

Highlights from TIMSS 2007 from Australia's perspective

Sue Thomson
Nicole Wernert
Catherine Underwood
Marina Nicholas



Highlights from the full report: Taking a closer look at mathematics and science in Australia



Who participated in TIMSS 2007?

Internationally

A total of 49 countries at Year 8 and 36 countries at Year 4 participated in TIMSS 2007. In addition four provinces of Canada, two states of the United States, Dubai Emirate, UAE and Basque Country, Spain, were also in the study as what are termed benchmarking participants*. These are shown in Figure 1.

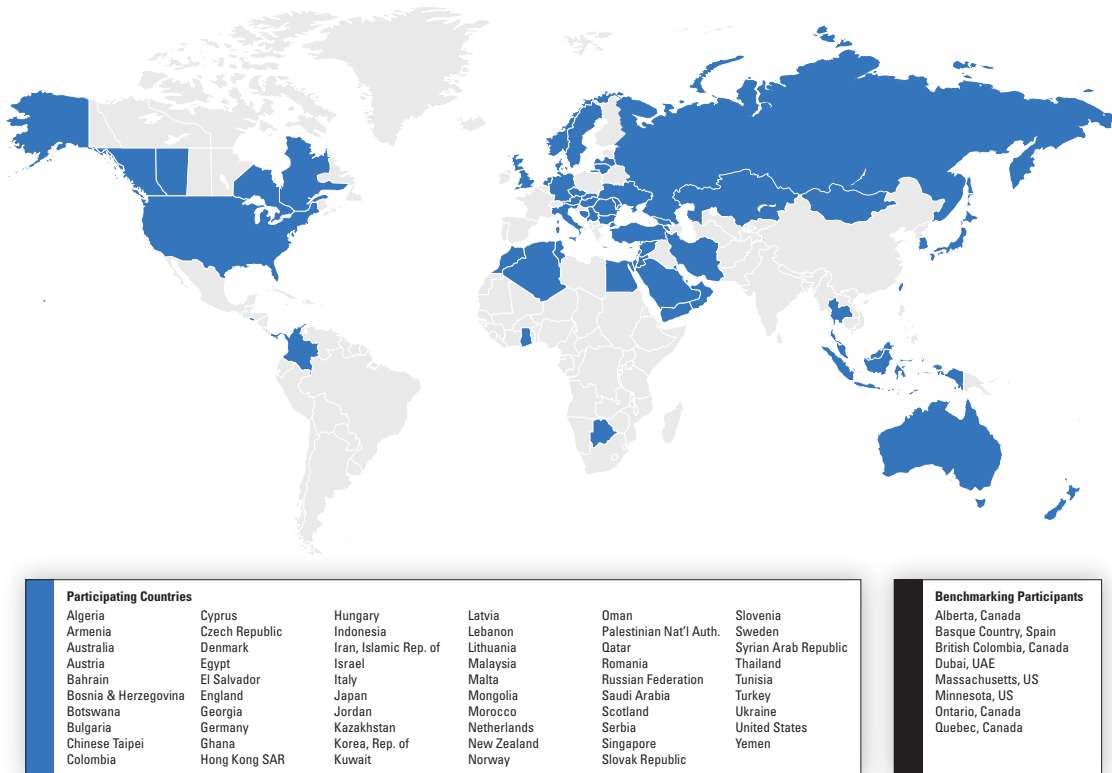


Figure 1 Map of participating countries

* Benchmarking participants are provinces or regions that participated in TIMSS for their own internal benchmarking purposes. Data from these regions are not included in the international average.

In Australia

A stratified random sample of 230 primary schools and 230 secondary schools was chosen in Australia, and of this sample 229 primary schools and 228 secondary schools participated in the data collection for TIMSS 2007. Table 1 provides the sample details for each of the states.

Figure 2 shows all schools in Australia (including those on Christmas Island, Norfolk Island and King Island) in light blue and all schools selected for TIMSS in black.

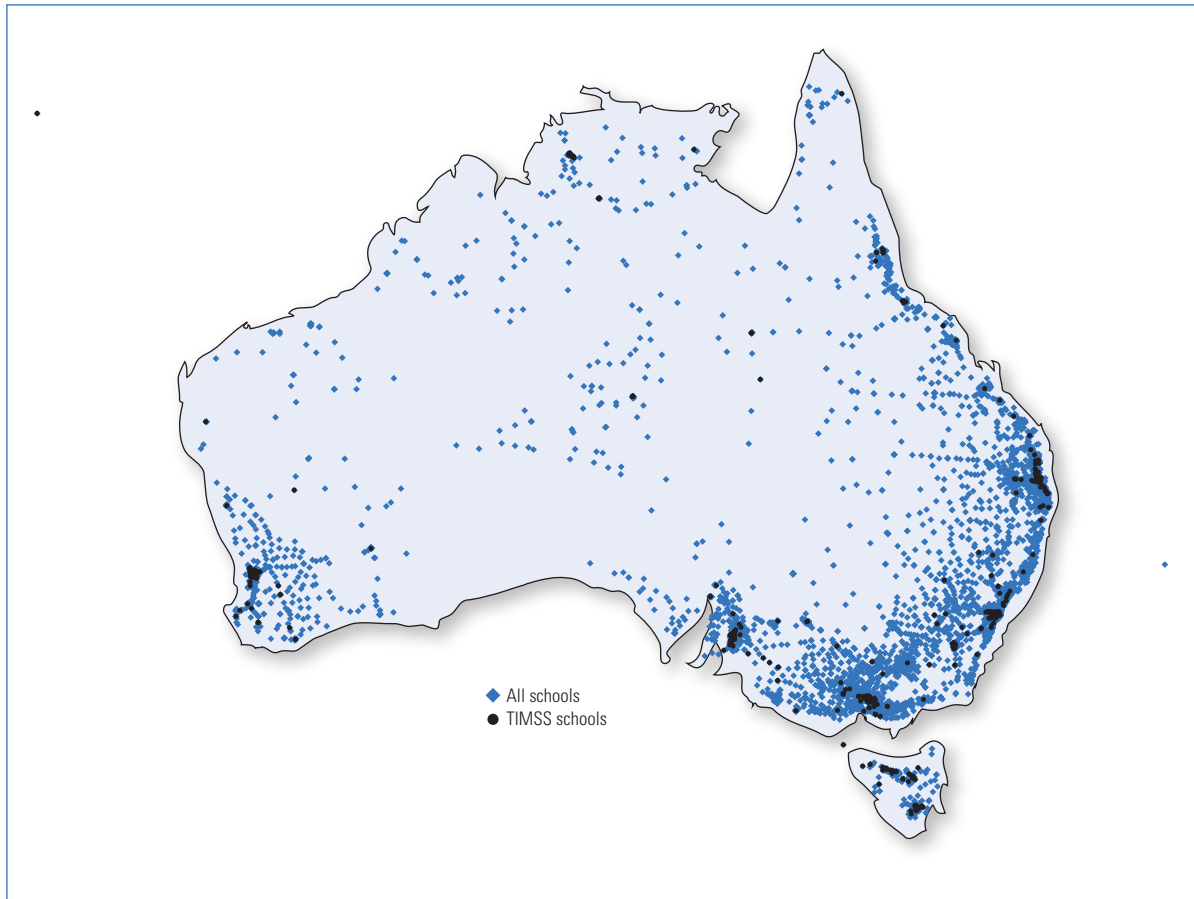


Figure 2 Australian schools and TIMSS sample schools

Table 1 Australian designed and achieved school sample

State	Designed school sample	Population 1				Population 2			
		N schools	N students	Weighted N	Weighted per cent	N schools	N students	Weighted N	Weighted per cent
NSW	40	40	832	81 108	34.67	39	716	81 880	32.02
VIC	35	35	559	58 945	25.2	35	598	61 401	24.01
QLD	35	35	849	49 463	21.15	35	648	50 442	19.73
SA	30	30	493	17 940	7.67	30	540	19 184	7.5
WA	30	29	477	13 956	5.97	30	548	28 513	11.15
TAS	30	30	446	5 988	2.56	30	510	7 417	2.9
NT	15	15	181	2 318	0.99	14	238	2 027	0.79
ACT	15	15	271	4 196	1.79	15	271	4 834	1.89
Total	230	229	4 108	233 914	100	228	4 069	255 699	100

What is TIMSS?

In 2007, Australia participated in the Trends in International Mathematics and Science Study (TIMSS 2007). TIMSS 2007 is the fourth in a cycle of internationally comparative assessments conducted under the aegis of the International Association for the Evaluation of Educational Achievement (IEA) dedicated to improving teaching and learning in mathematics and science for students around the world.

Carried out every four years at Year 4 and Year 8, TIMSS provides data about trends in mathematics and science achievement over time. In Australia, TIMSS is part of MCEETYA's National Assessment Program.

To inform educational policy in the participating countries, this world-wide assessment and research project also routinely collects extensive background information that addresses concerns about the quantity, quality, and content of instruction.

The internationally standard Student Questionnaire sought information on students and their family background, aspects of learning and instruction in science, and context of instruction.

The Teacher Questionnaire examined a variety of issues related to qualifications, pedagogical practices, teaching styles, use of technology, assessment and assignment of homework, and classroom climate.

The School Questionnaire, answered by the principal, sought descriptive information about the school and information about instructional practices. For example, questions were asked about recruitment of teachers and numbers of staff, teacher morale, school and teacher autonomy, school resources, and school policies and practices such as use of student assessments.

Some Explanatory Notes

Sample surveys

TIMSS is conducted as a sample survey in most countries. In surveys such as TIMSS a sample of students is selected to represent the population of students at a particular grade in that country. The samples are designed and conducted so that they provide reliable estimates about the population which they represent. Sample surveys are cheaper to undertake and less intrusive on schools than a full census of the particular population.

The basic sample design for TIMSS is generally referred to as a two-stage stratified cluster sample design. The first stage consisted of a sample of schools and the second stage consisted of a single mathematics classroom selected at random from the target year level in sampled schools.

The students in the selected classroom are representative of the students in the population and weights are used to adjust for any differences arising from intended features of the design (e.g. to over-sample minorities) or non-participation by students who were selected. In this way we can provide measures of achievement for the population, based on the responses of a sample of students, along with the confidence interval to indicate the precision of those measures.

What is the focus of TIMSS?

The main goal of TIMSS is to assist countries to monitor and evaluate their mathematics and science teaching across time and across year levels.

TIMSS has a curriculum focus. The three levels of the curriculum, which have been defined in previous studies, and considered in relation to the context in which they occur, are:

The *intended* curriculum – defined as the curriculum as specified at national or system level.

- *What are mathematics and science students around the world expected to learn?*
- *How do countries vary in their intended goals, and*
- *What characteristics of education systems, schools and students influence the development of these goals?*

The *implemented* curriculum – defined as the curriculum as interpreted and delivered by classroom teachers.

- *What opportunities are provided for students to learn mathematics and science?*
- *How do instructional practices vary among countries and*
- *What factors influence these variations?*

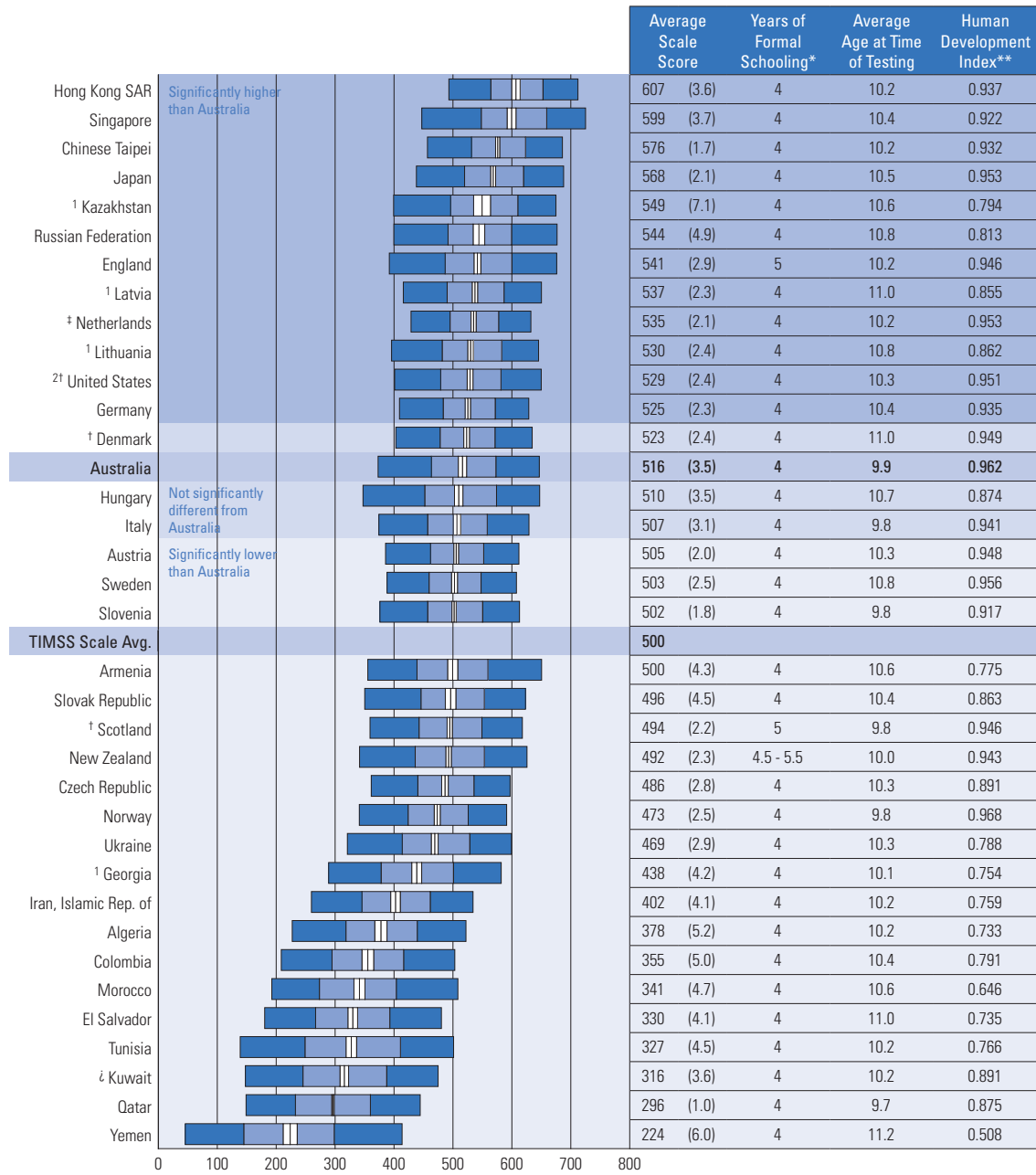
The *attained* curriculum – which is that part of the curriculum that is learned by students, as demonstrated by their attitudes and achievements.

- *What mathematics and science concepts, processes and attitudes have students learned?*
- *What factors are linked to students' opportunity to learn, and*
- *How do these factors influence students' achievements?*

How are mathematics and science assessed in TIMSS?

A content dimension and a cognitive dimension framed the mathematics and science assessment for TIMSS 2007, analogous to those used in the earlier TIMSS assessments. There are three content domains in mathematics and in science at Year 4 and four at Year 8. In addition there are three cognitive domains in each curriculum area: *knowing*, *applying* and *reasoning*. The two dimensions and their domains are the foundation of the mathematics and science assessments. The content domains define the specific subject matter covered by the assessment, and the cognitive domains define the sets of behaviours expected of students as they engage with the content.

What does TIMSS tell us about Year 4 mathematics?



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

** Taken from United Nations Development Programme's Human Development Report 2007/2008, p.229-232, except for Chinese Taipei taken from Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. Statistical Yearbook 2007. Data for England and Scotland are for the United Kingdom.

[†] Met guidelines for sample participation rates only after replacement schools were included.

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

¹ National Target Population does not include all of the International Target Population defined by TIMSS.

² National Defined Population covers 90% to 95% of National Target Population.

[‡] Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Figure 3 International achievement in mathematics – Year 4

- At Year 4, 17 of the TIMSS countries (Hong Kong through to Austria) scored significantly higher than the TIMSS mathematics scale average (500). Four countries scored at a similar level to the TIMSS scale average and 15 scored significantly lower. Hong Kong was the highest scoring country, outperforming all other participating countries.
- Australia's achievement score of 516 was significantly higher than the TIMSS scale average. Australia's performance was significantly higher than that of 20 countries, including Sweden and New Zealand, but below that of 12 countries, including most of the Asian countries and England and the United States.
- Australia's average Year 4 mathematics score in TIMSS 2007 was significantly higher than the achieved score in 2003.

Table 2 Multiple comparisons of average mathematics achievement by state, Year 4

			NSW	VIC	ACT	TAS	WA	SA	QLD	NT
	Mean	SE	534	532	513	510	493	493	485	484
	Mean	SE	(6.4)	(8.2)	(7.7)	(6.0)	(5.4)	(8.5)	(6.7)	(9.6)
New South Wales	534	(6.4)		●	▲	▲	▲	▲	▲	▲
Victoria	532	(8.2)	●		●	▲	▲	▲	▲	▲
Australian Capital Territory	513	(7.7)	▼	●		●	▲	●	▲	▲
Tasmania	510	(6.0)	▼	▼	●		▲	●	▲	▲
Western Australia	493	(5.4)	▼	▼	▼	▼		●	●	●
South Australia	493	(8.5)	▼	▼	●	●	●		●	●
Queensland	485	(6.7)	▼	▼	▼	▼	●	●		●
Northern Territory	484	(9.6)	▼	▼	▼	▼	●	●	●	

Note: Read across the rows to compare a state's performance with the performance of each state listed in the column headings.

▲ Average performance statistically significantly higher than comparison state

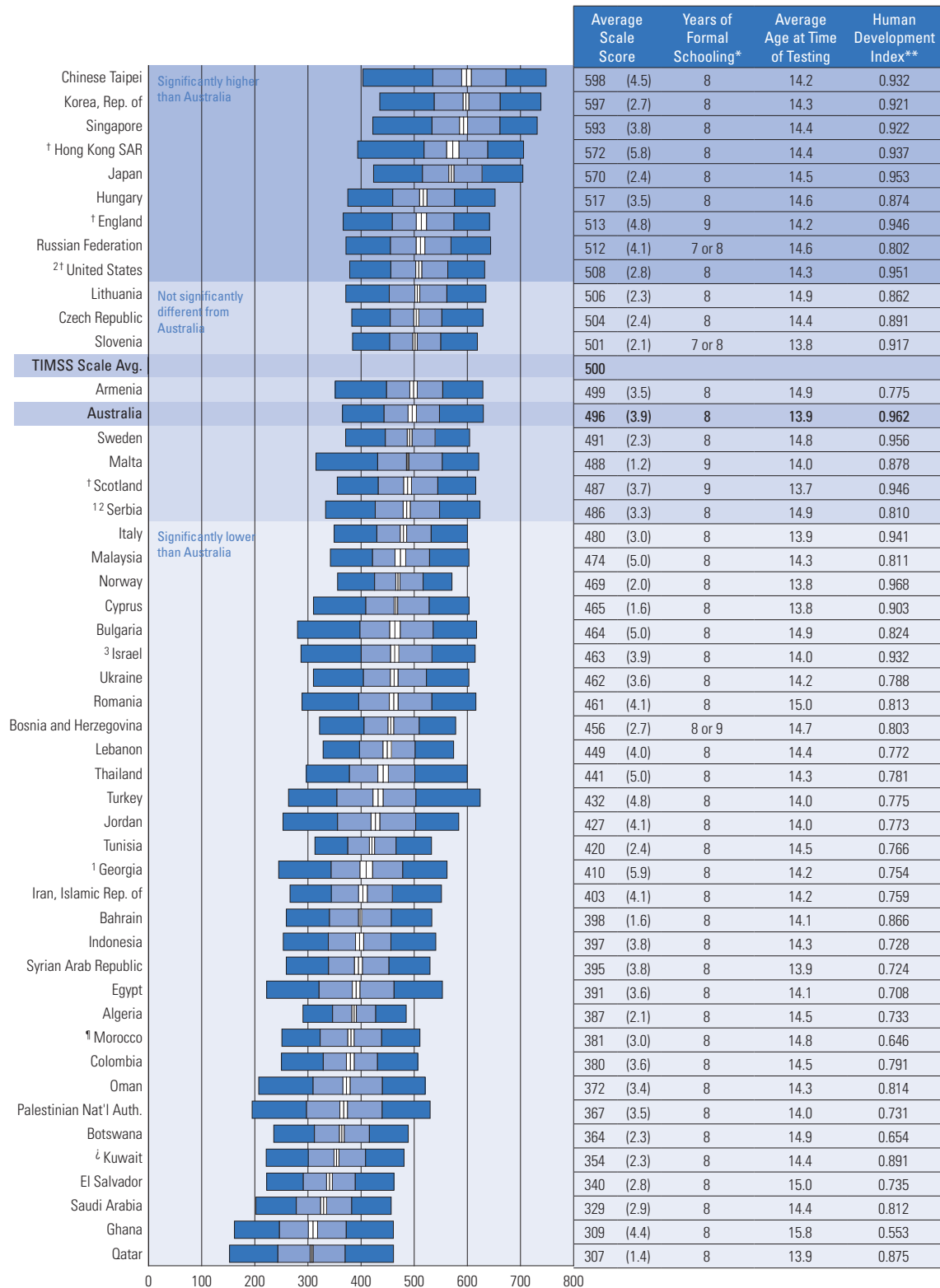
● Not statistically significantly different to comparison state

▼ Average performance statistically significantly lower than comparison state

Table 2 shows the statistical comparisons of the scores of students in each state.

There were some significant differences in Year 4 mathematics performance across the states. Students in New South Wales performed significantly better than students in all other states, except Victoria. Students in Victoria performed slightly below students in New South Wales, but significantly better than the remaining states, with the exception of the Australian Capital Territory, with which there was no statistically significant difference. Students from the Australian Capital Territory and Tasmania performed significantly better than students in Western Australia, Queensland and the Northern Territory.

What does TIMSS tell us about Year 8 mathematics?



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

** Taken from United Nations Development Programme's Human Development Report 2007/2008, p.229-232, except for Chinese Taipei taken from Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. Statistical Yearbook 2007. Data for England and Scotland are for the United Kingdom.

† Met guidelines for sample participation rates only after replacement schools were included.

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

¶ Did not satisfy guidelines for sample participation rates.

1 National Target Population does not include all of the International Target Population defined by TIMSS.

2 National Defined Population covers 90% to 95% of National Target Population.

3 National Defined Population covers less than 90% of National Target Population (but at least 77%).

‡ Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Figure 4 International achievement in mathematics – Year 8

- At Year 8, Chinese Taipei, Korea and Singapore scored the highest, about 100 score points higher than the TIMSS scale average. They were amongst 10 countries that scored higher than the TIMSS mathematics scale average (500). Four countries scored at a similar level to the TIMSS scale average (including Australia) and 35 scored significantly lower.
- Australia's mathematics achievement score of 496 was not significantly different to the TIMSS scale average. Nine countries achieved scores higher than Australia, including many of the Asian countries and England and the United States. Eight countries had scores not significantly different to Australia, while Australia scored significantly higher than the remaining 31 countries, including Italy, Malaysia and Norway.
- While Australia's score at Year 8 showed a statistically significant decrease of 13 score points from that of TIMSS 1995, there was no significant change from TIMSS 2003.

Table 3 Multiple comparisons of average mathematics achievement by state, Year 8

			ACT	VIC	NSW	QLD	SA	TAS	WA	NT
	Mean	SE	518	503	500	491	490	485	485	483
	Mean	SE	(22.4)	(8.5)	(10.0)	(4.9)	(6.7)	(6.8)	(8.3)	(13.9)
Australian Capital Territory	518	(22.4)		●	●	●	●	●	●	●
Victoria	503	(8.5)	●		●	●	●	●	●	●
New South Wales	500	(10.0)	●	●		●	●	●	●	●
Queensland	491	(4.9)	●	●	●		●	●	●	●
South Australia	490	(6.7)	●	●	●	●		●	●	●
Tasmania	485	(6.8)	●	●	●	●	●		●	●
Western Australia	485	(8.3)	●	●	●	●	●	●		●
Northern Territory	483	(13.9)	●	●	●	●	●	●	●	

Note: Read across the rows to compare a state's performance with the performance of each state listed in the column headings.

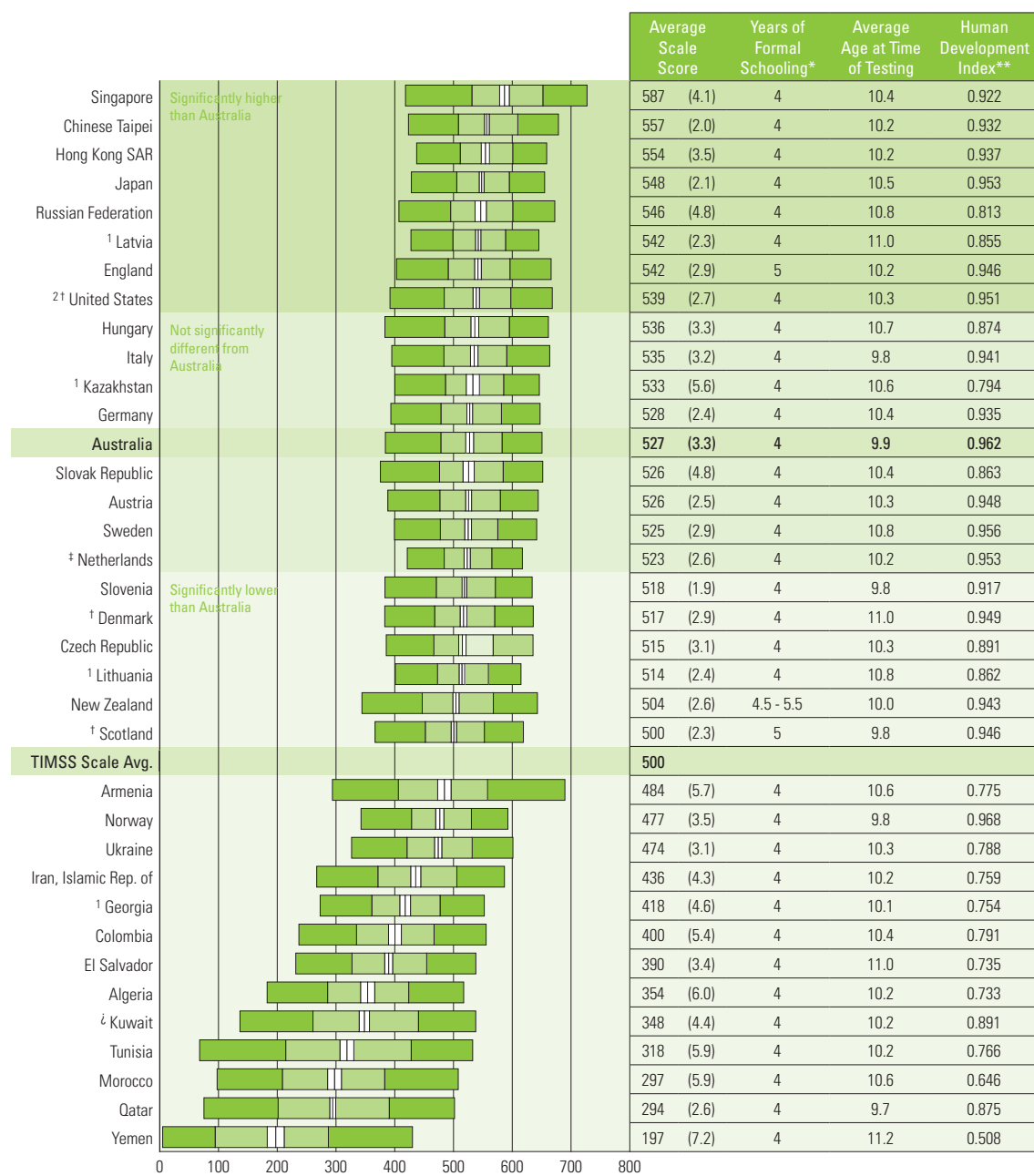
▲ Average performance statistically significantly higher than comparison state

● Not statistically significantly different to comparison state

▼ Average performance statistically significantly lower than comparison state

As can be seen in Table 3, there was little variation and no significant differences between the states in terms of average Year 8 mathematics scores.

What does TIMSS tell us about Year 4 science?



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

** Taken from United Nations Development Programme's Human Development Report 2007/2008, p.229-232, except for Chinese Taipei taken from Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. Statistical Yearbook 2007. Data for England and Scotland are for the United Kingdom.

† Met guidelines for sample participation rates only after replacement schools were included.

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

¹ National Target Population does not include all of the International Target Population defined by TIMSS.

² National Defined Population covers 90% to 95% of National Target Population.

[‡] Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Figure 5 International achievement in science – Year 4

- In science at Year 4, Singapore outscored all other participating countries. They, and 20 other countries, including Australia, scored significantly higher than the TIMSS scale average. Scotland and New Zealand scored similarly to the TIMSS scale average, while the 13 remaining countries scored significantly below the TIMSS scale average.
- Australia's average science score of 527 was similar to eight countries, significantly lower than that of eight countries (including most of the Asian countries, England and the United States), and significantly higher than that of 19 countries (including New Zealand and Scotland) and the TIMSS scale average.
- There was a significant change in average scale scores for a number of countries from TIMSS 2003. Countries to show a significant improvement included Armenia, by 48 score points, Slovenia by 28 score points, Iran and Singapore by 22 score points, and Italy by 20 score points. Australia showed an increase of 7 score points; however, this was not significant.

Table 4 Multiple comparisons of average science achievement by state, Year 4

			VIC	NSW	TAS	ACT	WA	SA	NT	QLD
	Mean	SE	544	538	533	527	512	512	503	501
	Mean	SE	(8.3)	(6.1)	(6.0)	(8.6)	(4.9)	(10.5)	(9.9)	(6.0)
Victoria	544	(8.3)		●	●	●	▲	▲	▲	▲
New South Wales	538	(6.1)	●		●	●	▲	▲	▲	▲
Tasmania	533	(6.0)	●	●		●	▲	●	▲	▲
Australian Capital Territory	527	(8.6)	●	●	●		●	●	●	▲
Western Australia	512	(4.9)	▼	▼	▼	●		●	●	●
South Australia	512	(10.5)	▼	▼	●	●	●		●	●
Northern Territory	503	(9.9)	▼	▼	▼	●	●	●		●
Queensland	501	(6.0)	▼	▼	▼	▼	●	●	●	

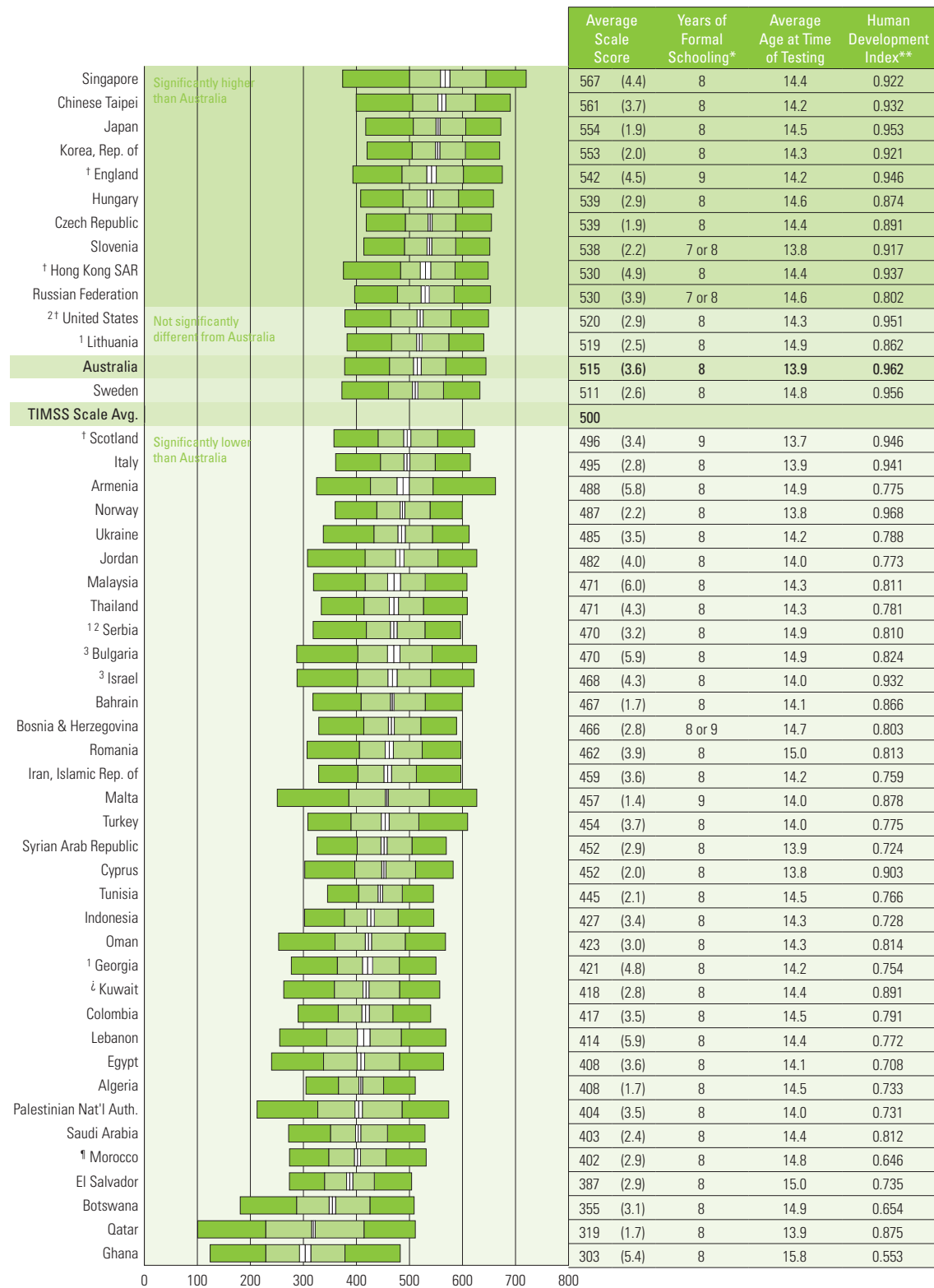
Note: Read across the rows to compare a state's performance with the performance of each state listed in the column headings.

- ▲ Average performance statistically significantly higher than comparison state
- Not statistically significantly different to comparison state
- ▼ Average performance statistically significantly lower than comparison state

As can be seen in Table 4, there were some significant differences in Year 4 science performance across the states.

Students in Victoria, New South Wales, Tasmania, and the Australian Capital Territory had similar scores, with the first two of these states outperforming students in South Australia, Western Australia, Queensland and the Northern Territory.

What does TIMSS tell us about Year 8 science?



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

** Taken from United Nations Development Programme's Human Development Report 2007/2008, p.229-232, except for Chinese Taipei taken from Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. Statistical Yearbook 2007. Data for England and Scotland are for the United Kingdom.

† Met guidelines for sample participation rates only after replacement schools were included.

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

¶ Did not satisfy guidelines for sample participation rates.

1 National Target Population does not include all of the International Target Population defined by TIMSS.

2 National Defined Population covers 90% to 95% of National Target Population.

3 National Defined Population covers less than 90% of National Target Population (but at least 77%).

4 Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Figure 6 International achievement in science – Year 8

- Singapore and Chinese Taipei had the highest average achievement in science at Year 8. These two countries had averages more than 60 points above the TIMSS scale average. Twelve other countries, including Australia, also scored significantly higher than the TIMSS scale average, while 33 scored significantly lower.
- At Year 8 Australia scored significantly higher than the international scale average. Australia's average score of 515 was similar to the scores of three other countries – the United States, Lithuania and Sweden. Australia's score was significantly higher than 35 countries, including Scotland, Italy, Armenia and Norway, but significantly lower than 10 countries, including England and the Asian countries.
- Australia's science score at Year 8 showed a statistically significant decrease of 12 score points from that of TIMSS 2003. Other countries to show a similar decline included Sweden, Scotland and Malaysia.

Table 5 Multiple comparisons of average science achievement by state, Year 8

			ACT	NSW	VIC	QLD	SA	TAS	WA	NT
	Mean	SE	(20.1)	(9.4)	(7.9)	(4.3)	(6.1)	(7.1)	(7.8)	(11.2)
Australian Capital Territory	538	(20.1)		●	●	●	●	●	●	●
New South Wales	521	(9.4)	●		●	●	●	●	●	●
Victoria	513	(7.9)	●	●		●	●	●	●	●
Queensland	513	(4.3)	●	●	●		●	●	●	●
South Australia	512	(6.1)	●	●	●	●		●	●	●
Tasmania	507	(7.1)	●	●	●	●	●		●	●
Western Australia	506	(7.8)	●	●	●	●	●	●		●
Northern Territory	502	(11.2)	●	●	●	●	●	●	●	

Note: Read across the rows to compare a state's performance with the performance of each state listed in the column headings.

- ▲ Average performance statistically significantly higher than comparison state
- Not statistically significantly different to comparison state
- ▼ Average performance statistically significantly lower than comparison state

Performance across the states was again fairly uniform at Year 8, with no significant differences in mean scores.

What are the TIMSS Benchmarks?

While the achievement scales in mathematics and science summarise student performance on the cognitive processes and content knowledge measured by the TIMSS tests, the international benchmarks help put these scores in context.

Internationally it was decided that performance should be measured at four levels. These four levels summarise the achievement reached by:

- the 'advanced international benchmark', which was set at 625;
- the 'high international benchmark', which was set at 550;
- the 'intermediate international benchmark', which was set at 475; and
- the 'low international benchmark', which was set at 400.

Benchmarks are only one way of examining student performance. The benchmarks discussed in this report are based solely on student performance in TIMSS 2007, on items that were developed specifically for the purpose of obtaining information on the mathematics and science domains in the TIMSS framework.

When reporting the proportion of students achieving a particular benchmark, this includes students achieving the benchmarks above this. For example, the 24 per cent of Year 8 students achieving the high international benchmark for mathematics includes the six per cent at the advanced benchmark.

In Year 4 mathematics, students at the advanced international benchmark were able to apply mathematical understanding and knowledge in a variety of relatively complex problem situations and were able to explain their reasoning, whereas those at the low international benchmark demonstrated some basic mathematical knowledge and were able to compute with whole numbers, recognise some geometric shapes, and read simple graphs and tables.

At Year 8, students at the advanced international benchmark were able to organise and draw conclusions from information, make generalisations, and solve non-routine problems involving numeric, algebraic, and geometric concepts and relationships. In comparison, those at the low international benchmark demonstrated some knowledge of whole numbers and decimals, operations, and basic graphs.

Table 6 International Benchmarks for Mathematics

	Mathematics	
	Year 4	Year 8
Advanced International Benchmark – 625	Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning.	Students can organise and draw conclusions from information, make generalisations, and solve non-routine problems.
High International Benchmark – 550	Students can apply their knowledge and understanding to solve problems.	Students can apply their understanding and knowledge in a variety of relatively complex situations.
Intermediate International Benchmark – 475	Students can apply basic mathematical knowledge in straightforward situations	Students can apply basic mathematical knowledge in straightforward situations.
Low International Benchmark – 400	Students have some basic mathematical knowledge.	Students have some knowledge of whole numbers and decimals, operations, and basic graphs.

Mathematics Examples

\triangle 4	→ Sean's Rule →	□ 9
\triangle 5	→ Sean's Rule →	□ 11
\triangle 8	→ Sean's Rule →	□ 17
\triangle 11	→ Sean's Rule →	□ 23

Sean used the same rule to get the number in the □ from the number in the \triangle .
What was the rule?

Answer: *double the number and add 1*

The first example illustrates the advanced international benchmark at Year 4. At Year 4 level, pre-algebraic concepts and skills are a part of the TIMSS framework and assessment. Students at this age typically explore number patterns, investigate the relationships between the terms and find or use the rules that generate them.

In this item students were shown a linear relationship between pairs of numbers and asked to write the two-step rule that described how to get the second number from the first. Internationally, 15 per cent of students were able to provide a correct response to this item. In Australia 20 per cent answered correctly; however, in Hong Kong, Japan and Singapore the proportion was between 36 and 39 per cent.

The table shows the temperatures at various times on a certain day.

Time	6 am	9 am	Noon	3 pm	6 pm
Temperature °C	12	17	14	18	15

A graph, without a temperature scale, is drawn. Of the following, which could be the graph that shows the information given in the table?

(A)

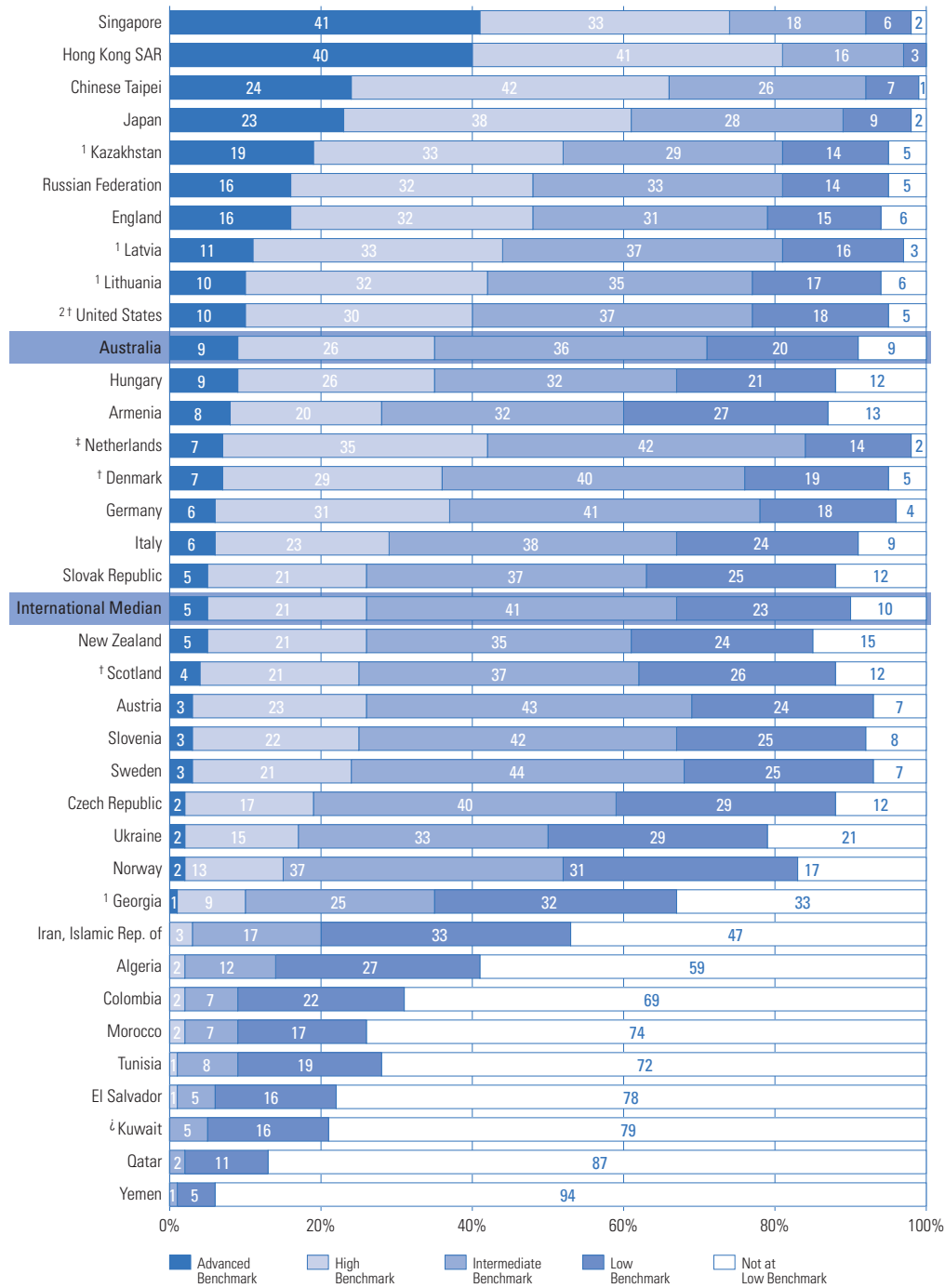
(B)

(C)

(D)

The second example illustrates the low international benchmark at Year 8. Students are expected to be able to draw on their knowledge in the data and chance domain to match the data in a line graph with the data in a table. The temperatures in the table rise and fall across time, and students needed to recognise that only one graph has this up and down pattern. Seventy-two per cent of students internationally answered this item correctly. At least 90 per cent of students in Korea, Japan, Singapore, Chinese Taipei, Lithuania and Slovenia also answered correctly, and 87 per cent of Australian students also answered correctly, significantly higher than the international average.

TIMSS Benchmarks – Year 4 mathematics



[†] Met guidelines for sample participation rates only after replacement schools were included.
[‡] Nearly satisfied guidelines for sample participation rates only after replacement schools were included.
¹ National Target Population does not include all of the International Target Population defined by TIMSS.
² National Defined Population covers 90% to 95% of National Target Population.
[‡] Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.
 () Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 7 Percentages of students reaching the international benchmarks for mathematics achievement by country, Year 4

- At Year 4, Australia performed reasonably well at some levels against the international mathematics benchmarks. Nine per cent of Australian students achieved the advanced international benchmark, compared with an international median of five per cent, and 35 per cent of Australian students achieved the high international benchmark, compared with 26 per cent internationally.
- At the lower levels of achievement, 71 per cent of Australian Year 4 students achieved the intermediate international benchmark compared with 67 per cent internationally, while 91 per cent of students achieved above the low international benchmark, similar to the international median of 90 per cent.
- Singapore had the highest proportion of students achieving the advanced international benchmark, with 41 per cent of students in Year 4 attaining this level.
- Other countries, while not achieving high proportions of students in the advanced international benchmark, appear to be doing a very good job of educating their students to an average standard. For example, the Netherlands had seven per cent at the advanced benchmark, but 98 per cent of students achieved above the low benchmark.
- In contrast, in the lower achieving countries, a different picture is apparent. In Kuwait, for example, only five per cent of students achieved the intermediate benchmark, while 79 per cent failed to achieve even the low benchmark.

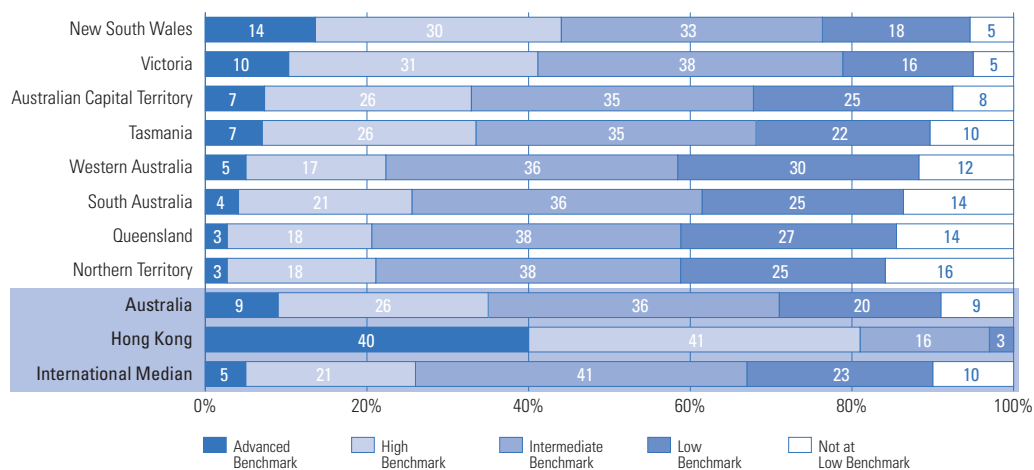


Figure 8 Percentages of students reaching the international benchmarks for mathematics achievement by state, Year 4

- At Year 4, New South Wales was the best performing state, with 14 per cent of students reaching the advanced international benchmark and 44 per cent reaching the high international benchmark, while in total 95 per cent achieved at least the low benchmark.
- The proportion of Australian students in each state achieving the advanced level benchmark is well below the 40 per cent of students in Hong Kong at this level. At the other end of the spectrum, the proportion of Australian students not achieving the low level benchmark is much higher than that in Hong Kong, which was less than one per cent.

TIMSS Benchmarks – Year 8 mathematics

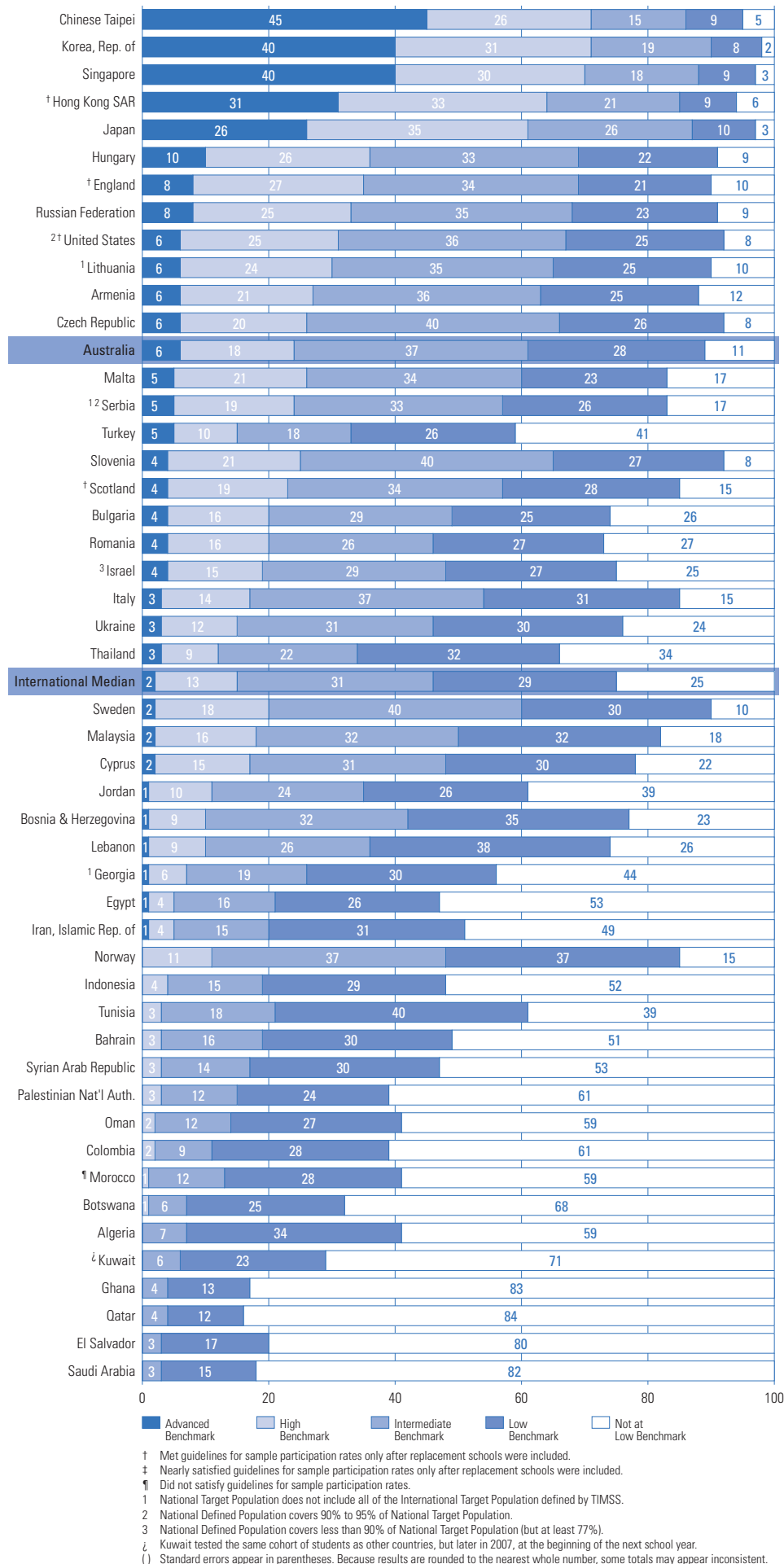


Figure 9 Percentages of students reaching the international benchmarks for mathematics achievement by country, Year 8

- At Year 8, Chinese Taipei, the highest scoring country, is also the country with the highest percentage (45%) of students who achieved the advanced benchmark for mathematics.
- Ninety-five per cent of students achieved the low international benchmark in four countries: Chinese Taipei, Korea, Singapore, and Japan. However, many countries had fewer than half of their students reaching the low benchmark and several had less than 20 per cent of their students reach this minimal benchmark, including Saudi Arabia (18%), Ghana (17%), and Qatar (16%).
- As at Year 4, there were some countries which appear to be focused on helping most students to achieve basic levels. That is, considering the percentage of Year 8 students reaching the advanced benchmark (less than 5%), several countries had relatively larger percentages reaching the intermediate and low benchmarks, including Slovenia (65% and 92% respectively) and Sweden (60% and 90% respectively).
- Six per cent of Australia's Year 8 students reached the advanced benchmark, a proportion that was significantly higher than the international median. The high benchmark was reached by 24 per cent of Australian Year 8 students, compared to the international median of 15 per cent; while 61 per cent achieved the intermediate benchmark (compared to 46 per cent internationally). The low benchmark was reached by 89 per cent which is also higher than the international median of 75 per cent. This means, however, that 11 per cent of Australian Year 8 students did not reach the low benchmark.

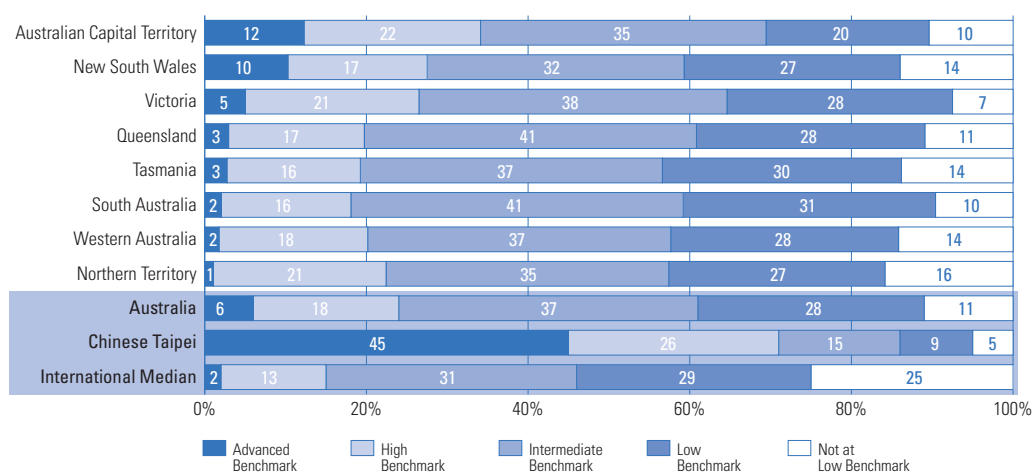


Figure 10 Percentages of students reaching the international benchmarks for mathematics achievement by state, Year 8

- More than 10 per cent of Year 8 students in the Australian Capital Territory and New South Wales reached the advanced benchmark, but in all other states the proportion at this level was five per cent or less, with only one per cent of Year 8 students in the Northern Territory performing at this level. While this compares reasonably well with the international median, it is well short of the 45 per cent of students in Chinese Taipei that achieve at this level. The Australian Capital Territory also had the highest proportion of students achieving at least the high benchmark (34%), closely followed by New South Wales (27%) and Victoria (26%). The proportion of students achieving at least the low benchmark ranged between 84 and 93 per cent, in the Northern Territory and Victoria, respectively.

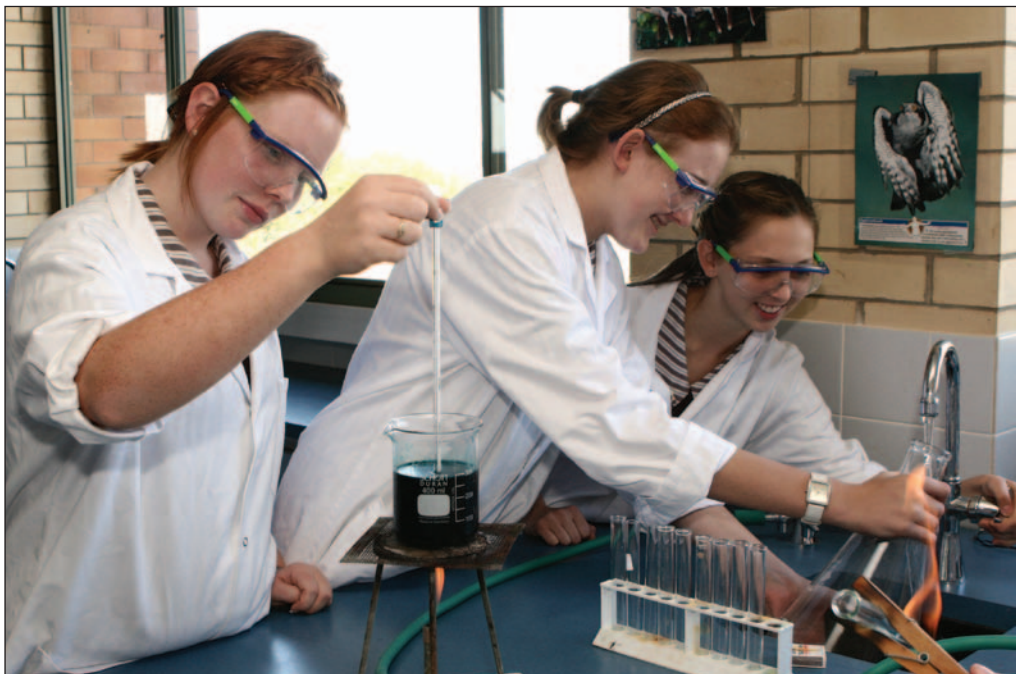
TIMSS Science Benchmarks

In Year 4 science, students at the advanced international benchmark were able to apply their knowledge and understanding of scientific processes and relationships in beginning scientific inquiry, whereas those at the low international benchmark displayed only elementary knowledge of life science and physical science.

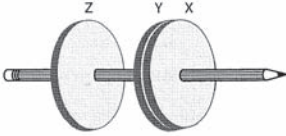
At Year 8, students at the advanced international benchmark demonstrated a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science. In comparison, those at the low international benchmark simply recognised some basic facts from the life and physical sciences.

Table 7 International Benchmarks for Science

	Science	
	Year 4	Year 8
Advanced International Benchmark – 625	Students can apply knowledge and understanding of scientific processes and relationships in beginning scientific inquiry.	Students can demonstrate a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science.
High International Benchmark – 550	Students can apply knowledge and understanding to explain everyday phenomena.	Students can demonstrate conceptual understanding of some science cycles, systems, and principles.
Intermediate International Benchmark – 475	Students can apply basic knowledge and understanding to practical situations in the sciences.	Students can recognise and communicate basic scientific knowledge across a range of topics.
Low International Benchmark – 400	Students have some elementary knowledge of life science and physical science.	Students can recognise some basic facts from the life and physical sciences.



Science examples



The diagram shows what happens to three magnets when they are placed close together on a pencil.

Magnets X and Y move until they touch each other, but magnets Y and Z remain separated.


1. Explain why magnets X and Y touch each other.
Because the south on X or Y would be facing the north on X or Y and north and south attract.
2. Explain why magnets Y and Z remain separated.
Because the south and south or north and north would be facing each other.


This example illustrates the advanced international benchmark at Year 8. It assesses students' understanding of the properties of magnets, and in particular magnetic polarity. Given the diagram depicting three magnets, two of which are touching and a third is separated from the touching pair, students were asked to provide two explanations: firstly why the touching magnets touch and secondly why the separated magnets stay separated. To earn full credit students had to apply knowledge of the polarity of magnets to explain that the touching magnets had facing north and south poles while the separated magnets had either facing north poles or facing south poles.


This was a very difficult question for students, with just 23 per cent on average internationally getting full credit for their answer on this item. The percentage answering correctly in Australia was the same as this international average.


The following item illustrates the low international benchmark at Year 4. At this level students demonstrated some elementary knowledge of the life and physical sciences. In this example students are presented with a pictorial representation of four animals and asked to identify the animal most likely to live in the desert. On average internationally 68 per cent of Year 4 students were able to identify the lizard as the most likely desert dweller. More than 90 per cent of students in the United States correctly answered this item, and 88 per cent of Australian students also identified the correct animal. This was significantly higher than the international average.

Which of these animals is most likely to live in the desert?

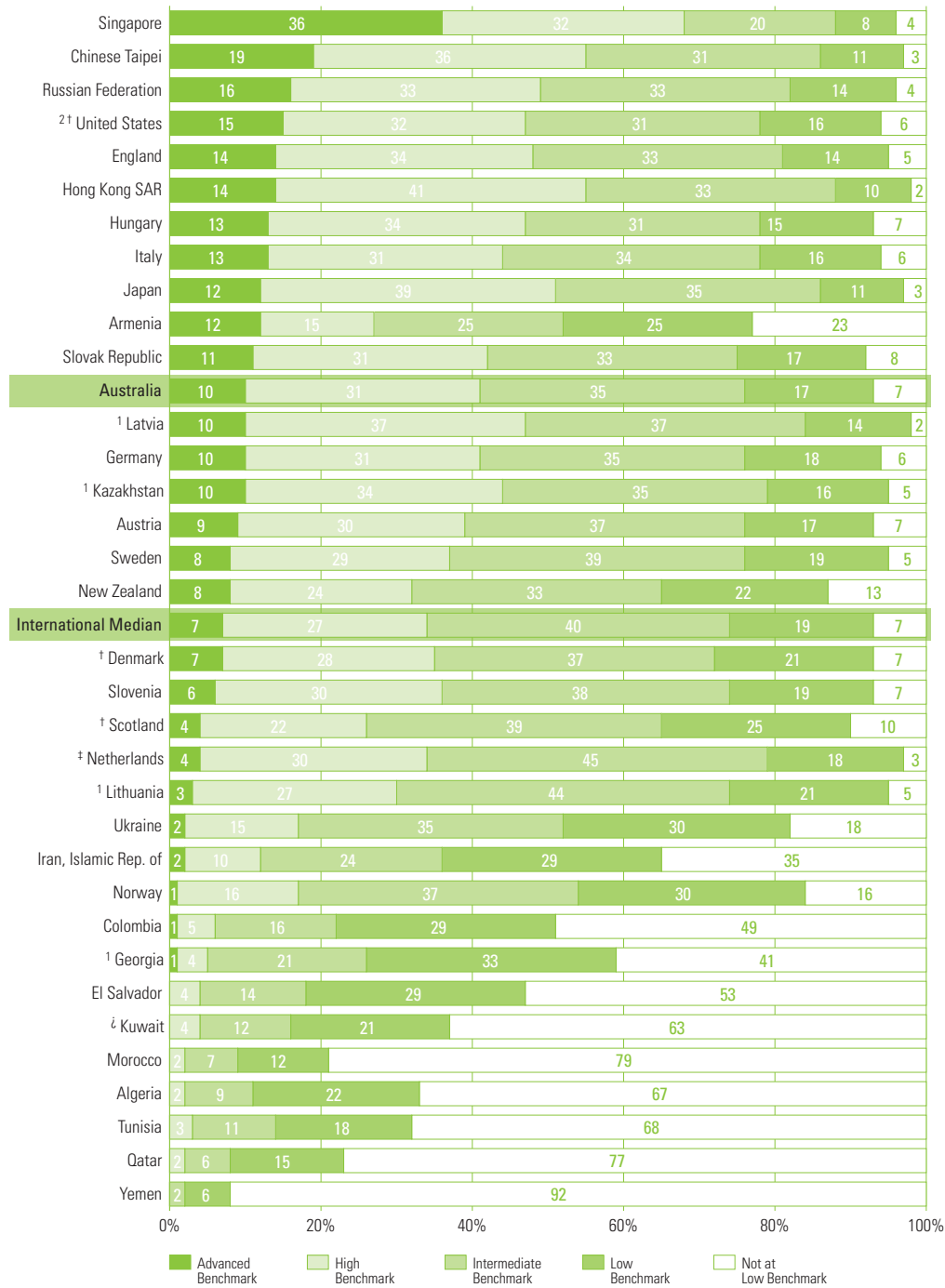
(A) 
bear

(B) 
crab


lizard

(D) 
tiger

TIMSS Benchmarks – Year 4 science



[†] Met guidelines for sample participation rates only after replacement schools were included.
[‡] Nearly satisfied guidelines for sample participation rates only after replacement schools were included.
¹ National Target Population does not include all of the International Target Population defined by TIMSS.
² National Defined Population covers 90% to 95% of National Target Population.
[‡] Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.
^() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 11 Percentages of students reaching the international benchmarks for science achievement by country, Year 4

- Australia performed reasonably well at some levels against the international science benchmarks at Year 4. Ten per cent of Australian students achieved the advanced benchmark, compared with an international median of seven per cent, and 41 per cent achieved at the high benchmark, compared with 34 per cent internationally.
- At the lower levels of achievement, 76 per cent of Australian Year 4 students achieved the intermediate international benchmark compared with 74 per cent internationally, while 93 per cent of students achieved above the low benchmark, which was similar to the international median.
- Singapore had the highest proportion of students achieving the advanced international benchmark, with 36 per cent of students in Year 4 attaining this level.
- Other countries, while not displaying these high proportions of students in the advanced international benchmark in science, appear to be doing a very good job of educating their students to an average standard. For example, Latvia had 10 per cent at the advanced benchmark, but 98 per cent of students achieved above the low benchmark, and in Kazakhstan, 10 per cent of Year 4 students achieved at the advanced benchmark, but 95 per cent achieved above the low benchmark.
- In some of the lower achieving countries, a different picture is apparent. In Qatar, for example, only eight per cent of students achieved the intermediate benchmark, with 23 per cent achieving at or above the low benchmark.

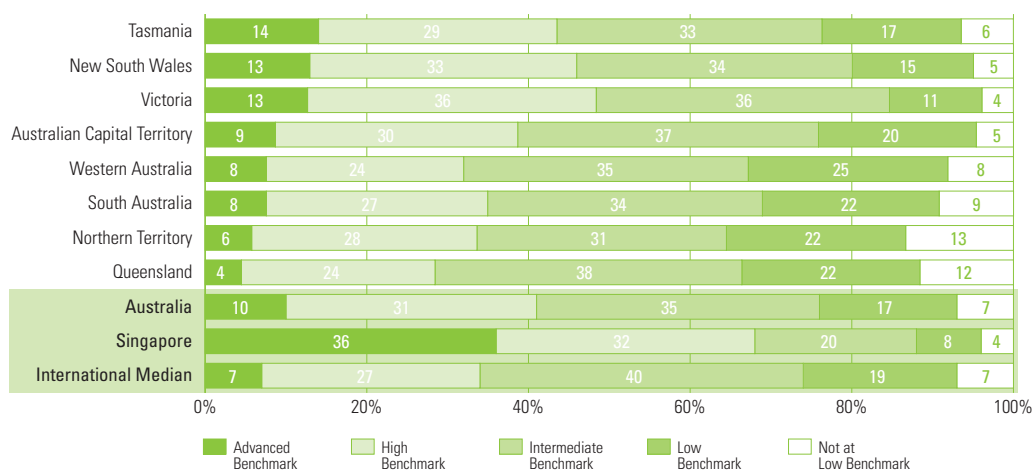
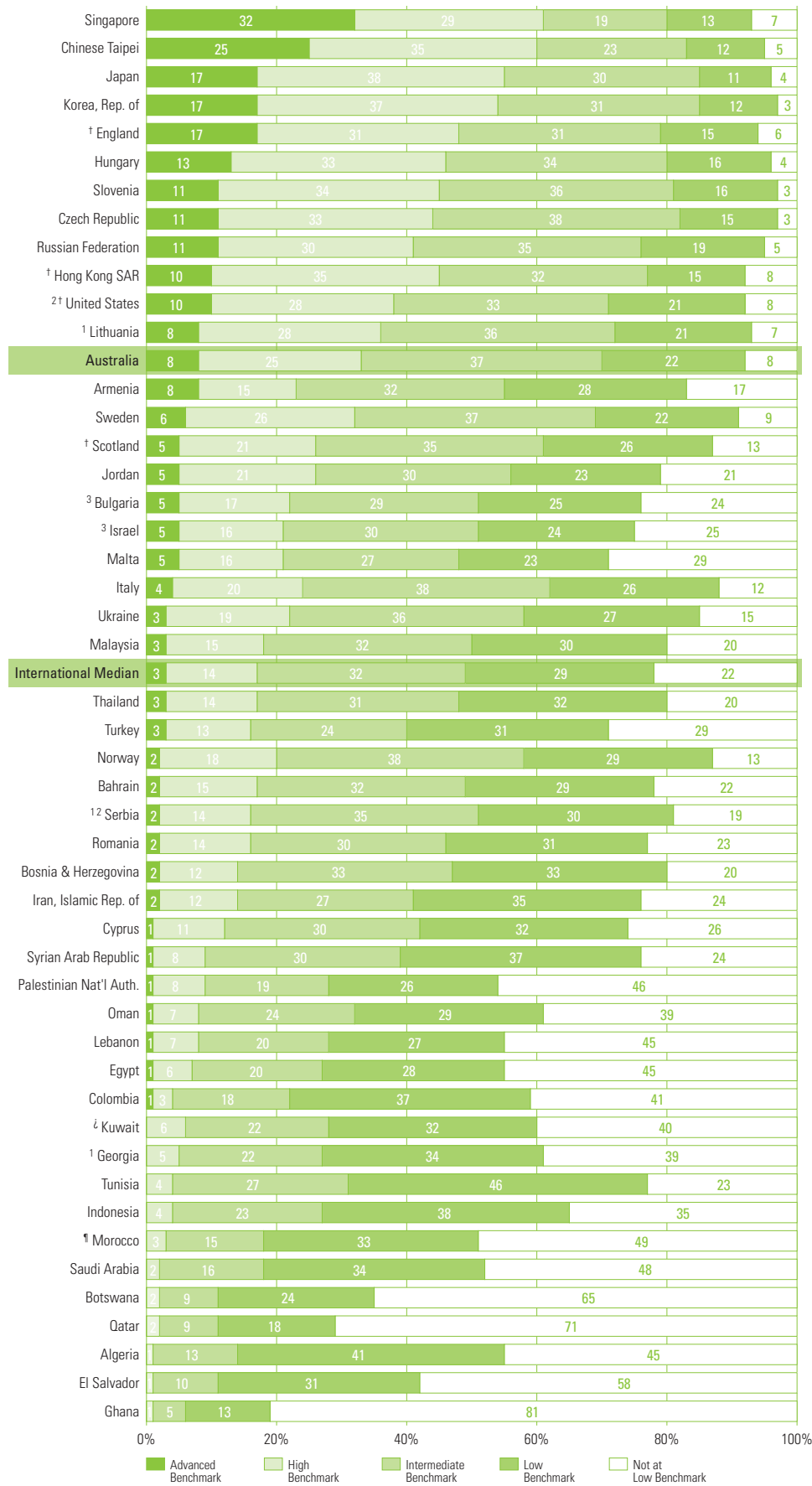


Figure 12 Percentages of students reaching the international benchmarks for science achievement by state, Year 4

- At Year 4, Tasmania was the best performing state with 14 per cent of students reaching the advanced international benchmark, and 43 per cent achieving the high international benchmark, while 94 per cent achieved at least the low benchmark. New South Wales and Victoria both had 13 per cent of Year 4 students reaching the advanced international benchmark and 95 per cent and 96 per cent respectively achieving at or above the low benchmark. At the other end of the performance spectrum are the Northern Territory and Queensland, with only six and four per cent of students, respectively, reaching the advanced benchmark, and over 10 per cent of students in both states failing to reach the low benchmark in science achievement.

TIMSS Benchmarks – Year 8 science



† Met guidelines for sample participation rates only after replacement schools were included.
 ‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included.
 ¶ Did not satisfy guidelines for sample participation rates.
 1 National Target Population does not include all of the International Target Population defined by TIMSS.
 2 National Defined Population covers 90% to 95% of National Target Population.
 3 National Defined Population covers less than 90% of National Target Population (but at least 77%).
 4 Kuwait tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.
 () Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Figure 13 Percentages of students reaching the international benchmarks for science achievement by country, Year 8

- At Year 8, Singapore, the highest scoring country, is also the country with the highest percentage (32%) of students who achieved at the advanced benchmark for science. Other countries with at least 10 per cent of students reaching this benchmark included Japan, England, and Korea (17%), Hungary (13%), the Czech Republic, Slovenia, and the Russian Federation (11%), and Hong Kong and the United States (10%). Eight per cent of Australia's Year 8 students reached the advanced benchmark in science.
- In addition to the eight per cent of Australia's Year 8 students who reached the advanced benchmark, 33 per cent reached the high benchmark (compared to the international median of 17%), while 70 per cent achieved the intermediate benchmark (compared to 49% internationally). The low benchmark was reached by 92 per cent of Australian Year 8 students, which is also higher than the international median of 78 per cent. Nonetheless, this indicates that eight per cent of Australian Year 8 students did not reach the minimum standards in science as defined by the international benchmarks.

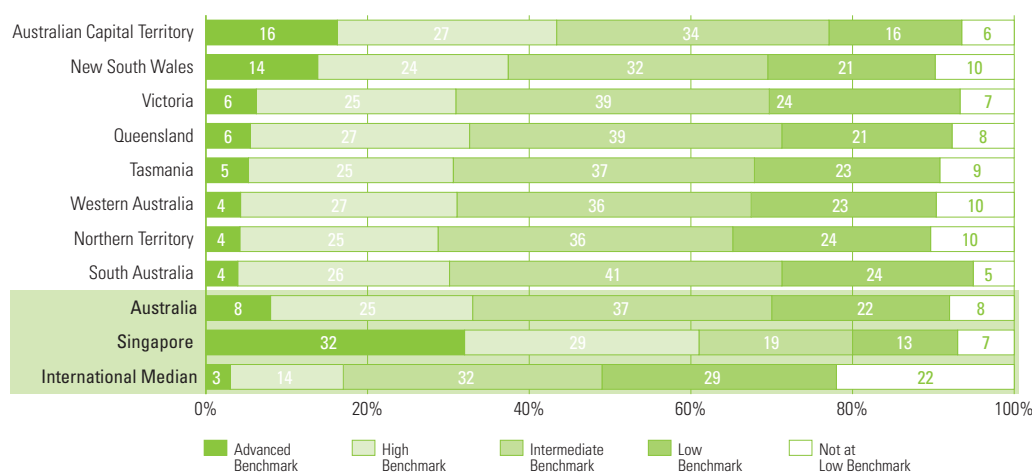


Figure 14 Percentages of students reaching the international benchmarks for science achievement by state, Year 8

- More than 10 per cent of Year 8 students in the Australian Capital Territory and New South Wales reached the advanced benchmark, but in all other states the proportion at this level was four to six per cent. While this compares reasonably well with the international median, it is well short of the 32 per cent of students in Singapore that performed at this level. The proportion of students achieving at least the low benchmark was between 90 per cent and 95 per cent in all states.

What does TIMSS tell us about achievement in the mathematics content and cognitive domains?

The TIMSS mathematics tests were organised along two dimensions – a cognitive dimension and a content dimension. The content domains included *number*, *geometric shapes and measures/geometry*, *data display/data and chance*, and *algebra*. The cognitive domains are *knowing*, *applying* and *reasoning*. These tables show the balance of the items across the content and cognitive domains.

Table 8 Mathematics Content Domains

	Year 4	Year 8
Number	50%	30%
Geometry Shapes and Measures/Geometry	35%	20%
Data Display/ Data and Chance	15%	20%
Algebra (Year 8)	-	30%

Table 9 Mathematics Cognitive Domains

	Year 4	Year 8
Knowing	40%	35%
Applying	40%	40%
Reasoning	20%	25%

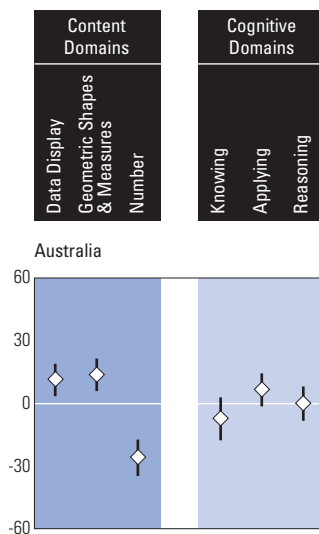


Figure 15 Year 4 mathematics content and cognitive domain within-country comparison - Australia

- Year 4 Australian students performed less well in *number* while they performed considerably better in *geometric shapes and measures*.
- In terms of the cognitive domains, Australian Year 4 students performed less well in the *knowing* domain while showing relative strength in the *applying* domain.

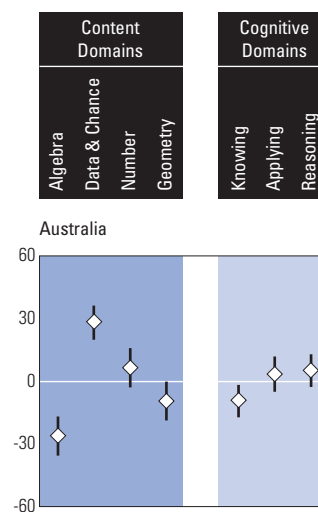


Figure 16 Year 8 mathematics content and cognitive domain within-country comparison - Australia

- At Year 8, students in Australia performed less well in *algebra* while they performed relatively better in *data and chance*. In terms of the cognitive domains, Year 8 students in Australia performed relatively equally across all domains. While *knowing* appears to be the relatively weaker domain, this difference was not significant.

What does TIMSS tell us about achievement in the science content and cognitive domains?

The TIMSS science tests were also organised along a cognitive dimension and a content dimension. The content domains included *life science/biology*, *physical science/chemistry* and *physics*, and *Earth science*. The cognitive domains are *knowing*, *applying* and *reasoning*. These tables show the balance of the items across the content and cognitive domains.

Table 10 Science Content Domains

	Year 4		Year 8
Life Science	45%	Biology	35%
Physical Science	35%	Chemistry	20%
		Physics	25%
Earth Science	20%	Earth Science	20%

Table 11 Science Cognitive Domains

	Year 4	Year 8
Knowing	40%	30%
Applying	35%	35%
Reasoning	25%	35%

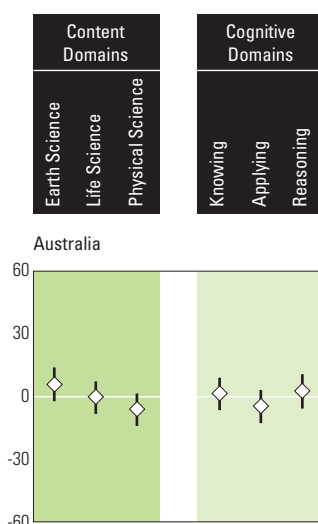


Figure 17 Year 4 science content and cognitive domain within-country comparison - Australia

- Year 4 Australian students performed less well in *physical science* and *life science*, while they performed considerably better in *Earth science*.
- In terms of the cognitive domains, Australian Year 4 students performed less well in the *applying* domain while they performed better in the *reasoning* and *knowing* domains.

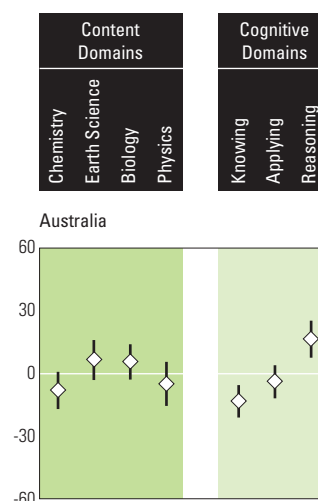


Figure 18 Year 8 science content and cognitive domain within-country comparison - Australia

- Year 8 students in Australia performed less well in *chemistry* and *physics* while they performed relatively better in *biology* and *Earth science*.
- In terms of the cognitive domains, Australian Year 8 students' achievement in the *knowing* domain was an area of relative weakness, while the *reasoning* domain was an area of relatively stronger performance.

What else does TIMSS tell us about students?

Performance and Gender Differences

- In Australia, in general, males outperform females. At Year 8, this difference is statistically significant. This is in contrast to the international trend for females to outperform males.
- In Australia at Year 4, males scored, on average, six points higher than females in mathematics, however there was no statistically significant gender difference. At Year 8, males outperformed females by 15 score points, a substantial as well as significant difference.
- At both year levels, a higher proportion of males than females reached the advanced and high benchmarks in mathematics.
- In science, Australian Year 4 males scored on average five points higher than females in science, but this difference was not statistically significant. At Year 8, males outperformed females by 18 score points, a substantial as well as significant difference.
- At both year levels, a slightly higher proportion of males than females reached the advanced benchmark in science. Around the same proportion of males and females failed to reach the low benchmark.

Trends and Gender differences

- In mathematics, Year 4 females showed improvement in eight countries compared to 1995. In five of these countries, there also was improvement from 2003 to 2007, including Australia, England, Hong Kong, Slovenia, and the United States.
- Year 8 males often showed increases or decreases in mathematics achievement in the same countries as females, indicating that overall trends were typically reflected in similar changes for both sexes. The notable exception to this pattern is in Iran, where females showed a 30-point increase between 1995 and 2007 compared to essentially no change for males. In Australia there was a significant decline in the scores for females but no corresponding decline in the scores for males.
- Over the 12-year period from 1995, Year 4 science scores increased for both males and females in Hong Kong, Hungary, Iran, Latvia, Singapore and Slovenia. The scores for both males and females declined in Austria, the Czech Republic, Norway, and Scotland. In Japan the average score for females stayed the same, while the score for males significantly declined. In Australia, at Year 4, there were no significant changes in science achievement for either males or females.
- At Year 8, females had higher average science achievement than in 1995 in eight countries (Colombia, England, Hong Kong, Iran, Japan, Korea, Lithuania, and Slovenia) and lower achievement over the 12-year period in two countries (Norway and Sweden). In general as with Year 4 students, overall trends were generally reflected in higher or lower levels of achievement for both males and females. There were some exceptions to this: England, where the average score for females increased by a significant 15 points but that of males by only three score points; Hong Kong, where females' score has increased by 41 score points since 1995 but that of males by only three score points; Iran, where the score for females has increased by 18 score points but the score for males has decreased by 22 points. In Australia there were no significant changes for either males or females.

Performance of Indigenous Students

- The results clearly show that Indigenous students at the Year 4 and Year 8 level did not perform as well as their non-Indigenous counterparts. In Year 4 Indigenous students achieved an average score of 431, which is 91 score points (almost one standard deviation) lower than the average score of non-Indigenous students at 522 points. At Year 8, Indigenous students achieved an average score of 431, 70 score points less than the average score for non-Indigenous students (501 score points).

- Both Year 4 and Year 8 Australian Indigenous students' average mathematics and science scores were also significantly lower than the international scale average.
- Almost two-thirds of Indigenous students in Year 4 were performing at the lower levels of the benchmarks in mathematics, with 27 per cent reaching the low international benchmark and 38 per cent not able to achieve the low international benchmark. Only 12 per cent achieved the high international benchmark, while two per cent achieved the advanced international benchmark.
- At Year 8, 37 per cent of Indigenous students did not reach the low benchmark in mathematics, compared to 10 per cent of non-Indigenous students. Two per cent of Indigenous students achieved the advanced benchmark, which was equivalent to the international median. However, the proportions of Year 8 Indigenous students reaching each of the other benchmarks are below that of the international median.
- In Year 4 Indigenous students achieved an average score of 441 in science, which is 92 score points (almost one standard deviation) lower than the average score of non-Indigenous students of 533 points. In Year 8 Indigenous students achieved an average score of 447, 72 score points less than the average score for non-Indigenous students (519 score points).
- Thirty-three per cent of Indigenous students were not able to reach the international low benchmark in Year 4 science, while a further 29 per cent performed at the low international benchmark. Thus, over three-fifths of Indigenous students were at or below the lowest international benchmarks for Year 4 science achievement. Only two per cent achieved the advanced international benchmark.
- Thirty-one per cent of Year 8 Indigenous students did not reach the low benchmark in science, compared to seven per cent of non-Indigenous students. Two per cent of Indigenous students achieved the advanced benchmark, a proportion that is less than the international median. The proportions of Year 8 Indigenous students reaching each of the other benchmarks are also below that of the international median.

Trends for Indigenous Students

- The relative performance of Year 4 Indigenous students (to non-Indigenous students) has worsened in 2007, compared to that found in 2003 and 1995. That is, an increase in the average mathematics score of non-Indigenous students and a decline in the average score of Indigenous students has led to a gap of more than 90 score points in 2007, compared to between 60 and 70 score points in 2003 and 1995. A similar trend is seen for science.
- In contrast, the score differences for Year 8, in both mathematics and science, have remained fairly consistent from 1995 and 2003 to 2007, at between 70 and 80 score points.



How well prepared do teachers feel they are to teach mathematics and science?

TIMSS 2007 asked the students' teachers of mathematics and science how prepared they felt to teach a subset of the mathematics and science topics included in the TIMSS 2007 frameworks.

Table 12 Percentage of Year 4 students with teachers that reported feeling "Very well" prepared to teach the TIMSS mathematics and science topics

Year 4	All mathematics	Number	Geometric shapes and measures	Data display
Australia	81 (1.9)	81 (1.9)	72 (2.5)	88 (2.0)
International avg.	72 (0.4)	77 (0.4)	68 (0.4)	71 (0.5)

Year 4	All science	Life science	Physical science	Earth science
Australia	46 (3.0)	48 (3.8)	37 (2.8)	52 (3.5)
International avg.	54 (0.4)	59 (0.5)	46 (0.5)	56 (0.5)

The average for *data display* was highest in Year 4, with 88 per cent of students in Australia having teachers who reported that they were 'well prepared' to teach the topics. Internationally, this was one of the weakest areas (71 per cent). The average for *geometric shapes and measures* was weakest both internationally and in Australia.

In contrast, at Year 4 for science, the international average across all science topics was 54 per cent while in Australia this was 46 per cent. In comparison to the international average, fewer Australian Year 4 students had teachers who reported feeling 'well prepared' to teach science topics.

Table 13 Percentage of Year 8 students with teachers that reported feeling "Very well" prepared to teach the TIMSS mathematics and science topics

Year 8	All mathematics	Number	Algebra	Geometry	Data and chance
Australia	91 (1.7)	92 (1.7)	89 (2.2)	88 (2.0)	93 (1.8)
International avg.	79 (0.3)	87 (0.3)	82(0.3)	79 (0.3)	68 (0.4)

Year 8	All science	Biology	Chemistry	Physics	Earth science
Australia	73 (1.9)	76 (2.4)	80 (2.4)	69 (2.7)	70 (2.4)
International avg.	71 (0.3)	67 (0.4)	77 (0.4)	70 (0.4)	62 (0.4)

At Year 8, the international average across all mathematics topics was 79 per cent. In Australia this was 91 per cent. In Australia, the average for *data and chance* was highest in having teachers who reported that they were 'well prepared' to teach this topic. The average for *geometry* and *algebra* were the weakest areas in Australia. However there were still more than 80 per cent of students that had teachers who felt 'well prepared' to teach the topics in these content areas.

The international average across all science topics was 71 per cent. In Australia this was 73 per cent. In *biology* 76 per cent of students and in *Earth science* 70 per cent of students had teachers who felt 'well prepared' to teach the topics in these content areas in Australia. These are again substantially higher than the international average. *Physics* and *Earth science* were the weakest areas in Australia, which is similar to the international average.

How safe and orderly are schools?

Since a supportive school environment for learning is one in which teachers and students feel safe and secure, the TIMSS asked teachers and students about their perceptions of safety in their schools. *The Index of Mathematics Teachers' Perception of Safety in School* (TPSS) is based on mathematics teachers' responses to three statements about their schools:

- This school is located in a safe neighbourhood
- I feel safe at this school
- This school's security policies and practices are sufficient.

Students were assigned to the high level when their teachers agreed with all three statements and to the low level when their teachers disagreed with all three. Students whose teachers provided other response combinations were assigned to the medium level. Year 4 teachers generally agreed that their schools were safe, reporting that, on average, most students were at the high (80%) or medium (15%) level of the teachers' perception of safety index

In Australia 86 per cent or more of students at both year levels were at the high level of the TPSS index. The average mathematics achievement was highest at the high level of the index (504 points at Year 8 in Australia), compared to the medium level (448 points).

To complement teachers' perceptions of school safety, students were asked about their school experiences in terms of how often the following happened in their school in the past month:

- Something of mine was stolen
- I was hit or hurt by other student(s) (e.g., shoving, hitting, kicking)
- I was made to do things I didn't want to do by other students
- I was made fun of or called names
- I was left out of activities by other students.

Students at the high level of the *Index of Students' Perception of Being Safe in School* (SPBSS) responded *No* to all five statements, while students at the low level responded *Yes* to three or more statements. Students with other combinations of responses were at the medium index level.

At Year 4, 42 per cent of students on average internationally were at the high level of the SPBSS index, implying that they encountered none of the events listed above. However, only 30 per cent of students in Year 4 in Australia answered at this level. A further 40 per cent internationally and 44 per cent in Australia were at the medium level. Eighteen per cent of students internationally and more than one-quarter of Year 4 students in Australian schools (26%) were at the low level, implying that they encountered at least some of these unpleasant events in school in the past month.

At Year 8, half (51%) the students across countries and almost half of the Australian students (46%) were at the high level of the students' perception of being safe index. There were a further 37 per cent internationally, and 38 per cent in Australia, at the medium level and 12 per cent internationally, and 15 per cent in Australia, at the low level.

Average mathematics achievement for Year 4 and Year 8 was highest at the high level of the index, compared to the medium and low levels.

For both Year 4 and Year 8 science, teachers and student's perception of being safe in school was similar to the mathematics findings, with only slight differences in the average achievement scores.

TIMSS offers countries an opportunity to find out:

- | What are mathematics and science students around the world expected to learn?
- | What opportunities are provided for students to learn mathematics and science?
- | What mathematics and science concepts, processes and attitudes have students learned?
- | What factors are linked to students' opportunity to learn?
- | How do these factors influence student achievement?

To access the full report or more information about TIMSS, visit www.acer.edu.au/timss.