548 (4.6)	73 (3.4)	557 (3.0)	10 (2.4)	583 (7.4)
International Avg.	**6 (0.3)**	**457 (2.3)**	**50 (0.5)**	**470 (0.8)**	**45 (0.5)**	**488 (0.9)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Safe and orderly category.

Source: Adapted from Exhibit 6.8, Martin, Mullis, Foy, and Stanco, 2012.

Table B.6: Proportion of students at each level of the School Discipline and Safety scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the School Discipline and Safety scale					
	Moderate problems		Minor problems		Hardly any problems	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
Kazakhstan	0 (0.0)	~ ~	56 (4.1)	495 (5.6)	44 (4.1)	484 (7.4)
Chinese Taipei	1 (0.8)	~ ~	58 (4.3)	564 (3.4)	41 (4.2)	564 (4.7)
Hong Kong SAR	1 (1.0)	~ ~	73 (4.5)	525 (5.3)	26 (4.3)	567 (4.6)
Singapore	1 (0.0)	~ ~	74 (0.0)	576 (5.0)	25 (0.0)	630 (7.9)
Japan	21 (3.5)	541 (3.9)	56 (4.8)	557 (3.1)	23 (3.9)	575 (5.9)
Korea, Rep of	17 (3.3)	551 (4.7)	61 (4.4)	560 (2.4)	22 (3.4)	566 (3.0)
England	5 (2.3)	484 (42.6)	76 (4.3)	534 (6.8)	19 (3.9)	548 (12.2)
United States	9 (1.3)	488 (10.9)	78 (2.1)	527 (3.3)	13 (1.9)	543 (7.6)
Australia	11 (1.9)	504 (12.2)	76 (3.0)	515 (4.6)	13 (2.3)	576 (16.8)
New Zealand	**9 (2.5)**	**492 (16.4)**	**85 (2.9)**	**513 (5.0)**	**6 (1.5)**	**554 (10.5)**
International Avg.	**18 (0.4)**	**452 (2.0)**	**66 (0.5)**	**477 (0.7)**	**16 (0.4)**	**492 (1.7)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Hardly any problems category.

Source: Adapted from Exhibit 6.10, Martin, Mullis, Foy, and Stanco, 2012.

Table B.7: Proportion of students at each level of the Collaborate to Improve Teaching scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the Collaborate to Improve Teaching scale					
	Somewhat collaborative		Collaborative		Very collaborative	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
Qatar	6 (1.2)	433 (14.7)	40 (4.4)	439 (11.2)	53 (4.2)	401 (8.3)
Oman	6 (1.7)	417 (14.1)	48 (3.1)	412 (5.4)	46 (3.2)	429 (5.3)
United States	16 (1.9)	516 (9.1)	47 (2.2)	529 (4.8)	38 (2.4)	528 (4.3)
Australia	11 (2.2)	518 (13.8)	52 (3.4)	530 (6.8)	37 (3.6)	520 (7.1)
Lebanon	6 (1.3)	381 (15.4)	60 (3.5)	402 (6.4)	34 (3.3)	417 (7.9)
New Zealand	**12 (2.7)**	**486 (10.9)**	**58 (3.9)**	**512 (6.4)**	**30 (2.8)**	**518 (8.4)**
England	16 (2.6)	535 (8.2)	57 (3.0)	536 (5.7)	27 (3.4)	521 (12.6)
Singapore	11 (1.8)	573 (11.8)	66 (2.7)	595 (5.6)	22 (2.3)	585 (10.8)
Hungary	15 (1.8)	531 (5.4)	65 (2.4)	526 (3.2)	20 (2.3)	506 (6.9)
Korea, Rep of	16 (2.9)	559 (4.3)	66 (3.7)	559 (2.3)	18 (2.7)	566 (5.0)
Japan	22 (3.2)	558 (5.6)	61 (4.0)	558 (3.1)	17 (3.3)	557 (6.8)
Chinese Taipei	28 (4.0)	563 (4.7)	58 (4.3)	563 (3.8)	15 (3.1)	568 (8.9)
Hong Kong SAR	14 (2.8)	536 (10.7)	73 (4.4)	537 (4.9)	13 (3.3)	520 (10.8)
International Avg.	**13 (0.4)**	**472 (2.1)**	**58 (0.5)**	**479 (0.8)**	**29 (0.5)**	**476 (1.1)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Very collaborative category.

Source: Adapted from Exhibit 8.13, Martin, Mullis, Foy, and Stanco, 2012.

Table B.8: Proportion of students at each level of the Teacher Working Conditions scale and science achievement in TIMSS 2010/11

	Proportion of students in each level of the Teacher Working Conditions scale					
	Moderate problems		Minor problems		Hardly any problems	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
United States	12 (1.5)	508 (8.1)	48 (2.5)	522 (3.8)	40 (2.6)	538 (5.8)
Hungary	22 (2.3)	531 (5.2)	49 (2.5)	526 (4.1)	29 (2.5)	510 (4.2)
Singapore	16 (1.8)	579 (10.0)	56 (2.6)	591 (6.2)	28 (2.5)	595 (8.9)
Australia	18 (2.7)	533 (9.9)	54 (3.0)	522 (6.0)	27 (3.4)	527 (10.0)
England	28 (3.3)	529 (9.9)	48 (3.5)	531 (7.3)	23 (3.0)	536 (9.5)
New Zealand	**21 (3.5)**	**501 (12.0)**	**56 (4.1)**	**514 (6.6)**	**23 (3.3)**	**511 (8.0)**
Japan	40 (4.2)	552 (3.6)	42 (4.5)	559 (3.7)	18 (3.2)	567 (7.9)
Chinese Taipei	21 (3.2)	569 (6.1)	61 (4.2)	563 (3.4)	17 (3.0)	561 (7.5)
Hong Kong SAR	25 (4.1)	541 (9.7)	58 (4.1)	532 (4.5)	16 (3.6)	541 (12.5)
Korea, Rep of	53 (3.8)	561 (2.7)	40 (3.7)	557 (3.0)	7 (2.0)	569 (6.2)
International Avg.	**32 (0.5)**	**473 (1.1)**	**48 (0.5)**	**477 (0.8)**	**20 (0.4)**	**489 (1.5)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Hardly any problems category.

Source: Adapted from 5.10, Martin, Mullis, Foy, and Stanco, 2012.

Table B.9: Proportion of students at each level of the Instruction Affected by Science Resource Shortages scale in TIMSS 2010/11

	Proportion of students in each level of the Instruction Affected by Science Resource Shortages scale					
	Affected a lot		Somewhat affected		Not affected	
Country	% of students	Mean science score	% of students	Mean science score	% of students	Mean science score
Singapore	8 (0.0)	604 (14.5)	28 (0.0)	578 (7.6)	64 (0.0)	593 (5.2)
Korea, Rep. of	2 (1.1)	~ ~	42 (4.2)	556 (3.0)	57 (4.1)	563 (2.7)
England	0 (0.0)	~ ~	53 (4.0)	542 (7.3)	47 (4.0)	525 (7.8)
Australia	3 (1.5)	523 (31.0)	52 (2.9)	514 (5.8)	45 (3.0)	531 (8.0)
New Zealand	**2 (1.3)**	**~ ~**	**56 (3.6)**	**506 (7.0)**	**43 (3.8)**	**524 (7.2)**
Hong Kong SAR	7 (2.5)	511 (23.0)	55 (4.8)	529 (5.3)	39 (4.2)	545 (7.9)
United States	3 (0.9)	543 (12.6)	59 (2.6)	517 (3.8)	39 (2.5)	538 (4.6)
Japan	1 (0.0)	~ ~	69 (4.3)	552 (2.6)	31 (4.3)	571 (4.8)
Chinese Taipei	2 (1.1)	~ ~	68 (4.1)	561 (2.8)	31 (4.0)	570 (6.3)
International Avg.	**7 (0.3)**	**464 (3.3)**	**71 (0.5)**	**474 (0.7)**	**22 (0.4)**	**494 (1.9)**

Note: Standard errors are presented in parentheses.

The order of this table is based on percentage of students in the Not affected category.

A tilde (~) indicates insufficient data to report achievement.

Source: Adapted from Exhibit 5.8, Martin, Mullis, Foy, and Stanco, 2012.

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Definitions and technical notes

This section gives a brief overview of the technical details and definitions applicable to this report. For a comprehensive description of the technical details pertaining to TIMSS see Methods and Procedures in TIMSS and PIRLS 2011 (Martin & Mullis, (Eds.), 2011).

Benchmarks

To describe more fully what achievement on the science scale means, the TIMSS international researchers have developed benchmarks. These benchmarks link student performance on the TIMSS science scale to performance on science questions and describe what students can typically do at set points on the science achievement scale. The international science benchmarks are four points on the science scale, the advanced benchmark (625), the high benchmark (550), the intermediate benchmark (475), and the low benchmark (400). The performance of students reaching each benchmark is described in relation to the types of questions they answered correctly.

Exclusions

Each country was permitted to exclude some students for whom the assessment was not appropriate or was difficult to administer. Countries were required to keep the amount of excluded students as small as possible, with a guideline of five percent of the 'target' population as the maximum. Any countries that exceeded this value are indicated in the international exhibits. The target population in New Zealand was Year 9 students.

School-level exclusions in New Zealand consisted of very small schools (fewer than four Year 5 students; fewer than seven Year 9 students), special education schools, the Closed Brethren School, the Correspondence School, and schools that provide more than 50% of their instruction in te reo Māori. Within-school exclusions consisted of special education classes, special needs students, students with insufficient instruction in English, and units within schools that provide more than 50% of their instruction in te reo Māori.

The New Zealand exclusion rate was 4.93% for Year 5 and 3.23% for Year 9.

Mean, medians, and averages

There are three measures of central tendency, but only the mean and the median are used in this report.

The mean of a set of scores is the sum of the scores divided by the number of scores, and is also sometimes referred to as 'the average', particularly in the international reports. Note that for TIMSS, as with other large-scale studies, the means for a country are adjusted slightly (in technical terms 'weighted') to reflect the total population of Year 9 rather than just the sample.

A median is the middle number when all numbers are put in order.

TIMSS scale centre point

To make comparisons, student achievement scores generated in each cycle are placed on the same scale. The scale was established during the second cycle of TIMSS to have a mean of 500 and a standard deviation of 100 based on the mean of country means from 1994. Equating is possible because a proportion of questions are the same in each assessment as the two previous cycles. A score of 500 in 2010/11 is the same as a score of 500 in all previous cycles.

In earlier cycles of TIMSS, an international mean was reported. However as the number of countries participating changed, this mean shifted so that it was difficult to make comparisons across years. In TIMSS 2010/11, only the TIMSS scale centre point of 500 is reported. This is the same as the TIMSS scale average reported in TIMSS 2006/07 but renamed to avoid confusion with a calculated mean of country means.

Minimum group size for reporting achievement data

In this report, student achievement data is not reported where the group size is fewer than 50 students or fewer than 10 schools.

Percentile

The percentages of students performing below or above particular points on the scale can be used to describe the range of achievement. The lowest outer limit of achievement reported in ranges is the 5th percentile – the score at which only five percent of students achieved a lower score and 95 percent of students achieved a higher score. The highest outer limit is the 95th percentile – the score at which only five percent of students achieved a higher score and 95 percent of students a lower score. Therefore 90 percent of the Year 9 student scores lie between the 5th and 95th percentiles.

Sampling

Schools were sampled for PIRLS and TIMSS together so that each was a unique sample. This was done to minimise the burden on individual schools. They were sampled from pre-defined groups. These pre-defined groups, or explicit strata, were based on size of school (small, small Year 5 and large Year 9, and large), language of instruction (Māori-medium schools were explicitly sampled for PIRLS and not for TIMSS), and year levels contained in the school. To improve the precision of sampling, the schools were ordered by decile, level of urbanisation, and for Year 9 only, school gender. This methodology meant that the schools selected better represented the population of schools in New Zealand. Within each school, classes were sampled with equal probability and all Year 9 students within each class were selected.

Scale score points

The design of TIMSS allows for a large number of questions to be used in mathematics and science; each student answers only a portion of these questions. TIMSS employs techniques to enable population estimates of achievement to be produced for each country even though a sample of students responded to differing selections of questions. These techniques result in scaled scores that are on a scale with a mean of 500 and a standard deviation of 100.

Created scales for contextual variables

A new feature of this cycle of TIMSS was that the international researchers used a different methodology to summarise responses to contextual questions given by students, teachers and principals. In previous cycles, responses to a series of contextual questions were given a number and summed. In this cycle, item response theory was applied to the responses so that clustering was taken into account. For example if nearly every student gave a highly positive response to one item then it did not overly contribute to the sum. Each respondent was then given a score which was put on a scale. Cut points on that scale were defined and descriptions provided that detailed the kind of responses given in the original questions.

Significance tests

In this report, all the comparisons that have been made are tested for statistical significance using the *t* statistic, with the probability of making an incorrect inference set at five percent. To compare the means of two groups of students, the formula to generate the test statistics computed in this report is:

1)
$$t = \frac{\bar{X}_1 - \bar{X}_2}{se_{diff}}$$

The calculation of se_{diff}, the standard error of the difference, varies depending on whether the groups were sampled independently or not. If the means for two groups that were sampled independently are being compared, for example, boys' achievement in 1994 and 2006, then the standard error of the difference is calculated as the square root of the sum of the squared standard errors of each mean:

2)
$$se_{diff} = \sqrt{se_1^2 + se_2^2}$$

For most of the comparisons, this formula was not applicable and so the se_{diff} is computed more accurately by combining variances using custom-written SAS programs. However as a rough estimate, the above formula will give a similar result.

Note that in all calculations, unrounded figures are used in these tests, which may account for some results appearing to be inconsistent.

When you are trying to compare a mean (say of New Zealand) to a mean it contributes to (say the international mean) then you cannot use the simple formula (2) for the standard error of the difference. Instead we use the following formula:

3)
$$\frac{\sqrt{\left(\sum_{i=1}^{n}(se_i^2) + n(n-2)se_k^2\right)}}{n}$$

where the se_i are the standard errors of all the contributing means (e.g., all countries) and se_k is the standard error of the mean that is being compared (e.g., NZ) and n is the number of means overall (e.g., number of countries).

Standard error

Because of the technical nature of TIMSS, the calculation of statistics such as means and proportions has some uncertainty due to (i) generalising from the sample to the total Year 9 school population, and (ii) inferring each student's proficiency from their performance on a subset of questions. The standard errors provide a measure of this uncertainty. In general, we can be 95 percent confident that the true population value lies within an interval of 1.96 standard errors either side of the given statistic. This confidence interval is represented in graphs by the lines extending in either direction from the points.

Statistically significant

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

Weighting

Due to the use of sampling, weights need to be applied when analysing the TIMSS data. Weighting ensures that any information presented more closely reflects the total population of Year 9 students rather than just the sample. The TIMSS weighting takes into account school, class, and student level information and the overall sampling weight is a product of the school, class, and student weights.

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