CHAPTER 2: New Zealand Year 9 Student Achievement in an International Context

KEY POINTS

Mathematics

- The mean mathematics score for New Zealand Year 9 students was about the same as the international mean for the 38 countries participating in TIMSS-98/99.
- The New Zealand mean was similar to the means for England and the United States, but significantly lower than the means for Australia and Canada.
- New Zealand, along with several other countries, recorded a decrease in mean mathematics achievement from 1994/95 to 1998/99. However, only the decrease observed in the Czech Republic was found to be of statistical significance.
- New Zealand's relative performance in mathematics essentially did not change from primary to lower secondary over the four years, compared to the 16 other countries that participated at these two educational levels in 1994/95 and 1998/99.
- The proportions of New Zealand Year 9 students reaching the international *Top 10%* benchmark did not change over the four years. Slightly larger proportions of students achieved below the international *Median* and *Lower Quarter* benchmarks for mathematics in 1998/99 than in 1994/95.

Science

- On average, New Zealand Year 9 students achieved significantly above the international mean for science for the 38 countries participating in TIMSS-98/99.
- The mean for New Zealand Year 9 students was similar to the means for their counterparts in Malaysia and the United States, but significantly lower than the means for students in Australia, Canada, and England.
- New Zealand was one of five countries where there was virtually no change in mean science achievement from 1994/95 to 1998/99. Bulgaria was the only country to observe a statistically significant decrease in mean science achievement.
- New Zealand's relative performance in science decreased slightly from middle primary to lower secondary over the four years, compared to 16 other countries that participated at these two educational levels in 1994/95 and 1998/99.

INTRODUCTION

This chapter presents the major mathematics and science achievement results for New Zealand Year 9 students in an international context. Thirty-eight countries (or education systems) participated in TIMSS-98/99 — 26 of these countries also took part in TIMSS-94/95 at the lower secondary level (or, in some cases, middle school)[1]. The performance of New Zealand Year 9 students in mathematics and in science is compared to that of students from the other 37 countries that took part in TIMSS-98/99. In addition, New Zealand student performance is considered alongside that of students in the other 25 countries that took part in TIMSS-94/95. The summary presented here is drawn entirely from material presented in the two international reports: Mullis et al (2000) and Martin et al (2000). In some instances minor adaptations have been made and these have been acknowledged where they occur.

MATHEMATICS

Student achievement in 1998/99

Figure 2.1 presents the mean mathematics scale scores for all countries that participated in TIMSS-98/99 relative to the mean score for New Zealand Year 9 students[2]. As shown in Figure 2.1, there was considerable variation in mean achievement for students across the 38 countries participating in TIMSS-98/99. On average, the highest performing students were in Singapore, Korea, and Chinese Taipei while, on average, the lowest performing students were in the Philippines, Morocco, and South Africa. The New Zealand mean — 491 — was not significantly different from the international country mean of 487, and in terms of rankings, New Zealand students performed around the middle for the 38 countries[3]. The figure also shows that, in general, there was very little difference in the mean mathematics scores for countries 'ranked' immediately above or below any given country under scrutiny.

For comparative purposes, countries from the Asia-Pacific region, as well as countries with which New Zealand has traditional links (eg, English-speaking or where education systems are similar), have been grouped in Table 2.1 according to how their students' mean achievement in mathematics compare to the mean for New Zealand's Year 9 students.

TABLE 2.1: NEW ZEALAND YEAR 9 STUDENTS' MATHEMATICS ACHIEVEMENT RELATIVE TO STUDENTS IN SELECTED COUNTRIES

Countries with mean student achievement in mathematics **statistically significantly higher** than New Zealand	Countries with mean student achievement in mathematics **about the same** as New Zealand (ie, no statistically significant difference)	Countries with mean student achievement in mathematics **statistically significantly lower** than New Zealand
Singapore Korea, Republic of Chinese Taipei Hong Kong, SAR Japan Canada Australia Malaysia	United States England	Thailand Indonesia Chile Philippines South Africa

[1] *TIMSS-94/95 was administered in Southern Hemisphere countries, including New Zealand, in late 1994 and in Northern Hemisphere countries in early 1995. TIMSS-98/99 was administered in Southern Hemisphere countries, including New Zealand, in late 1998 and in Northern Hemisphere countries in early 1999.*

[2] *Using the New Zealand class nomenclature, Year 9 students are located at the lower secondary level in form 3. The class is equivalent to the international 'grade 8'.*

[3] *The comparison of means have been adjusted for multiple comparisons based on the Dunn-Bonferroni procedure for multiple a priori comparisons. See TN.5 in Technical Notes.*

FIGURE 2.1: MEAN MATHEMATICS ACHIEVEMENT FOR NEW ZEALAND YEAR 9 STUDENTS IN TIMSS-98/99 RELATIVE TO THEIR INTERNATIONAL (GRADE 8) COUNTERPARTS

Year 9 equivalent		
All TIMSS-98/99 countries		Mean scale score (se)
Singapore	▲	604 (6.3)
Korea, Rep. of	▲	587 (2.0)
Chinese Taipei	▲	585 (4.0)
Hong Kong, SAR*	▲	582 (4.3)
Japan	▲	579 (1.7)
Belgium (Flemish)*	▲	558 (3.3)
Netherlands*	▲	540 (7.1)
Slovak Republic	▲	534 (4.0)
Hungary	▲	532 (3.7)
Canada	▲	531 (2.5)
Slovenia	▲	530 (2.8)
Russian Fed.	▲	526 (5.9)
Australia	▲	525 (4.8)
Finland	▲	520 (2.7)
Czech Republic	▲	520 (4.2)
Malaysia	▲	519 (4.4)
Bulgaria	●	511 (5.8)
Latvia (LSS)^	●	505 (3.4)
United States	●	502 (4.0)
England*	●	496 (4.1)
New Zealand		**491 (5.2)**
Lithuania^~	●	482 (4.3)
Italy	●	479 (3.8)
Cyprus	●	476 (1.8)
Romania	●	472 (5.8)
Moldova	▼	469 (3.9)
Thailand	▼	467 (5.1)
Israel	▼	466 (3.9)
Tunisia	▼	448 (2.4)
Macedonia, Rep. of	▼	447 (4.2)
Turkey	▼	429 (4.3)
Jordan	▼	428 (3.6)
Iran, Islamic Rep.	▼	422 (3.4)
Indonesia	▼	403 (4.9)
Chile	▼	392 (4.4)
Philippines	▼	345 (6.0)
Morocco	▼	337 (2.6)
South Africa	▼	275 (6.8)

→ **International country mean = 487 (0.7)**

▲ country mean is statistically significantly higher than NZ mean

● country mean not statistically significantly different from NZ mean

▼ country mean is statistically significantly lower than NZ mean

Significance tests adjusted for multiple comparisons

*Meet guidelines for sample participation rates only after replacement schools were included.

^National Desired Population does not cover all of International Desired Population.

~ Lithuania tested in 1999 but later than other Northern Hemisphere countries.

**National Defined Population covered less than 90 percent of National Desired Population.

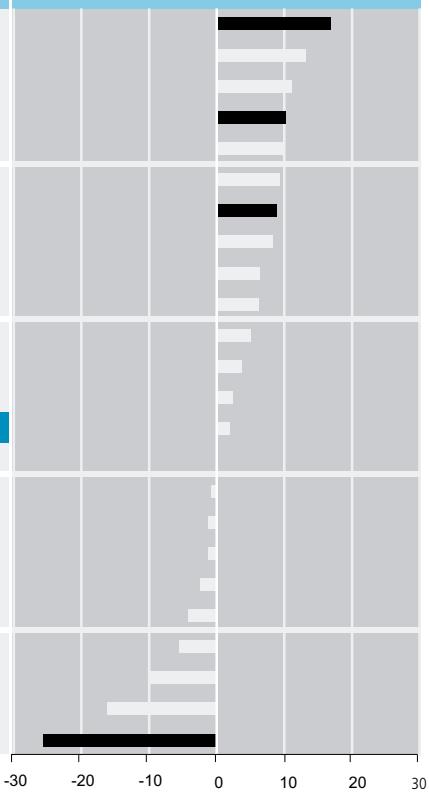
Note: (se) Standard errors are reported in parentheses. We can say, with 95% confidence, that the true population mean lies within plus or minus two standard errors of the sample (or reported) mean. See TN.3 in Technical Notes.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MULLIS ET AL, 2000.

While Figure 2.1, on the previous page, shows only the mean scores for each country, it is important to know that there was considerable variation in achievement within countries. One way of examining this was to look at the range of scores between the 5th and 95th percentiles for each country. These are the two points between which 90 percent of students for a given country scored. Only five percent of students scored below the 5th percentile, and five percent of students achieved a score higher than the 95th percentile. Most countries had a range somewhere between 250 and 290 scale score points. The range for New Zealand was relatively high (291 scale score points) when compared to Australia (261) and Canada (240) but was not dissimilar to that for the United States (286). It is interesting to note too that the distribution of New Zealand students' mathematics scores was similar to that of students in England. At least 75 percent of Singapore's students achieved a mathematics score of 555 compared with only about 25 percent of students in New Zealand and England, and less than five percent of students in Chile.

FIGURE 2.2: TRENDS IN MATHEMATICS ACHIEVEMENT FOR LOWER SECONDARY SCHOOL STUDENTS (GRADE 8 EQUIVALENT) FOR 1994/95 AND 1998/99

	1994/95 mean scale score	1998/99 mean scale score	1994/95-1998/99 difference
Latvia (LSS)	488 (3.6)	505 (3.4)	17 (5.0)
Hong Kong, SAR	569 (6.1)	582 (4.3)	13 (7.5)
Netherlands	529 (6.1)	540 (7.1)	11 (9.5)
Canada	521 (2.2)	531 (2.5)	10 (3.2)
Lithuania	472 (4.1)	482 (4.3)	10 (6.1)
United States	492 (4.7)	502 (4.0)	9 (6.2)
Cyprus	468 (2.2)	476 (1.8)	9 (2.9)
Belgium (Flemish)	550 (5.9)	558 (3.3)	8 (6.8)
Korea, Rep. of	581 (2.0)	587 (2.0)	6 (2.8)
Australia	519 (3.8)	525 (4.8)	6 (6.1)
Hungary	527 (3.2)	532 (3.7)	5 (4.9)
Iran, Islamic Rep.	418 (3.9)	422 (3.4)	4 (5.2)
Russian Federation	524 (5.3)	526 (5.9)	2 (8.0)
International mean §	**519 (0.9)**	**521 (0.9)**	**2** (1.3)
Slovak Republic	534 (3.1)	534 (4.0)	0 (4.9)
Slovenia	531 (2.8)	530 (2.8)	-1 (3.9)
Romania	474 (4.6)	472 (5.8)	-1 (7.4)
England	498 (3.0)	496 (4.1)	-1 (5.2)
Japan	581 (1.6)	579 (1.7)	-2 (2.2)
Singapore	609 (4.0)	604 (6.3)	-4 (7.4)
Italy	491 (3.4)	485 (4.8)	-6 (6.0)
New Zealand	501 (4.7)	491 (5.2)	-10 (7.1)
Bulgaria	527 (5.8)	511 (5.8)	-16 (8.2)
Czech Republic	546 (4.5)	520 (4.2)	-26 (6.1)
Countries with unapproved sampling procedures at the classroom level in 1994/1995			
Israel	513 (6.2)	482 (4.7)	-32 (7.8)
South Africa	278 (9.2)	275 (6.8)	-3 (11.5)
Thailand	516 (6.0)	467 (5.1)	-49 (7.9)



§ International mean is for countries that participated and met sampling guidelines in both 1994/95 and 1998/99.
Trend notes: Because coverage fell below 65% in 1995 and 1999, Latvia is annotated LSS for Latvian-Speaking Schools only. Lithuania tested later in 1999 than in 1995, at the beginning of the next school year. In 1995, Italy and Israel were unable to cover their International Desired Population; 1999 data are based on their comparable populations.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS) 1998-1999 — ADAPTED FROM MULLIS ET AL, 2000.

Further information on the distribution of New Zealand Year 9 students' mathematics scores is presented in Chapter 3.

How does the mathematics performance for the trend countries in 1998/99 compare with 1994/95?

Figure 2.2 presents the mean mathematics scores for the 26 'trend' countries participating at the lower secondary level in both TIMSS-94/95 and TIMSS-98/99. Note that classroom-level sampling procedures used by three countries (Israel, South Africa, and Thailand) in TIMSS-94/95 did not meet the international sampling requirements. These three countries are therefore excluded from the following discussion on trends in achievement, which focuses on the 23 countries that did meet sampling requirements.

Across the trend countries, the average increase in mean achievement was just two scale score points. Only students in Latvia (LSS), Canada, and Cyprus achieved, on average, statistically significantly higher mathematics scores in 1998/99 than their counterparts in 1994/98[4]. Although increases in mean achievement of 10 or more scale score points were observed in Hong Kong, the Netherlands, and Lithuania, these were found not to be of statistical significance.

Three countries, New Zealand, Bulgaria, and the Czech Republic, recorded decreases in mean achievement of 10 or more scale score points; the Czech Republic was the only country where the decrease was statistically significant.

Small gains or decreases (less than 10 scale score points) were observed in the remaining countries.

What 'progress' had the 1994/95 middle primary student cohort made in mathematics over the four year period to 1998/99?

Students in 17 of the 23 trend countries participated in TIMSS-94/95 at the middle primary level[5] as well as in TIMSS-98/99 at the lower secondary level. Although the mathematics 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 1994/95 cohort had made in four years. That is, the performance of New Zealand's Year 5 students is considered relative to that of their international grade 4 counterparts in 1994/1995. As well, the relative performance of New Zealand's Year 9 students in 1998/99 is also examined, bearing in mind that the Year 9 cohort was at the middle primary level at the time TIMSS-94/95 was administered.

As shown in Figure 2.3, the mean score for New Zealand Year 5 students was significantly below (by 48 scale score points) the international mean for the 17 countries. Four years on, while the mean for New Zealand's Year 9 students was still significantly below the international average, a small reduction in the differential between the New Zealand mean and the international country mean occurred. This accounted for the slight increase in New Zealand's standing relative to other countries. Notwithstanding the below average achievement, this result suggests that the New Zealand Year 5 cohort had made "gains" over the four years, and had progressed to a level not dissimilar to that of the 1994 New Zealand Year 9 students.

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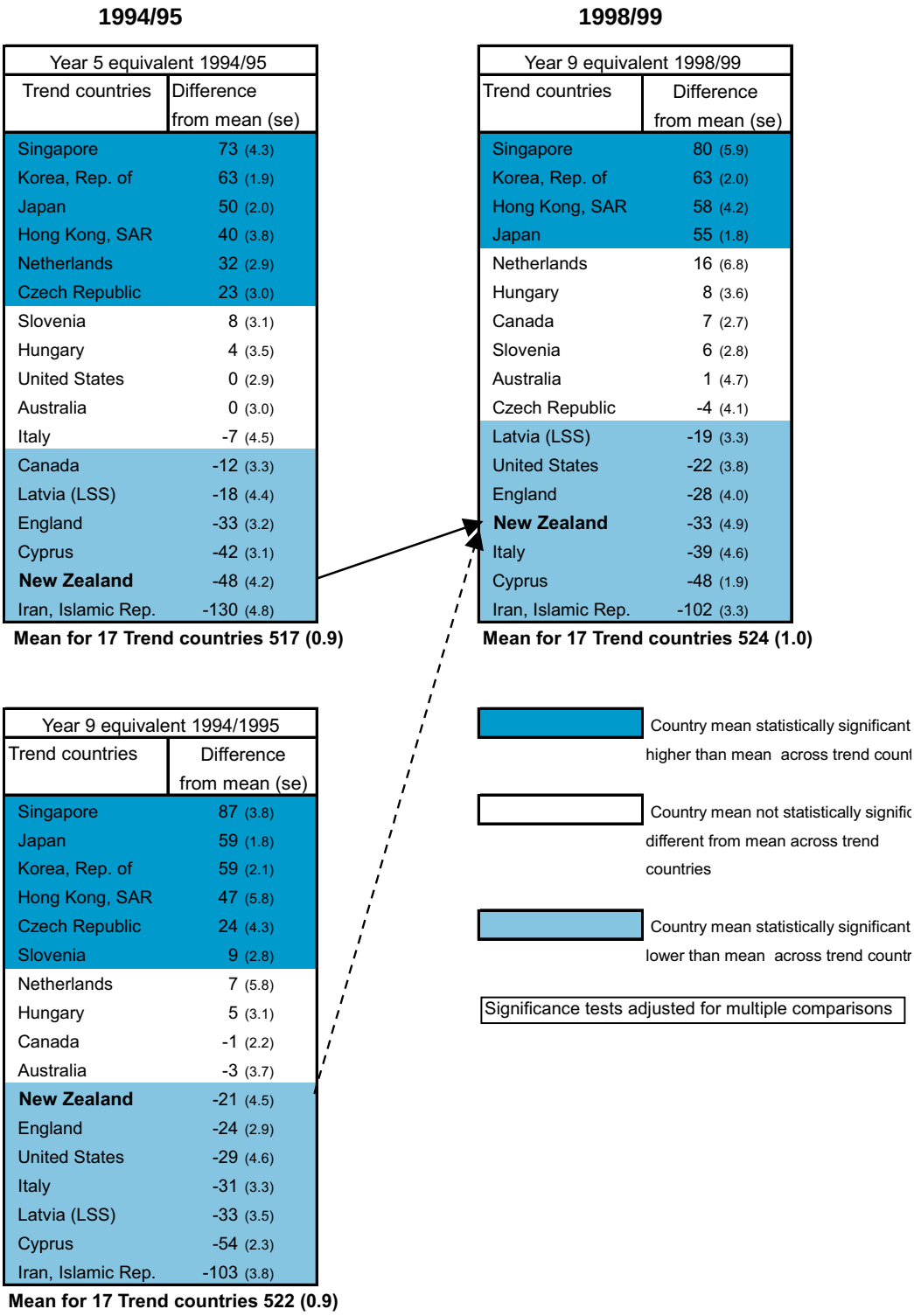
[4] *Both assessments used IRT scaling techniques to summarise achievement results. In order that accurate trend information can be reported, the 1994/1995 achievement results were re-scaled. This means the achievement information for both assessments for Grade 8 (Year 9 students) are on the same scale and therefore comparable.*

[5] *Grade 4 using international nomenclature.*

FIGURE 2.3: RELATIVE MATHEMATICS PERFORMANCE FOR TIMSS-98/99 COUNTRIES PARTICIPATING IN TIMSS-1994/95 AT BOTH THE MIDDLE PRIMARY AND LOWER SECONDARY LEVELS



Note: Year 9 students (grade 8 equivalent) in 1998/99 are not necessarily the same students that participated in TIMSS 1994/95 at the middle primary level (Year 5 or grade 4 equivalent). However, they were part of the middle primary cohort at that time.

(se) Standard errors are reported in parentheses. See note under Figure 2.1 for details.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MULLIS ET AL, 2000.

It is useful to compare and contrast these changes in New Zealand's achievement with those of other countries. For example, whereas Canadian grade 4 students achieved a mean score below the international mean for the 17 trend countries in 1994/95, four years later, in 1998/99, Canadian grade 8 students achieved a mean score that was at about the same level as the international mean. By contrast, grade 4 students in the United States and Italy achieved a mean score at about the international average for the middle primary level in 1994/95 but four years on the mean scores for grade 8 students in these countries were significantly below the international mean.

How did New Zealand student performance compare with the international benchmarks for mathematics?

To summarise students' mathematics performance across countries, international benchmarks were calculated using student achievement data from all participating countries in 1998/99. These benchmarks were defined as: the "*Top 10%*" (90th percentile), the "*Upper Quarter*" (75th percentile), the "*Median*" (50th percentile), and the "*Lower Quarter*" (25th percentile). Mullis et al (2000) notes that three factors seem to differentiate between student performance at the four levels:

- *the mathematical operation required;*
- *the complexity of the numbers or number system; and*
- *the nature of the problem situation.*

To provide a more meaningful interpretation of what it means to be at a particular benchmark, the International Study Centre also undertook a scale-anchoring exercise. This method involved both empirical and qualitative elements. Items that discriminated between the different points on the scale were identified, and subject-matter experts looked at the content of the items and made general statements as to the students' understanding and knowledge required for answering the items correctly[6]. For further details see Mullis et al, 2000.

It should be noted that the descriptions at each benchmark were cumulative. For example, students who reached the *Upper Quarter* benchmark also demonstrated the knowledge and understanding by which the lower benchmarks were categorised — the *Median* and *Lower Quarter* benchmarks.

The international benchmarks were:

- *Top 10% benchmark* = 616 — the top 10 percent of all TIMSS-98/99 students achieved scores above this point on the mathematics scale. Students performing at this level could organise information, make generalisations in order to solve problems, and were able to explain the strategies used when solving non-routine problems.
- *Upper Quarter benchmark* = 555 — the top 25 percent of all TIMSS-98/99 students across all countries achieved scores above this point on the mathematics scale. Students could apply their mathematical understanding and knowledge in a wide variety of relatively complex situations involving fractions, decimals, geometric properties, and algebraic expressions.
- *Median benchmark* = 479 — half of all TIMSS-98/99 students achieved scores higher than this point on the mathematics scale. Students could apply basic mathematical knowledge in straightforward situations, such as adding or subtracting whole numbers and decimals to answer one-step word problems. They could use basic properties of geometric figures; read and interpret graphs, tables, and scales, and understood simple algebraic relationships.

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[6] *The descriptions of achievement at each of the benchmarks are based solely on student performance on the TIMSS-98/99 items, one-third of which were also used in TIMSS-94/95.*

- *Lower Quarter benchmark* = 396 — three-quarters of all TIMSS-98/99 students achieved scores higher than this point on the mathematics scale. Students performing at this level could typically do basic computations with whole numbers, round to the nearest hundred, and could recognise basic notation and terminology. This point may also be useful for identifying low achieving students.

Source: Mullis et al, 2000.

Figure 2.4 presents four examples of items[7] which most students achieving at these benchmarks would be able to answer correctly. Alongside each item, the percentage of New Zealand students who answered the item correctly is given. Information for selected other countries is also shown for comparative purposes.

FIGURE 2.4: EXAMPLES OF MATHEMATICS ITEMS LIKELY TO BE ANSWERED CORRECTLY BY STUDENTS REACHING EACH OF THE FOUR BENCHMARKS

Example 1: *Top 10%* TIMSS International Benchmark
Content area: *Algebra*

V4. The figures show four sets consisting of circles.

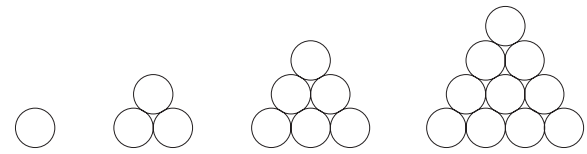


Figure 1 Figure 2 Figure 3 Figure 4

a). Complete the table below. First, fill in how many circles make up Figure 4. Then, find the number of circles that would be needed for the 5th figure if the sequence of figures is extended.

Figure	Number of circles
1	1
2	3
3	6
4	
5	

b). The sequence of figures is extended to the 7th figure. How many circles would be needed for Figure 7?

Answer:_____

c). The 50th figure in the sequence contains 1275 circles. Determine the number of circles in the 51st figure. Without drawing the 51st figure, explain or show how you arrived at your answer.

Country	Overall % correct
New Zealand	**31**
Australia	39
Canada	43
Chile	8
England	35
Malaysia	37
Singapore	65
United States	34
International Mean	**30**

*Students gained credit for each part of the item they answered correctly. The percentage correct marks shown above reflect the proportion of students answering **all** parts correctly.*

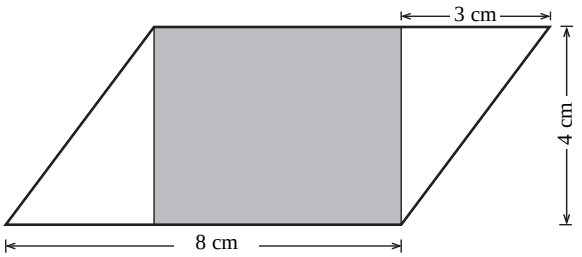
continued overleaf ...

[7] *The items are condensed for display purposes only.*

FIGURE 2.4: EXAMPLES OF MATHEMATICS ITEMS LIKELY TO BE ANSWERED CORRECTLY BY STUDENTS REACHING EACH OF THE FOUR BENCHMARKS - *continued*

Example 2: *Upper Quarter* TIMSS International Benchmark
Content area: *Measurement*

T3. The figure shows a shaded rectangle inside a parallelogram.



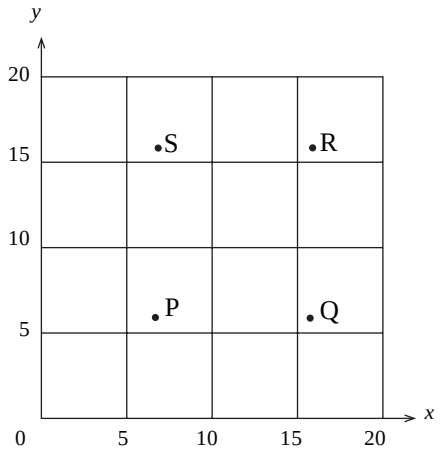
What is the area of the shaded rectangle?

Answer:_____

Country	Overall % correct
New Zealand	**41**
Australia	55
Canada	58
Chile	7
England	48
Malaysia	56
Singapore	83
United States	34
International Mean	**43**

Example 3: *Median* TIMSS International Benchmark
Content area: *Geometry*

J16. Which point on the graph could have coordinates (7,16)?



A. Point P
B. Point Q
C. Point R
D. Point S

Country	Overall % correct
New Zealand	**72**
Australia	74
Canada	67
Chile	23
England	75
Malaysia	78
Singapore	80
United States	67
International Mean	**58**

continued overleaf ...

FIGURE 2.4: EXAMPLES OF MATHEMATICS ITEMS LIKELY TO BE ANSWERED CORRECTLY BY STUDENTS REACHING EACH OF THE FOUR BENCHMARKS - *continued*

Example 4: *Lower Quarter* TIMSS International Benchmark
Content area: *Fractions and Number Sense*

R7. Subtract: 4.722 – 1.935 =

A. 2.787
B. 2.797
C. 2.887
D. 2.897

Country	Overall % correct
New Zealand	**61**
Australia	74
Canada	80
Chile	75
England	59
Malaysia	92
Singapore	90
United States	77
International Mean	**77**

The proportions of New Zealand students reaching the international TIMSS-98/99 benchmarks are presented in Table 2.2. As a comparison, the proportions of the students in 1994/95 reaching these same benchmarks are also shown in the table.

TABLE 2.2: PERCENTAGES OF NEW ZEALAND STUDENTS REACHING THE TIMSS-98/99 INTERNATIONAL BENCHMARKS OF MATHEMATICS ACHIEVEMENT

International Benchmark	TIMSS-94/95		TIMSS-98/99	
	Proportion of NZ students (%)	International mean for 23 trend countries* (%)	Proportion of NZ students (%)	International mean for 23 trend countries* (%)
Top 10%	8	14	8	15
Upper Quarter	26	37	25	37
Median	**62**	69	**56**	69
Lower Quarter	**90**	90	**85**	91

Smaller proportions of New Zealand students reached the international Median and Lower Quarter benchmarks in 1998 than in 1994.

* *Means have been calculated for the 23 countries that participated and met sampling guidelines in both 1994/95 and 1998/99.*

For the 23 countries that met all sampling requirements in both assessments[8], the majority of countries observed either small non-statistical increases or no change in the proportion of students reaching the *Top 10%* benchmark. There was no change in the proportion of New Zealand students reaching this benchmark (8% in both years).

[8] *Israel, South Africa, and Thailand had unapproved sampling procedures at the classroom level in 1994/95.*

About half of the trend countries observed small, non-significant increases in the proportions reaching the *Upper Quarter* benchmark. The Czech Republic was the only country where there was a significant decrease in the proportion reaching this benchmark.

New Zealand was one of nine countries to record a decrease in the proportion reaching the *Median* benchmark although the difference between 1994/95 and 1998/99 was only of statistical significance for Singapore and the Czech Republic.

The proportion of New Zealand students reaching the international *Lower Quarter* benchmark was lower in 1998/99 than was the case in 1994/95. Singapore, Slovenia, Hungary, and the Czech Republic also recorded small decreases in the proportions of students achieving above this international benchmark. However, the decreases were only of statistical significance for the Czech Republic. Cyprus was the only country to record a statistically significant increase in the proportion of students achieving above this benchmark.

How did boys' mathematics achievement compare to girls' mathematics achievement across countries in 1998/99?

Across most of the 38 countries that participated in TIMSS-98/99, boys achieved higher mean scores in mathematics than girls, but generally these differences were very small and not statistically significant. While there were fairly large differences (of 16 scale score points or more) favouring boys observed in South Africa, England, Morocco, Israel, the Czech Republic, Iran, and Tunisia, only those in the four latter countries were of statistical significance.

For New Zealand, Malaysia, and seven other countries, the converse was observed — that is, girls achieved higher mean scores in mathematics than boys. However, these differences were not large enough to be of statistical significance.

How did girls' and boys' mathematics achievement in 1998/99 compare to 1994/95?

Across the 22[9] trend countries, the mean mathematics achievement for both girls and boys increased only very slightly, by three and two scale score points respectively. Figure 2.5 presents a summary of trends in mathematics achievement across countries for TIMSS-94/95 and TIMSS-98/99, by gender.

While there were some relatively large increases in mean scores for girls in some countries, Korea was the only country where the increase was of statistical significance. New Zealand girls, on average, achieved at a slightly lower level than their 1994 Year 9 counterparts but this difference was not statistically significant (see also Chapter 3). The largest decrease in girls' mean achievement was observed in England and the Czech Republic (although only the latter difference was of statistical significance).

As was the case for girls, there were quite large increases (more than 10 scale score points) in boys' mean achievement in some countries; however, none were of statistical significance. The largest decreases in mean scores for boys were observed in New Zealand and the Czech Republic (a decrease of 18 and 24 scale score points respectively) — although only the difference for the latter was found to be statistically significant.

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[9] *There were 23 trend countries which met international sampling requirements, but trend gender data for Bulgaria were not available.*

FIGURE 2.5: TRENDS IN MATHEMATICS ACHIEVEMENT FOR STUDENTS AT THE LOWER SECONDARY LEVEL (GRADE 8 EQUIVALENT), BY GENDER

Girls	1994/95 mean scale score	1998/99 mean scale score	1994/95-1998/99 difference		Boys	1994/95 mean scale score	1998/99 mean scale score	1994/95-1998/99 difference	
Hong Kong, SAR	559 (7.0)	583 (4.7)	24 (8.4)	●	Latvia (LSS)	490 (4.2)	508 (4.4)	17 (6.2)	●
Latvia (LSS)	486 (4.0)	502 (3.8)	16 (5.4)	●	Canada	520 (3.0)	533 (3.2)	12 (4.5)	●
Netherlands	522 (6.6)	538 (7.6)	15 (10.2)	●	Lithuania	472 (4.6)	483 (4.8)	11 (6.7)	●
Korea, Rep. of	571 (3.0)	585 (3.1)	13 (4.3)	▲	United States	495 (5.2)	505 (4.8)	10 (7.0)	●
United States	490 (4.7)	498 (3.9)	8 (6.1)	●	Cyprus	465 (3.3)	474 (2.7)	10 (4.2)	●
Lithuania	472 (4.6)	480 (4.7)	8 (6.7)	●	Belgium (Flemish)	547 (8.7)	556 (8.3)	9 (12.0)	●
Cyprus	471 (2.6)	479 (2.1)	7 (3.3)	●	Australia	517 (5.0)	526 (5.7)	9 (7.5)	●
Belgium (Flemish)	553 (8.1)	560 (7.2)	7 (10.9)	●	Hungary	527 (3.6)	535 (4.3)	8 (5.5)	●
Canada	522 (2.4)	529 (2.5)	7 (3.3)	●	Netherlands	534 (6.6)	542 (7.0)	8 (9.6)	●
Australia	520 (4.3)	524 (5.7)	4 (7.0)	●	England	500 (5.5)	505 (5.0)	5 (7.5)	●
International mean §	516 (1.0)	520 (1.0)	3 (1.5)	●	Hong Kong, SAR	577 (7.2)	581 (5.9)	4 (9.4)	●
Iran, Islamic Rep.	405 (6.1)	408 (4.2)	3 (7.3)	●	Russian Federation	523 (6.2)	526 (6.4)	3 (8.9)	●
Romania	473 (4.4)	475 (6.3)	2 (7.7)	●	Iran, Islamic Rep.	429 (4.7)	432 (4.8)	3 (6.6)	●
Slovenia	527 (3.2)	529 (3.0)	2 (4.4)	●	International mean §	522 (1.1)	524 (1.2)	2 (1.6)	●
Hungary	527 (3.6)	529 (4.0)	2 (5.4)	●	Korea, Rep. of	588 (2.7)	590 (2.2)	1 (3.5)	●
Russian Federation	524 (5.0)	526 (6.0)	2 (7.8)	●	Slovak Republic	536 (3.7)	536 (4.5)	1 (5.7)	●
Slovak Republic	532 (3.1)	532 (4.2)	-1 (5.3)	●	Singapore	608 (4.7)	606 (7.5)	-2 (8.9)	●
New Zealand	497 (5.3)	495 (5.5)	-2 (7.6)	●	Japan	585 (2.2)	582 (2.3)	-3 (3.0)	●
Japan	577 (1.9)	575 (2.4)	-2 (3.0)	●	Slovenia	535 (3.1)	531 (3.6)	-4 (4.7)	●
Italy	488 (4.5)	483 (5.5)	-5 (7.1)	●	Romania	475 (5.3)	470 (6.2)	-5 (8.2)	●
Singapore	610 (4.9)	603 (6.1)	-7 (7.8)	●	Italy	494 (3.7)	488 (5.4)	-6 (6.5)	●
England	495 (4.0)	487 (5.4)	-8 (6.8)	●	New Zealand	505 (6.1)	487 (7.6)	-18 (9.9)	●
Czech Republic	539 (5.4)	512 (4.0)	-27 (6.6)	▼	Czech Republic	552 (4.6)	528 (5.8)	-24 (7.4)	▼
Countries with unapproved sampling procedures at the classroom level in 1994/95									
Israel	500 (7.0)	473 (5.1)	-27 (8.7)	▼	Israel	530 (6.9)	490 (5.3)	-40 (8.7)	▼
South Africa	264 (8.4)	267 (7.5)	4 (11.3)	●	South Africa	293 (12.7)	283 (7.3)	-10 (14.6)	●
Thailand	520 (7.4)	469 (5.7)	-51 (9.4)	▼	Thailand	511 (6.1)	465 (5.5)	-46 (8.3)	▼

▲ 1998/99 significantly higher than 1994/95

● No significant difference between 1994/95 and 1998/99

▼ 1998/99 significantly lower than 1994/95

Significance tests adjusted for multiple comparisons

§ International mean is for countries that participated and met sampling guidelines in both 1994/95 and 1998/99.
Trend notes: Because coverage fell below 65% in 1995 and 1999, Latvia is annotated LSS for Latvian-Speaking Schools only. Lithuania tested later in 1999 than in 1995, at the beginning of the next school year. In 1995, Italy and Israel were unable to cover their International Desired Population; 1999 data are based on their comparable populations. Trends in gender data for Bulgaria are unavailable.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MULLIS ET AL, 2000.

There were just two trend countries where statistically significant differences were observed between boys and girls' mean achievement in both 1994/95 and 1998/99 — the Czech Republic and Iran. Korea also recorded a significant change in the difference between girls' and boys' mean achievement: in TIMSS-94/95 Korean boys at the lower secondary level, on average, achieved statistically significantly higher scores in mathematics than their female counterparts; in TIMSS-98/99, the difference between Korean boys' and girls' mathematics achievement was not statistically significant.

SCIENCE

Student achievement in 1998/99

Figure 2.6 (overleaf) presents the mean science scores for the 38 TIMSS-98/99 countries relative to the mean achieved by New Zealand students. The mean of 510 for New Zealand students was statistically significantly higher than the international country mean of 488. As Figure 2.6 shows, there was considerable variation in mean science achievement across countries and New Zealand ranked in the middle performing group of countries. The highest mean science scores were observed in Chinese Taipei, Singapore, and Hungary (all more than 550 scale score points); whereas the lowest were observed in the Philippines, Morocco, and South Africa (all less than 350 scale score points).

While there was a very large difference in the means for the 'higher-performing' and 'lower-performing countries', it is important to note that there was very little difference in mean achievement between countries positioned or ranked adjacent to a country under scrutiny. For example, New Zealand students' mean achievement in science was not statistically significantly different from that of their counterparts in the United States.

The mean science achievement of students in countries in the Asia-Pacific region, as well as in countries with which New Zealand has traditional links, are presented in Table 2.3.

TABLE 2.3: NEW ZEALAND YEAR 9 STUDENTS' SCIENCE ACHIEVEMENT RELATIVE TO STUDENTS IN SELECTED COUNTRIES

Countries with mean student achievement in science **statistically significantly higher** than New Zealand	Countries with mean student achievement in science **about the same** as New Zealand (ie, no statistically significant difference)	Countries with mean student achievement in science **statistically significantly lower** than New Zealand
Chinese Taipei Singapore Japan Korea, Republic of Australia England Canada Hong Kong, SAR	United States Malaysia	Thailand Indonesia Chile Philippines South Africa

As was the case for mathematics, there was a considerable range in science achievement within countries, including New Zealand and the United States.

In New Zealand, for example, there was a difference of approximately 304 scale score points between the highest performing students (95th percentile) and the lowest performing students (5th percentile) in science. At 318 scale score points, the range between high- and low-achieving students in the United States was greater than for New Zealand. The range in science scores for Canada was lower, at 254. The greatest range between the highest and lowest achieving students was found in South Africa (more than 400 scale score points); the least variation in scores was found in Belgium (Flemish) and Tunisia (less than 230 scale score points).

FIGURE 2.6: MEAN SCIENCE ACHIEVEMENT FOR NEW ZEALAND YEAR 9 STUDENTS IN TIMSS-98/99 RELATIVE TO THEIR INTERNATIONAL (GRADE 8) COUNTERPARTS

Year 9 equivalent		
All TIMSS-98/99 countries		Mean scale score (se)
Chinese Taipei	▲	569 (4.4)
Singapore	▲	568 (8.0)
Hungary	▲	552 (3.7)
Japan	▲	550 (2.2)
Korea, Rep. of	▲	549 (2.6)
Netherlands*	▲	545 (6.9)
Australia	▲	540 (4.4)
Czech Republic	▲	539 (4.2)
England*	▲	538 (4.8)
Finland	▲	535 (3.5)
Slovak Republic	▲	535 (3.3)
Belgium (Flemish)*	▲	535 (3.1)
Slovenia	▲	533 (3.2)
Canada	▲	533 (2.1)
Hong Kong, SAR*	▲	530 (3.7)
Russian Fed.	●	529 (6.4)
Bulgaria	●	518 (5.4)
United States	●	515 (4.6)
New Zealand		**510 (4.9)**
Latvia (LSS)^	●	503 (4.8)
Italy	●	493 (3.9)
Malaysia	●	492 (4.4)
Lithuania^~	▼	488 (4.1)
Thailand	▼	482 (4.0)
Romania	▼	472 (5.8)
Israel**	▼	468 (4.9)
Cyprus	▼	460 (2.4)
Moldova	▼	459 (4.0)
Macedonia, Rep of	▼	458 (5.2)
Jordan	▼	450 (3.8)
Iran, Islamic Rep	▼	448 (3.8)
Indonesia	▼	435 (4.5)
Turkey	▼	433 (4.3)
Tunisia	▼	430 (3.4)
Chile	▼	420 (3.7)
Philippines	▼	345 (7.5)
Morocco	▼	323 (4.3)
South Africa	▼	243 (7.8)

International country mean = 488 (0.7)

▲ country mean is statistically significantly higher than NZ mean

● country mean not statistically significantly different from NZ mean

▼ country mean is statistically significantly lower than NZ mean

Significance tests adjusted for multiple comparisons

*Meet guidelines for sample participation rates only after replacement schools were included.

^National Desired Population does not cover all of International Desired Population.

~ Lithuania tested in 1999 but later than other Northern Hemisphere countries.

**National Defined Population covered less than 90 percent of National Desired Population.

Note: (se) Standard errors are reported in parentheses. We can say, with 95% confidence, that the true population mean lies within plus or minus two standard errors of the sample (or reported) mean.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MARTIN ET AL, 2000.

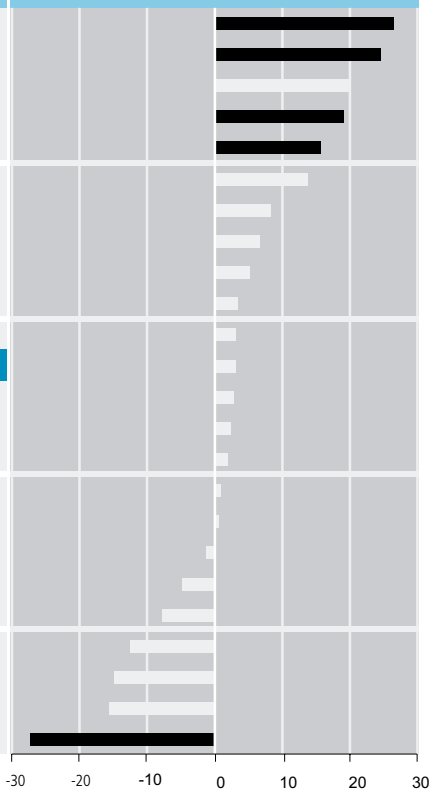
The distribution of New Zealand Year 9 students' science scores was similar to that of students in the United States. It is also worth noting that about 50 percent of Singaporean and Chinese Taipei students achieved a science score of at least 575, compared with only 25 percent of New Zealand and Hong Kong students, and less than five percent of Chilean students.

How does science performance for the trend countries in 1998/99 compare with 1994/1995?

Figure 2.7 presents the mean science scores for the 26 trend countries that participated in both TIMSS-94/95 and TIMSS-98/99 at the lower secondary level ('grade 8').

FIGURE 2.7: TRENDS IN SCIENCE ACHIEVEMENT FOR LOWER SECONDARY SCHOOL STUDENTS (GRADE 8 EQUIVALENT) FOR 1994/95 AND 1998/99

	1994/95 mean scale score	1998/99 mean scale score	1994/95-1998/99 difference
Latvia (LSS)	476 (3.3)	503 (4.8)	27 (5.9)
Lithuania	464 (4.0)	488 (4.1)	25 (5.7)
Hong Kong, SAR	510 (5.8)	530 (3.7)	20 (6.8)
Canada	514 (2.6)	533 (2.1)	19 (3.3)
Hungary	537 (3.1)	552 (3.7)	16 (4.9)
Australia	527 (4.0)	540 (4.4)	14 (6.0)
Cyprus	452 (2.1)	460 (2.4)	8 (3.3)
Russian Federation	523 (4.5)	529 (6.4)	7 (7.9)
England	533 (3.6)	538 (4.8)	5 (5.8)
Netherlands	541 (6.0)	545 (6.9)	3 (9.1)
Slovak Republic	532 (3.3)	535 (3.3)	3 (4.5)
International mean §	**518 (0.9)**	**521 (0.9)**	**3 (1.3)**
Korea, Rep. of	546 (2.0)	549 (2.6)	3 (3.4)
United States	513 (5.6)	515 (4.6)	2 (7.2)
Belgium (Flemish)	533 (6.4)	535 (3.1)	2 (7.1)
Romania	471 (5.1)	472 (5.8)	1 (7.8)
Italy	497 (3.6)	498 (4.8)	1 (5.9)
New Zealand	511 (4.9)	510 (4.9)	-1 (6.9)
Japan	554 (1.8)	550 (2.2)	-5 (3.0)
Slovenia	541 (2.8)	533 (3.2)	-8 (4.4)
Singapore	580 (5.5)	568 (8.0)	-12 (9.8)
Iran, Islamic Rep.	463 (3.6)	448 (3.8)	-15 (5.2)
Czech Republic	555 (4.5)	539 (4.2)	-16 (6.1)
Bulgaria	545 (5.2)	518 (5.4)	-27 (7.5)
Countries with unapproved sampling procedures at the classroom level in 1994/95			
Israel	509 (6.3)	484 (5.7)	-25 (8.3)
South Africa	263 (11.1)	243 (7.8)	-20 (13.7)
Thailand	510 (4.7)	482 (4.0)	-28 (6.2)



§ International mean is for countries that participated and met sampling guidelines in both 1994/95 and 1998/99.
Trend notes: Because coverage fell below 65% in 1995 and 1999, Latvia is annotated LSS for Latvian-Speaking Schools only. Lithuania tested later in 1999 than in 1995, at the beginning of the next school year. In 1995, Italy and Israel were unable to cover their International Desired Population; 1999 data are based on their comparable populations.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MARTIN ET AL, 2000.

There was virtually no difference between the mean scores achieved by New Zealand's Year 9 students in the two studies. This lack of change was not universal and students in four of the 23[10] trend countries — Latvia (LSS), Lithuania, Canada, and Hungary — achieved statistically significantly higher mean scores in science in 1998/99 than their respective counterparts in 1994/98. There were also increases in students' mean scores in Hong Kong and Australia, although these were not statistically significant when adjusted for multiple comparisons. On the other hand, Singapore, Iran, the Czech Republic, and Bulgaria all recorded decreases in their mean scores of more than 10 scale score points; but only that for Bulgaria's students was statistically significant. The remaining countries recorded very small positive or negative changes in the order of up to eight scale score points.

What 'progress' has the 1994/1995 middle primary student cohort made in science over the four year period to 1998/99?

Although the science achievement scales for the middle primary and lower secondary levels are not directly comparable, it is possible to look at the relative performance of each student group to see how they have progressed over the four years.

There were 17 countries that participated in both TIMSS-94/95 at the middle primary level and in TIMSS-98/99 at the lower secondary level. As shown in Figure 2.8, while the mean score for New Zealand Year 5 students was nine scale score points lower than the mean for the 17 trend countries in 1994/95, it was not statistically different from that mean. However, four years on, the difference between the mean for New Zealand and the overall mean for the trend countries was statistically significantly lower (at 15 scale score points), indicating a slight drop in New Zealand's performance relative to the trend countries.

Hungary, whose students achieved a mean score similar to that of New Zealand's students at the middle primary level in 1994/95, 'progressed' to having one of the highest mean science achievement scores at the lower secondary level in 1998/99. By way of contrast, the mean science score for students in the United States was significantly above the international mean for the trend countries at the middle primary level in 1994/95, but four years on it was not markedly different from the international mean for the lower secondary level. Italy's grade 4 students achieved a mean score above the international mean (although not statistically significantly so) in 1994/95, but in 1998/99 the grade 8 cohort achieved a mean well below (statistically significantly) the international mean.

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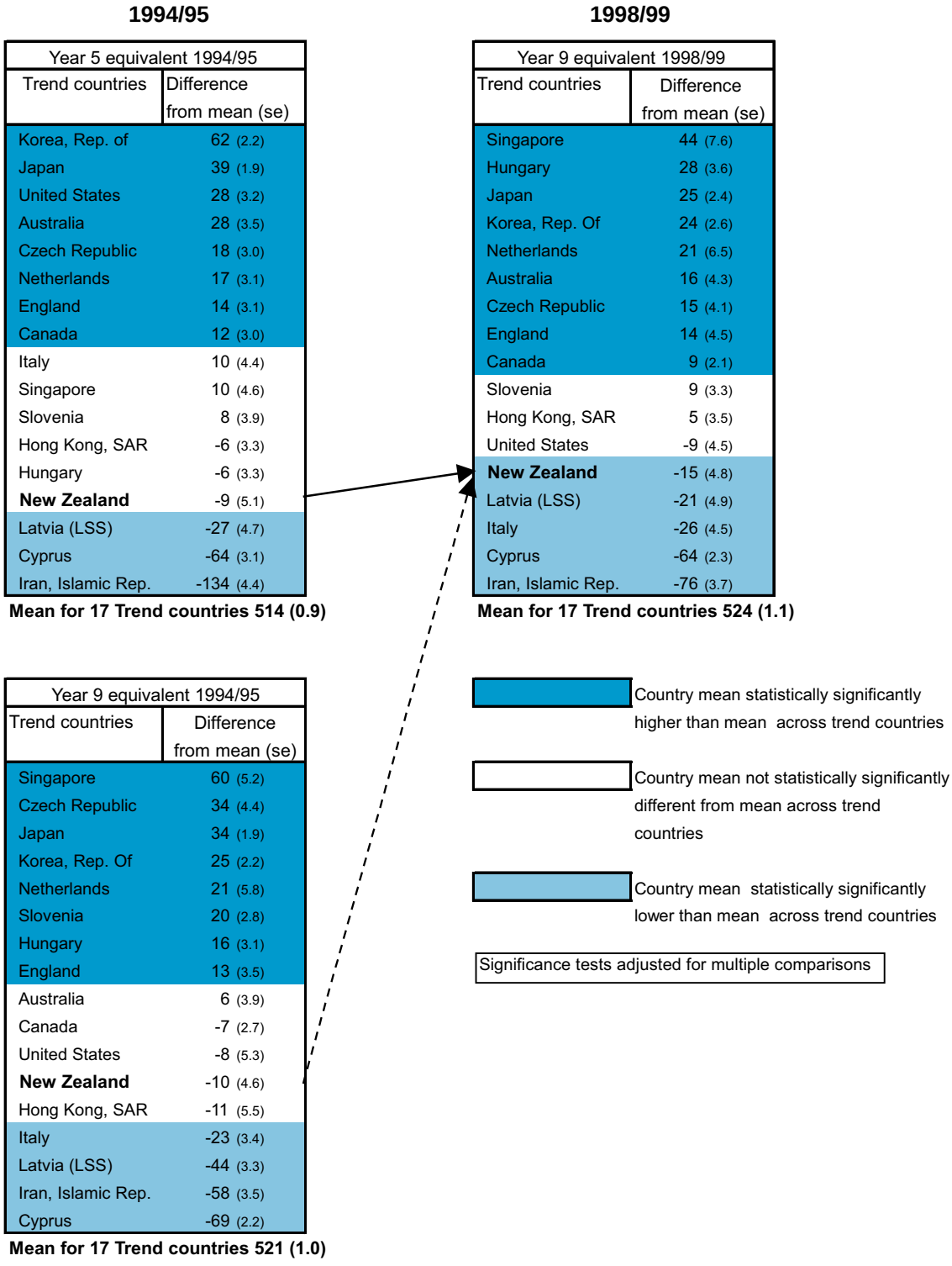
[10] *Excludes Israel, South Africa, and Thailand who had used unapproved sampling procedures at the classroom level in 1994/95. Large decreases were observed in Israel and Thailand but these are largely attributed to the sampling in 1994/95.*

FIGURE 2.8: RELATIVE SCIENCE PERFORMANCE FOR TIMSS-98/99 COUNTRIES THAT PARTICIPATED IN TIMSS-94/95 AT BOTH THE MIDDLE PRIMARY AND LOWER SECONDARY LEVELS



Notes: *Year 9 students (grade 8 equivalent) in 1998/99 are not necessarily the same students that participated in TIMSS 1994/95 at the middle primary level (Year 5 or grade 4 equivalent). However, they were part of the middle primary cohort at that time.*

(se) Standard errors are reported in parentheses. See note under Figure 2.6 for details.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MARTIN ET AL, 2000.

How did New Zealand student performance compare with the international benchmarks for science?

International benchmarks for science were calculated using achievement information from students in all TIMSS-98/99 countries. The benchmarks were defined as the "*Top 10%*" (90th percentile), "*Upper Quarter*" (75th percentile), the "*Median*" (50th percentile) and "*Lower Quarter*" (25th percentile).

As for mathematics, the International Study Centre also undertook the scale-anchoring exercise for science. The method involved both empirical and qualitative judgement methods. That is, items that discriminated between the different points on the science scale were identified, the content of these items was examined, and general statements were made regarding the understanding and knowledge students would need to answer the items correctly[11]. According to Martin et al (2000) there were six main factors that seemed to differentiate performance among the four levels:

- *The depth and breadth of content area knowledge*
- *The level of understanding and use of technical vocabulary*
- *The context of the problem (progressing from practical to more abstract)*
- *The level of scientific investigation skills*
- *The complexity of diagrams, graphs, table, and textual information used*
- *The completeness of written responses.*

The international benchmarks were:

- *Top 10% benchmark* = 616 — the top 10 percent of all TIMSS-98/99 students achieved scores above this point on the science scale. Students performing at this level demonstrated that they had a grasp of some complex and abstract science concepts such as an understanding of the principles of energy efficiency, phase change, thermal expansion, light properties, gravitational force, basic structure of matter, and chemical versus physical changes. They could apply understanding of the Earth's formation and cycles and the complexity of living organisms. They demonstrated detailed knowledge of environmental and resource issues. They understood the fundamentals of scientific investigation and can apply basic physical principles to solve quantitative problems. They could provide written explanations and used diagrams to communicate scientific knowledge.
- *Upper Quarter benchmark* = 558 — students in the top 25 percent across all countries achieved scores above this point on the science scale. Students demonstrated conceptual understanding of some science cycles, systems, and principles. They had some understanding of the Earth's processes, biological systems and populations. They solved physics problems related to light, speed, heat, and temperature, and demonstrated basic knowledge of major environmental concerns. They demonstrated some scientific inquiry skills. They could combine information to draw conclusions; interpret information in diagrams, graphs, and tables to solve problems; and provide short explanations conveying scientific knowledge in the life sciences.
- *Median benchmark* = 488 — half of all students achieved scores higher than this point on the science scale. Students could recognise and communicate basic scientific knowledge across a range of topics. They recognised some characteristics of the solar system, ecosystems, animals and plants, light reflection and radiation; energy sources, sound, force and motion and human impact on the

[11] *The descriptions of achievement at each of the benchmarks are based solely on student performance on the TIMSS-98/99 items, one-third of which were also used in TIMSS-94/95.*

environment. They could apply and briefly communicate knowledge to practical situations, extract tabular information, and interpret representational diagrams.

- *Lower Quarter benchmark* = 410 — three-quarters of all students achieved scores higher than this point on the science scale. Students recognised some basic facts from the earth, life, and physical sciences using non-technical language. They could interpret and use information presented in simple diagrams and graphs. This point may also be useful for identifying lower-achieving students.

Source: Martin et al, 2000.

Figure 2.9 presents examples of science items that were likely to be answered correctly by students at each benchmark. In addition, alongside each item, the proportion of New Zealand Year 9 students answering correctly is given, as well as the proportions of students who answered correctly in a number of selected countries for comparative purposes.

FIGURE 2.9: EXAMPLES OF SCIENCE ITEMS LIKELY TO BE ANSWERED CORRECTLY BY STUDENTS REACHING EACH OF THE FOUR BENCHMARKS

Example 1: *Top 10%* TIMSS International Benchmark
Content area: *Life Science*

P3. Ethan hammered a nail into the trunk of a young tree. Explain why the nail was still at the same height from the ground 20 years later even though the tree had grown to a height of 22 metres.

Country	Overall % correct
New Zealand	**56**
Australia	57
Canada	59
Chile	30
England	55
Malaysia	33
Singapore	49
United States	45
International Mean	**41**

Example 2: *Upper Quarter* TIMSS International Benchmark
Content area: *Chemistry*

N7. Which is an example of a chemical reaction?

A. Water boiling
B. Sugar dissolving
C. Nails rusting
D. Wax melting

Country	Overall % correct
New Zealand	**42**
Australia	53
Canada	55
Chile	37
England	66
Malaysia	57
Singapore	64
United States	52
International Mean	**49**

continued overleaf ...

FIGURE 2.9: EXAMPLES OF SCIENCE ITEMS LIKELY TO BE ANSWERED CORRECTLY BY STUDENTS REACHING EACH OF THE FOUR BENCHMARKS — *continued*

Example 3: *Median* TIMSS International Benchmark
Content area: *Earth science*

J9. Diana and Mario were discussing what it might be like on other planets. Their science teacher gave them data about Earth and an imaginary planet Proto. The table shows these data.

	Earth	Proto
Distance from a star like the Sun	148 640 000 km	902 546 000 km
Atmospheric pressure at surface of planet	101 325 Pa	100 Pa
Atmospheric conditions • gas components	21% oxygen 0.03% carbon dioxide 78% nitrogen	5% oxygen 5% carbon dioxide 90% nitrogen
• ozone layer	yes	no
• cloud cover	yes	no

Write down one important reason why it would be difficult for humans to live on Proto if it existed. Explain your answer.

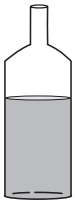
Country	Overall % correct
New Zealand	**80**
Australia	83
Canada	82
Chile	57
England	82
Malaysia	67
Singapore	86
United States	78
International Mean	**66**

Example 4: *Lower Quartile* TIMSS International Benchmark

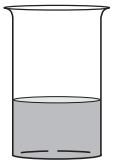
Content area: *Physics*

J4. A student put 100mL in each of the open containers and let them stand in the sun for one day. Which container would probably lose the most water due to evaporation?

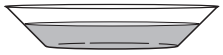
A.



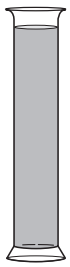
B.



C.



D.



Country	Overall % correct
New Zealand	**88**
Australia	90
Canada	91
Chile	72
England	92
Malaysia	93
Singapore	98
United States	84
International Mean	**84**

The proportion of New Zealand students in 1998/99 reaching the international benchmarks is presented in Table 2.2, along with the proportions of Year 9 students reaching these benchmarks in 1994/1995.

TABLE 2.4: PERCENTAGES OF NEW ZEALAND STUDENTS REACHING THE TIMSS-98/99 INTERNATIONAL BENCHMARKS OF SCIENCE ACHIEVEMENT

International Benchmark	TIMSS-94/95		TIMSS-98/99	
	Proportion of NZ students (%)	International mean for 23 trend countries* (%)	Proportion of NZ students (%)	International mean for 23 trend countries* (%)
Top 10%	11	13	12	14
Upper Quarter	30	34	32	35
Median	62	65	61	66
Lower Quarter	87	88	86	89

* *International means have been calculated for the 23 countries that participated and met sampling guidelines in both 1994/95 and 1998/99.*

For the 23 trend countries that met all sampling requirements[12], just over a half of the countries observed a small increase in the proportion of students reaching the *Top 10%* benchmark, including Hungary (14 to 22%), Australia (17% to 19%), and Canada (11% to 14%). However, Hungary's increase was the only increase of statistical significance.

Statistically significant increases in the proportions of students reaching the *Upper Quarter* benchmark were only found for Hungary (40% to 49%), Canada (30% to 38%), Latvia (LSS) (15% to 24%), and Lithuania (12% to 20%). For the remaining countries, including New Zealand (30% to 32%), there were only small increases or decreases that were not found to be of statistical significance. Statistically significant increases in the proportions of students reaching the *Median* benchmark were found in three countries — Canada, Latvia (LSS), and Lithuania.

The proportion of New Zealand students achieving a score below the *Lower Quarter* benchmark was marginally lower (ie, not statistically significantly lower) in 1998/99 than in 1994/95. Singapore, Slovenia, and Iran recorded statistically significant decreases in proportions of students reaching this international benchmark. That is, significantly more students performed below this score in 1998/99 than in 1994/95. By contrast, statistically significantly higher proportions of students in Hong Kong, Canada, and Latvia (LSS) reached the international *Lower Quarter* in 1998/99 than was the case in 1994/95.

How did boys' science achievement compare to girls' science achievement across countries in TIMSS-98/99?

Across all 38 countries, boys on average achieved a science score 15 scale score points higher than girls. Significant gender differences in favour of boys were evident in 17 countries, including the United States, the Netherlands, England, and the Czech Republic. In fact, although the differences in mean achievement were not all found to be statistically significant, the direction of the differences favoured boys in all but two countries — the Philippines and Jordan. The smallest differences (seven scale score points or less) between mean scores were observed in New Zealand, Macedonia, Turkey, Thailand, and Romania.

[12] *Israel, South Africa, and Thailand had unapproved sampling procedures at the classroom level in 1994/95.*

FIGURE 2.10: TRENDS IN SCIENCE ACHIEVEMENT FOR STUDENTS AT LOWER SECONDARY LEVEL (GRADE 8 EQUIVALENT), BY GENDER

Girls	1994/95 mean scale score	1998/99 mean scale score	1994/95-1998/99 difference		Boys	1994/95 mean scale score	1998/99 mean scale score	1994/95-1998/99 difference	
Latvia (LSS)	464 (3.8)	495 (5.6)	32 (6.5)	▲	Lithuania	477 (4.5)	499 (5.0)	22 (6.6)	▲
Hong Kong, SAR	492 (6.5)	522 (4.4)	30 (7.8)	▲	Latvia (LSS)	490 (4.3)	510 (4.8)	21 (7.0)	●
Lithuania	452 (4.3)	478 (4.4)	26 (6.1)	▲	Canada	521 (3.4)	540 (2.4)	19 (4.1)	▲
Canada	508 (3.2)	526 (3.2)	18 (4.4)	▲	Hungary	549 (3.5)	565 (4.5)	17 (5.6)	●
Hungary	525 (3.7)	540 (4.0)	15 (6.0)	●	Australia	533 (5.5)	549 (6.0)	16 (8.2)	●
Australia	520 (4.4)	532 (5.1)	12 (6.6)	●	Cyprus	451 (2.4)	465 (3.0)	14 (3.9)	▲
New Zealand	497 (5.6)	506 (5.4)	9 (7.9)	●	Hong Kong, SAR	525 (6.3)	537 (5.1)	12 (8.2)	●
Netherlands	528 (5.7)	536 (7.1)	8 (9.0)	●	England	543 (6.0)	554 (5.3)	11 (7.9)	●
Korea, Rep. of	530 (2.5)	538 (4.0)	8 (4.8)	●	Russian Federation	530 (5.1)	540 (6.2)	9 (8.2)	●
International mean §	**506 (1.1)**	**512 (1.0)**	**6 (1.5)**	▲	United States	520 (6.1)	524 (5.5)	5 (8.2)	●
Slovak Republic	520 (4.1)	525 (3.4)	5 (5.4)	●	**International mean** §	**527 (1.1)**	**531 (1.1)**	**3 (1.6)**	●
Romania	464 (5.4)	468 (6.4)	4 (8.4)	●	Italy	503 (3.8)	505 (6.4)	2 (7.1)	●
Russian Federation	516 (4.5)	519 (7.1)	4 (8.6)	●	Belgium (Flemish)	542 (9.0)	544 (7.2)	2 (11.7)	●
Belgium (Flemish)	524 (8.7)	526 (4.6)	2 (9.7)	●	Slovak Republic	545 (3.3)	546 (4.5)	1 (5.4)	●
Cyprus	454 (2.9)	455 (3.1)	1 (4.5)	●	Korea, Rep. of	559 (2.8)	559 (3.2)	0 (4.5)	●
Slovenia	526 (3.3)	527 (3.7)	0 (5.1)	●	Netherlands	554 (7.4)	554 (7.3)	0 (10.4)	●
United States	505 (5.4)	505 (4.6)	0 (7.1)	●	Romania	478 (5.6)	475 (6.5)	-3 (8.7)	●
England	522 (4.0)	522 (6.2)	-1 (7.5)	●	Japan	564 (2.2)	556 (3.6)	-7 (4.6)	●
Italy	492 (4.5)	491 (5.1)	-1 (6.9)	●	Singapore	587 (7.0)	578 (9.7)	-9 (12.0)	●
Japan	544 (1.9)	543 (2.8)	-2 (3.5)	●	New Zealand	524 (6.1)	513 (7.0)	-11 (9.4)	●
Czech Republic	538 (5.7)	523 (4.8)	-14 (7.6)	●	Iran, Islamic Rep.	475 (4.6)	461 (4.4)	-14 (6.2)	●
Singapore	574 (6.7)	557 (7.9)	-16 (10.4)	●	Czech Republic	572 (4.8)	557 (4.9)	-15 (6.8)	●
Iran, Islamic Rep.	448 (5.7)	430 (5.7)	-18 (8.2)	●	Slovenia	556 (3.3)	540 (3.7)	-16 (5.0)	▼
Countries with unapproved sampling procedures at the classroom level in 1994/95									
Israel	494 (6.9)	476 (6.6)	-17 (9.2)	●	Israel	532 (6.8)	492 (6.2)	-39 (9.0)	▼
South Africa	243 (9.7)	234 (9.2)	-9 (13.4)	●	South Africa	283 (15.4)	253 (7.7)	-30 (17.3)	●
Thailand	511 (5.4)	481 (4.6)	-30 (7.1)	▼	Thailand	509 (4.9)	484 (4.4)	-25 (6.7)	▼

▲ 1998/99 significantly higher than 1994/95

● No significant difference between 1994/95 and 1998/99

▼ 1998/99 significantly lower than 1994/95

Significance tests adjusted for multiple comparisons

§ International mean is for countries that participated and met sampling guidelines in both 1994/95 and 1998/99.
Trend notes: Because coverage fell below 65% in 1995 and 1999, Latvia is annotated LSS for Latvian-Speaking Schools only. Lithuania tested later in 1999 than in 1995, at the beginning of the next school year. In 1995, Italy and Israel were unable to cover their International Desired Population; 1999 data are based on their comparable populations. Trends in gender data for Bulgaria are unavailable.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

SOURCE: IEA THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS 1998-1999) — ADAPTED FROM MARTIN ET AL, 2000.

How did girls' and boys' science achievement in 1998/99 compare to 1994/95?

As shown in Figure 2.10, both girls' and boys' mean science achievement in 22 trend countries[13] increased over the four years from 1994/95 to 1998/99. The increase for boys was small and non-significant (three scale score points). However, the six scale score points by which the girls' mean science score increased was statistically significant.

[13] *Trend gender data for Bulgaria were unavailable.*

The largest increases in mean scores for girls that were of statistical significance were observed in Latvia (LSS), Hong Kong, Lithuania and Canada. New Zealand girls, on average, achieved scores nine points higher than their 1994 counterparts although this increase was found not to be statistically significant. The largest decreases for girls were found in the Czech Republic, Singapore, and Iran (more than 12 scale score points) but were not statistically significant.

Boys in three countries — Lithuania, Canada, and Cyprus — achieved significantly higher mean scores (more than 10 scale score points) in 1998/99 than their 1994/95 counterparts. In contrast, the largest decreases in mean scores for boys (more than 10 scale score points) were in New Zealand, Iran, the Czech Republic, and Slovenia, although only the latter was of statistical significance.

Across the trend countries, the difference between girls' and boys' mean science achievement for the 1994/95 assessment averaged 21 scale score points. By 1998/99, the difference had reduced slightly to 18 scale score points. Although this difference was still found to be statistically significant — that is, boys on average scored significantly higher than girls — the decrease itself was also of statistical significance. This reduction in the 'gender gap' internationally was largely attributed to the substantial decreases in gender differences evident in Hong Kong and Slovenia (Martin et al, 2000).

This chapter has provided an overview of the achievement of New Zealand Year 9 students in both mathematics and science relative to their international counterparts in 1998/99 as well as their own New Zealand counterparts in 1994/95. Chapter 3 will focus on trends in New Zealand Year 9 students' mathematics achievement within a New Zealand context.