MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Mathematics and Science Achievement In New Zealand

First results from the Trends in International Mathematics and Science Study (TIMSS) 2002-2003 for Year 5 students

YEAR 5

The Trends in International Mathematics and Science Study, 2002-2003 (TIMSS-02/03) is the third cycle of this international study of mathematics and science achievement conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA). The study was administered in New Zealand and other Southern Hemisphere countries in late 2002 and in Northern Hemisphere countries in early 2003. The study involved students equivalent to New Zealand's Year 5 and Year 9 students from 25 and 46 countries respectively. This report presents some of the main results for New Zealand at the Year 5 level, placed in an international context. There is a separate report for Year 9.

Key Points

Mathematics achievement

- New Zealand Year 5 students, on average, achieved at about the international mean in mathematics for the 25 countries participating in TIMSS-02/03 at the middle primary level.
- The New Zealand student mean in mathematics was similar to those reported for students in Australia and Scotland, but significantly[1] lower than the mean scores of students in 15 other countries, including England and the United States.
- New Zealand was one of six countries that recorded a significant improvement in mean mathematics achievement between TIMSS-94/95 and TIMSS-02/03. Other countries in this group were Hong Kong (SAR), Latvia, England, Cyprus and Slovenia.

Science achievement

- New Zealand Year 5 students, on average, achieved significantly above the international mean in science across the 25 countries in TIMSS-02/03.
- The New Zealand mean science score was similar to that recorded for students in the Russian Federation, the Netherlands, Australia, Belgium (Flemish) and Italy, but significantly lower than the means for students in eight other countries, including England and the United States.
- New Zealand was one of nine countries reporting a significant increase in mean science achievement between TIMSS-94/95 and TIMSS-02/03. England, Hong Kong (SAR) and Singapore were also in this group.

Students, classroom and school context

- About half of the New Zealand Year 5 students in TIMSS-02/03 expressed a high level of self-confidence in mathematics and science. This was similar to the proportion across all countries, but lower than the proportions of Australian, American and Dutch students.

The remaining key points for Maths and Science continue on the next page ...

1. *The use of the term 'significant' refers to statistical significance at the 0.05 level.*

- New Zealand students in middle primary generally enjoyed learning mathematics and science, as did their Australian and American counterparts. There was a significant increase between TIMSS-94/95 and TIMSS-02/03 in the proportions of New Zealand students who reported enjoying these subjects 'a lot'.
- Proportionally more Year 5 students in New Zealand attended schools where principals' perceptions of the school climate were more positive than was observed internationally.
- There has been a significant increase between 1994 and 2002 in the proportion of New Zealand Year 5 students who attended schools where principals felt that resource shortages had no or minimal impact on the schools' ability to provide instruction in either mathematics or science.

The background to TIMSS-02/03

TIMSS-02/03 was the third in a cycle of studies designed to measure trends in mathematics and science at the middle primary and lower secondary levels. It involved 46 countries or education systems at the lower secondary level, and 25 of these also participated at the middle primary level.[2] This cycle was carried out in Southern Hemispheres countries in late 2002 and in Northern Hemisphere countries in early 2003.[3] In New Zealand TIMSS-02/03 involved approximately 4300 Year 5[4] and 3800 Year 9 students, plus 600 teachers, from a total of 390 schools.

The first cycle, referred to as TIMSS-94/95, was administered at three educational levels during 1994 and 1995. TIMSS-98/99, the second study administered in New Zealand in late 1998, was not as extensive as TIMSS-94/95 as the focus was on Grade 8 (Year 9 equivalent) students only.[5]

TIMSS-02/03 examines student achievement by:

- comparing students' achievement with their overseas counterparts in TIMSS-02/03 (*international* comparison), and
- comparing students' achievement with their national counterparts in TIMSS-94/95 and, in the case of Year 9 students, with their TIMSS-98/99 counterparts (*historical* trend).

The publication *TIMSS Assessment Frameworks and Specifications*[6] provides a foundation for the TIMSS-02/03 assessment as well as future cycles. The frameworks define the content and cognitive skills to be assessed with a particular focus on objectives specific to the international Grades 4 and 8 (Years 5 and 9). They also encompass the mathematics and science curricular goals regarded as important in most participating countries, and, therefore, represent a consensus among participating countries about the mathematics and science that students at these educational levels should be expected to have learned.

TIMSS Assessment Frameworks and Specifications also describes the contextual framework associated with students' learning, as well as providing an overview of the design of the assessment.[7]

2. *A full list of the participating countries and education systems can be found at the end of this report. There were also four benchmarking participants in this cycle.*
3. *The Comparative Education Research Unit was responsible for carrying out the TIMSS-02/03 activities in New Zealand. This unit is located within the Research Division of the Ministry of Education.*
4. *Year 5 was defined as those students who had three further years of primary education to complete before entering secondary school in 2006.*
5. *New Zealand also chose to do a replication of the middle primary 1994-1995 assessment for Year 5 students in 1998.*
6. *Mullis et al (2004). Please refer to end of this report for details of the full reference for the framework.*
7. *Calculators were not permitted at the Grade 4 level.*

This summary is divided into two sections. The first section looks at the student outcomes[8] in terms of both Year 5 student achievement, often referred to as the *attained curriculum*, and student attitudes. The second section focuses on the contextual information that is an important aid in the interpretation of the student outcome results. Here, aspects of some of the national-level contextual information (the *intended curriculum*) are presented, as well as information on the classroom and school contexts in which learning was taking place (the *implemented curriculum*).

SECTION 1

Achievement in mathematics for Year 5 students

As shown in Figure 1, the mean mathematics score for New Zealand Year 5 students was close to the international country mean[9]. They scored an average of 493 scale score points[10], which was not significantly different from the international mean of 495. Nor were the means for students in Australia and Scotland significantly different from the mean for all countries combined. In contrast, the mean mathematics scores for 14 of the 25 countries that took part in TIMSS-02/03 at this level, including Singapore, the Netherlands, England and the United States, were significantly higher than the international mean. Norway and the Philippines were two of the seven countries that scored significantly below the international mean score in mathematics.

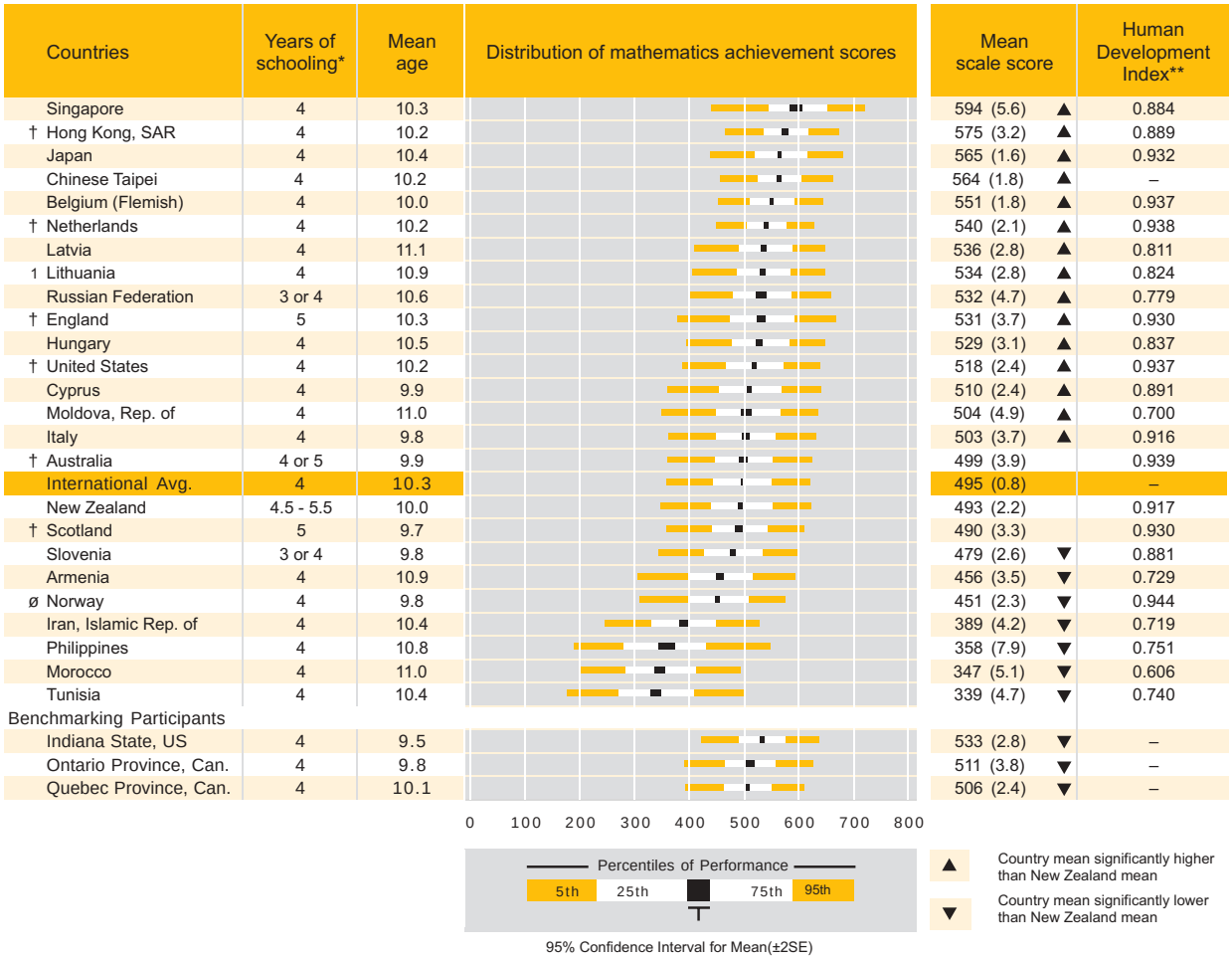
New Zealand's mean mathematics score can also be compared with the mean scores of other countries. New Zealand's performance was not significantly different from that of Australia and Scotland, but it was significantly lower than the performance of 15 countries including Singapore, the Netherlands, England and the United States.

8. *TIMSS was designed to measure achievement in content as well as in the use of particular cognitive skills, such as reasoning and conceptual understanding. Achievement results for the cognitive domains are to be reported internationally in 2005.*

9. *The international country mean (hereafter referred to as the 'international mean') was obtained by averaging the mean scale scores for each of the 25 countries.*

10. *Item Response Theory (IRT) scale scores summarise the achievement results on a scale using information on the characteristics of both the test items and students taking the test. For further details, readers should refer to the TIMSS 2003 Technical Report referenced at the end of this report.*

Figure 1: Distribution of middle primary mathematics achievement in TIMSS-02/03



Countries	Years of schooling*	Mean age	Mean scale score	Human Development Index**
Singapore	4	10.3	594 (5.6) ▲	0.884
† Hong Kong, SAR	4	10.2	575 (3.2) ▲	0.889
Japan	4	10.4	565 (1.6) ▲	0.932
Chinese Taipei	4	10.2	564 (1.8) ▲	–
Belgium (Flemish)	4	10.0	551 (1.8) ▲	0.937
† Netherlands	4	10.2	540 (2.1) ▲	0.938
Latvia	4	11.1	536 (2.8) ▲	0.811
1 Lithuania	4	10.9	534 (2.8) ▲	0.824
Russian Federation	3 or 4	10.6	532 (4.7) ▲	0.779
† England	5	10.3	531 (3.7) ▲	0.930
Hungary	4	10.5	529 (3.1) ▲	0.837
† United States	4	10.2	518 (2.4) ▲	0.937
Cyprus	4	9.9	510 (2.4) ▲	0.891
Moldova, Rep. of	4	11.0	504 (4.9) ▲	0.700
Italy	4	9.8	503 (3.7) ▲	0.916
† Australia	4 or 5	9.9	499 (3.9)	0.939
International Avg.	4	10.3	495 (0.8)	–
New Zealand	4.5 - 5.5	10.0	493 (2.2)	0.917
† Scotland	5	9.7	490 (3.3)	0.930
Slovenia	3 or 4	9.8	479 (2.6) ▼	0.881
Armenia	4	10.9	456 (3.5) ▼	0.729
ø Norway	4	9.8	451 (2.3) ▼	0.944
Iran, Islamic Rep. of	4	10.4	389 (4.2) ▼	0.719
Philippines	4	10.8	358 (7.9) ▼	0.751
Morocco	4	11.0	347 (5.1) ▼	0.606
Tunisia	4	10.4	339 (4.7) ▼	0.740
Benchmarking Participants				
Indiana State, US	4	9.5	533 (2.8) ▼	–
Ontario Province, Can.	4	9.8	511 (3.8) ▼	–
Quebec Province, Can.	4	10.1	506 (2.4) ▼	–

* Represents years of schooling counting from the first year of ISCED Level 1.
** Taken from United Nations Development Program's
† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.8).
1 National Desired Population does not cover all of International Desired Population (see Exhibit A.5).
ø Norway: 4 years of formal schooling, but First Grade is called "First grade/Preschool."
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear incon
A dash (–) indicates comparable data are not available.

Source: Exhibits 1.1 and 1.2 in Mullis, et al (2004) with minor adaptations

Trends in mathematics achievement[11]

New Zealand was one of 15 countries that took part in both TIMSS-94/95 and TIMSS-02/03 at the middle primary level. Six of these, including New Zealand, were found to have a significant increase in their mean mathematics achievement over the eight year period between the two studies. The five other countries were Hong Kong (SAR), Latvia, England, Cyprus and Slovenia. Singapore, Hungary, Australia and Iran recorded small, non-significant increases in mean achievement. Of the remaining trend countries, the Netherlands and Norway reported significant decreases, Japan and Scotland non-significant decreases, and the United States no change. These data are presented in Table 1. Note that, despite New Zealand's improved performance between the two studies, an initial examination of mean mathematics scores for the 15 countries indicates that New Zealand's performance relative to the country average for these trend countries remains largely unchanged.

Table 1: Trends in mathematics achievement at middle primary level for selected countries

	Mean mathematics score (s.e.)		
Countries	**1994/95**	**2002/03**	**Overall change 1995-2003**
England	484 (3.3)	531 (3.7)	▲ 47 (5.0)
New Zealand	**469 (4.4)**	**496 (2.1)**	**▲ 26 (4.9)**
Hong Kong (SAR)	557 (4.0)	575 (3.2)	▲ 18 (5.0)
Australia	495 (3.4)	499 (3.9)	4 (5.2)
Singapore	590 (4.5)	594 (5.6)	4 (7.2)
United States	518 (2.9)	518 (2.4)	0 (3.8)
Japan	567 (1.9)	565 (1.6)	- 3 (2.5)
Scotland	493 (4.2)	490 (3.3)	-3 (5.3)
Netherlands	549 (3.7)	540 (2.1)	▼ -9 (3.7)
Norway	476 (3.0)	451 (2.3)	▼ -25 (3.7)

Notes:
▲ = *increase in mean achievement was significant.*
▼ = *decrease in mean achievement was significant.*
Standard errors are in parentheses. Because results are rounded to the nearest whole number some totals may appear inconsistent.

Source: Exhibit 1.3 in Mullis, et al (2004)

International benchmarks in mathematics[12]

The TIMSS-02/03 mathematics scale summarises student performance on test items designed to measure a wide range of student knowledge and understanding. Four points on each scale were identified by the international mathematics expert group for use as international benchmarks at the middle primary level.[13]

[11] *In order to be able to make comparisons across cycles, the IRT scaling methods employed enabled the achievement results to be placed on the same scale.*

[12] *A scale anchoring exercise was undertaken by the international researchers in order to describe performance at these benchmarks.*

[13] *The mathematics benchmarks in previous cycles were defined at the 90th, 75th, 50th, and 25th percentiles using achievement information from all countries.*

The International Mathematics Benchmarks for Grade 4 (Year 5)

- The **Advanced** benchmark corresponds to a score of 625 or above. Students reaching this benchmark can apply their understanding and knowledge in a wide variety of relatively complex situations. They demonstrate a developing understanding of fractions and decimals and the relationship between them. They can select appropriate information to solve multi-step word problems involving proportions. They can formulate or select a rule for a relationship. They show understanding of area and can use measurement concepts to solve a variety of problems. They show some understanding of rotation. They can organise, interpret, and represent data to solve problems.

- The **High** benchmark corresponds to a score at or above 550. Students can apply their knowledge and understanding to solve problems. They can solve multi-step word problems involving addition, multiplication, and division. They can use their understanding of place value and simple fractions to solve problems. They can identify a number sequence that represents situations. Students show understanding of three-dimensional objects, how shapes can make other shapes, and simple transformation in a plane. They demonstrate a variety of measurement skills and can interpret and use data in tables and graphs to solve problems.

- The **Intermediate** benchmark corresponds to a score of 475 or above. Students can apply basic mathematical knowledge in a straightforward situation. They can read, interpret, and use different representations of numbers. They can perform operations with three- and four-digit numbers and decimals. They can extend simple patterns. They are familiar with a range of two-dimensional shapes and read and interpret different representations of the same data.

- The **Low** benchmark corresponds to a score at or above 400. Students have some basic mathematical knowledge. They demonstrate an understanding of whole numbers and can do simple computations with them. They demonstrate familiarity with basic properties of triangles and rectangles. They can read information from simple bar graphs.

Source: Exhibit 2.1 in Mullis, et al (2004)

Year 5 student performance against international mathematics benchmarks

The proportions of New Zealand Year 5 students achieving at or above the international benchmarks for mathematics in TIMSS-02/03 are presented in Table 2. As a comparison, the proportions of Year 5 students in TIMSS-94/95 reaching the percentile-defined benchmarks are also shown, as well as the corresponding data for all trend countries combined. There were significantly higher proportions of New Zealand students reaching High, Intermediate and Low benchmarks in 2002/03 relative to 1994/95, but virtually no difference in the proportions reaching the Advanced benchmark. The same pattern was observed internationally. The distribution of New Zealand Year 5 students across the benchmark categories was similar to that observed in Australia and Scotland. England recorded significant increases on all four benchmarks, as well as higher proportions of students at each level than was evident in New Zealand.

Table 2: Trends in the proportions of middle primary students achieving *at or above* the international mathematics benchmarks

International Benchmark	New Zealand students (%)		International mean (%)*	
	1994/95	2002/03	1994/95	2002/03
Advanced (625)	4	5	10	10
High (550)	19	27 ▲	33	36 ▲
Intermediate (475)	51	62 ▲	63	69 ▲
Low (400)	78	86 ▲	85	88 ▲

Note:

* *The international mean is calculated for the 15 trend countries that participated in TIMSS-94/95 and TIMSS-02/03.*

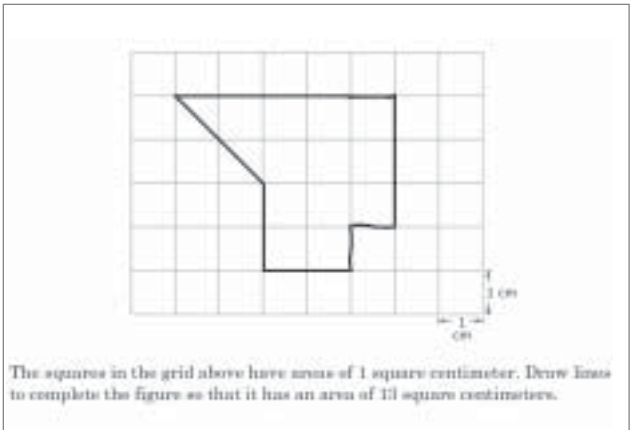
▲ = *The proportion of students reaching the benchmark in 2002 was significantly higher than the proportion reaching this benchmark in 1994.*

Source: Exhibit 2.4 in Mullis, et al (2004)

Figures 2 and 3 are examples of mathematics questions that Year 5 students achieving at or above the *Advanced* and *Intermediate* benchmarks were likely to have answered correctly. The proportions of students answering the questions correctly are presented alongside for a selection of countries. The content of both questions was judged to be in the *intended* curriculum for New Zealand Year 5 students.

Figure 2: Mathematics assessment question that students at or above the Advanced international benchmark were likely to have answered correctly[14]

Content Area: Measurement
Description: Completes an irregular figure on a grid so that it has a given area



Country	Percentage of students gaining full credit
Japan	68 (2.1) ▲
Hong Kong (SAR)	52 (2.8) ▲
Singapore	43 (2.2) ▲
Netherlands	37 (2.6) ▲
International mean	**29 (0.4)**
Scotland	29 (2.4)
England	29 (2.3)
Australia	29 (2.2)
Belgium (Flemish)	28 (2.2)
United States	24 (1.7) ▼
New Zealand	15 (1.6) ▼
Norway	10 (1.6) ▼

▲ country percentage significantly higher than international mean.

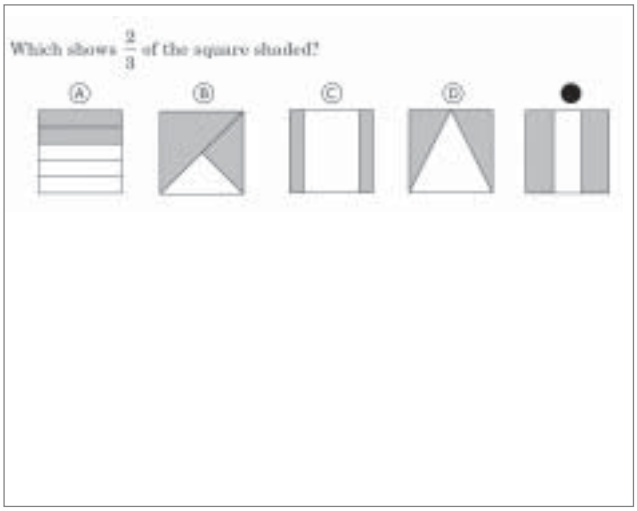
▼ country percentage significantly lower than international mean.

Source: Exhibit 2.18 in Mullis, et al (2004)

[14] *International version of the item is presented in the figure.*

Figure 3: Mathematics assessment question that students at or above the Intermediate international benchmark were likely to have answered correctly[15]

Content Area: Number
Description: Recognises a familiar fraction represented by a figure with shaded parts (region model).



Selected countries	Percentage of students gaining full credit
Singapore	93 (1.0) ▲
Hong Kong (SAR)	86 (1.7) ▲
United States	82 (1.1) ▲
Belgium (Flemish)	79 (1.8) ▲
Japan	76 (1.5) ▲
Netherlands	73 (2.1) ▲
England	67 (2.2) ▲
Australia	62 (2.2) ▲
New Zealand	59 (2.2)
International mean	**57 (0.4)**
Scotland	52 (2.2) ▼

▲ country percentage significantly higher than international mean.
▼ country percentage significantly lower than international mean.

Source: Exhibit 2.23 in Mullis, et al (2004)

Mathematics achievement and gender

On average, internationally as well as in New Zealand, there was virtually no difference between the performance of girls and boys on the TIMSS-02/03 mathematics assessments. Of the nine countries where a statistically significant gender difference was observed, five (the Netherlands, the United States, Italy, Cyprus and Scotland) reported differences in favour of boys and four (Singapore, Moldova, the Philippines and Armenia) reported differences in favour of girls.

Six of the 15 trend countries, including New Zealand, recorded significant increases in performance for both boys and girls over the eight year period from 1994/95 to 2002/03. Other countries reporting improved performances were Cyprus, England, Hong Kong (SAR), Latvia (LSS) and Slovenia. Internationally, across the trend countries, there was also a significant increase for both boys and girls between the two studies (Table 3).

Table 3: Trends in middle primary students' mean mathematics achievement, by gender

	New Zealand mean scores (s.e.)		International mean scores (s.e.)*	
	1994/95	**2002/03**	**1994/95**	**2002/03**
Girls	474 (4.3)	495 (2.8) ▲	501 (n.a.)	512 (0.9) ▲
Boys	465 (6.1)	496 (2.4) ▲	505 (n.a.)	515 (1.0) ▲

Notes:
* *The international mean is calculated for the 15 trend countries that participated in TIMSS-94/95 and TIMSS-02/03.*
▲ = *increase in mean achievement was significant.*
Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Source: 1994 mean scores, Chamberlain & Walker (2001); Exhibit 1.5 in Mullis, et al. (2004)

[15] *International version of the item is presented in the figure.*

Achievement in the mathematics content areas

Content scale scores were calculated separately from the overall mathematics score in order to provide additional information for countries around curricular variations within mathematics. More importantly, these content scale scores allow each country to examine their relative strengths and weaknesses across content areas within a subject.

At the middle primary level the TIMSS-02/03 mathematics assessment consisted of the following five content areas:

- Number
- Patterns and Relationships
- Measurement
- Geometry
- Data

New Zealand Year 5 students achieved significantly above the international means in *Measurement, Geometry* and *Data,* at the international mean for *Patterns and Relationships* and significantly lower than the mean in *Number*. The performance of New Zealand students in each of the five content areas was broadly similar to that of middle primary students in Australia and Scotland. The data for New Zealand reveal a relative strength in *Geometry* and *Data* and a weakness in *Number*.

The only significant gender difference observed in the mathematics content areas in New Zealand was in *Geometry* where girls achieved higher scores than did boys. This gender difference was also evident in Australia, as well as internationally. However, across all countries, boys performed significantly better than girls in *Measurement* and *Data*.

There were insufficient trend items to calculate trend data at the Year 5 level for mathematics content areas.

Achievement in science for Year 5 students

New Zealand Year 5 students achieved, on average, significantly above the international mean for science (520 points compared with 489). Students in 15 other countries, including Singapore, the United States, England, the Netherlands and Australia, also recorded mean science scores significantly higher than that reported for all countries combined. The mean scores for Moldova and Slovenia were not significantly different from the international mean, whereas mean achievement scores for seven countries, such as Norway and the Philippines, were significantly below the mean across all countries. Figure 4 shows the distribution of science achievement scores for the 25 countries.

The comparison of New Zealand's performance in science with that of other countries is also shown in Figure 4. New Zealand's mean science achievement was not statistically different from the means of five countries including Australia and the Netherlands. It was, however, significantly lower than those of eight countries such as Singapore, England, and the United States.

Figure 4: Distribution of middle primary science achievement in TIMSS-02/03

Countries	Years of Schooling*	Mean age	Distribution of science achievement scores	Mean scale score	Human Development Index**
Singapore	4	10.3		565 (5.5) ▲	0.884
Chinese Taipei	4	10.2		551 (1.7) ▲	–
Japan	4	10.4		543 (1.5) ▲	0.932
† Hong Kong, SAR	4	10.2		542 (3.1) ▲	0.889
† England	5	10.3		540 (3.6) ▲	0.930
† United States	4	10.2		536 (2.5) ▲	0.937
Latvia	4	11.1		532 (2.5) ▲	0.811
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† Australia	4 or 5	9.9		521 (4.2)	0.939
New Zealand	4.5 - 5.5	10.0		520 (2.5)	0.917
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Philippines	4	10.8		332 (9.4) ▼	0.751
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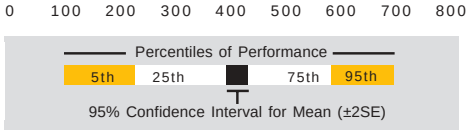
Morocco	4	11.0		304 (6.7) ▼	0.606
Benchmarking Participants					
Indiana State, US	4	9.5		553 (3.7) ▲	–
Ontario Province, Can.	4	9.8		540 (3.7) ▲	–
Quebec Province, Can.	4	10.1		500 (2.5) ▼	–



▲ Country mean significantly higher than New Zealand mean

▼ Country mean significantly lower than New Zealand mean

* Represents years of schooling counting from the first year of ISCED Level 1.

** Taken from United Nations Development Program's

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.8).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.5).

ø Norway: 4 years of formal schooling, but First Grade is called "First grade/Preschool."

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

A dash (–) indicates comparable data are not available.

Source: Exhibits 1.1 and 1.2 in Martin, et al (2004), with minor adaptations

Trends in science achievement[16]

As shown in Table 4, New Zealand was one of nine trend countries reporting a significant increase in mean science achievement over the eight years between the two TIMSS studies. Other countries in this group included Singapore, Hong Kong (SAR) and England. In contrast, Japan, Scotland and Norway had significant decreases in mean science achievement between 1994/95 and 2002/03, while the United States, the Netherlands and Australia recorded non-significant decreases. Furthermore, as well as New Zealand's improved performance between the two studies, an initial examination of mean science scores for the 15 countries indicates that New Zealand's performance relative to the country average for these trend countries has also improved.

Table 4: Trends in science achievement at middle primary level for selected countries

	Mean science score		
Countries	**1994/95**	**2002/03**	**Overall change 1995-2003**
Singapore	523 (4.8)	565 (5.5)	▲ 42 (7.3)
Hong Kong (SAR)	508 (3.3)	542 (3.1)	▲ 35 (4.5)
New Zealand	505 (5.3)	523 (2.3)	▲ 18 (5.8)
England	528 (3.1)	540 (3.6)	▲ 13 (4.8)
Australia	521 (3.8)	521 (4.2)	-1 (5.6)
Netherlands	530 (3.2)	525 (2.0)	-5 (3.5)
United States	542 (3.3)	536 (2.5)	-6 (4.2)
Japan	553 (1.8)	543 (1.5)	▼ -10 (2.3)
Scotland	514 (4.5)	502 (2.9)	▼ -12 (5.3)
Norway	504 (3.7)	466 (2.6)	▼ -38 (4.6)

Notes:
▲ = *increase in mean achievement was significant.*
▼ = *decrease in mean achievement was significant.*
Standard errors are in parentheses. Because results are rounded to the nearest whole number some totals may appear in consistent.

Source: Exhibit 1.3 in Martin, et al (2004)

International benchmarks in science[17]

As with mathematics, the TIMSS-02/03 science scale summarises student performance on test items designed to measure a wide range of student knowledge and understanding. Four points on each scale were identified by the international science expert group for use as international benchmarks at the middle primary level.[18]

16. *In order to be able to make comparisons across cycles, the IRT scaling methods employed enabled the achievement results to be placed on the same scale.*
17. *A scale anchoring exercise was undertaken by the international researchers in order to describe performance at these benchmarks.*
18. *As with mathematics, the science benchmarks in previous cycles were defined at the 90th, 75th, 50th, and 25th percentiles using achievement information from all countries.*

The International Science Benchmarks for Grade 4 (Year 5)

- The **Advanced** benchmark corresponds to a scale score at or above 625. Students can apply knowledge and understanding in beginning scientific inquiry. They demonstrate some knowledge of Earth's features and processes and the solar system. They can communicate their understanding of structure, function, and life processes in organisms and classify organisms according to major physical and behavioural features. They demonstrate some understanding of physical phenomena and properties of common materials. Students demonstrate beginning scientific inquiry knowledge and skills.

- The **High** benchmark corresponds to a score of 550 or above. Students can apply knowledge and understanding to explain everyday phenomena. They demonstrate some knowledge of Earth structure and processes and the solar system and some understanding of plant structure, life processes, and human biology. They demonstrate some knowledge of physical states, common physical phenomena, and chemical changes. They provide brief descriptions and explanations of some everyday phenomena and compare, contrast, and draw conclusions.

- The **Intermediate** benchmark corresponds to a score at or above 475. Students can apply basic knowledge and understanding to practical situations in the sciences. They demonstrate knowledge of some basic facts about Earth's features and processes and the solar system. They recognise some basic information about human biology and health and show some understanding of development and life cycles of organisms. They know some basic facts about familiar physical phenomena, states, and changes. They apply factual knowledge to practical situations, interpret pictorial diagrams, and combine information to draw conclusions.

- The **Low** benchmark corresponds to a score of 400 or above. Students have some elementary knowledge of earth, life and physical sciences. They recognise simple facts presented in everyday language and context about Earth's physical features, the seasons, the solar system, human biology, and the development and characteristics of animals and plants. They recognise facts about a range of familiar physical phenomena - rainbows, magnets, electricity, boiling, floating, and dissolving. They interpret labelled pictures and simple pictorial diagrams and provide short written responses to questions requiring factual information.

Source: Exhibit 2.1 in Martin, et al (2004)

Year 5 performance against international science benchmarks

The proportions of New Zealand Year 5 students achieving at or above the international benchmarks for science in TIMSS-02/03 are shown in Table 5, along with the corresponding 1994 data and the international comparisons. Across all countries, there was a significant increase in the proportion of students reaching the High, Intermediate and Low benchmarks, but a decrease in those reaching the Advanced benchmark. Significantly more New Zealand students achieved at or above the Intermediate and Low benchmarks in 2002 than occurred in 1994. The proportions reaching each benchmark in New Zealand were similar to those reported by Australia, while England and the United States recorded proportionally more students than did New Zealand at each benchmark.

Table 5: Trends in the proportions of middle primary students *at or above* the TIMSS international science benchmarks

International Benchmark	New Zealand students (%)		International mean (%)*	
	1994/95	2002/03	1994/95	2002/03
Advanced (625)	11	9	9	8 ▼
High (550)	35	39	32	35 ▲
Intermediate (475)	66	74 ▲	63	71 ▲
Low (400)	85	92 ▲	85	90 ▲

Notes:

* *The international mean is calculated for the 15 trend countries that participated in TIMSS-94/95 and TIMSS-02/03.*

▲ = *The proportion of students reaching the benchmark in 2002 was significantly higher than the proportion reaching this benchmark in 1994.*

▼ = *The proportion of students reaching the benchmark in 2002 was significantly lower than the proportion reaching this benchmark in 1994.*

Source: Exhibit 2.4 in Martin, et al (2004)

Figures 5 and 6 are examples of science questions that Year 5 students achieving at or above the *Advanced* and *Intermediate* benchmarks were likely to have answered correctly. The proportions of students answering the questions correctly are presented alongside for a selection of countries. The content of both questions was judged to be in the *intended* curriculum for New Zealand Year 5 students.

Figure 5: Science assessment question that students at or above the Advanced international benchmark were likely to have answered correctly[19]

Content Area: Physical Science
Description: Interprets information from a table of physical properties of three materials to identify wood, rock and iron.

The properties of three materials are compared in the table below. One of the materials is wood, one is rock and one is iron.

Property	Material 1	Material 2	Material 3
Sinks in water?	Yes	No	Yes
Burns easily?	No	Yes	No
Attracted by a magnet?	Yes	No	No

Identify the three materials by filling in the spaces below.

Wood is material number: 2

Rock is material number: 3

Iron is material number: 1

Country	Percentage of students gaining full credit
Singapore	74 (2.3) ▲
Japan	69 (1.6) ▲
Netherlands	59 (2.7) ▲
Hong Kong (SAR)	58 (2.7) ▲
England	53 (2.5) ▲
Belgium (Flemish)	52 (2.4) ▲
Australia	39 (2.8) ▲
United States	39 (1.7) ▲
International mean	**38 (0.4)**
Scotland	38 (2.6)
New Zealand	37 (1.9)
Norway	25 (2.0) ▼

▲ country percentage significantly higher than international mean.

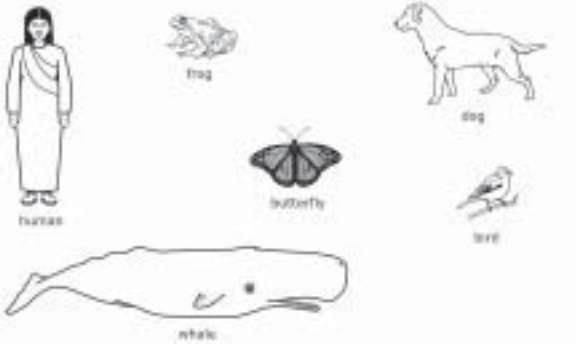
▼ country percentage significantly lower than international mean.

Source Exhibit 2.19 in Martin, et al (2004)

[19] *International version of the item is presented in the figure.*

Figure 6: Science assessment question that students at or above the Intermediate international benchmark were likely to have answered correctly[20]

Content Area: Life Science
Description: Given a diagram of six organisms, classifies them into those that give birth and those that lay eggs.



Some of the organisms shown above give birth to young that develop inside the mother. Some of the organisms have young that hatch from eggs that are laid outside the mother.

In the table below, write down the names of the organisms that belong to each group.

Organisms that give birth	Organisms that lay eggs
Human Dog Whale	Frog Butterfly Bird

Country	Percentage of students gaining full credit
Singapore	84 (1.3) ▲
United States	76 (1.1) ▲
New Zealand	74 (1.9) ▲
Netherlands	73 (2.5) ▲
Australia	72 (2.6) ▲
England	67 (2.0) ▲
Japan	67 (1.8) ▲
Belgium (Flemish)	63 (2.2) ▲
Scotland	59 (2.1)
Norway	58 (1.7)
Hong Kong (SAR)	58 (2.3)
International mean	**58 (0.4)**

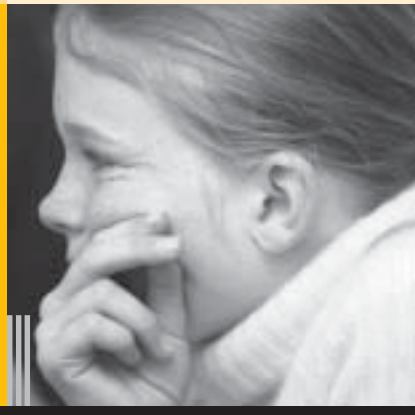
▲ country percentage significantly higher than international mean.
▼ country percentage significantly lower than international mean.

Source Exhibit 2.25 in Martin, et al (2004)

Science achievement and gender

There was virtually no difference, internationally, between boys' and girls' mean achievement in the TIMSS-02/03 science assessments. The small difference in favour of girls observed in New Zealand was not significant. However, in nine countries differences were large enough to be statistically significant. Differences in favour of boys were reported by the United States, Chinese Taipei, Cyprus, the Netherlands and Scotland, while differences in favour of girls were reported by Armenia, Moldova, the Philippines and Iran.

[20] *International version of the item is presented in the figure.*



Who carried out TIMSS-02/03?

The International Study Centre at Boston College's Lynch School of Education in the United States managed the international coordination of the project. The other organisations involved with the TIMSS activities were:

- Statistics Canada in Ottawa;
- the IEA Data Processing Centre in Hamburg (Germany); and
- the Educational Testing Service in Princeton, New Jersey (United States).

International TIMSS web site: www.timss.org

The Comparative Education Research Unit was responsible for carrying out the TIMSS activities in New Zealand. This unit is located within the Research Division of the Ministry of Education.

Sources for this summary

Mullis, I.V.S., Martin, M.O., Smith, T.A., Garden, R.A., Gregory K.D., Gonzalez, E.J., Chrostowski, S.J., and O'Connor, K.M. (2001). *TIMSS Assessment frameworks and specifications 2003*. Chestnut Hill, MA: International Study Center, Boston College.

Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., and Chrostowski, S.J. (2004). *TIMSS 2003 International Science Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. Chestnut Hill, MA: International Study Center, Boston College.

Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., and Chrostowski, S.J. (2004). *TIMSS 2003 International Mathematics Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. Chestnut Hill, MA: International Study Center, Boston College.

Also for additional technical information, readers should refer to:

Martin, M.O., Mullis, I.V.S., and Chrostowski, S.J. (Eds.) (2004). *TIMSS 2003 Technical Report*, Chestnut Hill, MA: International Study Center, Boston College.

New Zealand

For further information in New Zealand

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