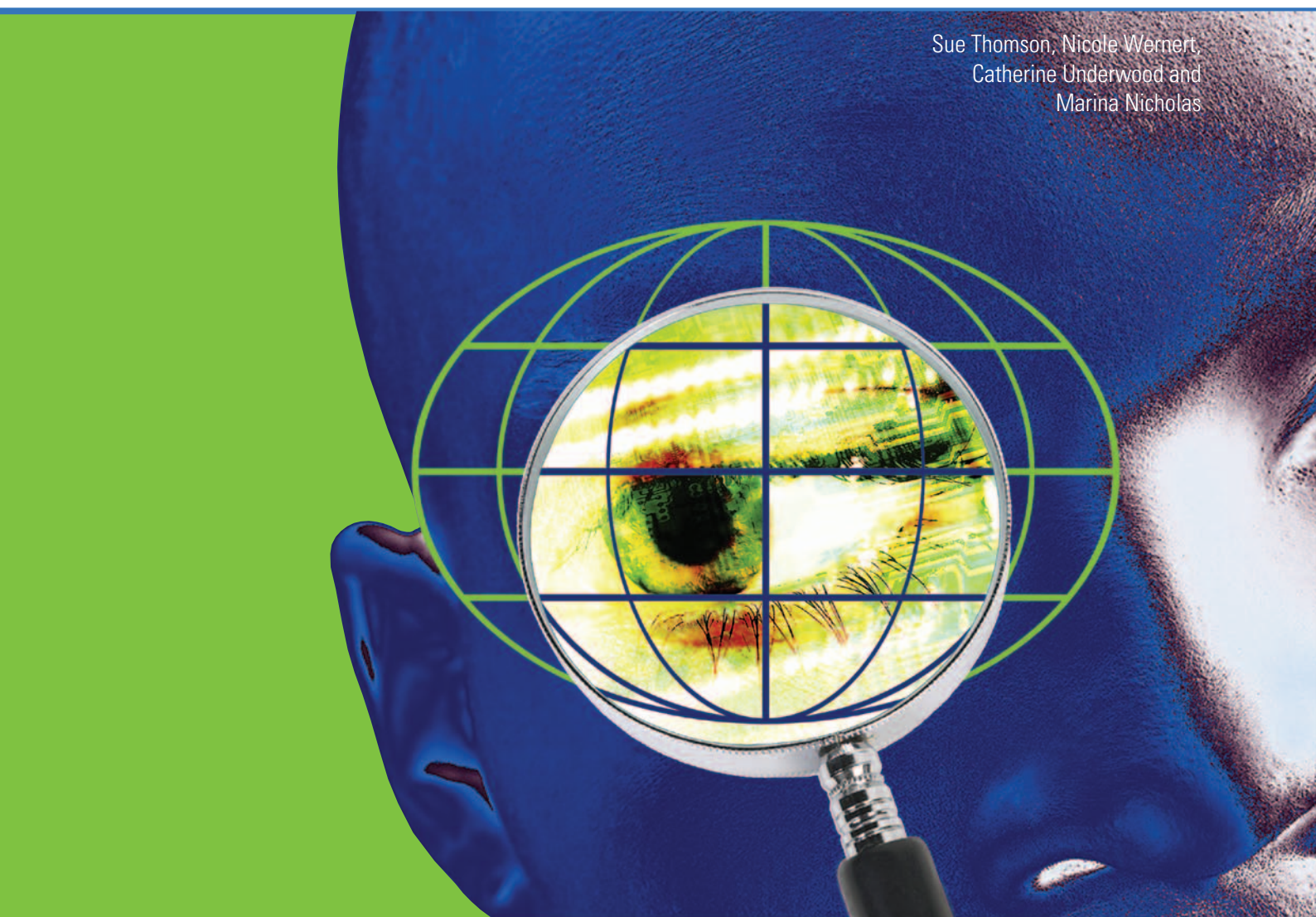


# TIMSS 07:

Taking a closer look at mathematics and science in Australia

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Results from the Trends in International Mathematics and Science Study (TIMSS) 2007



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# Executive Summary

The Trends in International Mathematics and Science Study (TIMSS 2007) is the latest in a series of international studies of mathematics and science, conducted under the aegis of the International Association for the Evaluation of Educational Achievement (IEA).

The goal of TIMSS is to provide comparative information about educational achievement across countries to improve teaching and learning in mathematics and science. TIMSS measures trends in mathematics and science achievement at Year 4 and Year 8, as well as monitoring the outcomes of curricular implementation. Conducted on a regular four-year cycle, TIMSS has assessed mathematics and science in 1995, 1999, 2003, and 2007. In addition to monitoring trends in achievement at Year 4 and Year 8, TIMSS provides information about relative progress across years as the cohort of students assessed in Year 4 in one cycle moves to Year 8 four years later (e.g. the Year 4 students of 2003 became the Year 8 students of 2007). Also, to provide comparative perspectives on trends in achievement in the context of different educational systems, school organisational approaches, and instructional practices, TIMSS collects a rich array of background information.

This report analyses and interprets the Australian data collected as part of the TIMSS study. Where appropriate, this report makes comparisons with the results of other countries and the international average to better understand Australian achievement and its context.

## Research Design

Building on previous IEA studies, TIMSS uses the curriculum as the major organising concept in considering how educational opportunities are provided to students and how students use these opportunities. It considers three levels of the curriculum in relation to the context in which they operate. The first level refers to what it is intended that students should learn and the educational system within which that curriculum is realised. This is referred to as the *Intended Curriculum*. The second level refers to what is taught in classrooms, who teaches it and how it is taught; the *Implemented Curriculum*. The third level refers to what students have learned and their attitudes towards what they have learned; the *Attained Curriculum*.

From this broad framework TIMSS develops tests to describe what students have learned and questionnaires to find out about what is intended to be taught and about how it is actually taught in classrooms. These instruments are based on assessment frameworks that are developed after extensive analysis of national curricula with input from an international panel of mathematics, science and assessment experts, and reviewed by the National Research Coordinators (NRCs) in each country. This ensures that goals of mathematics and science education regarded as important in a significant number of countries are included and that what is assessed links to previous studies as well as being oriented to future developments in mathematics and science education.

## Who is assessed?

TIMSS 2007 focuses on two populations of students. Population 1 is students in Year 4. In most countries it is the year level that contains most nine-year-olds. Population 2 is students in Year 8. In most countries this is the year level that contains most 13-year-olds.

TIMSS 2007 took place in 59 countries around the world. Population 2 students were assessed in 49 of the participating countries, whereas Population 1 students were assessed in 36 countries.

The testing took place at the end of the school year, which was October-November 2006 in the southern hemisphere and May-June 2007 in the northern hemisphere.

TIMSS 2007 used a two-stage sampling procedure to ensure a nationally representative sample of students. In the first stage, schools were randomly selected to represent states and sectors. In the next stage, one mathematics class of Year 4 or Year 8 students was randomly selected to take part in the study.

In Australia, over 8,000 students in 457 schools participated in the main sample of TIMSS 2007. In addition, an extra sample of Indigenous students in all participating schools was also collected in order to provide a more detailed examination of the achievements of Australia's Indigenous students.

## What is assessed?

Two organising dimensions, 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. The content dimension of the assessment specifies the domains or subject matter to be assessed within mathematics or science, while the cognitive domain specifies the domains or thinking processes to be assessed. The cognitive domains describe the sets of behaviours expected of students as they engage with the mathematics or science content. 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*.

In TIMSS 2007 the intended balance was as follows:

Mathematics Content Domains	Year 4	Year 8	Science Content Domains	Year 4	Year 8
Number	50%	30%	Life science (Y4) / Biology (Y8)	45%	35%
Geometric shapes and measures (Y4) / Geometry (Y8)	35%	20%	Physical science (Y4) / Physics (Y8)	35%	20%
Algebra (Y8)	-	30%	Chemistry (Y8)	-	25%
Data display (Y4) / Data and chance (Y8)	15%	20%	Earth science	20%	20%

Cognitive Domain	Mathematics		Science	
	Year 4	Year 8	Year 4	Year 8
Knowing	40%	35%	40%	30%
Applying	40%	40%	35%	35%
Reasoning	20%	25%	25%	35%

## What did TIMSS 2007 participants do?

So that the full range of the assessment framework is covered, TIMSS divides the assessment material among students using a matrix sampling approach. This involves dividing the material among a set of student test booklets with each student completing just one of the booklets. For each year level, mathematics and science items were grouped into clusters, which were then rotated through 14 booklets, with each cluster found in more than one booklet.

The booklets were designed to be administered in two sessions, separated by a short break. Each session was of 45 minutes duration at Year 8 and 36 minutes at Year 4. Each booklet contained both mathematics and science items, and included both multiple choice and constructed response items. The questionnaire that students completed took 30 minutes.

## How are the results reported?

Results are reported as average scores with the standard error, as distributions of scores, and as percentages of students who attain the international benchmarks, for countries and specific groups of students within Australia.

The international benchmarks were developed using scale anchoring techniques. Internationally it was decided that performance should be measured at four levels: 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.

## How is TIMSS managed?

TIMSS was organised by the IEA and managed by the International Study Centre, Lynch School of Education, at Boston College in the United States. In Australia, the study was funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) and by State and Territory Departments of Education proportional to the size of their student population. The study was managed in Australia by the Australian Council for Educational Research (ACER), which represents Australia on the IEA.

Meetings of National Research Coordinators occur twice yearly in order to plan and report on each stage of the process, in consultation with the International Studies Centre, Statistics Canada and the IEA Data Processing Centre, Hamburg.

## Australia's performance in TIMSS 2007

Some highlights from the TIMSS 2007 results are provided on the following pages. Differences are only mentioned if tests of statistical significance showed that the differences were likely to indicate real differences.

### Performance internationally:

- *Year 4 mathematics* – Hong Kong and Singapore outscored all other participating countries. Australia's mean score of 516 was similar to three countries (Denmark, Hungary and Italy), significantly lower than that of 12 countries (including the Asian countries, England and the United States), and significantly higher than that of 20 countries and the TIMSS scale average.
- *Year 8 mathematics* – At Year 8, Australia's mean score in mathematics was 496, not significantly different from the TIMSS scale average of 500. Nine countries achieved scores higher than Australia, including the highest scoring countries, Chinese Taipei, Korea and Singapore. Eight countries scored similarly to Australia, while Australia scored significantly higher than 31 countries.

- *Year 4 science* – Singapore outscored all other participating countries. Australia’s mean score of 527 was similar to eight countries (including Germany and the Netherlands), significantly lower than that of eight countries (including the Asian countries, England and the United States), and significantly higher than that of 19 countries and the TIMSS scale average.
- *Year 8 science* – Singapore and Chinese Taipei outscored all other participating countries. Australia’s mean score of 515 was similar to three countries (including the United States), significantly lower than that of 10 countries (including five Asian countries and England) and significantly higher than that of 35 countries and the TIMSS scale average.

#### Performance at the international benchmarks:

- *Year 4 mathematics* – While the proportion of Australian Year 4 students at each of the international benchmarks was higher than the international median, the nine per cent reaching the advanced benchmark was considerably less than that of the highest scoring countries. The proportion reaching the low benchmark (91%) was, however, fairly similar to the highest performing countries.
- *Year 8 mathematics* – Six per cent of Australia’s Year 8 students reached the advanced benchmark, which was higher than the international median, and 11 per cent of Australian Year 8 students failed to achieve the low benchmark.
- *Year 4 science* – While the proportion of Australian Year 4 students at each of the international benchmarks was higher than the international median, the 10 per cent reaching the advanced benchmark was less than that of the highest scoring countries. The proportion reaching the low benchmark (93%) was, however, fairly similar to the highest performing countries.
- *Year 8 science* – Eight per cent of Australia’s Year 8 students reaching the advanced benchmark, which was higher than the international median, but much less than that of the highest scoring countries. The proportion reaching the low benchmark (92%) was, however, similar to the proportions of students performing at this level in the highest scoring countries.

#### Performance in the content and cognitive domains:

- *Year 4 mathematics* – In terms of the mathematics content domains, Australian Year 4 students were strongest in *geometric shapes and measures* and *data display*, rather than in *number*. This pattern of strengths and weaknesses was apparent for all states in the content domains, and in the cognitive domains Year 4 students were strongest in *applying* and *reasoning* rather than *knowing*. The only significant gender differences were in favour of males in the *number* content domain and the *applying* cognitive domain.
- *Year 8 mathematics* – At Year 8, Australian students’ performance in both *algebra* and *geometry* was significantly lower than the TIMSS scale average, while performance in *number* was equivalent, and *data and chance*, as in previous cycles, was found to be a strength. In terms of the cognitive domains, Australian Year 8 students performed at a similar level to the TIMSS scale average in *applying* and *reasoning*, and lower in *knowing*. This pattern of strengths and weaknesses was also apparent for all states. In addition, the gender bias in favour of males was found to be significant for *data and chance*, *number* and *applying*.
- *Year 4 science* – In terms of the content domains, Australian Year 4 students were stronger in *Earth science* and *life science* than in *physical science*. In the cognitive domains, performance in the areas of *reasoning* and *knowing* was relatively strong, while *applying* was the weakest area. This pattern of strengths and weaknesses was apparent for all states. There were no significant gender differences in performance in each of the three content domains.
- *Year 8 science* – In terms of the content domains, Australian Year 8 students were stronger in *Earth science* and *biology* than in *physics* and *chemistry*. In the cognitive domains, *reasoning* was a strength, while *knowing* was an area of relative weakness. This pattern of strengths and weaknesses was apparent for all of the states. The gender difference in overall science achievement in favour of males was also found to be significant in most of the content and cognitive domains, except for *biology* and *reasoning*. The gender difference was largest (around 30 score points) for *Earth science* and *physics*.

#### Between 1995, 2003 and 2007:

- *Year 4 mathematics* – Australia’s score has increased significantly by 17 score points since 2003 and by 22 score points since 1995. In terms of relative position internationally, Australia was outperformed in 2007, as in 2003, by all of the Asian countries, as well as England and the United States. However, Australia’s score in 2007 was significantly higher than the TIMSS scale average and also the scores of both Scotland and New Zealand.
- *Year 8 mathematics* – Australia’s score remained unchanged from 2003 and decreased significantly from that of 1995. In 2007, as in 2003 and 1995, Australia was outperformed by all of the Asian countries other than Indonesia, but the increased scores of England, the United States and the Russian Federation, in combination with the decrease in Australia’s score, resulted in those countries also significantly outperforming Australia.
- *Year 4 science* – Australia’s score has remained relatively unchanged between assessments. Australia’s relative position in 2007 was also much the same as in 2003. Australia was again outperformed in 2007 by all of the Asian countries, and by England and the United States. The Russian Federation’s increase also resulted in a score significantly higher than Australia in 2007; on the other hand the decline in New Zealand’s score has resulted in a score significantly lower than that of Australia.
- *Year 8 science* – Australia’s average score has declined by 12 score points since TIMSS 2003, and is relatively unchanged since 1995. This, combined with significant improvements by the Russian Federation and Slovenia, has moved Australia a little downwards in relative terms. The same Asian countries (Singapore, Chinese Taipei, Korea, Hong Kong and Japan) outperformed Australia, as did England, Czech Republic and Hungary. In 2007 the Russian Federation and Slovenia also significantly outperformed Australia. Australia still performed on a par with the United States and outperformed Scotland.

#### In terms of results for the Australian states:

- *Year 4 mathematics* – Across the states there were some significant differences in Year 4 mathematics performance. Students in New South Wales performed significantly better than students in all other states. 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, for 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.
- *Year 8 mathematics* – There was little variation and no significant differences between the states in terms of average Year 8 scores. As for performance at each of the benchmarks, there was little variation across the states except for the substantially larger proportion of students achieving the advanced benchmark in the Australian Capital Territory and New South Wales than in the other states.
- *Year 4 science* – Across the states there were some significant differences in Year 4 performance. 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.
- *Year 8 science* – Performance across the states was fairly uniform at Year 8, with no significant differences in mean scores. There was very little variation in attainment at each of the benchmarks across the states except for the substantially larger proportion of students achieving the advanced benchmark in the Australian Capital Territory and New South Wales compared to the other states.
- *Trends* – There was little movement in terms of achievement levels in the states. In Year 4 mathematics, New South Wales and Victoria had a significant increase in scores from 2003 to 2007, and New South Wales showed a sustained increase over the 12-year period from 1995. Scores in Western Australia were significantly higher in 2007 than 2003, while in Tasmania there was a slower but sustained growth over the 12-year period from 1995 resulting in a significant increase in scores from TIMSS 1995.

In Year 8 mathematics the only changes in scores were a significant decline in the scores of South Australia and Western Australia over the period since 1995, most of which seems to have occurred in the period 1995 – 2003, with less of a decline in recent years.

In science there were fewer changes – a decline of 30 score points from 1995 – 2007 in the Australian Capital Territory at Year 4 and a decline of 25 score points in Western Australia at Year 8 over the same time span.

#### **In terms of results for males and females:**

- *Year 4 mathematics* – There was no significant gender difference in the Year 4 mathematics performance of Australian students. This was similar to the results internationally, in which males and females performed equally well at this level. In Australia, a slightly higher proportion of males achieved at the advanced benchmark, while a similar proportion of males and females achieved at the low benchmark. With respect to performance within the Australian states, there were no gender differences.
- *Year 8 mathematics* – At Year 8 nationally, there was a substantial and significant gender difference in favour of males. More males than females achieved the higher benchmark levels, while similar proportions of females and males failed to achieve at the low benchmark level. The gender difference in favour of males was only significant in Queensland.
- *Year 4 science* – At Year 4, there was no significant difference between the average performance of males and females in Australia. This is different to the results internationally where females outperformed males on average. In Australia, a higher proportion of males achieved at the advanced benchmark, while a similar proportion of males and females achieved at the low benchmark. There was no difference across the states in terms of the performance of male and female students.
- *Year 8 science* – At Year 8, there was a substantial and significant gender difference in favour of males in Australia, while internationally it was female students, on average, who outperformed males. In Australia, the better performance of males is apparent mainly at the higher benchmarks – there was little difference in the proportion of females and males achieving at the low benchmark. At the state level, the only significant gender difference (in favour of males) was found in Queensland.
- *Trends* – The increased score for Australia overall for Year 4 mathematics was the result of a significant increase in the scores of both males and females.

In contrast, the significant gender difference in favour of males found in Year 8 mathematics (not previously seen in 2003 or 1995) appears to be due to a significant decline in the average score for females over the 1995 – 2007 time span.

#### **In terms of Indigenous students' results:**

- Students who identified themselves as Indigenous performed at a significantly lower level than both non-Indigenous students and the TIMSS scale average at both Year 4 and Year 8, for mathematics and science.
- The proportion of Australian Indigenous students performing at each of the international benchmarks was also similar to or less than the international median at both year levels and in both subject areas.
- *Trends* – For Australia's Indigenous students there were no significant changes in achievement in either subject at either year level. However, significant changes in the scores of non-Indigenous students, coupled with changes in the scores for Indigenous, has resulted in a widening gap between the mathematics achievement of Indigenous and non-Indigenous students to about 90 score points at Year 4.

#### **For other student groups:**

- *Year 4 mathematics* – The geographic location of schools had a significant relationship with mathematics achievement at Year 4 such that metropolitan students performed better than provincial students, who in turn performed better than students in remote schools. A lower proportion of students from remote schools achieved at each of the higher benchmarks,

compared to metropolitan and provincial students. Students in Year 4 who spoke a language other than English at home achieved significantly lower scores on average in mathematics than students who predominantly spoke English. In addition, a smaller proportion of students who did not speak English as their main language at home reached the high benchmark and a greater proportion of these students, compared to predominantly English-speaking students, failed to reach the low benchmark.

- *Year 8 mathematics* – The geographic location of schools had a limited relationship with mathematics achievement at Year 8. There was no significant difference in the average performance of students from metropolitan, provincial or remote areas. However, a smaller proportion of remote students compared to metropolitan and provincial students achieved each of the higher benchmarks. At Year 8, there was no significant difference in mean mathematics scores according to language background. However, there was a much larger spread of scores for those that spoke a language other than English at home. The proportion of these students who were performing at the advanced benchmark or who were failing to attain the low benchmark was greater than the proportion of English-speaking students at each of these levels. Parental education was also significantly related to mathematics achievement, with mean mathematics achievement increasing as parental education increased. The proportion of students achieving the advanced and high benchmarks was considerably higher for students with at least one parent who had completed a university degree than for any other group.
- *Year 4 science* – The geographic location of schools had a significant relationship with science achievement at Year 4, such that metropolitan students performed better than provincial students, who similarly performed better than students in remote schools. Students from remote schools were much less likely to achieve at each of the higher benchmarks. Students in Year 4 who spoke a language other than English at home achieved significantly lower on average in science than students who spoke English only. This was related to a lower proportion of students who spoke a language other than English reaching the advanced benchmark, and far more students who spoke a language other than English not reaching the low benchmark.
- *Year 8 science* – The geographic location of schools had little relationship with science achievement at Year 8. Students in metropolitan and provincial schools performed at the same level, and remote students, while less likely to achieve at the higher benchmarks, were not significantly different from their metropolitan and provincial peers at other levels. Speaking a language other than English at home was related, on average, to lower achievement in science. However, the spread of scores for these students was quite large, with the proportion of students reaching the advanced benchmark similar to that of English-speaking students, but far more not reaching the low benchmark. Parental education was also significantly related to science achievement, with mean science achievement increasing as parental education increased. The proportion of students achieving the advanced benchmark was strikingly higher for students with at least one parent who had completed a university degree compared to all other parental education groups.

#### **Students' educational resources in the home:**

- Australia was amongst a small number of countries with high levels of educational resources in the home.
- At both Year 4 and Year 8, Australia had very high percentages (relative to other countries) of students who reported having over 100 books in the home.
- High percentages of Australian Year 4 and Year 8 students also had a computer and Internet connection.
- Both internationally and within Australia, a higher number of books in the home, the presence of a computer and an Internet connection were associated with higher mathematics and science achievement at Years 4 and 8.

- Students in Australia were also far more likely than students in many of the participating countries to use a computer at both home and school. At both year levels, students using a computer at home and at school had higher mathematics and science achievement than students using a computer at home but not at school or at school but not at home.
- Australian students tended to receive less mathematics and science homework at both Year 4 and Year 8 than students in other countries. On average, at both year levels, Australian students tended to receive less science homework than mathematics homework. At Year 4, Australian students who indicated they received low amounts of mathematics and science homework had higher achievement than those receiving medium or high amounts of homework, perhaps reflecting that much of the homework given at the Year 4 level had a remedial focus. However, at Year 8, students completing high amounts of mathematics and science homework had the highest average achievement. This reflects the different role of homework at Year 8, where it can provide an extension as well as remediation.

#### Students' attitudes and beliefs:

- Both internationally and within Australia, Year 4 students tended to have a more favourable opinion of mathematics and science than Year 8 students. However, far fewer Australian Year 8 students had high positive affect toward mathematics and science than was the case internationally. At both Year 4 and Year 8 the percentage of Australian students with high positive affect toward mathematics decreased significantly from 1995, while there was a slight increase in positive affect toward science at Year 4. At both year levels, higher positive affect toward mathematics and science was associated with higher achievement.
- Australian Year 8 students placed a relatively high value on mathematics, similar to the international average. However, the percentage placing a high value on science was considerably lower than both the international average for science and the percentage placing a high value on mathematics. Students indicating that they placed a high value on mathematics or science had higher achievement than those who did not.
- Both internationally and within Australia, Year 4 students tended to have higher self-confidence in learning mathematics and science than Year 8 students. The proportions of Australian students indicating high, medium and low self-confidence in learning mathematics and science were fairly similar to that of the international average at both year levels. Students with high self-confidence in learning mathematics and science had higher average achievement than those with medium or low self-confidence.
- More males than females had high self-confidence in learning mathematics, both within Australia and internationally, and at both year levels. For science, however, there was no gender difference in self-confidence at Year 4, contrasting with a gender difference in favour of males at Year 8. Within Australia, the gender difference in self-confidence in learning mathematics and science could help to explain the gender difference in achievement at Year 8.
- A substantial proportion of both Year 4 and Year 8 students agree that they like school. At both year levels, those that *disagree a lot* that they like school have significantly lower achievement than those that *disagree a little* or *agree* that they like school.
- Approximately one-third of Year 8 students intended to study at least an undergraduate degree, while 13 per cent expected only to finish secondary school. A clear positive relationship was found between mathematics and science achievement and students' educational aspirations.

#### Australian teachers and their preparation for teaching:

- Across Australia, a majority of Year 4 teachers were female and about one half of Year 8 students were taught mathematics by female teachers. Internationally, more Year 8 students are taught by females than males. Nationally, in Year 8 science classes, there were equal proportions of male and female teachers. Internationally, however, Year 8 students were taught science more often by females than males.

- The Australian teaching workforce was well-educated in terms of completion of university and postgraduate university degrees. The majority of Year 4 and Year 8 students had teachers with a university or postgraduate university degree.
- Internationally, about one-quarter of Year 4 students were taught by teachers with a qualification in primary education and a specialisation in either mathematics or science (or both). However, in Australia, most year 4 students have teachers with a specialisation in primary education without a major or specialisation in science or mathematics. In Australia, at Year 8, about one half of students had teachers with a mathematics education qualification or mathematics qualification. Over two-thirds of students had science teachers that had studied biology, physics, chemistry or Earth science.
- At Year 4 and Year 8, across all mathematics topics, Australian students generally had teachers who reported feeling 'very well' prepared to teach all topics. Teachers of science at Year 4 were less well-prepared to teach all topics. At Year 8, more students had science teachers who reported being well prepared than was the case for Year 4 science; however, Year 8 mathematics teachers reported a higher level of preparedness to teach than Year 8 science teachers.
- For Year 4 mathematics, the percentage of students with teachers who reported feeling 'very well' prepared to teach *geometric shapes and measures* was lowest both internationally and in Australia. For Year 4 science, *physical science* was the weakest area both in Australia and internationally. For Year 8 mathematics, *data and chance* was strongest and *geometry* and *algebra* were the weakest areas in Australia. For Year 8 science, the percentage of students whose teachers reported feeling 'very well' prepared for *chemistry* was highest and *physics* and *Earth science* were the lowest areas in Australia.

#### Classroom activities and characteristics:

- An emphasis on problem-solving activities has been an important part of the mathematics curriculum for a number of years, and improving students' problem-solving skills continues to be a goal for educators. In Australia, being asked to explain answers was the most common of the reported problem-solving activities in mathematics classes, with over two-thirds of students saying that at least half of their lessons involved this type of activity. Forty percent of students said they spent more than half of their time in mathematics classes deciding on procedures for solving complex problems, while 42 per cent of students reported spending at least half of their time in class relating classroom mathematics to their daily lives.
- Engaging students in scientific inquiry is an important part of the science curriculum in many countries. According to students in Australia, the most common activities of scientific inquiry (i.e. those in which students reported spending at least half of their class time) were working in small groups on an experiment (68%); watching the teacher demonstrate an experiment (60%); writing explanations about what was observed and why it happened (59%); conducting an experiment (59% of students); and designing an experiment (52%). The area of least attention was being asked to relate classroom science to their daily lives, for which 39 per cent of students reported spending at least half of their time in class.
- The textbook is the foundation of mathematics and science instruction at both Year 4 and Year 8 in most countries in the TIMSS study, although less so for science at Year 4. Australia stands out amongst the countries surveyed at Year 4 as having a quarter of classes not using a textbook for mathematics. Australia and New Zealand at Year 4 reported a large proportion of classes not using a textbook for science. At Year 8, Australian mathematics teachers used a textbook in a similar manner to teachers in most other countries, but for science, Australian teachers use a science textbook as a primary basis to a lesser extent than other countries.
- At both Year 4 and Year 8, average mathematics and science achievement was related to the diversity of the students in the class and the instructional challenges involved. That is, students of teachers who reported that their classrooms were impacted only a little by these factors had higher average achievement than those whose teachers reported some limitations. This latter group had higher average achievement than those students whose teachers reported a lot of limitations. Over 40 per cent of students were in classrooms with little or no such limitations.

### School contexts for learning:

- About one-third of Australian students attended schools in which there were fewer than 10 per cent of students who came from economically disadvantaged homes. This was the same as the international average for Year 4 students and substantially greater than the international average for Year 8 students. At the other end of the scale, a lower proportion of Year 4 and Year 8 students attend schools in which the principal believes that more than half of the students were from economically disadvantaged homes. At both year levels, but particularly at Year 8, this was much lower than the international averages.
- At Year 4, about one half of students in Australia attended schools rated by their principal as being at the high level of the Index of Availability of School Resources for Mathematics/ Science Instruction (i.e. resource shortages essentially were not a problem for mathematics or science classes). Very few Australian students were rated at the low level of the index. Average mathematics and science achievement was highest among students in Australia at the high level of the index. The situation was similar at Year 8.
- In Australia, a majority of students attended schools where principals reported a high positive school climate (50% at Year 4 and 33% at Year 8). Around 50–60 per cent of students attended schools in which principals rated the school climate at a medium level and very few were at the low level. Students in schools in which principals rated the school climate positively had higher achievement than students in schools in which the principal rated the school climate as medium or low.
- About one-third of Year 4 students and almost one-half of Year 8 students reported a high level of feeling safe in their school. More than one-quarter of Year 4 students in Australian schools were at the low level, implying that they encountered at least some unpleasant events in school in the past month. Average achievement was higher for those students who reported a high level of feeling safe in their school.

## Policy Issues

The only area in which Australian achievement has shown improvement over the cycles of TIMSS since 1995 has been in mathematics at Year 4. However, in Year 8 mathematics and Year 4 science there has been no change to Australia's scores and in Year 8 science scores have declined significantly. This is in comparison to other countries that have improved already high scores, often associated with systemic and curricular reform.

These results suggest that greater attention be given to curriculum and teaching in junior secondary science, particularly in the areas of *physics* and *chemistry*. A failure to give sufficient attention to science in the junior secondary years is likely to have consequences for building the basis for education in the science-based occupations and for building a scientifically literate community. In addition, there are curriculum issues.

Related to this is the issue of teacher preparedness to teach. While most Year 8 teachers believed they were well-prepared to teach all of the mathematics topics covered in TIMSS, and around three-quarters of Year 8 science teachers felt they were well-prepared to teach science, this was only the case for half of the primary teachers surveyed. Further analysis needs to be conducted on this issue. There also seem to be some areas where teachers have misplaced confidence; that is, where teachers believe they are well-prepared to teach the subject matter but where the achievement of their students is not high. Professional development might well be needed to address this discrepancy.

Other important policy considerations are the gender differences in favour of males in both mathematics and science at Year 8 (particularly after a number of years in which there were no such differences); the disparity in achievement between those from a high socioeconomic background and those from a low socioeconomic background; and the education of Indigenous students. If the ideals of the National Goals for Schooling are to be realised it is imperative that action is taken that will improve these outcomes.

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### Peak non-government representatives

**Mr Brian Huppertz**

Catholic Education Office, Adelaide

**Ms Robyn Yates**

*Mr Andrew Smith*

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### Indigenous Education Representative

**Ms Isabelle Adams**

Vision Network Pty Ltd

### Professional association representatives

**Mr Paul Carnemolla**

Australian Science Teachers Association,  
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**Ms Christine Stocks**

Australian Association of Mathematics  
Teachers, Adelaide

### Teacher organisation representatives

**Mr Peter Job**

*Mr Roy Martin*

Australian Education Union, Melbourne

### Australian Council for Educational Research

**Dr John Ainley**

Deputy CEO

**Dr Sue Thomson**

National Research Coordinator



# Reader's Guide

## TIMSS scores

TIMSS used item response theory (IRT) methods to summarise the achievement for each year level on a scale with a mean of 500 and a standard deviation of 100. It should be noted that the results for Year 4 and Year 8 are not directly comparable, nor are the results for mathematics and science. While the scales are expressed in the same numerical units, they are not directly comparable in terms of being able to say how much achievement or learning at one year equals how much achievement or learning at the other year (or how much learning in mathematics equals how much learning in science). That is, achievement on the TIMSS scales cannot be described in absolute terms (like all such scales developed using IRT technology). Comparisons only can be made in terms of relative performance (higher or lower), for example, among countries and population groups as well as between assessments (at 1995, 1999, 2003 or 2007). The TIMSS mathematics and science scales for Year 4 and Year 8 were established based on the 1995 assessments and the methodology enables comparable trend measures from assessment to assessment within each year level.

## International comparison statistics

Several international comparison statistics are given in the report: the *TIMSS scale average*, the *international average* and the *international median*.

The *TIMSS scale average* is the mean of the scales (for each of Year 4 Mathematics, Year 4 Science, Year 8 Mathematics and Year 8 Science) established in 1995, calibrated to be 500, with a standard deviation of 100 score points. Each of the content and cognitive domains have also been established to have a mean of 500 to enable direct comparison across the domains within the subject at a specific year level.

The *international average* is the mean score or percentage of all countries participating in TIMSS 2007 at that year level.

The *international median* is the midpoint in a ranking of countries by score or percentage. By definition, half of the countries will have a score or percentage above the median and half below.

## Reporting of achievement of the international benchmarks

When the proportion of students achieving a particular benchmark is reported in the text, the students achieving the benchmarks above are included. 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. This is because the higher benchmarks include the skills of all lower benchmarks such that all students at the advanced benchmark also have the skills displayed by

those at the high benchmark and, therefore, should be included when reporting the proportion achieving the high benchmark. However, as this is hard to portray graphically, all figures in this report display the percentage of students at each benchmark (that is 18% at the high benchmark, rather than 24% achieving the high benchmark).

## Rounding of figures

Due to rounding, some figures in tables may not exactly add to the totals. Totals, differences and averages are always calculated on the basis of exact numbers and are rounded only after calculation. When standard errors have been rounded to one decimal place and the value 0.0 is shown, this does not imply that the standard error is zero, but that it is smaller than 0.05.

## Confidence intervals and standard errors

In this and other reports, student achievement is often described by a mean score. For TIMSS, each mean score is calculated from the sample of students who undertook the TIMSS assessment, and is referred to as the *sample* mean. These sample means are an approximation of the actual mean score (known as the population mean) that would have been derived had *all* students in Australia sat the TIMSS assessment.

If another sample of students was chosen on a different day, it is highly likely that the sample mean would be slightly different. Indeed the sample mean is just one point along the range of student achievement scores, and so more information is needed to gauge whether the sample mean is an underestimation or overestimation of the population mean.

In this report, sample means are presented with an associated standard error. The standard error is an estimate of the error in the estimate of the population mean from the sample and is based on the standard deviation of sampling distribution of the mean. The size of the sample, as well as the variance in the scores within the sample, can affect the size of the standard error. Smaller samples, or samples with a lot of variance in scores, will have larger standard errors.

The calculation of confidence intervals can assist our assessment of a sample mean's precision as a population mean. Confidence intervals provide a range of scores within which we are 'confident' that the population mean actually lies. The confidence interval is within plus or minus 1.96 standard errors of the sample mean.

## Statistical significance

The term 'significantly' is used throughout the report to describe a difference that meets the requirements of statistical significance at the 0.05 level, indicating that the difference is real, and would be found in at least 95 analyses out of 100 if the comparison were to be repeated. It is not to be confused with the term 'substantial', which is qualitative and based on judgement rather than statistical comparisons. A difference may appear substantial but not be statistically significant (due to factors that effect the size of the standard errors around the estimate, for example) while another difference may seem small but reach statistical significance because the estimate was more accurate.

## 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 year level 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 generally 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

## Footnotes to international tables and figures

In order to ensure unbiased, accurate and internationally comparable survey estimates, stringent guidelines are given for sampling within countries. Those countries that did not achieve a sample that fulfilled all of the requirements are indicated, by way of footnotes to the tables and figures in the report, so that readers are aware of the potential for bias and incomparability in the data for the country concerned. These footnotes indicate issues of population coverage as well as problems in achieving requirements for school and student participation. See Appendix 1 for more information about sampling and sampling results.

## Definitions of background characteristics

There are a number of definitions used in this report that are particular to the Australian context, as well as many which are international. This section provides an explanation for those that are not self-evident.

- Indigenous status: Indigenous status is derived from students' self-identification as being of Australian Aboriginal or Torres Strait Islander descent. For the purposes of this report, data for the two groups are presented together for Indigenous Australian students.
- Geographic location: In Australia, the participating schools were coded with respect to the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) Schools Geographic Location Classification. For the analysis in this report, only the broadest categories are used:
- Metropolitan – Including mainland state capital cities or major urban districts with a population of 100 000 or more (e.g. Queanbeyan, Cairns, Geelong, Hobart).
  - Provincial – including provincial cities and other non-remote provincial areas (e.g. Darwin, Ballarat, Bundaberg, Geraldton, Tamworth).
  - Remote – Remote areas and Very remote areas. Remote: very restricted accessibility of goods, services and opportunities for social interaction (e.g. Coolabah, Mallacoota, Capella, Mt Isa, Port Lincoln, Port Hedland, Swansea and Alice Springs). Very remote: very little accessibility of goods, services and opportunities for social interaction (e.g. Bourke, Thursday Island, Yalata, Condingup, Nhulunbuy).

Language spoken at home: The language spoken at home indicates whether a student has a language background other than English. The question asked how often English was spoken at home. Where the student spoke English never or only sometimes, the student was considered to have a language background other than English. Those that indicated that they spoke English always or almost always were considered to be from an English-speaking background.

Parental Education: Parental education is based on the answers to the questions:

- What is the highest level of education completed by your mother (or stepmother or female guardian)?; and
- What is the highest level of education completed by your father (or stepfather or male guardian)?

These questions were only asked of Year 8 students.

For the analyses in this report, the responses from both questions were combined to identify the highest level of education attained by either parent. Where no response is given for one parent, the response for the other parent was used. Where no information was given for either parent, parental education was recorded as missing.

## Regression analysis

Regression analysis is a statistical tool used to investigate relationships between variables. Most often regression analysis is used to establish whether a variable has a causal effect on another. Where the relative effect of more than one independent (or causal) variable is of interest, multiple regression analysis is used. Both simple and multiple regression analyses rely on the assumption of a linear relationship between the independent and dependent variables. The output of a regression provides an estimate of the intercept (the value of the dependent variable when the independent variables equal zero) and regression coefficients for each independent variable (which indicates the rate of change in the dependent variable for every unit increase in the independent variable). These parameters enable a value of the dependent variable to be estimated given the values of the independent variables. In addition, an estimate of the amount of variance in the dependent variable explained by the independent variables is provided via the  $R^2$  value. An  $R^2$  value close to one indicates a strong relationship where most of the variation in the dependent variable has been explained. Statistical significance of the overall model is provided via the F-test.

## TIMSS assessments – nomenclature

The international name of this study was TIMSS 2007, just as those that went before were TIMSS 2003, TIMSS 1999 and TIMSS 1995. In each of those studies, students in Australia and other southern hemisphere countries tested in the previous year, to ensure that students were all at the same stage of the school year when tested. In previous reports, the study has been referred to as, for example, TIMSS 2002/03. For this and future reports it was decided to report by the name of the study, not the year in which Australia participated.

# Introduction

Towards the end of 2006, just over 8 000 Australian students in Year 4 and Year 8 participated in the Trends in International Mathematics and Science Study<sup>1</sup>. These students completed tests in mathematics and science achievement, and answered questionnaires on their background and experiences in learning mathematics and science at school. School principals and the students' mathematics and science teachers also completed detailed questionnaires. In 58 other countries and eight regions or benchmarking participants<sup>2</sup>, students, teachers and principals completed the same tests and questionnaires.

The goal of TIMSS is to provide comparative information about educational achievement across countries to improve teaching and learning in mathematics and science. TIMSS measures trends in mathematics and science achievement at Year 4 and Year 8, as well as monitoring curricular implementation. TIMSS is a project of the IEA (International Association for the Evaluation of Educational Achievement), which is an independent international cooperative of national research institutions and government agencies that has been conducting studies of cross-national achievement in a wide range of subjects since 1959. In Australia it is implemented by the Australian Council for Educational Research (ACER), which is Australia's representative to the IEA.

Conducted on a regular four-year cycle, TIMSS has assessed mathematics and science in 1995, 1999, 2003, and 2007. In addition to monitoring trends in achievement at Year 4 and Year 8, TIMSS provides information about relative progress across years as the cohort of students assessed in Year 4 in one cycle moves to Year 8 four years later (e.g. the Year 4 students of 2003 became the Year 8 students of 2007). Also, to provide comparative perspectives on trends in achievement in the context of different educational systems, school organisational approaches, and instructional practices, TIMSS collects a rich array of background information.

## Why TIMSS?

The main goal of TIMSS<sup>3</sup> is to assist countries to monitor and evaluate their mathematics and science teaching across time and across year levels. TIMSS offers countries an opportunity to:

- have comprehensive and internationally comparable data about what mathematics and science concepts, processes, and attitudes students have learned by Year 4 and Year 8;

1 For comparability across countries and across assessments, testing was conducted at the end of the school year. The countries in the southern hemisphere tested in October to November 2006. The remaining countries tested at the end of the northern hemisphere school year: May to June 2007.

2 Benchmarking participants: Provinces or regions that participated in TIMSS for their own internal benchmarking. Data from these provinces are not included in the international mean and are not included in the report.

3 Parts of this chapter are modified, with permission, from the TIMSS 2007 Assessment Frameworks (Mullis, Martin, Ruddock, O'Sullivan, Arora & Erberber, 2005)

- assess progress internationally in mathematics and science learning across time for students in Year 4 and for students in Year 8;
- identify aspects of growth in mathematical and scientific knowledge and skills from Year 4 to Year 8;
- monitor the relative effectiveness of teaching and learning at Year 4 as compared to Year 8, since the cohort of Year 4 students is assessed again as Year 8 students;
- understand the contexts in which students learn best. TIMSS enables international comparisons among the key policy variables in curriculum, instruction, and resources that result in higher levels of student achievement;
- use TIMSS to address internal policy issues. Within countries, for example, TIMSS provides an opportunity to examine the performance of population subgroups and address equity concerns.
- allow countries to add questions of national importance (national options) as part of their data collection effort.

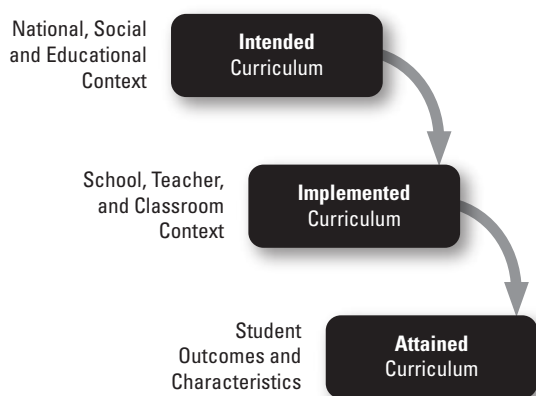
This report provides the Australian perspective for achievement in mathematics and science in TIMSS 2007, examining the issues presented above and issues particular to the Australian context, such as:

- How do Australian students score in each subject domain, at each year level?
- How does this compare internationally and what is happening within Australia?
- Are there trends in mathematics and science achievement that can be seen from these data?
- Has Australia's achievement remained the same in comparison to other countries to which we would normally compare ourselves?

Another characteristic of TIMSS is that data is also collected at the teacher and school level, so that such data can be used to highlight characteristics of teaching and learning mathematics and science in Australia.

## Research model for IEA studies

TIMSS focuses on three levels of the curriculum, considered in relation to the context in which they occur. These levels are shown in Figure 1.1.



**Figure 1.1** Three levels of curriculum developed in IEA research models

The research questions associated with each of the levels of curriculum 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? How should the education system be organised to facilitate this learning?*
- The *implemented* curriculum – defined as the curriculum as interpreted and delivered by classroom teachers. *What is actually taught in classrooms? Who teaches it? 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 student's opportunity to learn, and how do these factors influence students' achievements?*

The data describing the intended curriculum were gathered through curriculum questionnaires. These extensive questionnaires were completed in Australia by curriculum experts in each state and territory education department, the results collated by ACER and submitted to the International Study Centre.

The data describing the implemented curriculum were gathered through the school and teacher questionnaires. The school questionnaire investigated aspects related to the teaching of mathematics and science, such as organisation, teaching resources and time allocation, and the teacher questionnaire explored the implementation of the curriculum in the school by the actual teachers of mathematics and science for the TIMSS students.

Finally the data describing the attained curriculum are those data presented in this report – the achievement data from the assessment conducted for TIMSS 2007.

## Organisation of TIMSS

TIMSS was organised by the IEA and managed by the TIMSS & PIRLS International Study Centre, Lynch School of Education, at Boston College in the United States. In Australia, the study was funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) and by State and Territory Departments of Education proportional to the size of their student population. The study was managed in Australia by the Australian Council for Educational Research (ACER), which represents Australia to the IEA.

Meetings of National Research Coordinators occur twice yearly in order to plan and report on each stage of the process, in consultation with Statistics Canada and the IEA Data Processing Centre, Hamburg.

## What is assessed in TIMSS?

Two organising dimensions, 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. The content dimension of the assessment specifies the domains or subject matter to be assessed within mathematics or science, while the cognitive dimension specifies the domains or thinking processes to be assessed. The cognitive domains describe the sets of behaviours expected of students as they engage with the mathematics or science content.

The content domains differ for Year 4 and Year 8 students, reflecting the nature and difficulty of the mathematics and science widely taught at each year level. In mathematics there is more emphasis on number at Year 4 than in Year 8, in science there is more emphasis on life science in Year 4 than in Year 8. In mathematics at Year 8, geometry and algebra are assessed, while in Year 4 these content areas are not generally included in the curriculum. Similarly in science in Year 8, physics and chemistry are assessed as separate content domains, and receive more emphasis than in Year 4, where they are assessed as one content domain, physical science. Nevertheless the cognitive framework, is the same for both year levels, encompassing a range of cognitive processes involved in working mathematically or scientifically and solving problems right through the primary and middle school years.

Details about the content and cognitive domains, as well as the contextual domain, will be provided in Chapter 2.

## Development of the TIMSS assessment tasks

Developing the TIMSS tests for 2007 was a cooperative venture involving representatives from the participating countries throughout the entire process. The TIMSS & PIRLS International Study Centre began the process with an item-writing workshop for the National Research Coordinators from the participating countries and their colleagues.

The curriculum guides and textbooks of many countries were analysed to identify priority and common topics, and curriculum specialists collaborated to produce international frameworks for mathematics and science that guided the test development. Through this series of efforts, countries then submitted items that were reviewed by mathematics and science subject-matter specialists. Participating countries field-tested the items with representative samples of students, and all of the potential new items were reviewed by the TIMSS 2007 Science and Mathematics Item Review Committee of subject-area experts. The National Research Coordinators had several opportunities to review the items and scoring criteria to ensure the items were measuring objectives in the frameworks, and were appropriate for students in their countries.

## What did TIMSS 2007 participants do?

As the focus of TIMSS is on international curricula in mathematics and science, a large number of test items were required to cover the range of topics and abilities, at both Year 4 and Year 8. For each year level, mathematics and science items were grouped into clusters, which were then rotated through 14 booklets, with each cluster found in more than one booklet. The booklets were designed to be administered in two sessions, separated by a short break. Each session was of 45 minutes duration at Year 8 and 36 minutes at Year 4. Each booklet contained both mathematics and science items, and included both multiple choice and constructed response items. Participating students completed only one of these booklets, which were evenly distributed within classes. This meant that only two or three students in each class completed each particular booklet.

Procedures for administering the test were determined by the TIMSS & PIRLS International Study Centre so that data from all students from all schools in all countries could be considered equivalent. These were operationalised by National Centres in each country, such as ACER in

Australia. School Coordinators, nominated by the school principal, assisted the National Centre with the management of TIMSS within the school, including administering the School and Teacher questionnaires. The actual test and student questionnaires were administered, in most cases, by a teacher from the school. The Test Administrator followed strict guidelines and had to complete a report about any situation that constituted a deviation from these guidelines. A National Quality Control Observer visited 10% of schools to observe the test administration. An International Quality Control Observer visited a further 15 schools as well as examining the operations of the National Centre.

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

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 (or the principal's designate), sought descriptive information about the school and information about instructional practices. For example, questions were asked about recruitment and numbers of staff, teacher morale, school and teacher autonomy, school resources, and school policies and practices, such as use of student assessments.

In Australia, a National Advisory Committee guides all aspects of the project. The National Research Coordinator is responsible for the implementation of TIMSS at the national level.

## How results are reported

International comparative studies have provided an arena to observe the similarities and differences between educational policies and practices and enable researchers and others to observe what is possible for students to achieve and what environment is most likely to facilitate their learning. TIMSS provides regular information on educational outcomes within and across countries by providing insight about the range of skills and competencies in mathematics and science at two key year levels.

Similar to other international studies, TIMSS results are reported as means that indicate average performance and various statistics that reflect the distribution of performance. School, teacher and student variables further enhance the understanding of student performance. TIMSS also attaches meaning to the performance scale by providing a profile of what students have achieved in terms of 'benchmarks'. Students at a particular benchmark not only typically demonstrate the knowledge and skills associated with that level but also the proficiencies required at lower levels. Further details on the benchmarks, as well as exemplars, are provided in Chapter 2.

It should be noted that the results for Year 4 and Year 8 are not directly comparable. While the scales for the two year levels are expressed in the same numerical units, they are not directly comparable in terms of being able to say how much achievement or learning at one year level equals how much achievement or learning at the other year level. That is, achievement on the TIMSS scales cannot be described in absolute terms (like all scales developed using IRT technology). Comparisons only can be made in terms of relative performance (higher or lower) for example, among countries and population groups as well as between assessments.

## Who participates in TIMSS?

### Countries

A total of 49 countries at Year 8 and 36 countries at Year 4 participated in TIMSS 2007. In addition eight regional entities participated at Year 8 and seven at Year 4 as benchmarking participants. The participating countries are shown in Figure 1.2.

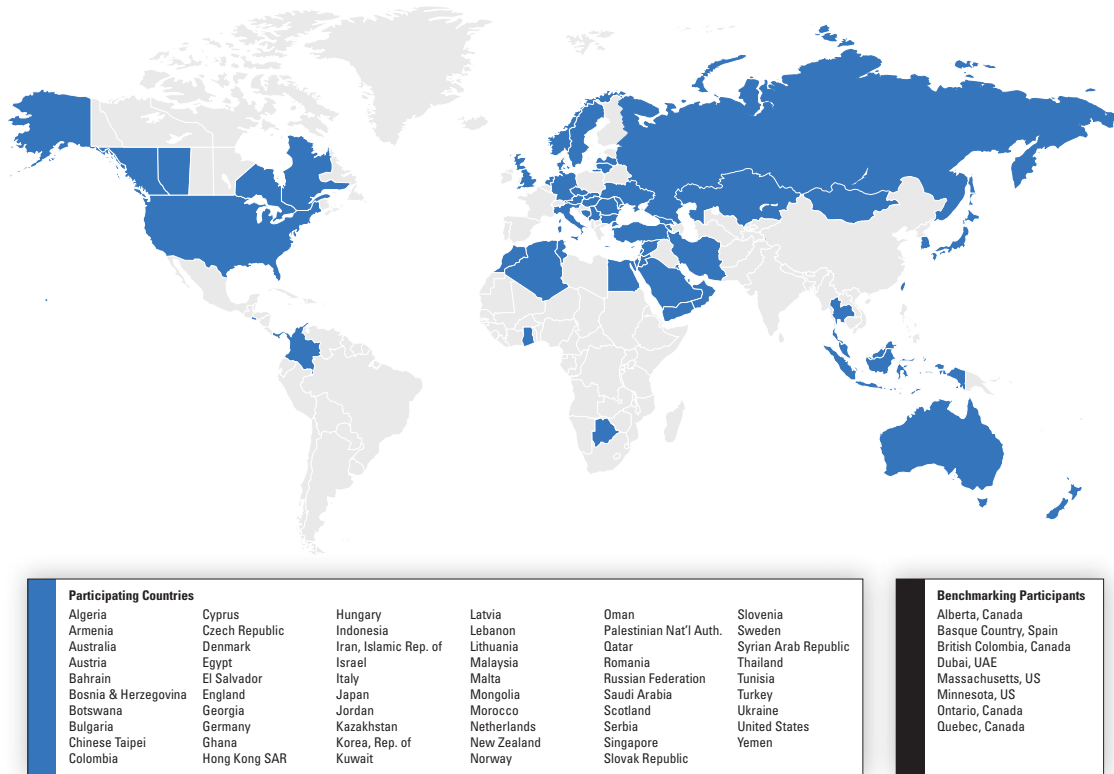


Figure 1.2 Countries participating in TIMSS 2007

### Schools and students

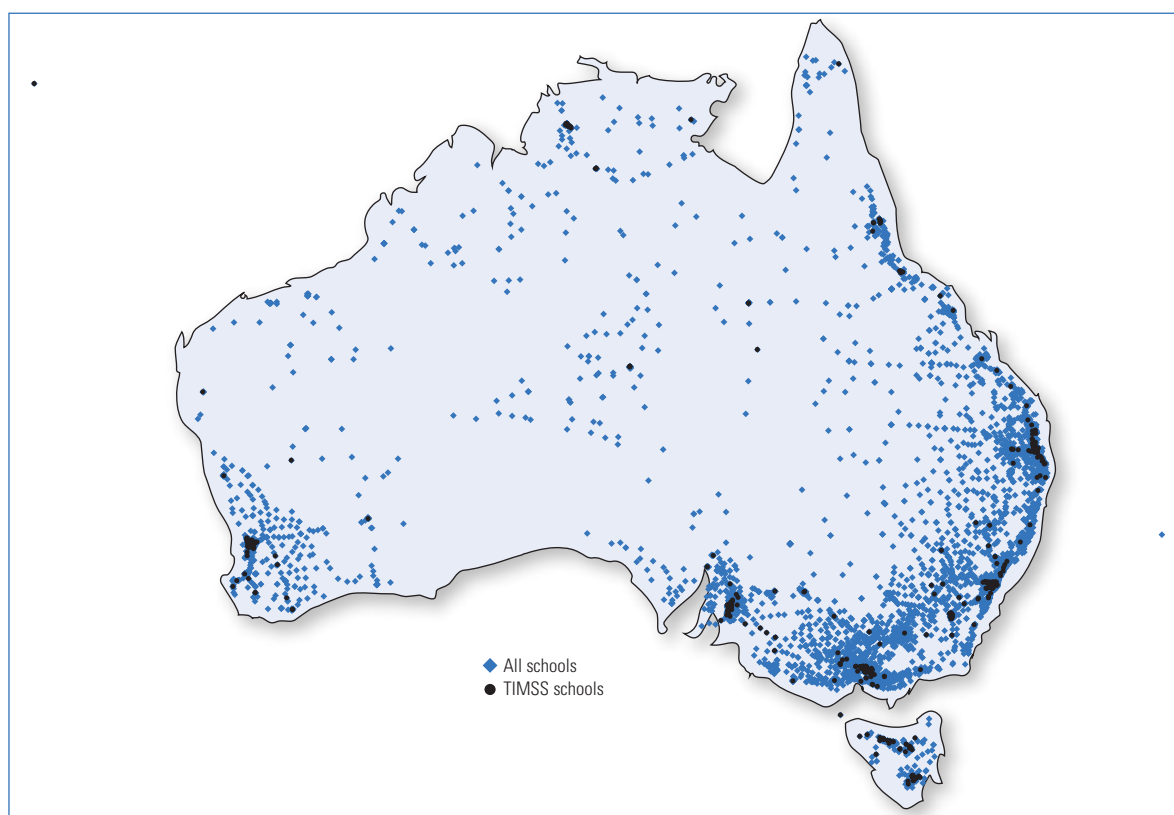
The international sample design for TIMSS is generally referred to as a two-stage stratified cluster sample design. The first stage consists of a sample of schools, which in Australia is stratified by state<sup>4</sup>, sector and by geographic location. This ensures that the sample drawn is representative of each of those strata. The second stage of sampling consists of a sample of one classroom from the target year in sampled schools.

To ensure accurate and unbiased data, the TIMSS & PIRLS International Study Center set minimum participation rates of 85 per cent of sampled schools and 85 per cent of sampled students (or a combined school and student participation rate of 75%). Non-participating sampled schools could be replaced by replacement schools that had been matched according to strata and size. However, countries that only achieved these requirements by the use of replacement schools are annotated in the International Reports. Countries with less than 50 per cent of sampled schools participating are segregated in the International Reports. Australia

4 In this report the Australian states and Territories are referred to collectively as the 'states'.

achieved the minimum participation rate for both Population 1 (Year 4) and Population 2 (Year 8).

Figure 1.3 shows the distribution across Australia of schools participating in TIMSS 2007. On this map the light blue shading shows the locations of all of the schools in Australia, while the black indicates participating schools.



**Figure 1.3** Distribution across Australia of schools in participating in TIMSS 2007

The weighted<sup>5</sup> numbers for Australia for Year 4 and Year 8, along with the number of schools and actual number of students participating are shown in Table 1.1.

**Table 1.1** Australia's designed & achieved sample in TIMSS 2007 by state

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
<b>Total</b>	<b>230</b>	<b>229</b>	<b>4 108</b>	<b>233 914</b>	<b>100</b>	<b>228</b>	<b>4 069</b>	<b>255 699</b>	<b>100</b>

<sup>5</sup> Sample numbers are weighted to represent the proportion of students in each state within the Australian population of Year 4 and 8 students

For TIMSS 1995, students were selected from the two adjacent year levels containing the largest number of nine-year-olds for Population 1 and 13-year-olds for Population 2. However, school entry age is not standard in Australia, nor is the year level into which students start school or move from primary schooling to secondary schooling, which meant that a range of year levels had to be selected from which to sample students. Due to these differences, data collection for TIMSS 1995 was undertaken at the following year levels:

- Years 3 and 4 and Years 7 and 8 in the Australian Capital Territory (ACT), New South Wales (NSW), Victoria (VIC) and Tasmania (TAS); and
- Years 4 and 5 and Years 8 and 9 in Queensland (QLD), South Australia (SA), Western Australia (WA) and the Northern Territory (NT).

The target population for TIMSS 1999 was defined as the upper of the two adjacent year levels identified in TIMSS 1995 as Population 2. In Australia, this was interpreted as Year 8 in the ACT, NSW, Victoria and Tasmania, and Year 9 in Queensland, SA, WA and the NT, and students were sampled from these year levels.

For the TIMSS 2003 and subsequent cycles, a decision was made by the IEA and the International Study Centre that the focus for Population 1 would be Year 4 and Year 8 for Population 2, as these were in most cases the upper of the two adjacent year levels containing the most 9 or 13-year-olds, respectively. In Australia at the time, this had consequences for Western Australia and Queensland, which were the only states to enrol students directly into Year 1, without a preparatory year. In those states, the TIMSS 2003 data showed that students were on average 8 months younger than their peers in other states.

The implication of this decision for Australia is that accurate trend comparisons cannot be made using data from TIMSS 1999, as this population was quite unique. Internationally, comparisons can however be made with TIMSS 1995, using data sets containing only the revised target year levels from each state. Trend comparisons conducted for this study will be for TIMSS 1995, 2003 and 2007.

Between 2003 and 2007, entry to school policies changed in Western Australia and Queensland, but as can be seen in Table 1.2, there is still about 8 months difference in the ages of students in TIMSS 2007 across states. There are also other structural changes between the states in terms of transition from primary to secondary school, and the year level at which this transition occurs is also included in Table 1.2. For a curriculum-based study such as TIMSS, it is conceivable that students in those states who are in their first year of differentiated curriculum might be somewhat disadvantaged.

**Table 1.2** Average ages and primary to secondary transition years for Australian states

State/Territory	Population 1	Population 2	
	Average age (SE)	First year of secondary school	Average age (SE)
NSW	10.0 (0.02)	Year 7	14.1 (0.02)
VIC	10.2 (0.03)	Year 7	14.2 (0.02)
QLD	9.5 (0.02)	Year 8	13.5 (0.02)
SA	10.0 (0.03)	Year 8	13.9 (0.02)
WA	9.6 (0.02)	Year 8	13.4 (0.02)
TAS	10.3 (0.02)	Year 7	14.3 (0.02)
NT	9.9 (0.04)	Year 8	13.9 (0.04)
ACT	10.1 (0.02)	Year 7	14.1 (0.02)

## TIMSS and PISA

TIMSS and the Programme for International Student Assessment (PISA) are both international surveys of student achievement; however, they differ in a number of important ways. Firstly, they are aimed at different cohorts – while PISA assesses an age-based sample of students at age 15, TIMSS focuses on Year 4 and Year 8 students (mainly 10 and 14 year-olds). Secondly, the focus of TIMSS is specifically on mathematics and science achievement, whereas PISA's focus is more broadly on what the Organisation for Economic Co-operation and Development (OECD) have described as 'literacies', in a range of subject areas. Third, and probably most importantly, is the nature of the assessments. The TIMSS assessment items were prepared following a detailed curriculum analysis in each participating country, to ensure core coverage across countries. TIMSS assessments reflect what students cover in the classroom, and to an extent the way in which it is covered and assessed. In PISA, the focus of the assessment is more on broad skills and competencies considered crucial to full participation in society beyond school.

## Organisation of this report

Chapter 2 describes in more detail the content and cognitive domains and the contextual framework upon which TIMSS is framed, as well as describing the international benchmarks and providing exemplars. Chapter 3 focuses on the international and national results for achievement overall, in the content and cognitive domains and for the international benchmarks, for mathematics at both year levels. Chapter 4 mirrors this for science. Chapter 5 examines trends in mathematics and science achievement, Chapter 6 examines the TIMSS students and their engagement with school, Chapter 7 looks at teachers and schools and Chapter 8, the final chapter, presents a summary and policy considerations arising from the TIMSS results.



# Assessing mathematics and science in TIMSS

The study of mathematics and science has been a focal area of concern for educators at most levels in Australia and internationally for the past few decades. Over this time, both mathematics and science have played an increasingly important role in terms of economic development for countries, and in an increasingly technological age it is important that all sections of society have at least a basic proficiency in mathematics and science.

In order to obtain some international benchmark of national achievement in both areas, Australia participated in the First International Mathematics Study (FIMS), which was conducted between 1959 and 1967, and the First International Science Study (FISS) in the early 1970s. To redress gender inequities that both studies highlighted, as well as the perceived shortage of scientists, government policy in Australia during the 1970s and 1980s focused on encouraging more students, particularly girls, into non-traditional areas of study, including mathematics and science (e.g. McKinnon, 1975; Miland, 1984).

## The Australian education system

In Australia, there are both government and non-government schools. Overall, government schools enrol 68 per cent of students, while non-government schools enrol 32 per cent of students. Most non-government schools have some religious affiliation, with approximately two-thirds of non-government school students enrolled in Catholic schools. Most government schools are coeducational; however, there are a few government same-sex high schools in the larger cities like Sydney and Melbourne. Many of the non-government schools are same-sex schools. All schools receive funding from either the federal or a state government.

The compulsory starting age for school varies across states, ranging from 5 years to 6 years, 6 months. As such, generally students are either 17 or 18 by the time they leave Year 12. While some students leave school early, most students go straight on to complete Years 11 and 12 and obtain their Senior Certificate. Year 12 or Adult Matriculation is necessary if students want to go on to higher education courses at universities and also necessary for some Technical and Further Education centres (TAFEs) and private commercial courses.

Each state government in Australia runs their own school system from Kindergarten through to Year 12. However, in 1989 State and Commonwealth education ministers made an historic commitment to improve Australian schooling within a framework of national collaboration. Agreement was reached at this time to address the areas of common concern embodied in the first set of Common and Agreed National Goals for Schooling in Australia. The National Goals for Schooling in the Twenty-first Century aim to provide high quality schooling in Australia, which will secure for students the necessary knowledge, understanding, skills and values for a productive

and rewarding life. These National Goals are currently under review<sup>1</sup>, and, for example, ‘commit to supporting all young Australians to become successful learners, confident individuals and active and informed citizens’.

### National goals for schooling

For the first time the 1989 National Goals provided a framework for cooperation between schools, states, and the Commonwealth. They were intended to assist schools and systems to develop specific objectives and strategies, particularly in the areas of curriculum and assessment.

Following this, the Australian Education Council (the forerunner of today’s MCEETYA – the Ministerial Council on Education, Employment, Training and Youth Affairs) developed eight sets of statements and profiles. The statements set out a common framework for curriculum development in each learning area, in terms of its content, processes and concepts. The profiles described the progression of learning, in eight levels of achievement, which provided a common framework for reporting student achievement. Although each state has developed the statements and profiles independently, the focus on outcomes against which the progress of students can be charted remains.

### Statements of learning

At a 2003 meeting of the MCEETYA, Ministers agreed that statements of learning should be developed nationally for English, science, mathematics, and civics and citizenship. These have now been finalised and approved. Each statement of learning describes the skills, knowledge, understandings and capacities that students are given the opportunity to learn by the designated year levels: Years 3, 5, 7 and 9. The purpose of the statements is to guide the curriculum documents for the individual states. As a result of this, the majority of states are currently re-drafting and finalising the relevant curriculum documents, to address and incorporate the statements of learning. These statements are used as part of Australia’s curriculum analysis for the purposes of developing the frameworks for TIMSS mathematics and science.

### TIMSS and the National Assessment Program

Within Australia TIMSS is an element of the National Assessment Program. Together with the OECD’s Programme for International Student Assessment (PISA), TIMSS provides data from internationally standardised tests that enables Australia to compare its performance with that of other countries. The international measures complement national literacy and numeracy assessments for students in Years 3, 5, 7 and 9, and national sample assessments of science at Year 6, Civics and Citizenship at Years 6 and 10, and Information and Communications Technology at Years 6 and 10. A National Advisory Committee, which comprises representatives from the Australian Government and all state and territory governments, private and Catholic schools, teacher unions and mathematics and science subject associations, as well as the National Research Coordinator at ACER, guides all aspects of the project within Australia.

The results from these assessments allow for nationally comparable reporting of student outcomes against the National Goals. Reporting on the assessments is undertaken through the annual National Reports on Schooling as well as through monographs and reports on particular assessments.

TIMSS enables reporting on comparable performance data every four years, and as agreed by all Education Ministers, student outcomes are reported disaggregated by sex, Indigenous status, language background and geographic location.

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<sup>1</sup> [http://www.curriculum.edu.au/verve/\\_resources/Draft\\_National\\_Declaration\\_on\\_Educational\\_Goals\\_for\\_Young\\_Australians.pdf](http://www.curriculum.edu.au/verve/_resources/Draft_National_Declaration_on_Educational_Goals_for_Young_Australians.pdf)

## How are mathematics and science assessed in TIMSS?

Two organising dimensions, 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. These are elaborated in the next section.

### Content domains

The content domains for mathematics in Year 4 and Year 8 are shown in Table 2.1. For a more detailed description of each of the content domains in both mathematics and science refer to the TIMSS 2007 Assessment Frameworks (Mullis, et al., 2005).

For each of the content domains shown in Table 2.1, the mathematics framework identifies several topic areas to be included in the assessment. For example at Year 4, *number* is further categorised by whole numbers, fractions and decimals, number sentences, and patterns and relationships. At Year 8, *number* is further categorised by whole numbers, fractions and decimals, integers and ratio, proportion and percent.

**Table 2.1** TIMSS mathematics content domains and proportion of assessment for each domain

Content Domains	Topic areas	Target % of TIMSS assessment
<b>Mathematics Year 4</b>		
Number	<ul style="list-style-type: none"> <li>■ Whole numbers</li> <li>■ Fractions and decimals</li> <li>■ Number sentences</li> <li>■ Patterns and relationships</li> </ul>	50
Geometric shapes and measurement	<ul style="list-style-type: none"> <li>■ Lines and angles</li> <li>■ Two- and three-dimensional shapes</li> <li>■ Location and movement</li> </ul>	35
Data display	<ul style="list-style-type: none"> <li>■ Reading and interpreting</li> <li>■ Organising and representing</li> </ul>	15
<b>Mathematics Year 8</b>		
Number	<ul style="list-style-type: none"> <li>■ Whole numbers</li> <li>■ Fractions and decimals</li> <li>■ Integers</li> <li>■ Ratio, proportion and per cent</li> </ul>	30
Algebra	<ul style="list-style-type: none"> <li>■ Patterns</li> <li>■ Algebraic expressions</li> <li>■ Equations/formulas and functions</li> </ul>	30
Geometry	<ul style="list-style-type: none"> <li>■ Geometric shapes</li> <li>■ Geometric measurement</li> <li>■ Location and movement</li> </ul>	20
Data and Chance	<ul style="list-style-type: none"> <li>■ Data organisation and representation</li> <li>■ Data interpretation</li> <li>■ Chance</li> </ul>	20

Similarly, the content domains for science for Year 4 and Year 8 are shown in Table 2.2. For each of the content domains shown in this table, the science framework identifies several topic areas to be included in the assessment. For example at Year 4, *life science* is further categorised by the topic areas: characteristics and life processes of living things; life cycles, reproduction and heredity; interaction with the environment; ecosystems and human health. At Year 8, the equivalent

content area, *biology*, is further categorised by the topic areas: characteristics, classification and life processes of organisms; cells and their functions; life cycles; reproduction; heredity, diversity, adaptation, and natural selection; ecosystems and human health.

**Table 2.2** TIMSS science content domains and proportion of assessment for each domain

Content Domains	Topic areas	Target % of TIMSS assessment
<b>Science Year 4</b>		
Life science	<ul style="list-style-type: none"> <li>■ Characteristics and life processes of living things</li> <li>■ Life cycles, reproduction and heredity</li> <li>■ Interaction with the environment</li> <li>■ Ecosystems</li> <li>■ Human health</li> </ul>	45
Physical science	<ul style="list-style-type: none"> <li>■ Classification and properties of matter</li> <li>■ Physical states and changes in matter</li> <li>■ Energy sources, heat, and temperature</li> <li>■ Light and sound</li> <li>■ Electricity and magnetism</li> <li>■ Forces and motion</li> </ul>	35
Earth science	<ul style="list-style-type: none"> <li>■ Earth's structure, physical characteristics, and resources</li> <li>■ Earth's processes, cycles, and history</li> <li>■ Earth in the solar system</li> </ul>	20
<b>Science Year 8</b>		
Biology	<ul style="list-style-type: none"> <li>■ Characteristics, classification, and life processes of organisms</li> <li>■ Cells and their functions</li> <li>■ Life cycles, reproduction, and heredity</li> <li>■ Diversity, adaptation, and natural selection</li> <li>■ Ecosystems</li> <li>■ Human health</li> </ul>	35
Chemistry	<ul style="list-style-type: none"> <li>■ Classification and composition of matter</li> <li>■ Properties of matter</li> <li>■ Chemical change</li> </ul>	20
Physics	<ul style="list-style-type: none"> <li>■ Physical states and changes in matter</li> <li>■ Energy transformations, heat, and temperature</li> <li>■ Light</li> <li>■ Sound</li> <li>■ Electricity and magnetism</li> <li>■ Forces and motion</li> </ul>	25
Earth science	<ul style="list-style-type: none"> <li>■ Earth's structure and physical features</li> <li>■ Earth's processes, cycles, and history</li> <li>■ Earth's resources, their use and conservation</li> <li>■ Earth in the solar system and the universe</li> </ul>	20

Each topic area is presented in the framework as a list of objectives covered in a majority of participating countries, at either Year 4 or Year 8. The organisation of topics across the content domains reflects some minor revision in the reporting categories used in each of the previous assessments; however, each of the trend items from the previous assessments may be mapped directly onto the content domains defined for 2007.

## Cognitive domains

To respond correctly to TIMSS test items, students need to be familiar with the mathematics and science content of the items. Just as importantly, the items were designed to elicit the use of particular cognitive skills. The assessment framework presents detailed descriptions of the skills and abilities that make up the cognitive domains and that are assessed in conjunction with the content. These skills and abilities should play a central role in developing items and achieving a balance in learning outcomes assessed by the items at Year 4 or Year 8. The student behaviours used to define both the mathematics and the science framework at both Year 4 and Year 8 have been classified into three cognitive domains.

The three domains can be described as follows:

- Knowing – which covers the facts, procedures, and concepts students need to know;
- Applying – which focuses on the ability of students to apply knowledge and conceptual understanding to solve problems or answer questions; and
- Reasoning – which goes beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems.

These three cognitive domains are used for both year levels, but the balance of testing time differs, reflecting the difference in age and experience of students in the two year levels. For Year 4 and Year 8, each content domain included items developed to address each of the three cognitive domains. For example, the *number* domain included *knowing*, *applying*, and *reasoning* items, as did the other content domains in both mathematics and science. The percentage of time assigned to the evaluation of each of the cognitive domains in the 2007 assessment is shown in Table 2.3.

**Table 2.3** Target percentages of the TIMSS 2007 mathematics and science assessments devoted to cognitive domains at Year 4 and Year 8

Cognitive Domain	Mathematics		Science	
	Year 4	Year 8	Year 4	Year 8
Knowing	40%	35%	40%	30%
Applying	40%	40%	35%	35%
Reasoning	20%	25%	25%	35%

## Scientific inquiry

Scientific inquiry is treated as an overarching assessment strand in the TIMSS 2007 framework. It overlaps all of the fields of science and has both content- and skills-based components. Assessment of scientific inquiry includes items and tasks requiring students to demonstrate knowledge of the tools, methods, and procedures necessary to do science, to apply this knowledge to engage in scientific investigations, and to use scientific understanding to propose explanations based on evidence. These processes of scientific inquiry promote a broader understanding of science concepts as well as reasoning and problem-solving skills. It is expected that students at both year levels will possess some general knowledge of the nature of science and scientific inquiry, including the fact that scientific knowledge is subject to change, the importance of using different types of scientific investigations in verifying scientific knowledge, the use of basic 'scientific methods', communication of results, and the interaction of science, mathematics, and technology. In addition to this general knowledge, students are expected to demonstrate the skills and abilities involved in five major aspects of the scientific inquiry process:

- Formulating questions and hypotheses
- Designing investigations
- Representing data
- Analysing and interpreting data
- Drawing conclusions and developing explanations.

Further examples of the behaviours associated with each of the cognitive domains may be found in Mullis et al. (2005).

## TIMSS Contextual Framework

For a more complete understanding of what the TIMSS achievement results mean and how they may be used to improve student learning in mathematics and science, it is important to understand the contexts in which students learn. After the achievement data were collected from students, each student completed a background questionnaire. The background information collected included demographic data and students' attitudes towards mathematics and science.

Teacher and school questionnaires were also administered to the mathematics and science teacher(s) of the selected class and to the principal of the school. The type of data that was sought in the school questionnaire included information on school organisation, school goals, the role of the school principal, parental involvement and the extent to which the school has a disciplined home environment. The teacher questionnaire examined a variety of issues related to training, pedagogical practices, teaching styles, use of technology, assessment and assignment of homework, and classroom climate<sup>2</sup>.

## The structure of the TIMSS assessment

TIMSS 2007 reports student outcomes by both major content domain and subdomain, as well as by cognitive domain. A consequence of these assessment goals is that there are many more questions on the assessment than can be answered by a student in the amount of testing time available. Accordingly, TIMSS 2007 uses a matrix-sampling approach that involves packaging the entire assessment pool of mathematics and science questions into a set of 14 student achievement booklets, with each student completing just one booklet. Each question, or item, appears in two booklets, providing a mechanism for linking together the student responses from the various booklets. Booklets are distributed among students in participating classrooms so that the groups of students completing each booklet are approximately equivalent in terms of student ability. Using item response theory (IRT) scaling techniques, a comprehensive picture of the achievement of the entire student population is assembled from the combined responses of individual students to the booklets they are assigned. This approach reduces to manageable proportions what would otherwise be an impossible student burden, (albeit at the cost of greater complexity in booklet assembly, data collection, and data analysis).

To facilitate the process of creating the student achievement booklets, TIMSS groups the assessment items into a series of item blocks, with approximately 10 to 15 items in each block. TIMSS 2007 had 28 blocks in total, 14 containing mathematics items and 14 containing science items. Student booklets were assembled from various combinations of these item blocks. Following the 2003 assessment, half of the mathematics blocks and half of the science blocks were secured for use in measuring trends in 2007. The remaining blocks were released into the public domain for use in publications, research, and teaching, to be replaced by newly developed items in the TIMSS 2007 assessment. Accordingly, the 28 blocks in the TIMSS 2007 assessment comprise 14 blocks of trend items (seven mathematics and seven science) and 14 blocks of new items developed for 2007.

In choosing how to distribute assessment blocks across student achievement booklets, the major goal was to maximise coverage of the framework while ensuring that every student responded to sufficient items to provide reliable measurement of trends in both mathematics and science. A further goal was to ensure that trends in the mathematics and science content areas could be

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2 For more details on the TIMSS Contextual Framework, see Mullis et al. (2005)

measured reliably. To enable linking among booklets while keeping the number of booklets to a minimum, each block appeared in two booklets.

Countries participating in TIMSS aim for a sample of at least 4,500 students to ensure that there are enough respondents for each item. The 14 student booklets are distributed among the students in each sampled class according to a predetermined order, so that approximately equal proportions of students respond to each booklet.

## Question types and scoring the responses

Students' knowledge and understanding of mathematics and science are assessed through a range of questions in each subject. Two question formats are used in the TIMSS assessment – multiple-choice and constructed-response. At least half of the total number of points represented by all the questions will come from multiple-choice questions. Each multiple-choice question is worth one score point.

*Multiple-Choice Questions:* Multiple-choice questions provide four response options, of which only one is correct. These questions can be used to assess any of the behaviours in the cognitive domains. However, as they do not allow for students' explanations or supporting statements, multiple-choice questions may be less suitable for assessing students' ability to make more complex interpretations or evaluations.

In assessing Year 4 and Year 8 students, it is important that linguistic features of the questions be developmentally appropriate. Therefore, the questions are written clearly and concisely. The response options also are written succinctly in order to minimise the reading load of the question. The options that are incorrect are written to be plausible, but not deceptive. For students who may be unfamiliar with this test question format, the instructions given at the beginning of the test include a sample multiple-choice item that illustrates how to select and mark an answer.

*Constructed-Response Questions:* For this type of test item students are required to construct a written response, rather than select a response from a set of options. Constructed-response questions are particularly well-suited for assessing aspects of knowledge and skills that require students to explain phenomena or interpret data based on their background knowledge and experience.

The scoring guide for each constructed-response question describes the essential features of appropriate and complete responses. The guides point to evidence of the type of behaviour the question assesses. They describe evidence of partially correct and completely correct responses. In addition, sample student responses at each level of understanding provide important guidance to those who will be rating the students' responses. In scoring students' responses to constructed-response questions, the focus is solely on students' achievement with respect to the topic being assessed, not on their ability to write well. However, students need to communicate their response in a manner that will be clear to scorers.

As each student's achievement book contained only a sample of items from the assessment, student responses are combined for an overall picture of the assessment results for each country. Item response theory (IRT) methods are used to place the individual student responses to the items onto a common scale that links to TIMSS results for 1995, 1999 and 2003. This allows countries to accurately compare their Year 8 achievement in 2007 with that of 1995, 1999 and 2003 (for the years in which the country participated) and their Year 4 achievement with that of 1995 and 2003, as TIMSS 1999 did not include a Year 4 assessment.

## 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. The benchmarks were developed using scale anchoring techniques and student achievement data from all countries that participated in TIMSS 2007. A similar exercise was carried out for the TIMSS 1999 study, and Martin et al. (2000) noted that six factors seemed to differentiate between student performance at each level:

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

Scale anchoring is a way of describing students' performance on the TIMSS 2007 achievement scales at both year levels in terms of the types of items that students at the particular year level answered correctly. It has both empirical and qualitative components. The empirical component used IRT to identify items that discriminated between successive points on the scale. For the empirical component, the results of all students taking part in TIMSS 2007 were pooled so that the levels describe what the best students can do, irrespective of which country they come from. For the qualitative component, subject matter specialists examined the content of the items and generalised to the students' knowledge and understanding. The descriptions of the levels are cumulative, so that a student who reached the high international benchmark can typically demonstrate the knowledge and skills of both the intermediate and low benchmarks. These are shown in Figures 2.1, 2.6, 2.14 and 2.19.

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 science domains in the TIMSS framework. There are undoubtedly other curricular elements on which students at the various benchmarks would have been successful if they had been included in the assessment. The remainder of this chapter provides more detail and examples of the benchmarks.

For each benchmark, in both subjects at each year level, illustrative items and examples of the answers typically given by Australian students are provided. After each example is a table providing the percentage of students in various countries answering the item correctly, to gain an idea of how Australia has performed. The countries that make up this table are: the three countries with the highest proportion of students answering correctly; England, the United States and New Zealand, as countries against which Australia often makes comparisons; and finally Australia and the international average per cent correct.

## Year 4 Mathematics – Descriptors of performance at the international benchmarks

Figure 2.1 provides descriptors for each level of the benchmarks for Year 4 mathematics. More detailed descriptions of the benchmarks can be found in the TIMSS international mathematics and science reports (Mullis, Martin & Foy, 2008; Martin, Mullis & Foy, 2008). As can be seen in Figure 2.1, students at the advanced international benchmark applied 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 4, half of the assessment items were devoted to assessing the *number* content domain, including understanding place value, ways of representing numbers, and the relationships between numbers. According to the *TIMSS 2007 Mathematics Framework*, students should have developed number sense and computational fluency, be able to use numbers and operations to solve problems, and be familiar with a range of number patterns.

Within the *geometric shapes and measures* domain (35% of the assessment), students should be able to identify and analyse the properties and characteristics of lines, angles, and a variety of geometric figures, including two- and three-dimensional shapes, and to provide explanations based on geometric relationships. This domain also included understanding informal coordinate systems and using spatial visualisation skills.

The *data display* content domain (15%) included understanding how to organise data that have been collected and how to display it in graphs as well as reading and interpreting various data displays. Students at Year 4 should be able to compare characteristics of data and to draw conclusions based on data displays. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

Year 4	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	<p><i>Students have some basic mathematical knowledge.</i></p> <p>Students demonstrate an understanding of adding and subtracting with whole numbers. They demonstrate familiarity with triangles and informal coordinate systems. They can read information from simple bar graphs and tables.</p>	<p><i>Students can apply basic mathematical knowledge in straightforward situations.</i></p> <p>Students at this level demonstrate an understanding of whole numbers. They can extend simple numeric and geometric patterns. They are familiar with a range of two-dimensional shapes. They can read and interpret different representations of the same data.</p>	<p><i>Students can apply their knowledge and understanding to solve problems.</i></p> <p>Students can solve multi-step word problems involving operations with whole numbers. They can use division in a variety of problem situations. They demonstrate understanding of place value and simple fractions. Students can extend patterns to find a later specified term and identify the relationship between ordered pairs. Students show some basic geometric knowledge. They can interpret and use data in tables and graphs to solve problems.</p>	<p><i>Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning.</i></p> <p>Students can apply proportional reasoning in a variety of contexts. They demonstrate a developing understanding of fractions and decimals. They can select appropriate information to solve multi-step word problems. They can formulate or select a rule for a relationship. Students can apply geometric knowledge of a range of two- and three-dimensional shapes in a variety of situations. They can organise, interpret, and represent data to solve problems.</p>

**Figure 2.1** Descriptors of performance at the international benchmarks, Year 4 mathematics

### Year 4 Mathematics – Performance at the advanced international benchmark

Year 4 students achieving at the advanced international benchmark demonstrated fluency with many framework topics. They also demonstrated their ability to apply their understanding and knowledge in a wide variety of relatively complex situations. They typically demonstrated success on the knowledge and skills represented by this benchmark, as well as those demonstrated at the high, intermediate and low benchmarks.

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. As an example of this, Figure 2.2 shows a number pattern item likely to be answered correctly by students who are performing at the advanced benchmark.

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.

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

Answer: *double the number and add 1*

Country	Per cent full correct
Hong Kong	39 (2.7)
Japan	38 (2.1)
Singapore	36(2.1)
England	28 (2.3)
USA	23 (1.4)
<b>Australia</b>	<b>20 (3.1)</b>
International average	15 (0.3)
New Zealand	17 (1.6)
El Salvador	0 (0.0)

Figure 2.2 Mathematics Year 4 example item 1

### Year 4 Mathematics – Performance at the high international benchmark

Students reaching the high international benchmark in mathematics demonstrated some competency with many of the topics in the framework. For example, in the *number* domain they applied their knowledge and understanding to solve problems involving whole numbers, including division. They also demonstrated understanding of place value, simple fractions, and how to extend a pattern to find a later specified term. They had some geometric knowledge about angles and triangles as well as distances, perimeters, and areas, and displayed some spatial visualisation skills. They could interpret and use data in tables and graphs to solve problems. Figure 2.3 provides an example of a constructed-response item that was typically answered correctly by students achieving at the high benchmark.

This item, involving subtraction with three digits, was answered correctly by 42 per cent of students internationally, and by 88 per cent of students in Chinese Taipei. In ten countries internationally (Chinese Taipei, Hong Kong, Singapore, Russian Federation, Kazakhstan, Japan, Lithuania, Latvia, Ukraine and Armenia), two-thirds or more students answered this item correctly. However in Australia only 20 per cent of students did so.

$$\begin{array}{r} 942 \\ -5\blacksquare7 \\ \hline 415 \end{array}$$

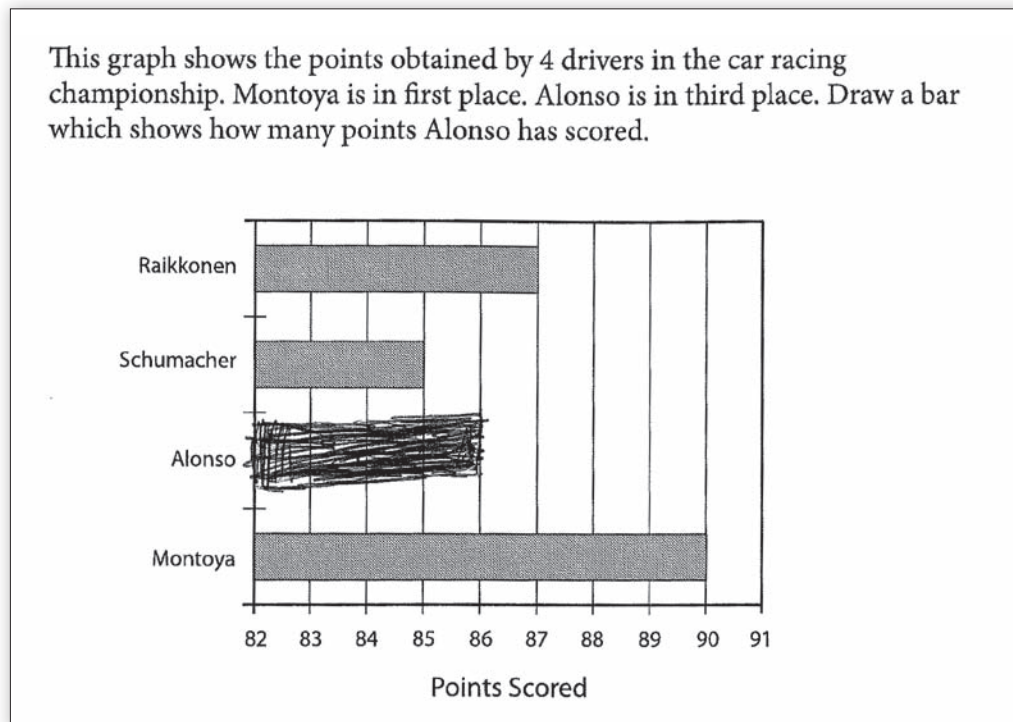
Adam did the subtraction problem above for homework but spilled some of his drink on it. One digit could not be read. His answer of 415 was correct. What is the missing digit?

Answer:     2

Country	Per cent full correct
Chinese Taipei	88 (1.6)
Hong Kong	85 (1.9)
Singapore	85 (1.4)
International average	42 (0.4)
United States	41 (1.8)
England	28 (2.1)
<b>Australia</b>	<b>20 (3.1)</b>
New Zealand	18 (1.6)
Qatar	5 (0.8)

Figure 2.3 Mathematics Year 4 example item 2

Whilst in this example the percentage of Australian students correctly answering the question was well below the international average, this was not the case for all aspects of the framework expressed in the benchmark descriptions. The next example shows an example of a *data display* problem likely to be answered correctly by students at the high benchmark. Students were asked to use data interpretation and representation skills to complete the bar graph provided. Internationally on average, 38 per cent of the students drew the bar that correctly completed the graph. More than half of the Australian students correctly completed the graph, which was significantly higher than the international average.



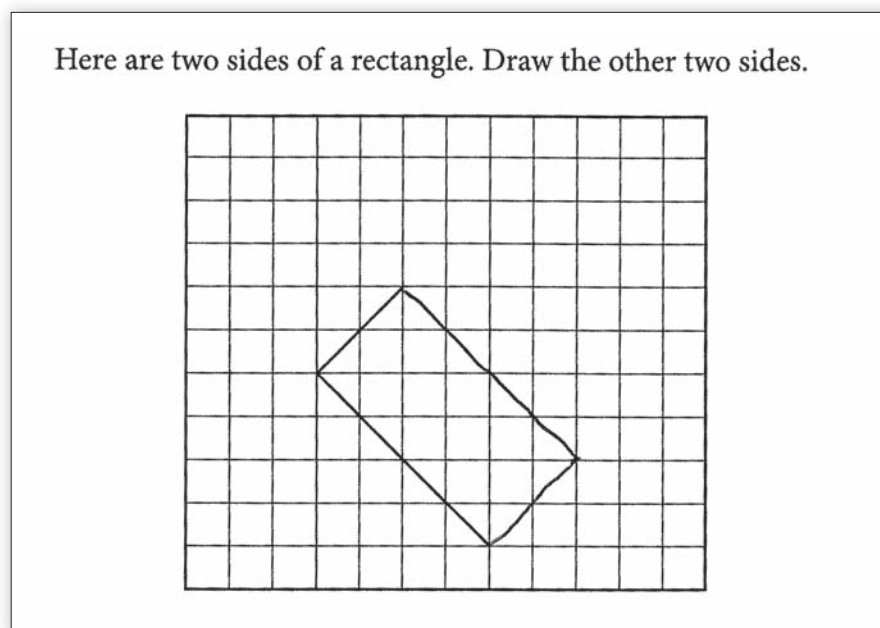
Country	Per cent full correct
Hong Kong	77 (1.9)
Chinese Taipei	72 (1.8)
Japan	71 (2.0)
<b>Australia</b>	<b>52 (3.0)</b>
England	52 (2.5)
United States	51 (1.7)
New Zealand	42 (1.9)
International average	38 (0.4)
Yemen	1 (0.4)

Figure 2.4 Mathematics Year 4 example item 3

### Year 4 Mathematics – Performance at the intermediate international benchmark

Students reaching the intermediate international benchmark are able to apply basic mathematical knowledge to straightforward situations. They are able to order, add, subtract and multiply whole numbers, can identify basic fractions and extend patterns from the first few terms to next terms. They demonstrate familiarity with a range of two-dimensional shapes and can read and interpret different representations of the same data.

In this example, from the domain of *geometric shapes and measures*, students were given two adjacent sides of a rectangle on a grid and asked to draw the other two sides. On average internationally more than half of the students completed the rectangle correctly. In Hong Kong 90 per cent of students answered correctly. Australian students also did well, with 68 per cent completing the rectangle correctly.



Country	Per cent full correct
Hong Kong	90 (1.4)
Japan	78 (1.8)
Chinese Taipei	77 (1.9)
England	70 (1.9)
<b>Australia</b>	<b>68 (3.3)</b>
New Zealand	61 (1.8)
United States	55 (1.7)
International average	54 (0.4)
Yemen	5 (1.0)

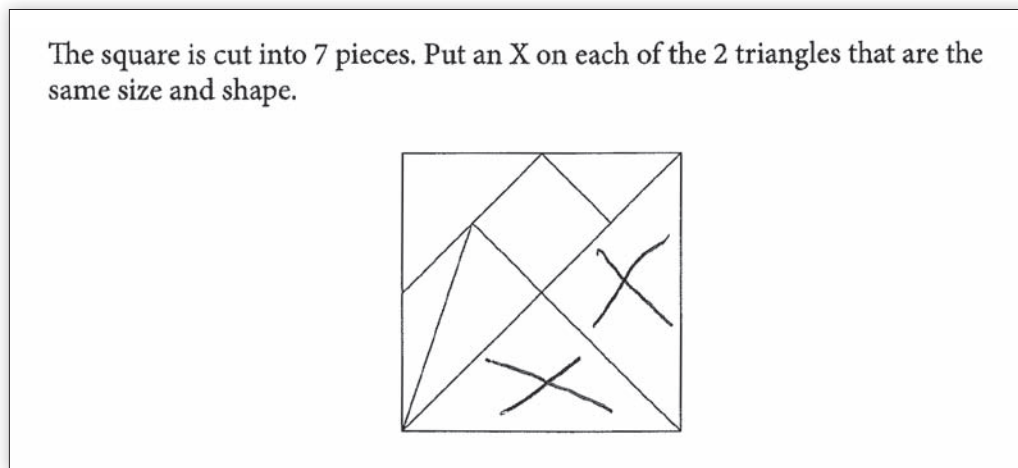
Figure 2.5 Mathematics Year 4 example item 4

### Year 4 Mathematics – Performance at the low international benchmark

Students performing at the low international benchmark demonstrate some mathematical knowledge, including adding and subtracting whole numbers. They show familiarity with simple number sentences, have some knowledge of triangles and informal coordinate systems and can read information from simple bar graphs and tables.

In this example, students were asked to use their knowledge of shape and size to classify and identify which of the triangles in the diagram were the same. This is an example of the type of item likely to be answered correctly by students reaching the low international benchmark.

Internationally, 72 per cent of students correctly identified the two triangles, however this was as high as 91 per cent in Hong Kong and Slovenia. In Australia, 85 per cent of students answered correctly, which was significantly higher than the international average.



Country	Per cent full correct
Hong Kong	91 (1.2)
Slovenia	91 (1.3)
Lithuania	89 (1.3)
England	88 (1.4)
<b>Australia</b>	<b>85 (1.9)</b>
United States	85 (1.0)
New Zealand	81 (1.4)
International average	72 (0.3)
Yemen	13 (1.5)

Figure 2.6 Mathematics Year 4 example item 5

## Year 4 Science – Descriptors of performance at the international benchmarks

Figure 2.7 provides the brief descriptors for science for Year 4. At this year level, almost half (45%) of the assessment items were devoted to assessing the *life science* content domain. A further 35 per cent devoted to assessing *physical science* and the remaining 20 per cent to *Earth science*. As can be seen in Figure 2.7, students at the advanced international benchmark applied knowledge and understanding of scientific processes and relationships in beginning scientific inquiry, whereas those at the low international benchmark displayed some elementary knowledge of life science and physical science.

According to the *TIMSS 2007 Science Framework*, in the *life science* domain, Year 4 students should be able to demonstrate knowledge of the characteristics and life processes of living things, know and be able to compare the life cycles of common organisms such as the butterfly and frog, describe relationships between plants and animals in common ecosystems, and have a rudimentary knowledge of human health, nutrition, and disease. Within the *physical science* domain Year 4 students should be able to compare or classify objects and materials on the basis of physical properties, identify common energy sources and have some understanding of heat flow, relate familiar physical phenomena to the behaviour of light and sound, have some notion of a complete electrical circuit and some practical knowledge of magnets and their uses, and have some grasp of the idea of forces as they relate to movement. In the *Earth science* content domain Year 4 students were expected to demonstrate some general knowledge about the structure and physical characteristics of Earth; Earth's processes, cycles, and history; and some understandings about Earth's place in the solar system. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

Year 4	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	<p><i>Students have some elementary knowledge of life science and physical science.</i></p> <p>Students can demonstrate knowledge of some simple facts related to human health and the behavioural and physical characteristics of animals. They recognise some properties of matter, and demonstrate a beginning understanding of forces. Students interpret labelled pictures and simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.</p>	<p><i>Students can apply basic knowledge and understanding to practical situations in the sciences.</i></p> <p>Students recognise some basic information related to characteristics of living things and their interaction with the environment, and show some understanding of human biology and health. They also show some understanding of familiar physical phenomena. Students know some basic facts about the solar system and have a developing understanding of Earth's resources. They demonstrate some ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.</p>	<p><i>Students can apply knowledge and understanding to explain everyday phenomena.</i></p> <p>Students demonstrate some understanding of plant and animal structure, life processes, and the environment and some knowledge of properties of matter and physical phenomena. They show some knowledge of the solar system, and of Earth's structure, processes, and resources. Students demonstrate beginning scientific inquiry knowledge and skills, and provide brief descriptive responses combining knowledge of science concepts with information from everyday experience of physical and life processes.</p>	<p><i>Students can apply knowledge and understanding to explain everyday phenomena.</i></p> <p>Students communicate their understanding of characteristics and life processes of organisms as well as of factors relating to human health. They demonstrate understanding of relationships among various physical properties of common materials and have some practical knowledge of electricity. Students demonstrate some understanding of the solar system and Earth's physical features and processes. They show a developing ability to interpret the results of investigations and draw conclusions as well as a beginning ability to evaluate and support an argument.</p>

**Figure 2.7** Descriptors of performance at the international benchmarks, Year 4 science

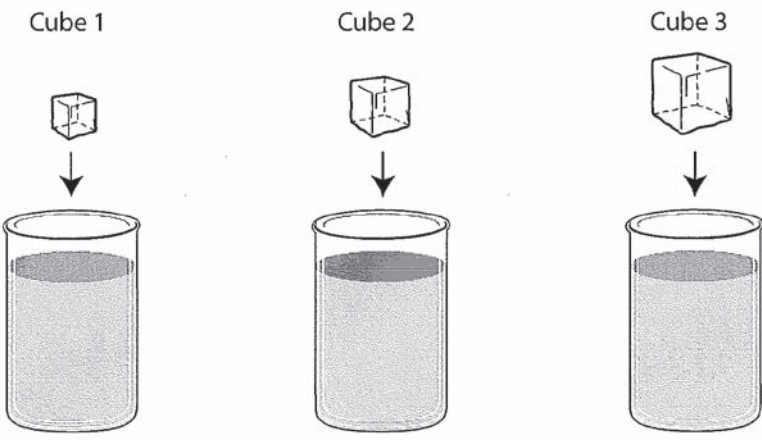
### Year 4 Science – Performance at the advanced international benchmark

Students achieving at or above this benchmark at Year 4 demonstrated fluency with most framework topics. They typically demonstrated success on the knowledge and skills represented by this benchmark, as well as those demonstrated at the high, intermediate and low benchmarks.

Figure 2.8 provides an example of an item that students achieving at this benchmark would be expected to have answered correctly. While not expecting students to have mastered the concept of density, students at the fourth grade are expected to understand that an object's capacity to sink or float is not determined by its size. In this example, students are presented with a diagram showing three beakers the same size that contain the same amount of water, and three ice cubes of varying size.

On average across countries, 39 per cent of students recognised that all three ice cubes would float, regardless of their size. Sixty per cent of the students in Chinese Taipei answered this item correctly, closely followed by Japan, Singapore, Austria and Australia.

Susie has three ice cubes of different sizes. She places each ice cube into an identical beaker containing the same volume of water, as shown in the diagram.



What happens to the ice cubes when they are placed in the water?

- (A) Cubes 1, 2, and 3 will sink.
- (B) Cubes 1, 2, and 3 will float.
- (C) Cube 1 will float, and cubes 2 and 3 will sink.
- (D) Cubes 1 and 2 will float, and cube 3 will sink.

Country	Per cent full correct
Chinese Taipei	60 (2.1)
Japan	58 (2.3)
Singapore	57 (1.8)
<b>Australia</b>	<b>56 (2.4)</b>
United States	44 (1.6)
New Zealand	44 (2.5)
International average	39 (0.4)
England	37 (2.2)
Algeria	20 (1.8)

Figure 2.8 Science Year 4 example item 1

An example of a constructed-response item that demonstrates a student's understanding of basic principles of heredity and reproduction is shown in Figure 2.9. This example is likely to be correctly answered by students reaching the advanced level in science. The question asks students to explain whether the last remaining member of a species, the giant turtle, can reproduce so the species does not die out. To gain credit on this item, students were required to explain that turtles cannot reproduce by themselves, and that a male turtle needed a female turtle in order to reproduce.

Internationally just 30 per cent of students gained credit for this item. Australian students achieved significantly better than the international average, with almost half (48%) answering correctly. Students in Lithuania and Latvia achieved the highest proportion of students answering correctly, followed by Germany, with a percentage around the same as that for Australia.

There is a giant turtle that lives on an island. He is the only turtle left of a special type of giant turtle.

Can he reproduce so that this type of turtle does not die out?

(Tick one box.)

Yes

No

Give a reason for your answer.

Because the only way to reproduce is by having babies but he needs someone to mate with to have babies.

Country	Per cent full correct
Lithuania	58 (2.4)
Latvia	55 (2.4)
Germany	49 (2.1)
<b>Australia</b>	<b>48 (2.5)</b>
England	47 (2.4)
United States	42 (1.6)
New Zealand	35 (2.0)
International average	30 (0.3)
Yemen	1 (0.4)

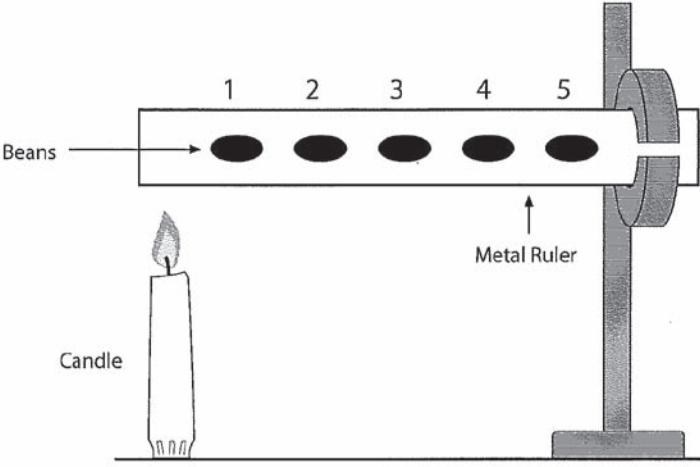
Figure 2.9 Science Year 4 example item 2

### Year 4 Science – Performance at the high international benchmark

Students achieving the high international benchmark in science at Year 4 demonstrated some competency with many of the topics in the framework. At this level, students demonstrate some knowledge of life processes, and some knowledge of properties of matter and physical phenomena.

The following examples illustrate the types of items that are typically answered correctly by students reaching the high benchmark. In the first example, Figure 2.10, students are required to recognise that when heat is applied to one end of a metal ruler that heat will be conducted to the other end.

On average internationally this was answered correctly by 57 per cent of Year 4 students. In Japan 92 per cent of students were able to answer correctly, and in both England and the United States around two-thirds of students answered correctly. In Australia 59 per cent of students answered correctly. This was not significantly different to the international average.



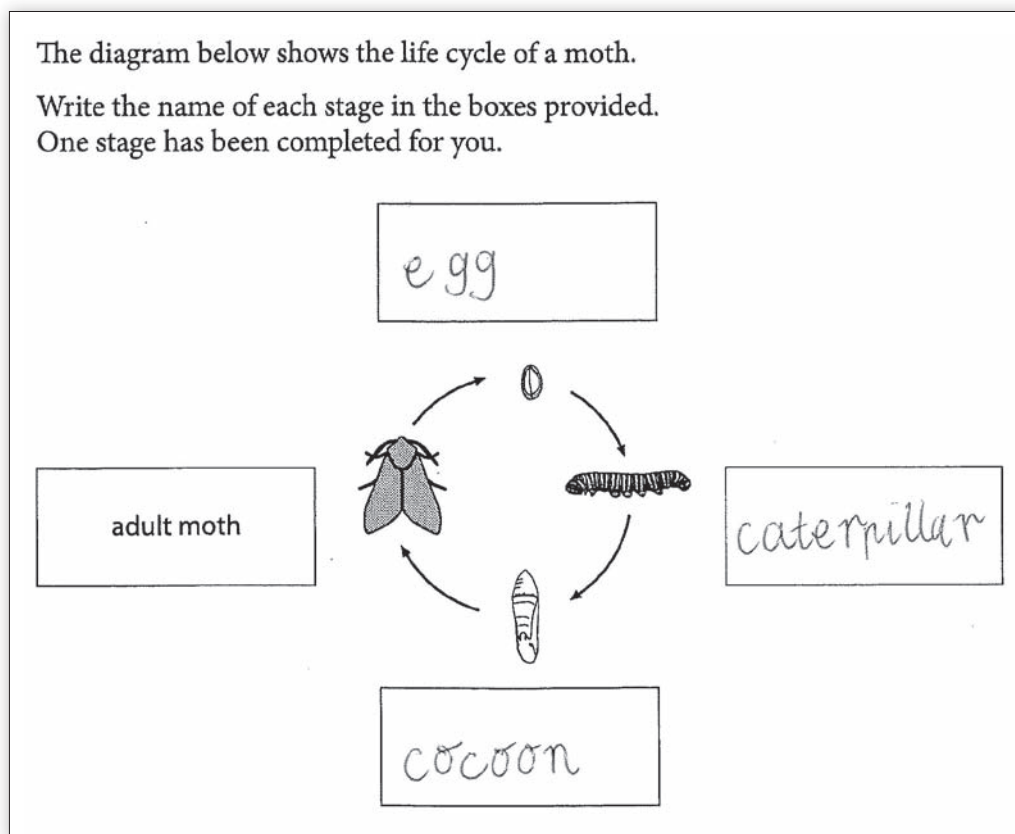
Beans are fixed on a metal ruler with butter as shown in the figure above. The ruler is heated at one end. In which order will the beans fall off?

- 1, 2, 3, 4, 5
- (B) 5, 4, 3, 2, 1
- (C) 1, 3, 5, 4, 2
- (D) All at the same time

Country	Per cent full correct
Japan	92 (1.2)
Singapore	88 (1.4)
Hong Kong	75 (2.1)
England	67 (2.3)
United States	66 (1.7)
<b>Australia</b>	<b>59 (2.8)</b>
New Zealand	58 (2.2)
International average	57 (0.4)
Yemen	20 (1.6)

Figure 2.10 Science Year 4 example item 3

Figure 2.11 is an example of a *life science* item likely to be completed by students reaching the high benchmark. This constructed-response item shows the life cycle of a moth and students are asked to label three of the four stages. Internationally on average 33 per cent of students correctly labelled the egg, caterpillar and pupa stages of the cycle. More than 60 per cent of students in the Slovak Republic (66%) and Singapore (64%) answered this item correctly, as did 93 per cent of Japanese students and 56 per cent of Australian students.



Country	Per cent full correct
Japan	93 (1.3)
Slovak Republic	66 (2.3)
Singapore	64 (2.0)
<b>Australia</b>	<b>56 (2.5)</b>
New Zealand	52 (1.9)
United States	48 (1.8)
England	36 (2.2)
International average	33 (0.4)
Morocco	0 (0.0)

Figure 2.11 Science Year 4 example item 4

**Year 4 Science – Performance at the intermediate international benchmark**


Students achieving at the intermediate international benchmark were able to apply basic knowledge and understanding to practical situations in the sciences. For example they can recognise some basic information about characteristics of living things.

In the following example, students were shown a picture of two sunflower plants grown in similar pots of soil from seeds from the same plant. One plant was clearly larger and healthier looking than the other, and to earn full credit on this item students had to describe one way in which the larger plant may have been treated differently from the smaller one.

On average across countries 63 per cent of students answered correctly, explaining, for example, that the larger plant may have been given more light and water. Students in Australia and England did very well on this item, with 83 and 81 per cent of students, respectively, gaining credit. This was not significantly different to that of Singapore, but significantly higher than the international average.

Carl and Jan each had a sunflower seed taken from the same plant. They took two identical pots and put potting soil in each. They then planted one seed in each pot. Carl looked after one pot in his home, and Jan looked after the other pot in her home.

After some time, they compared the plants and saw that there was a large difference in their growth, as shown in the pictures below.



Carl's plant                      Jan's plant

Describe one way in which Carl may have treated his plant differently from the way Jan treated hers.

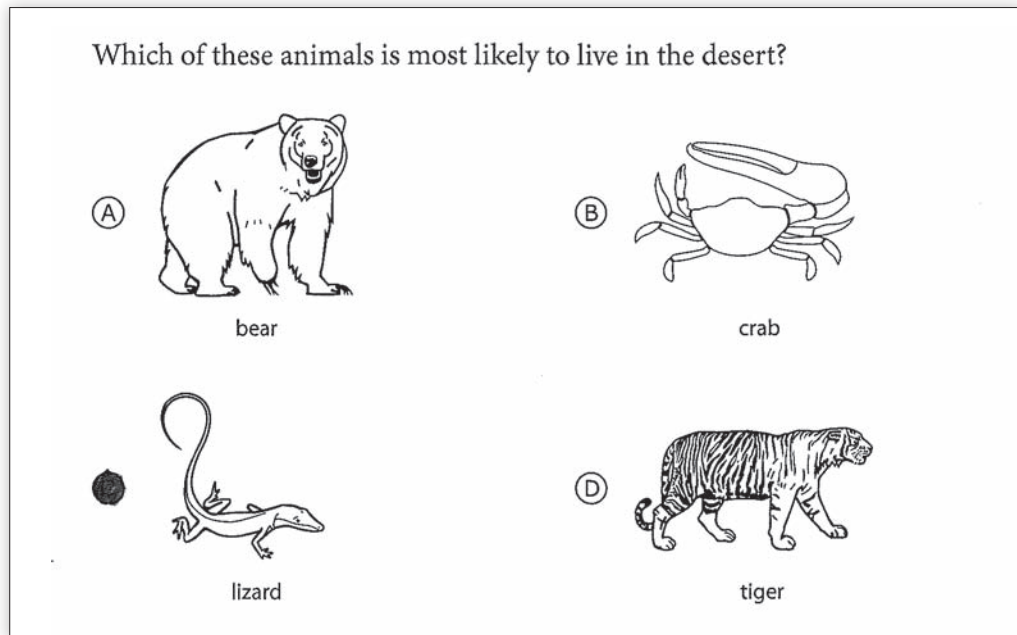
Carl may have kept it in more sun and watered it more than Jan did.

Country	Per cent full correct
Singapore	85 (1.8)
Lithuania	85 (1.7)
Netherlands	84 (2.0)
<b>Australia</b>	<b>83 (2.3)</b>
England	81 (1.8)
United States	78 (1.2)
New Zealand	77 (1.6)
International average	63 (0.4)
Yemen	7 (1.2)

**Figure 2.12** Science Year 4 example item 5

### Year 4 Science – Performance at the low international benchmark

Figure 2.13 presents an example of student achievement at the low international benchmark. At this level students demonstrated some elementary knowledge of the life and physical sciences. This included simple facts related to human health and the behavioural and physical characteristics of animals and humans. 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.

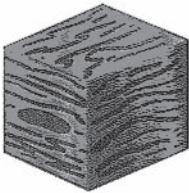


Country	Per cent full correct
United States	92 (0.8)
Russian Federation	89 (2.2)
<b>Australia</b>	<b>88 (1.8)</b>
Kazakhstan	86 (2.3)
England	84 (1.9)
Denmark	84 (2.1)
New Zealand	81 (1.4)
International average	68 (0.4)
Yemen	28 (2.1)

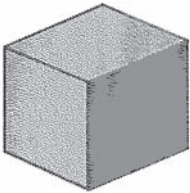
Figure 2.13 Science Year 4 example item 6

In other areas of Year 4 science, Australian students did not fare quite so well. In Figure 2.14, another example of an item that students at the low international benchmark would be expected to answer correctly, students were presented with three objects of the same size and shape and required to recognise that the object made of iron is the heaviest. More than 90 per cent of students in Japan and the Russian Federation and almost 90 per cent of students in England answered this item correctly. While around two-thirds (68%) of Australian students also answered correctly, this was significantly lower than the international average.

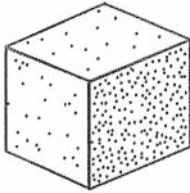
The three objects below are the same shape and size.



wood



iron



styrofoam

Which statement about the weight of the objects is most likely to be correct?

- (A) The wood object is the heaviest.
- (B) The iron object is the heaviest.
- (C) The styrofoam object is the heaviest.
- (D) All three objects weigh the same.

Country	Per cent full correct
Japan	94 (1.2)
Russian Federation	92 (1.3)
Chinese Taipei	91 (1.4)
England	89 (1.6)
United States	80 (1.1)
International average	80 (0.3)
<b>Australia</b>	<b>68 (3.1)</b>
New Zealand	67 (2.3)
Qatar	47 (1.6)

Figure 2.14 Science Year 4 example item 7

## Year 8 Mathematics – Descriptors of performance at the international benchmarks

Figure 2.15 provides the brief descriptors of achievement at the international benchmarks for Year 8 mathematics.

At Year 8, students at the advanced international benchmark organised and drew conclusions from information, made generalisations, and solved 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.

At Year 8, TIMSS 2007 assessed four content domains with each given similar weight – *number* (30%), *algebra* (30%), *geometry* (20%), and *data and chance* (20%).

According to the *TIMSS 2007 Mathematics Framework*, within the *number* domain, students should have developed computational fluency with fractions and decimals, understand how operations relate to one another, and extended their understanding to operations with integers. By Year 8 students should be able to move flexibly among equivalent fractions, decimals and percentages and use proportional reasoning to solve problems.

In *algebra*, students should have developed an understanding of linear relationships and the concept of variables. They are expected to use and simplify algebraic formulas, solve linear equations, inequalities, pairs of simultaneous equations involving two variables, and use a range of functions. They should be able to solve problems using algebraic models and to explain relationships involving algebraic concepts.

In *geometry*, the focus is on using geometric properties and their relationships to solve problems. It also includes understanding coordinate representations and using spatial visualisation skills to move between two- and three-dimensional shapes and their representations.

The *data and chance* domain includes describing and comparing characteristics of data (shape, spread, and central tendency). Students should be able to use data to draw conclusions and make predictions, and understand issues related to misinterpretation of data. Year 8 students should understand elementary probability in terms of the likelihood of familiar events and use data from experiments to predict the chance of a given outcome.

Within each content domain, students needed to draw on a range of cognitive skills and go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems. At Year 8, calculator use was permitted but not required. If students usually used calculators in the classroom then countries were encouraged to allow calculator use; however, if this was not the norm then countries could not permit their use. In Australia, students were allowed to use calculators, reflecting general practice in schools.

Year 8	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	<p>Students have some knowledge of whole numbers and decimals, operations, and basic graphs.</p>	<p>Students can apply basic mathematical knowledge in straightforward situations.</p> <p>They can add and multiply to solve one-step word problems involving whole numbers and decimals. They can work with familiar fractions. They understand simple algebraic relationships. They demonstrate understanding of properties of triangles and basic geometric concepts. They can read and interpret graphs and tables. They recognise basic notions of likelihood.</p>	<p>Students can apply their understanding and knowledge in a variety of relatively complex situations.</p> <p>They can relate and compute with fractions, decimals, and percentages, operate with negative integers, and solve word problems involving proportions. Students can work with algebraic expressions and linear equations. Students use knowledge of geometric properties to solve problems, including area, volume, and angles. They can interpret data in a variety of graphs and tables and solve simple problems involving probability.</p>	<p>Students can organise and draw conclusions from information, make generalisations, and solve non-routine problems.</p> <p>They can solve a variety of ratio, proportion, and percentages problems. They can apply their knowledge of numeric and algebraic concepts and relationships. Students can express generalisations algebraically and model situations. They can apply their knowledge of geometry in complex problem situations. Students can derive and use data from several sources to solve multi-step problems.</p>

**Figure 2.15** Descriptors of performance at the international benchmarks, Year 8 mathematics

**Year 8 Mathematics – Performance at the advanced international benchmark**

Figure 2.16 provides an example of an item likely to be answered correctly by students at the advanced international benchmark in mathematics at Year 8. Students at the advanced benchmark demonstrated fluency with many of the most complex topics in the mathematics framework. This item is from the geometry domain, and asks students to use the properties of isosceles and right-angled triangles to find the size of an angle.

Around three-quarters of the students in Singapore, Chinese Taipei, Korea and Japan responded correctly to this item, but only around one-third (32%) of students in Australia and internationally answered it correctly.

In this diagram,  $CD = CE$ .  
What is the value of  $x$ ?

(A) 40  
(B) 50  
(C) 60  
 70

Country	Per cent full correct
Singapore	75 (1.7)
Chinese Taipei	73 (2.2)
Korea	73 (1.8)
Japan	71 (1.9)
England	42 (2.8)
International average	32 (0.3)
<b>Australia</b>	<b>32 (2.8)</b>
United States	26 (1.4)
Ghana	14 (1.5)

Figure 2.16 Mathematics Year 8 example item 1

Figure 2.17 provides a good example of the reason that students in the Asian countries outperformed other countries at Year 8. This was one of the most difficult items in the Year 8 assessment. The example is a word problem that can be expressed as a linear equation with two variables, with students asked to show their work. While the aim of this item was for students to solve the item algebraically, only about three per cent of Australian students used this method. Alternative methods were also acceptable. Most of the remaining students who answered this item correctly used a 'guess and check' method, which was fairly straightforward for this particular item.

On average across countries, only 18 per cent of students gained full credit for their response to this item, but in Chinese Taipei and Korea more than two-thirds (68%) of students and in Singapore 59 per cent and Hong Kong 53 per cent did so. Students in Australia, England and the United States also performed well above the international average on this item, with more than a third of students gaining full credit.

Joe knows that a pen costs 1 zed more than a pencil.  
His friend bought 2 pens and 3 pencils for 17 zeds.  
How many zeds will Joe need to buy 1 pen and 2 pencils?

Show your work.

pens = 4 zed  
pencils = 3 zed

$$\begin{aligned} 4 \times 2 &= 8 \\ 3 \times 3 &= 9 \end{aligned} = 17 \text{ zed}$$

$$\begin{aligned} 1 \times 4 &= 4 \\ 2 \times 3 &= 6 \end{aligned} = 10 \text{ zed}$$

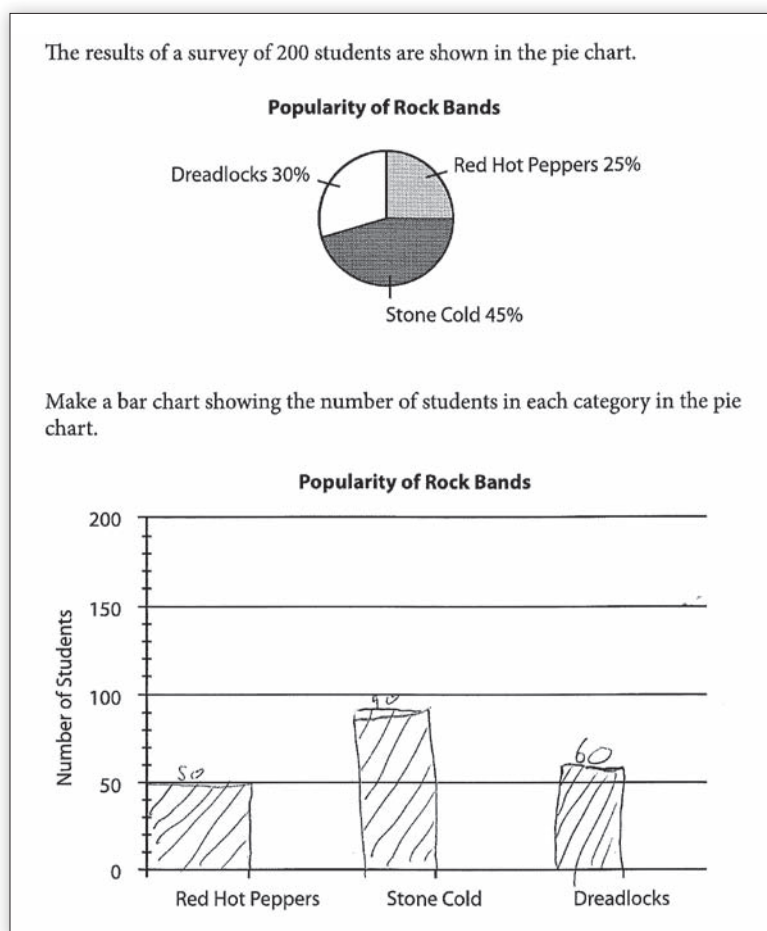
Country	Per cent full correct
Chinese Taipei	68 (2.3)
Korea	68 (2.1)
Singapore	59 (1.9)
United States	37 (2.0)
<b>Australia</b>	<b>36 (2.6)</b>
England	34 (2.5)
International average	18 (0.2)
Palestinian National Authority	1 (0.7)

Figure 2.17 Mathematics Year 8 example item 2

### Year 8 Mathematics – Performance at the high international benchmark

Students reaching the high international benchmark level were able to apply their understanding and knowledge to a variety of relatively complex situations. They were able to relate fractions, decimals, and percentages and operate with negative integers. They demonstrated the ability to work with algebraic expressions and linear equations, and used their knowledge of geometric properties to solve problems. They were able to compare and integrate several sets of data, and to solve simple problems involving outcomes and probabilities.

Figure 2.18 presents an item from the *data and chance* domain that assesses students' ability to read, organise and display data using various types of graphs, in this case a bar graph and a pie chart. Students needed to draw the bar graph in its entirety to receive full credit, and 27 per cent of students internationally received full credit for this item. In the Asian countries of Korea, Singapore, Chinese Taipei, Japan and Hong Kong, at least two-thirds of students gained full credit on this item. The proportion of students gaining full credit in Australia (38%), the United States (40%) and England (45%) was also significantly higher than the international average.



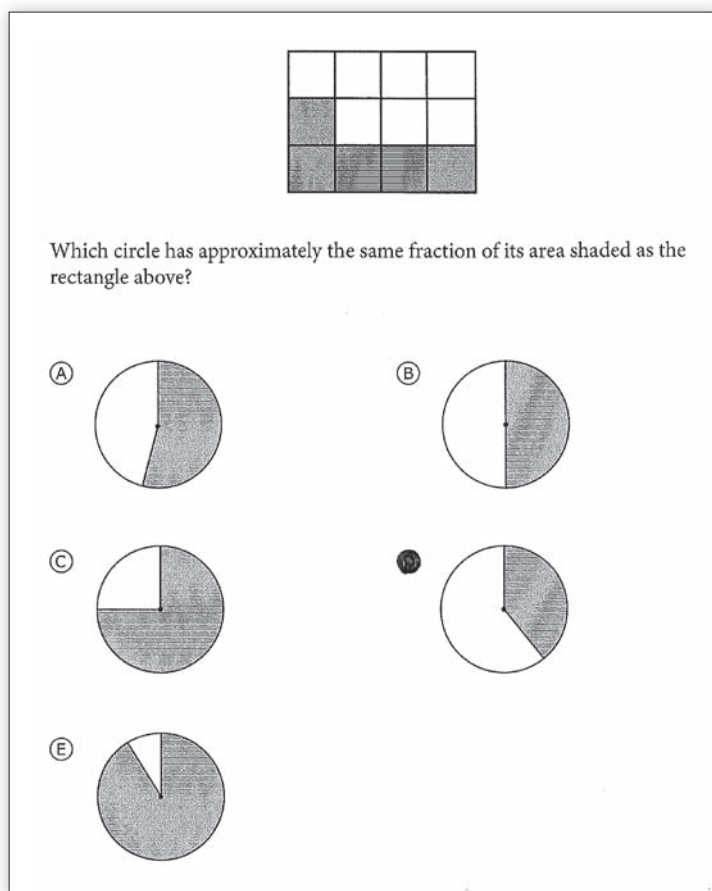
Country	Per cent full correct
Korea	76 (2.0)
Singapore	75 (1.7)
Chinese Taipei	70 (2.1)
England	45 (2.7)
United States	40 (1.9)
<b>Australia</b>	<b>38 (2.7)</b>
International average	27 (0.3)
Ghana	2 (0.6)

Figure 2.18 Mathematics Year 8 example item 3

### Year 8 Mathematics – Performance at the intermediate international benchmark

Students reaching the intermediate international benchmark were able to apply basic mathematical knowledge in relatively straightforward situations. For example, they solved one-step word problems involving addition and multiplication of decimals, and worked with familiar fractions. They demonstrated understanding of simple algebraic relationships, properties of triangles, and basic geometric concepts. They read and interpreted graphs and tables, and recognised basic notions of likelihood.

Figure 2.19 shows an example of the type of item that was typically answered correctly by students at the intermediate benchmark. This item called on students' understanding of representations of fractions. Students needed to recognise that of the circular models presented, the only one showing less than  $\frac{1}{2}$  best represents the fractional part shown in a rectangle as  $\frac{5}{12}$ . On average internationally, 63 per cent of the Year 8 students answered correctly. The Korean students were the top-performers with 89 per cent answering correctly. Students in Australia also performed well on this item, with three-quarters answering correctly, significantly higher than the international average.

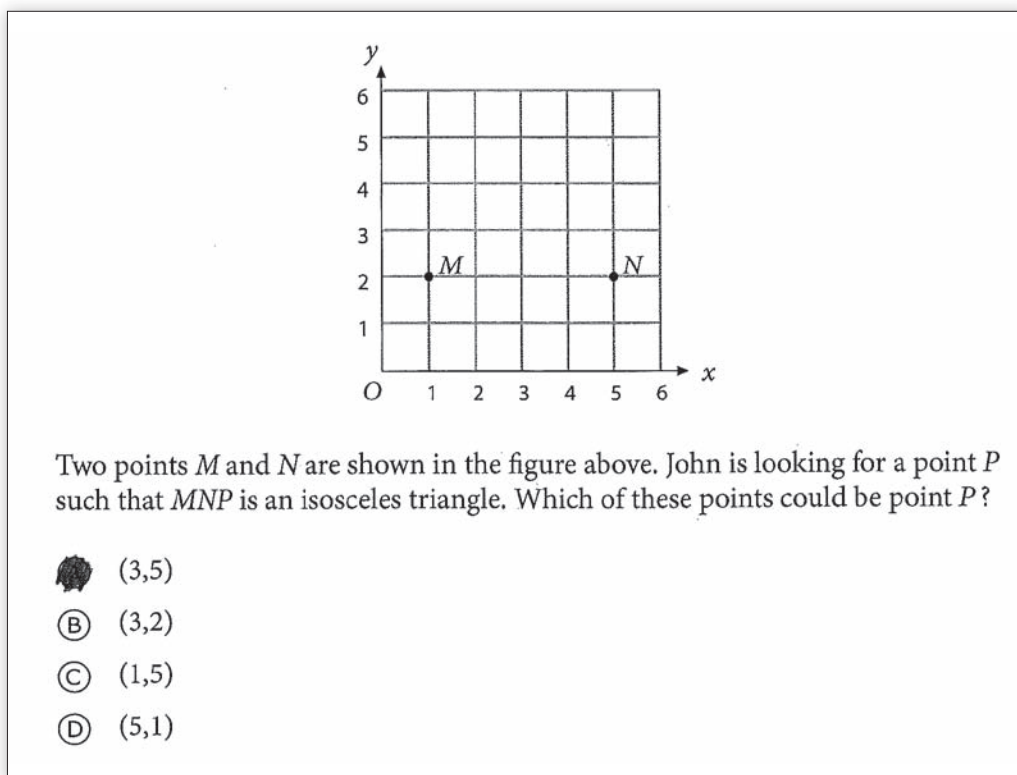


Country	Per cent full correct
Korea	89 (1.3)
Japan	85 (1.8)
Hong Kong	82 (2.3)
United States	81 (2.2)
England	77 (2.2)
<b>Australia</b>	<b>75 (2.3)</b>
International average	63 (0.3)
Ghana	34 (2.3)

Figure 2.19 Mathematics Year 8 example item 4

Example Item 5 presented in Figure 2.20 also illustrates the type of item likely to be answered correctly by students reaching the intermediate benchmark. Students were asked to use the properties of an isosceles triangle to identify the point on the grid that completes the triangle. On average internationally, more than half (57%) did so, and in Slovenia, Chinese Taipei, Korea, Japan, and Hong Kong at least 80 per cent of students answer correctly.

Australia's performance was significantly lower than that of the international average on this item, with just over half the students (51%) answering correctly.



Country	Per cent full correct
Chinese Taipei	86 (1.5)
Korea	82 (1.6)
Japan	81 (1.6)
England	63 (2.2)
International average	57 (0.3)
<b>Australia</b>	<b>51 (2.3)</b>
United States	45 (1.6)
Ghana	26 (1.6)

Figure 2.20 Mathematics Year 8 example item 5

**Year 8 Mathematics – Performance at the low international benchmark**

The few items that anchored at this level provided some evidence that students have an elementary knowledge of whole numbers and decimals, operations, and basic graphs.

In the example provided in Figure 2.21, example 6, 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.

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)

Country	Per cent full correct
Korea	97 (0.7)
Japan	96 (0.8)
Singapore	93 (1.1)
United States	89 (1.0)
<b>Australia</b>	<b>87 (1.7)</b>
England	81 (2.1)
International average	72 (0.3)
Qatar	40 (1.6)

**Figure 2.21** Mathematics Year 8 example item 6

## Year 8 Science – Descriptors of performance at the international benchmarks

At Year 8, TIMSS assessed four content domains, which were allotted varying weights: *biology* (35%), *chemistry* (20%), *physics* (25%) and *Earth science* (20%).

According to the *TIMSS 2007 Science Framework*, in *biology*, Year 8 students should be able to classify organisms into the major taxonomic groups, identify cell structures and their function, distinguish between growth and development in different organisms, and show some understanding of diversity, adaptation, and natural selection among organisms. By Year 8, students are expected to have an understanding of the interdependence of living organisms and their relationship to the physical environment, and demonstrate knowledge of human health, nutrition, and disease.

In *chemistry*, students should be able to classify substances on the basis of characteristic physical properties and have a clear understanding of the properties of matter. Students should recognise the differences between physical and chemical changes and recognise the conservation of matter during these changes.

In *physics*, students are expected to be able to describe processes involved in changes of state and apply knowledge of energy transformations, heat, and temperature. They should know basic properties of light and sound, understand the relationship between current and voltage in electrical circuits, and describe properties and forces of permanent magnets and electromagnets. Students are expected to have a quantitative knowledge of mechanics, as well as a commonsense understanding of density and pressure as they relate to familiar physical phenomena.

In the *Earth science* domain, Year 8 students are expected to demonstrate knowledge of the structure and physical characteristics of Earth's crust, mantle, and core, and apply the concept of cycles and patterns to describe Earth's processes, including the rock and water cycles. Students should have an understanding of Earth's resources and their use and conservation, and demonstrate knowledge of the solar system in terms of the relative distances, sizes, and motions of the sun, the planets, and their moons, and of how phenomena on Earth relate to the motion of bodies in the solar system.

Within each content domain, students needed to draw on a range of cognitive skills and go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems.

Figure 2.22 provides the brief descriptors for the international benchmarks at Year 8. As the figure shows, students at the advanced international benchmark in Year 8 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.

Year 8	Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
	(400)	(475)	(550)	(625)
	<p><i>Students can recognise some basic facts from the life and physical sciences.</i></p> <p>They have some knowledge of the human body, and demonstrate some familiarity with everyday physical phenomena. Students can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.</p>	<p><i>Students can recognise and communicate basic scientific knowledge across a range of topics.</i></p> <p>They demonstrate some understanding of characteristics of animals, food webs, and the effect of population changes in ecosystems. They are acquainted with some aspects of sound and force and have elementary knowledge of chemical change. They demonstrate elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students extract information from tables and interpret pictorial diagrams. They can apply knowledge to practical situations and communicate their knowledge through brief descriptive responses.</p>	<p><i>Students can demonstrate conceptual understanding of some science cycles, systems, and principles.</i></p> <p>They have some understanding of biological concepts including cell processes, human biology and health, and the interrelationship of plants and animals in ecosystems. They apply knowledge to situations related to light and sound, demonstrate elementary knowledge of heat and forces, and show some evidence of understanding the structure of matter, and chemical and physical properties and changes. They demonstrate some understanding of the solar system, Earth's processes and resources, and some basic understanding of major environmental issues. Students demonstrate some scientific inquiry skills. They combine information to draw conclusions, interpret tabular and graphical information, and provide short explanations conveying scientific knowledge.</p>	<p><i>Students can demonstrate a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science.</i></p> <p>They have an understanding of the complexity of living organisms and how they relate to their environment. They show understanding of the properties of magnets, sound, and light, as well as demonstrating understanding of structure of matter and physical and chemical properties and changes. Students apply knowledge of the solar system and of Earth's features and processes, and apply understanding of major environmental issues. They understand some fundamentals of scientific investigation and can apply basic physical principles to solve some quantitative problems. They can provide written explanations to communicate scientific knowledge.</p>

**Figure 2.22** Descriptors of performance at the international benchmarks, Year 8 science

**Year 8 Science – Performance at the advanced international benchmark**

Students achieving at or above the advanced benchmark demonstrated a grasp of some complex and abstract science concepts. For example, they have an understanding of the complexity of living organisms and how they relate to their environment, and show knowledge of the structure of matter and of physical and chemical properties and changes. They show understanding of the properties of magnets, sound, and light. Students apply knowledge and understanding of the solar system and Earth’s features and processes, and of major environmental issues. They understand some fundamentals of scientific investigation, can apply basic physical principles to solve quantitative problems, and can provide written explanations to communicate scientific knowledge.

Example 1 in Figure 2.23 provides an example of the type of item a student performing at the advanced international benchmark is likely to answer correctly. Students were told that two substances together had a mass of 110 grams. They were asked to predict the mass of a new substance formed by combining the two original substances and explain their reasoning.

On average across countries only 23 per cent of students obtained full credit for their answer. In Japan, Korea and Chinese Taipei, more than half of the students answered correctly, while in Australia the proportion answering correctly was 25 per cent, not significantly different to the international average.

The mass of substances A and B are measured on a balance, as shown in Figure 1. Substance B is put into the beaker and substance C is formed. The empty beaker is put back on the balance, as shown in Figure 2.

**Figure 1** **Figure 2**

The scale in Figure 1 shows a mass of 110 grams.  
 What will it show in Figure 2?

(Tick one box.)

More than 110 grams  
 110 grams  
 Less than 110 grams

Explain your answer.

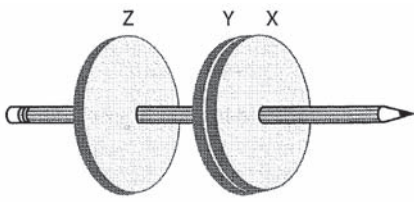
*The two substances are still on the scales, one has just dissolved in the other. As both substances are still there it will still weigh the same.*

Country	Per cent full correct
Japan	65 (2.1)
Korea	51 (2.0)
Chinese Taipei	51 (2.3)
England	28 (2.1)
<b>Australia</b>	<b>25 (2.4)</b>
United States	24 (1.6)
International average	23 (0.3)
Botswana	1 (0.4)

**Figure 2.23** Science Year 8 example item 1

Example 2, shown in Figure 2.24, is set in the *physics* domain, and 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. The percentage answering correctly in Australia was the same as this international average.



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.

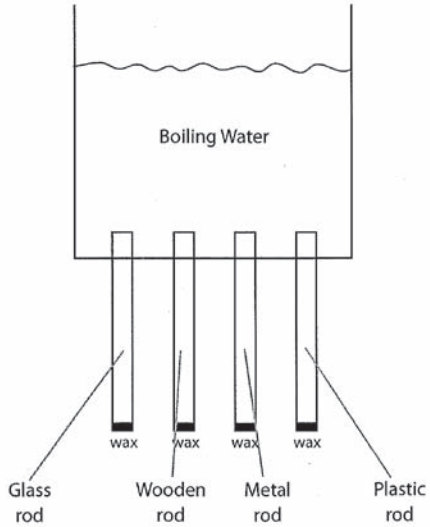
Country	Per cent full correct
Japan	71 (2.0)
Singapore	61 (1.8)
Korea	52 (2.3)
England	46 (2.5)
<b>Australia</b>	<b>23 (2.2)</b>
International average	23 (0.3)
United States	16 (1.6)
Algeria	2 (0.6)

Figure 2.24 Science Year 8 example item 2

### Year 8 Science – Performance at the high international benchmark

Students reaching this benchmark were able to recognise and communicate basic scientific knowledge across a range of topics. They demonstrated some understanding of characteristics of animals, and were acquainted with some aspects of sound, force, and chemical change. They demonstrated elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students could extract information from tables and diagrams, apply knowledge to practical situations, and communicate their knowledge through brief descriptive responses.

Example 3 in Figure 2.25 shows the type of *physics* item likely to be answered correctly by students reaching the high benchmark. In the context of an investigation into thermal conductivity, this multiple-choice question asks students to choose among glass, wood, metal, and plastic for the best conductor of heat. On average, internationally, 47 per cent of students correctly chose metal as the best conductor. More than 70 per cent of students answered correctly in Singapore (79%) and in Chinese Taipei (75%). Students in Australia (60%), England (66%) and the United States (57%) performed on average significantly higher than the international average.



The diagram shows four identical size rods each of a different material sealed into the bottom of a container. The same amount of wax is placed on the end of each rod and then the container is filled with boiling water. On which rod will the wax melt first?

(A) Glass rod  
 (B) Wooden rod  
 (C) Metal rod  
 (D) Plastic rod

Country	Per cent full correct
Singapore	79 (1.7)
Chinese Taipei	75 (1.8)
Japan	68 (1.9)
England	66 (2.3)
<b>Australia</b>	<b>60 (2.5)</b>
United States	57 (1.8)
International average	47 (0.3)
Indonesia	21 (2.1)

Figure 2.25 Science Year 8 example item 3

### Year 8 Science – Performance at the intermediate international benchmark

Students reaching this benchmark were able to recognise and communicate basic scientific knowledge across a range of topics. They demonstrated some understanding of characteristics of animals, and were acquainted with some aspects of sound, force, and chemical change. They demonstrated elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students could extract information from tables and diagrams, apply knowledge to practical situations, and communicate their knowledge through brief descriptive responses.

Figure 2.26 presents example item 4, from the *biology* domain. This multiple-choice item requires students to identify an animal characteristic found only in mammals. On average internationally, 63 per cent of Year 8 students recognised *glands that make milk* as the correct answer. More than 80 per cent of students in Chinese Taipei (91%), Hong Kong (86%), Thailand (84%), and Turkey (82%) answered correctly. Students in Australia, England and the United States performed poorly on this item, with the average for each of these three countries significantly lower than the international average. Particularly for Australian students, living in a country full of mammals, this result is surprising.

Which characteristic is found **ONLY** in mammals?

- (A) eyes that detect colour
- (B) glands that make milk
- (C) skin that absorbs oxygen
- (D) bodies that are protected by scales

Country	Per cent full correct
Chinese Taipei	91 (1.3)
Hong Kong	86 (1.8)
Thailand	84 (1.5)
International average	63 (0.3)
<b>Australia</b>	<b>56 (2.7)</b>
United States	53 (1.8)
England	53 (2.4)
Ghana	31 (2.1)

Figure 2.26 Science Year 8 example item 4

In example item 5, shown in Figure 2.27, students are asked to draw on their knowledge of *physics* to recognise the reason that a sound can cause an echo on the Earth but not on the moon. Almost two-thirds (65%) of students internationally recognised that there would be no echo on the moon because there is no air for the sound to travel through.

In Korea (90%), Chinese Taipei (89%), Hong Kong SAR (84%), Lithuania (83%), Japan (82%), Sweden (81%), and Hungary (80%) at least 80 per cent of students answered this item correctly. In Australia (73%) and the United States (71%), almost three-quarters, and in England a little more than this (77%), answered correctly, all significantly higher than the international average.

In a deep valley on Earth, a person shouting will hear an echo as the sound is reflected back off the surrounding mountains. In a similar valley on the Moon, no echo will be heard. This is because

- (A) the gravitational pull on the Moon is too low
- (B) the temperature on the Moon is too low
- (C) there is no air on the Moon for the sound to travel through
- (D) the mountains on the Moon cannot reflect sound

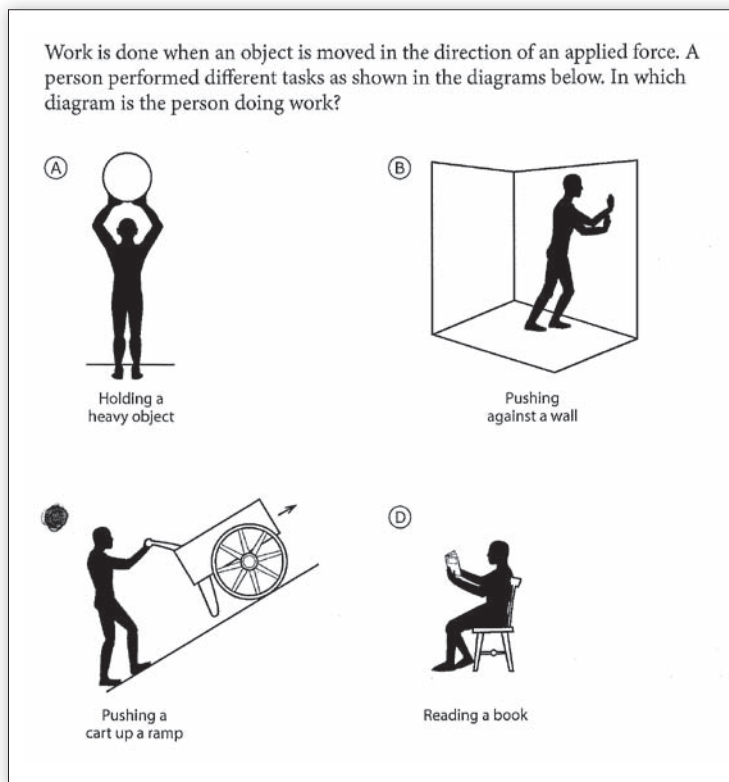
Country	Per cent full correct
Korea	90 (1.3)
Chinese Taipei	89 (1.3)
Hong Kong	84 (1.9)
England	77 (2.3)
<b>Australia</b>	<b>73 (2.4)</b>
United States	71 (1.7)
International average	65 (0.3)
Ghana	34 (1.9)

Figure 2.27 Science Year 8 example item 5

### Year 8 Science: Performance at the low international benchmark

Students performing at this level recognised some basic facts from the life and physical sciences. They have some knowledge of the human body and demonstrate some familiarity with everyday physical phenomena. They can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.

The multiple-choice item shown as example item 6 (Figure 2.28) illustrates the type of item likely to be answered correctly by students reaching the low benchmark. In this item from the *physics* domain, students are given a definition of work (work is done when an object is moved in the direction of an applied force) and asked to identify a diagram depicting a person doing work. On average internationally, this item was answered correctly by 78 per cent of students, who recognized that a person pushing a cart up a ramp was doing work. Every country except Tunisia had more than half their students answer correctly. Eighty-six per cent of Australian students answered this item correctly, significantly higher than the international average.



Country	Per cent full correct
Singapore	96 (0.9)
United States	91 (1.0)
Bulgaria	91 (2.1)
Russian Federation	91 (1.3)
<b>Australia</b>	<b>86 (1.6)</b>
England	85 (1.7)
International average	78 (0.3)
Tunisia	49 (2.1)

Figure 2.28 Science Year 8 example item 6

The next chapter of this report examines the mathematics scores for TIMSS 2007 – internationally, within Australia and for particular groups within Australia, both in terms of mean scores and distributions and also in terms of these described benchmarks.

# Australian students' achievement in mathematics

This chapter presents the international and national results for mathematics, firstly for mathematics overall and then for the content and cognitive domains described in Chapter 2. The reporting of these results includes both mean scores and percentages achieving the international benchmarks, as both are important to policy makers.

## Overall achievement in mathematics

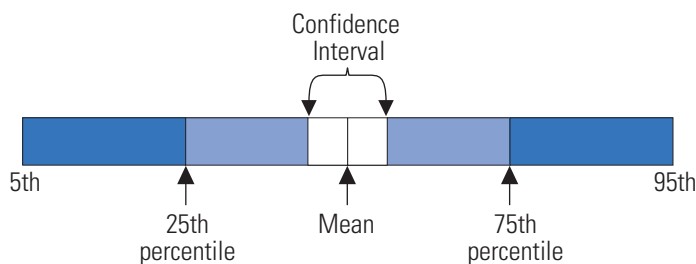
### An international perspective

Figures 3.1A and 3.1B<sup>1</sup> provide a summary of the overall performance of students in Years 4 and 8 across different countries on the combined mathematics scale, in terms of the mean scores achieved by students in each country, and the range of scores achieved between the 5<sup>th</sup> and 95<sup>th</sup> percentiles.

Typically changes in mean performance of students from one cycle of an assessment to the next are used to assess improvement in the quality of schools and education systems. However, the mean level of performance does not provide the complete picture of student achievement and can mask significant variation within an individual class, school or education system. Countries aim not only to encourage high performance but also to minimise internal disparities in performance. Therefore, as well as a high mean score, a limited range of scores is also desirable.

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<sup>1</sup> Generally throughout the report, figures and tables are presented in pairs, with the Year 4 graph or table followed by its corresponding Year 8 figure or table. To facilitate reading of the report the figures and tables have been labelled with an A to indicate a Year 4 figure or table and B to indicate a Year 8 figure or table.



### READING THE GRAPHS

Each country's results are represented in horizontal bars with various colours. On the left end of the bar is the 5<sup>th</sup> percentile – this is the score below which 5 per cent of the students have scored. The next line indicates the 25<sup>th</sup> percentile. The white band is the confidence interval for the mean – i.e. we are 'confident' that the mean will lie within this white band. The line in the centre of the white band is the mean. The lines to the right of the white band indicate the 75<sup>th</sup> and 95<sup>th</sup> percentiles.

Results for the states are presented vertically; however, the interpretation is the same.

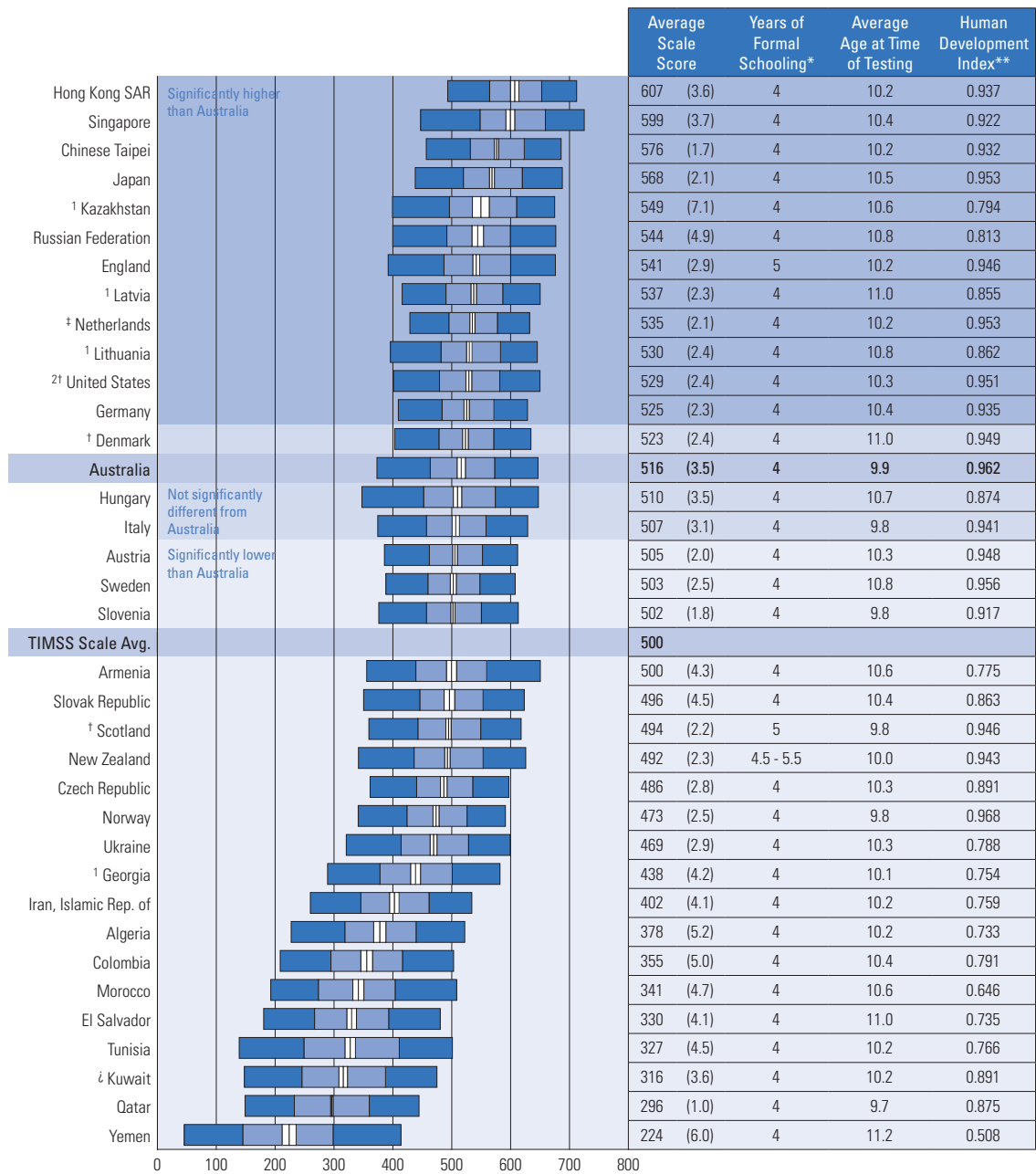
At Year 4, 17 of the TIMSS countries (Hong Kong through to Austria) scored significantly higher than the TIMSS international scale average (500). Hong Kong outperformed all other countries, and Singapore outperformed all countries other than Hong Kong. The achievement levels of Chinese Taipei and Japan were significantly higher than that of the countries below them in Figure 3.1A. A group comprising seven European countries (Kazakhstan, Russian Federation, England, Latvia, the Netherlands, Lithuania and Germany) and the United States, all of which achieved a significantly higher average score than Australia, followed these four countries. Australia's achievement score of 516 was significantly higher than the international scale average, and was not significantly different to that of Denmark, Hungary and Italy. Australia's performance was significantly higher than that of 20 countries, including Sweden and New Zealand.

As might be expected, the results reveal substantial differences in mathematics achievement between the highest and lowest performing countries (607 in Hong Kong to 224 in Yemen at Year 4). Hong Kong, along with the highest overall level of achievement, also had a reasonably small range of achievement of 219 scale points between the 5<sup>th</sup> and 95<sup>th</sup> percentiles. The largest range was 368 scale points, in the lowest achieving country Yemen. The smallest range was 203 scale points in the Netherlands. Australia's range was about midway between these at 274 score points.

As a point of comparison, Figure 3.1A provides the average years of schooling and average age at time of testing. The average ages of students in Year 4 varied by a full year between countries – from around 11 years in Yemen, Latvia, Denmark, and El Salvador to under 10 years in Australia, Italy, Slovenia, Scotland, Norway and Qatar. Years of schooling was most commonly 4 years, but ranged from 4½ years to 5½ years in New Zealand and 5 years in England and Scotland.

Figure 3.1A also shows the value for each country on the Human Development Index. This index has a minimum value of 0 and a maximum of 1.0. Countries with high values on the index enjoy long life expectancy, high levels of school enrolment and adult literacy, and a good standard of living as measured by per capita GDP. At the Year 4 level in mathematics, TIMSS countries with index values greater than 0.9 included Norway, Australia, Sweden, Japan, the Netherlands, the United States, England, New Zealand, Hong Kong, Chinese Taipei and Singapore (presented in rank order). With the exception of New Zealand and Norway, all of these countries achieved an average scale score in mathematics above the TIMSS scale average. However, not all countries performing above this average had an index value as high as 0.9. Kazakhstan and the Russian Federation, for example, both had an index score of around 0.8.

A number of countries experienced a significant change in average mathematics scale scores from the previous to the current TIMSS cycle. Australia showed an increase of 17 score points across the 2003 and 2007 cycles for Year 4. Other countries that showed a significant improvement included Armenia by 44 score points, Hong Kong by 32 score points, Slovenia by 23 score points, and Norway by 22 score points.



\* 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.

<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included.

<sup>‡</sup> Nearly satisfied guidelines for sample participation rates only after replacement schools were included.

<sup>1</sup> National Target Population does not include all of the International Target Population defined by TIMSS.

<sup>2</sup> National Defined Population covers 90% to 95% of National Target Population.

<sup>‡</sup> 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.

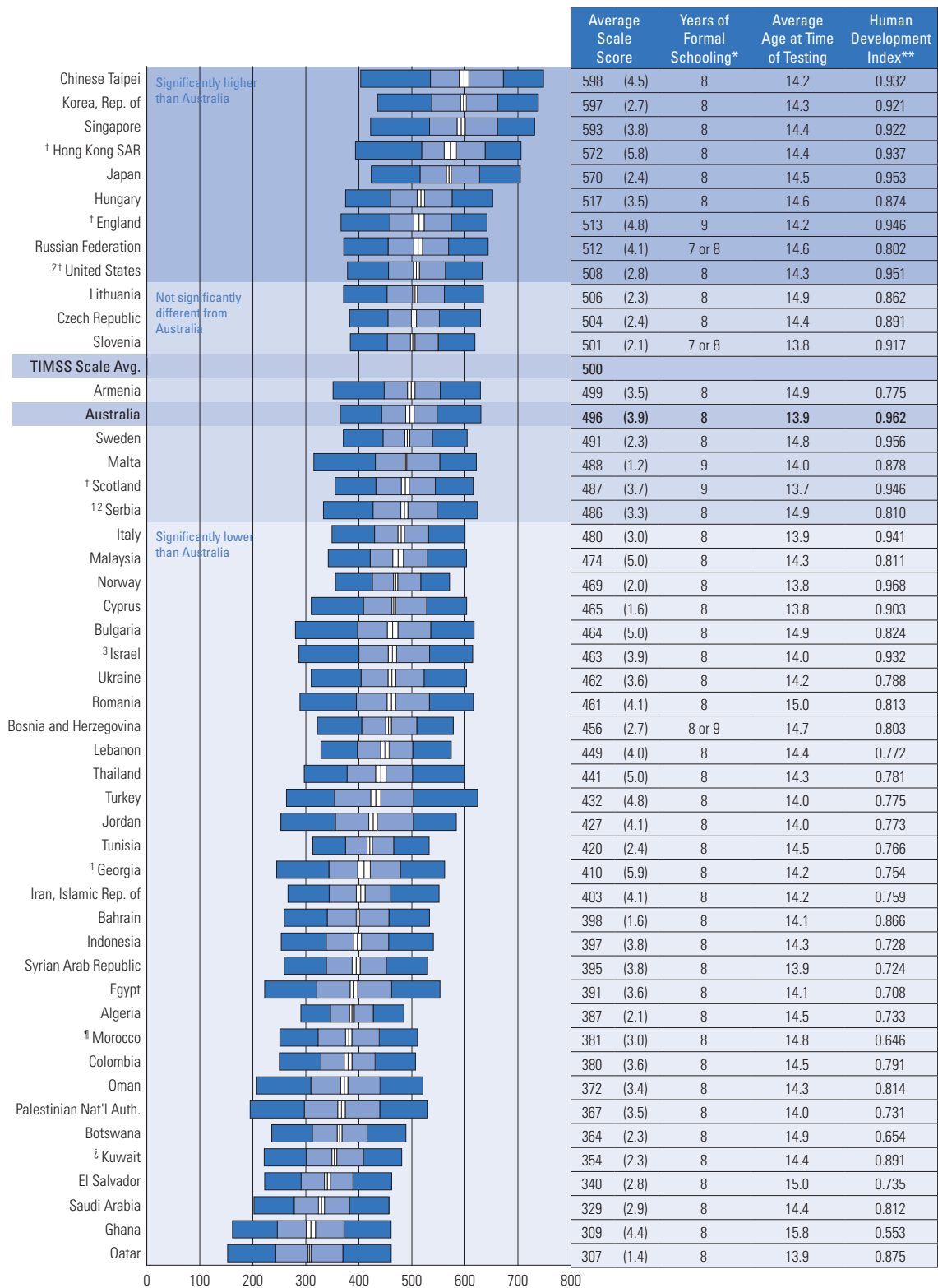
Figure 3.1A Distribution of mathematics achievement scores by country, Year 4

At Year 8, 10 of the TIMSS countries (Chinese Taipei through to Lithuania) scored significantly higher than the TIMSS scale average of 500. Chinese Taipei, Korea and Singapore scored the highest, about 100 score points higher than the TIMSS scale average. These three countries scored significantly higher than Hong Kong and Japan, the next highest achieving countries. Four other countries, Hungary, England, the Russian Federation and the United States of America, also achieved significantly higher mean mathematics scores than Australia and the TIMSS scale average. Australian Year 8 students achieved a mean score of 496 in mathematics, not significantly different from the TIMSS scale average. Eight countries had mean scores not significantly different from that of Australia – Lithuania, the Czech Republic, Slovenia, Armenia, Sweden, Malta, Scotland and Serbia. Australia's score was significantly higher than all other 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.

As at Year 4, the results reveal substantial differences in mathematics achievement at Year 8 between the highest and lowest performing countries (598 in Chinese Taipei to 307 in Qatar). In addition, the percentiles shown in Figure 3.1B show the wide range of achievement within countries. The difference between the 5<sup>th</sup> and 95<sup>th</sup> percentiles within countries is often approximately 300 scale points, which is similar to the difference across countries. Chinese Taipei, which has the highest achievement, also has one of the largest ranges in achievement with 345 scale points between the 5<sup>th</sup> and 95<sup>th</sup> percentiles. The smallest range is that of 194 scale points in Algeria. Australia's range of 265 scale points is again about midway between these two points.

The average ages of students in Year 8 varied by a full year between countries – from over 15 years in Ghana to under 14 years in Australia, Italy, Slovenia, Scotland, Cyprus, Norway, Syria and Qatar. Years of schooling was most commonly 8 years, but ranged from '7 or 8 years' in Slovenia and the Russian Federation to 9 years in England, Scotland and Malta.

As at Year 4, many of the TIMSS countries with Human Development Index values greater than 0.9 in rank achieved an average Year 8 scale score above the TIMSS scale average. Exceptions to this included Sweden, Scotland, Italy, Norway, Israel and Cyprus, all countries with an index value above 0.9 yet with an average achievement below the TIMSS scale average. Lithuania, the Russian Federation and Hungary all scored above the TIMSS scale average, despite index values below 0.9.



\* 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.

<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included.

<sup>‡</sup> Nearly satisfied guidelines for sample participation rates only after replacement schools were included.

<sup>¶</sup> Did not satisfy guidelines for sample participation rates.

<sup>1</sup> National Target Population does not include all of the International Target Population defined by TIMSS.

<sup>2</sup> National Defined Population covers 90% to 95% of National Target Population.

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

<sup>‡</sup> 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 3.1B** Distribution of mathematics achievement scores by country, Year 8

## Performance at the international benchmarks

In addition to comparing mean scores, it is possible to use the international benchmarks described in Chapter 2 to gain further insight into student achievement. Figures 3.2A and 3.2B provide the proportion of students in each country at each of the international benchmarks for Years 4 and 8. Countries are ordered according to the percentage of students achieving the advanced benchmark. As a point of reference, the international median in TIMSS 2007 (see the Reader's Guide) is provided for each of the international benchmarks. By definition, half the countries will have a percentage above the median and half below.

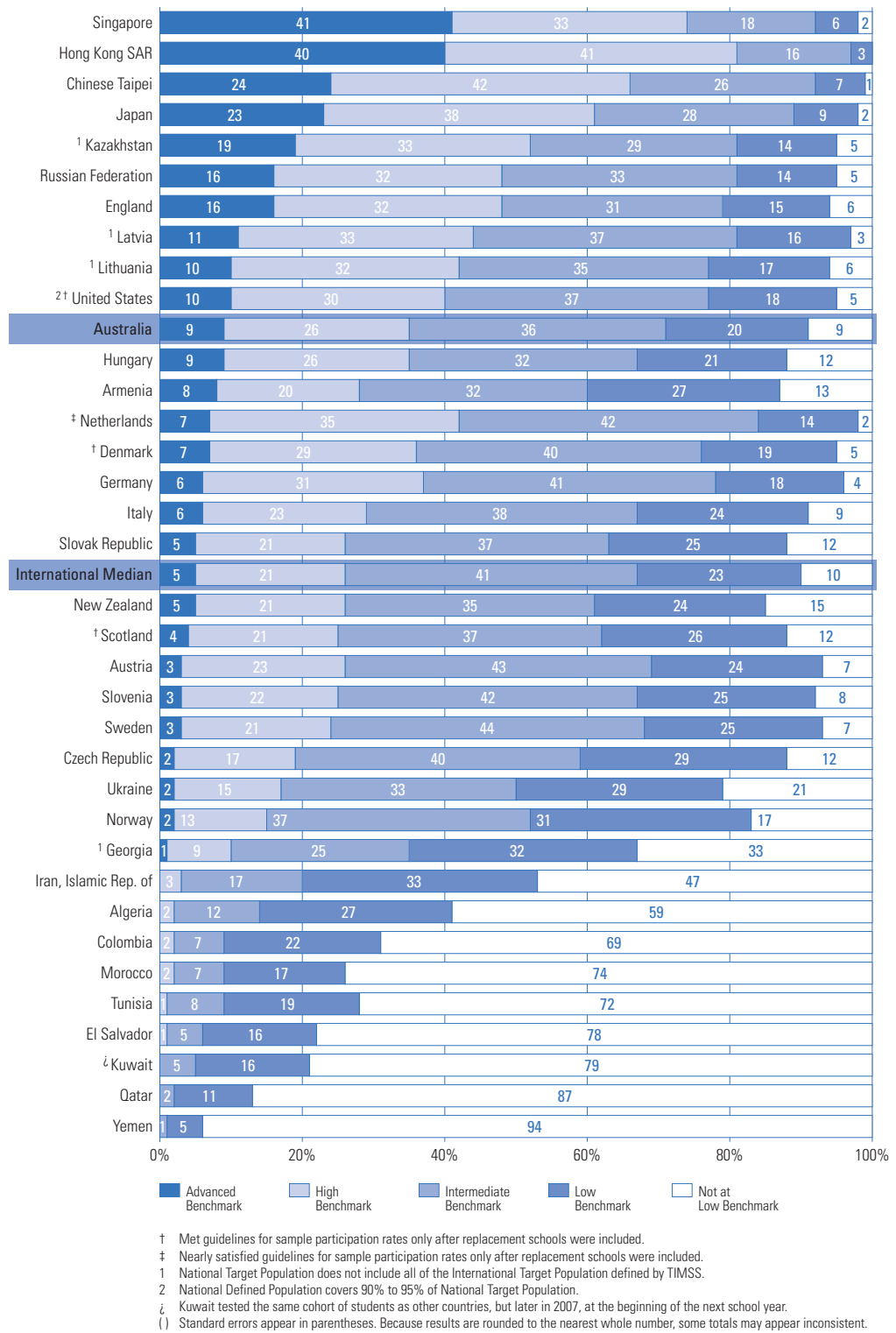
At Year 4, students at the advanced benchmark demonstrated the ability to apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning. In contrast, those at the low benchmark demonstrated only some basic mathematical knowledge.

Australia performed reasonably well at some levels against the international 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. Figure 3.2A shows the proportion of students at each benchmark for all TIMSS 2007 countries.

Singapore had the highest proportion of students achieving the advanced international benchmark, with 41 per cent of students in Year 4 attaining this level. This figure was similar to the 38 per cent of students in Singapore who attained the advanced international benchmark in TIMSS 2003. Hong Kong also stood out as one of the highest achieving countries with 40 per cent of Year 4 students attaining the advanced international benchmark, followed by Chinese Taipei (24%) and Japan (23%), respectively. What is particularly impressive about achievement in these countries is the fact that almost all (98% to 100%) of the students in Year 4 in these high achieving countries achieved the low international benchmark. The majority of students in these countries demonstrated a strong grasp of the basic levels of mathematical achievement, with very few performing below international minimum standards.

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. Similarly, in Germany six per cent of Year 4 students achieved at the advanced benchmark but 96 per cent 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.

Overall, in 11 of the 36 countries participating in TIMSS 2007 at the Year 4 level, more than 95 per cent of students achieved the low international benchmark.



**Figure 3.2A** Percentages of students reaching the international benchmarks for mathematics achievement by country, Year 4

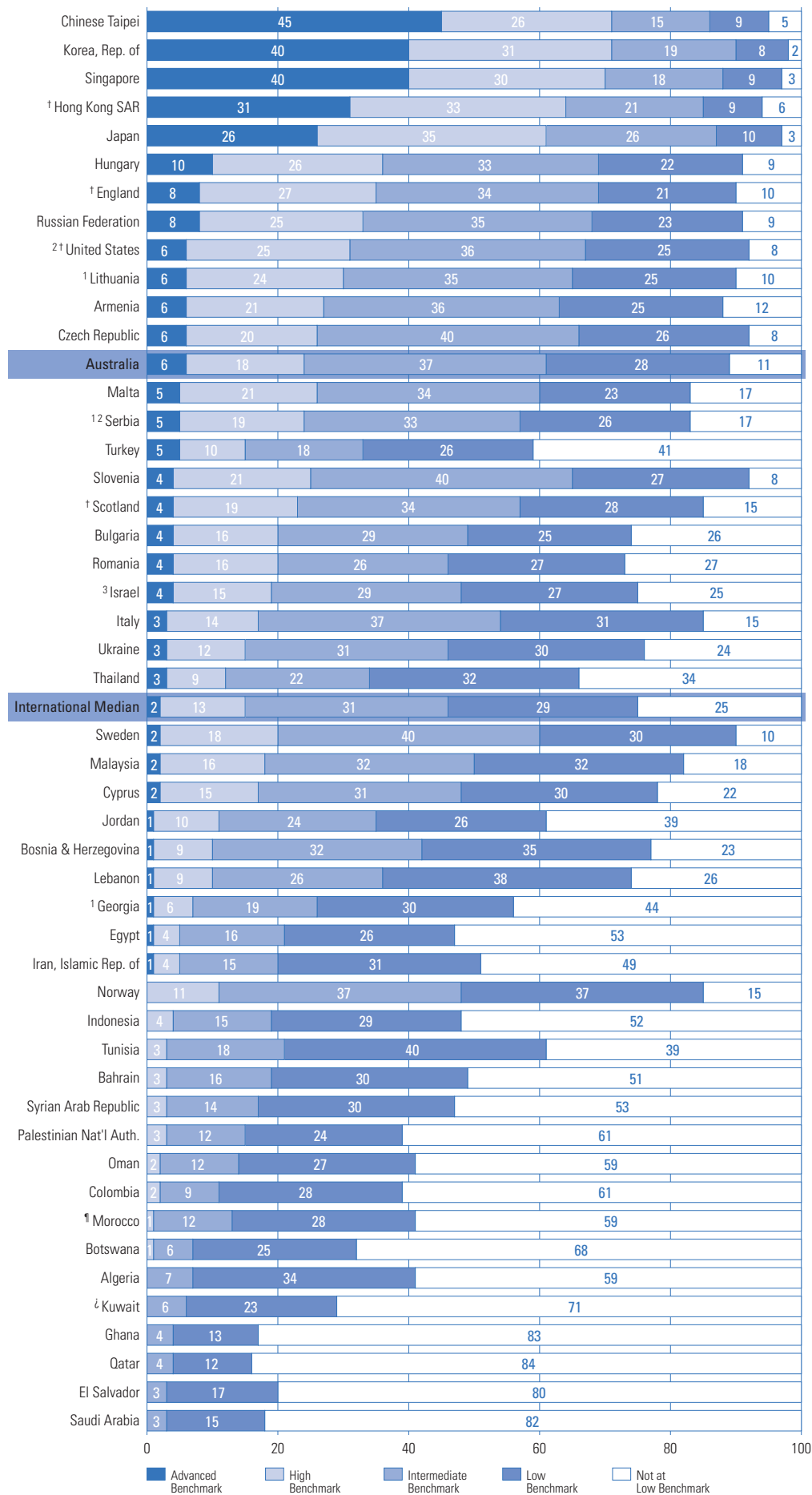
At Year 8, students at the advanced international benchmark organised and drew conclusions from information, made generalisations, and solved non-routine problems involving numeric, algebraic, and geometric concepts and relationships. In comparison, those at the low international benchmark demonstrated some knowledge of whole numbers and decimals, operations, and basic graphs.

Figure 3.2B displays the percentage of Year 8 students in each country that reached each international benchmark in mathematics. It shows that Chinese Taipei, the highest scoring country, is also the country with the highest percentage (45%) of students who achieved the advanced benchmark. Forty per cent of students in Korea and Singapore reached the advanced benchmark, followed by about a third of Year 8 students in Hong Kong and a quarter in Japan. There is a considerable gap between these countries and the next best performing country, with Hungary having 10 per cent of students reaching the advanced benchmark. All the remaining TIMSS 2007 countries had less than 10 per cent of students performing at the advanced level in Year 8, with the international median being two per cent.

The substantial variation in achievement at the advanced international benchmark was evident at each of the other benchmarks. The high international benchmark was reached by at least 70 per cent of students in Chinese Taipei, Korea, and Singapore as well as by 60 per cent in Hong Kong and Japan, but only by approximately half that proportion (30 to 36%) in the next highest group of countries (Hungary, England, the Russian Federation, Lithuania, and the United States). The percentage of students achieving the intermediate international benchmark ranged from 90 per cent in Korea to three per cent in El Salvador and Saudi Arabia. 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). Norway also displayed this pattern with essentially no students at the advanced benchmark but 48 per cent reaching the intermediate benchmark and 85 per cent reaching the low benchmark.

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. Alternatively this means that 11 per cent of Australian Year 8 students did not reach the low benchmark.



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

**Figure 3.2B** Percentages of students reaching the international benchmarks for mathematics achievement by country, Year 8

## Performance by gender

Figures 3.3A and 3.3B show gender differences in Year 4 and 8 mathematics achievement across the countries participating in TIMSS 2007. They present average achievement separately for females and males, as well as the difference between the averages. This is shown by a bar indicating the size and direction of the difference (in favour of males or females) and whether the difference was statistically significant (indicated by a darkened bar). Countries are shown in increasing order of this difference in average achievement in favour of males; that is, countries in which the average score of males was significantly greater than that of females will appear towards the right-hand side of the figure.

There was no statistically significant gender difference in the international average score for mathematics at Year 4 in TIMSS 2007; however, males significantly outperformed females in Slovenia, the United States, the Czech Republic, Sweden, the Slovak Republic, Norway, Scotland, the Netherlands, Germany, Austria, Italy and Colombia. Females scored significantly higher than males in Singapore, the Russian Federation, Kazakhstan, Armenia, Tunisia, Yemen, Qatar and Kuwait. The significant differences in favour of males ranged in size from five score points in Slovenia to 17 score points in Columbia. For females the significant differences ranged from 6 score points in Singapore to 37 score points in Kuwait.

In Australia, Year 4 males scored on average six score points higher than females, but this difference was not statistically significant.



<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included.

<sup>‡</sup> Nearly satisfied guidelines for sample participation rates only after replacement schools were included.

<sup>1</sup> National Target Population does not include all of the International Target Population defined by TIMSS.

<sup>2</sup> National Defined Population covers 90% to 95% of National Target Population.

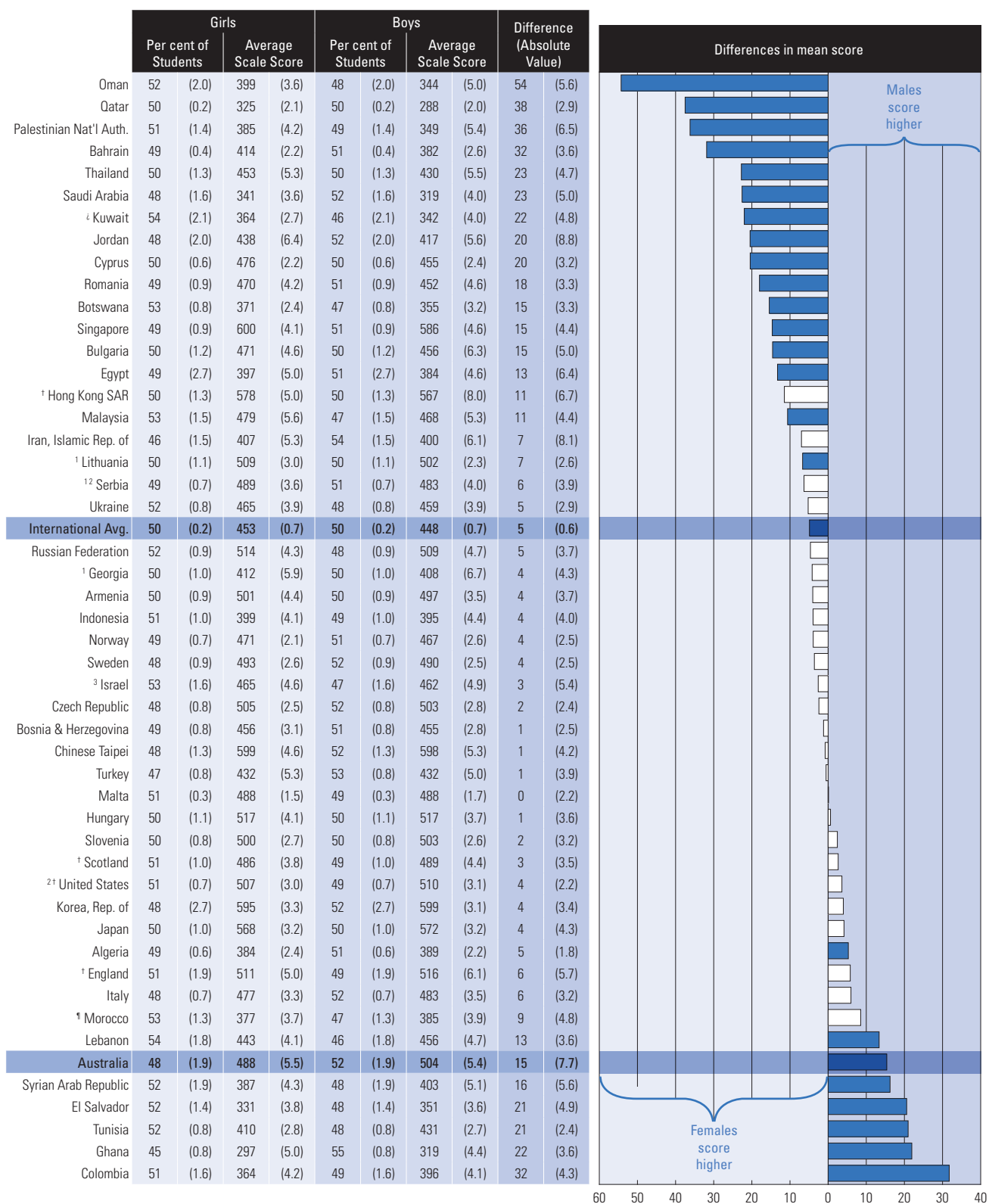
<sup>‡</sup> Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

■ Difference statistically significant  
 □ Difference not statistically significant

**Figure 3.3A** Average mathematics achievement by gender within country, Year 4

Figure 3.3B shows that, on average across the TIMSS 2007 countries, females in Year 8 achieved a significantly higher average score than males (by 5 score points). Females achieved significantly higher average scores than males in 16 of the participating countries, including many of the countries situated geographically in the Middle East. The significant differences in favour of females ranged in size from seven score points in Lithuania to 54 score points in Oman. Males achieved significantly higher average scores than females in eight countries, including Australia. Across the participating countries, the significant differences in favour of males ranged in size from five score points in Algeria to 32 score points in Colombia. In Australia males outperformed females by 15 score points, a substantial as well as significant difference. Interestingly, in 25 countries there was no significant difference between females and males.



<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included.

<sup>‡</sup> Nearly satisfied guidelines for sample participation rates only after replacement schools were included.

<sup>¶</sup> Did not satisfy guidelines for sample participation rates.

<sup>1</sup> National Target Population does not include all of the International Target Population defined by TIMSS.

<sup>2</sup> National Defined Population covers 90% to 95% of National Target Population.

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

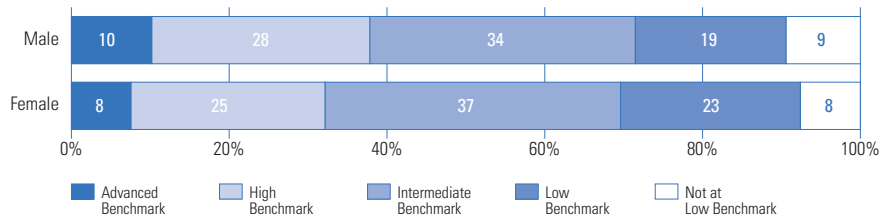
<sup>4</sup> Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

**Figure 3.3B** Average mathematics achievement by gender within country, Year 8

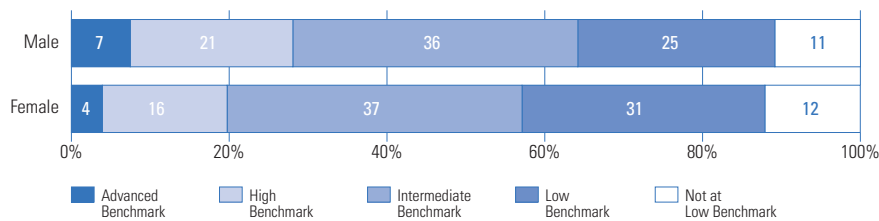
Figure 3.4A shows the proportion of male and female Year 4 Australian students achieving at each of the international benchmarks.

A higher proportion of males than females reached the advanced and high benchmarks. More females tended to achieve around the middle bands of achievement, with a slightly higher proportion of females than males at the intermediate and low benchmark levels. Similar proportions of male and female students did not reach the international low benchmark at Year 4.



**Figure 3.4A** Percentages of Australian students reaching the international benchmarks for mathematics achievement by gender, Year 4

Figure 3.4B shows the corresponding proportions for Year 8 students. While approximately the same percentage of females and males (88% and 89% respectively) achieved the low benchmark, it can be seen that most of the significant difference between males and females in mathematics achievement was due to differences in the distribution of students across the scale. Around three per cent more males than females achieved the advanced benchmark, and eight per cent more males than females achieved at least the high benchmark.



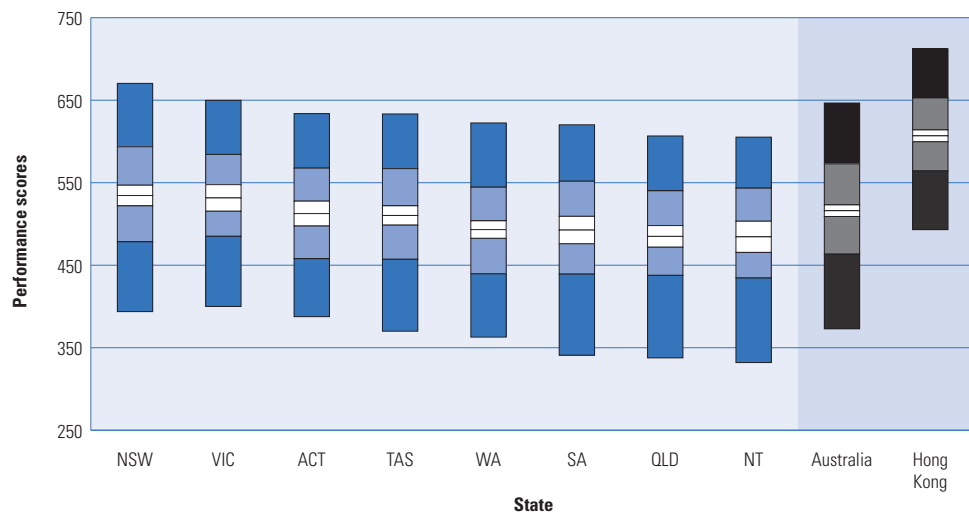
**Figure 3.4B** Percentages of Australian students reaching the international benchmarks for mathematics achievement by gender, Year 8

## Performance by state

Figures 3.5A and 3.5B present the distribution of mathematics performance for each of the Australian states for Year 4 and Year 8 in a similar way to that of the international results in Figures 3.1A and 3.1B. To place the state results in perspective, the means and distributions for Australia as a whole, and for the highest achieving country, are also included in each figure. The states are shown in order from highest to lowest mean scores.

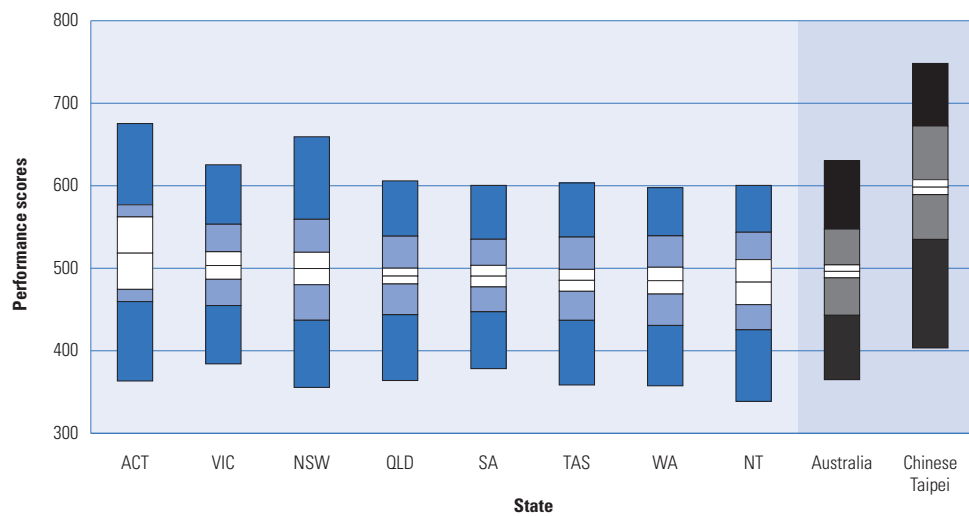
Figures 3.5A and 3.5B should be read in conjunction with Tables 3.1A and 3.1B (respectively), which present the multiple comparisons of mean performance between the states.

Figure 3.5A shows that South Australia had the widest range of student performance, with the range from the 5<sup>th</sup> to 95<sup>th</sup> percentile of 279 score points, whilst the ranges for the two highest performing states, New South Wales and Victoria, were 277 and 250 score points respectively. New South Wales, Victoria, the Australian Capital Territory and Tasmania all had mean scores higher than the TIMSS scale average.



**Figure 3.5A** Distribution of mathematics achievement scores by state, Year 4

Figure 3.5B presents the distribution of Year 8 achievement for each state. It shows that in 2007, the Australian Capital Territory had the highest average achievement (518 score points) and also the widest distribution of scores, with a range of 312 score points between the 5<sup>th</sup> and 95<sup>th</sup> percentiles. South Australia had the narrowest range, with only 222 score points separating the 5<sup>th</sup> and 95<sup>th</sup> percentiles.



**Figure 3.5B** Distribution of mathematics achievement scores by state, Year 8

Figure 3.5A and Table 3.1A together show that at Year 4, the spread of average scores across the states was not large, being in the order of half a standard deviation, or 50 score points. However the performance of students in New South Wales was significantly higher than that of students in all other states except Victoria. Victoria's average score was also similar to the average for students in the Australian Capital Territory, but higher than that for students in the other states.

**Table 3.1A** 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 row to compare a state's performance with the performance of each state listed in the column heading.

- ▲ Average performance statistically significantly higher than in comparison state.
- No statistically significant difference from comparison state.
- ▼ Average performance statistically significantly lower than in comparison state.

Figure 3.5B and Table 3.1B together show that at Year 8 there is even less variation in the average mathematics achievement scores across the states (35 score points from 483 for the Northern Territory to 518 for the Australian Capital Territory) than was evident at Year 4. In fact, there were no significant differences in the average performance of students in the different states and territories. This is due, in part, to the large standard errors for some states (see the Reader's Guide).

**Table 3.1B** Multiple comparisons of average mathematics achievement by state, Year 8

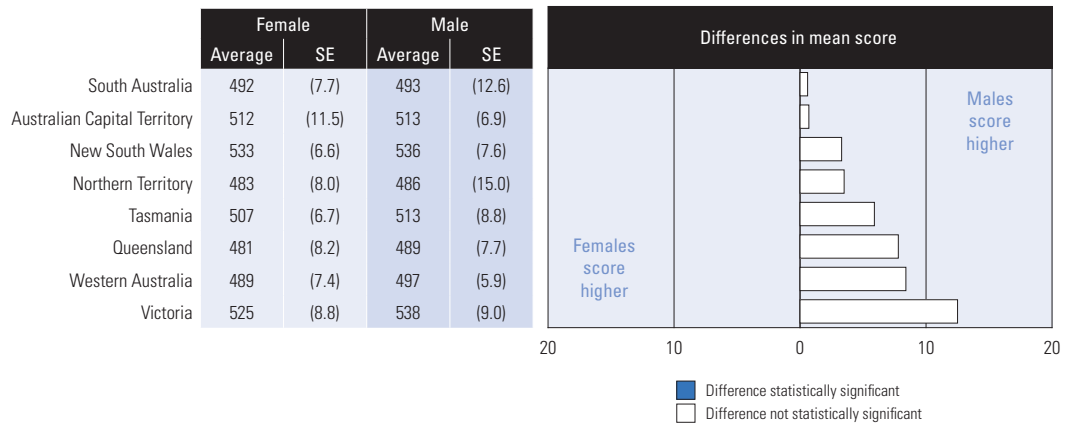
			ACT	VIC	NSW	QLD	SA	TAS	WA	NT
	Mean	SE	518	503	500	491	490	485	485	483
	Mean	SE	(22.4)	(8.5)	(10.0)	(4.9)	(6.7)	(6.8)	(8.3)	(13.9)
Australian Capital Territory	518	(22.4)		●	●	●	●	●	●	●
Victoria	503	(8.5)	●		●	●	●	●	●	●
New South Wales	500	(10.0)	●	●		●	●	●	●	●
Queensland	491	(4.9)	●	●	●		●	●	●	●
South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

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

- ▲ Average performance statistically significantly higher than in comparison state.
- No statistically significant difference from comparison state.
- ▼ Average performance statistically significantly lower than in comparison state.

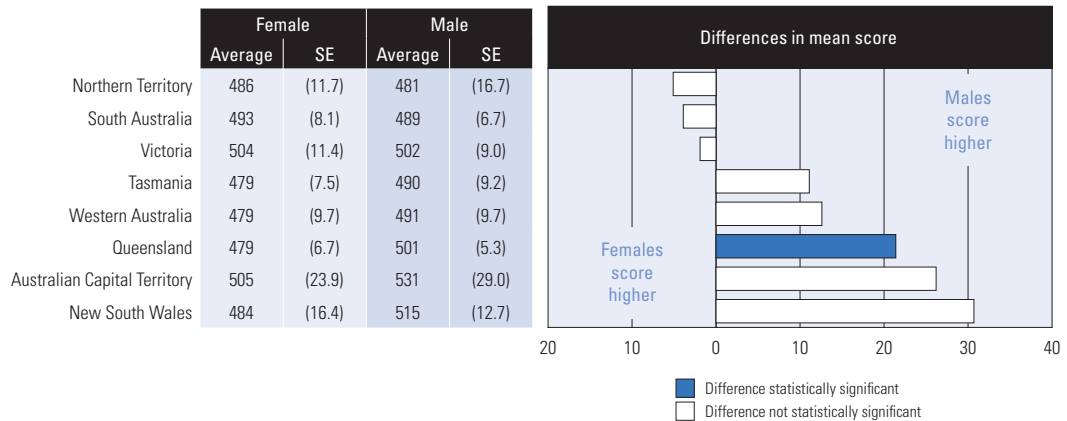
### Gender differences by state

Figure 3.6A shows there were no statistically significant differences by gender in performance in mathematics at the Year 4 level in any of the states.



**Figure 3.6A** Average mathematics achievement by gender within state, Year 4

Figure 3.6B shows the gender differences at Year 8 in each state and territory. Given there is gender difference in favour of males for Australia as a whole, it would be expected that this difference would also be found in a majority of the states. Five states had a gender difference in favour of males. However, due to large standard errors, only the difference in Queensland was found to be significant.



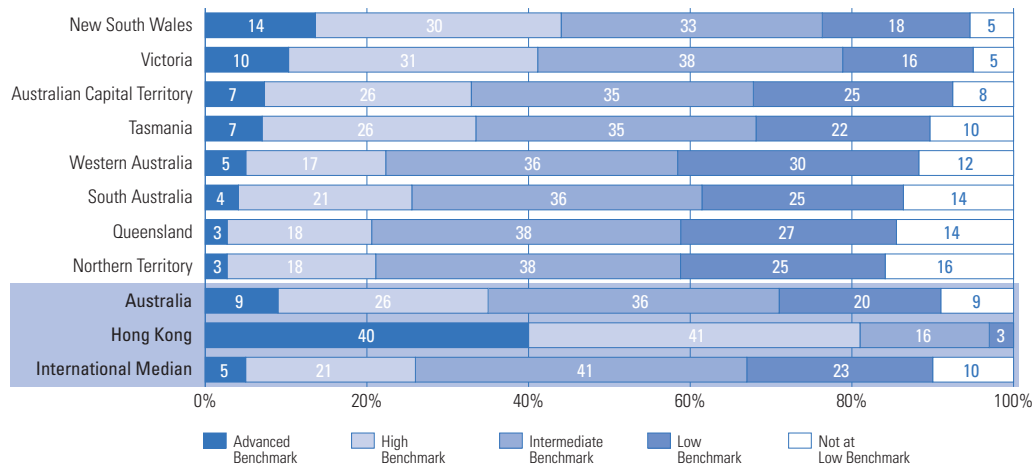
**Figure 3.6B** Average mathematics achievement by gender within state, Year 8

### Performance at the international benchmarks by state

Figures 3.7A and 3.7B show the proportion of students in each state at each of the international benchmarks for Years 4 and 8 respectively, along with the percentages for the international median, Australia as a whole, and the highest scoring country, for comparison.

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 at least the high international benchmark, while in total 95 per cent achieved at least the low benchmark. The next best achieving state was Victoria, in which 10 per cent of Year 4 students reached the advanced international benchmark, while 41 per cent reached at least the high international benchmark and 95 per cent achieved at least the low benchmark. The Australian Capital Territory and Tasmania both had seven per cent of students who achieved the advanced international benchmark, with 92 per cent and 90 per cent of students in Year 4 respectively attaining at least the low benchmark. However, the proportion of Australian students in each state achieving the advanced benchmark is well below the 40 per cent of students in Hong Kong at this level. At the other end of the scale, the proportion of Australian students not achieving at even the low benchmark is much higher than that in Hong Kong, which was less than one per cent.

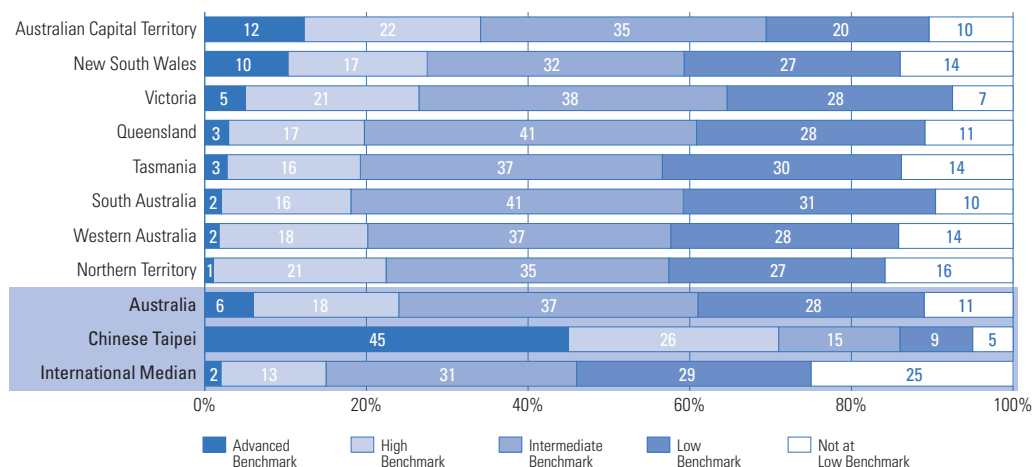
In all other states (Western Australia, South Australia, Queensland and the Northern Territory), the proportion of students achieving at the advanced international benchmark was the same as or lower than the international median. Similarly, the proportion of students achieving at least the low international benchmark was the same as or lower than the international median. Five per cent of Western Australian students attained the advanced benchmark and 88 per cent attained at least the low benchmark, while in South Australia four per cent of students achieved the advanced benchmark and 86 per cent the low benchmark. In Queensland, just three per cent of students achieved the advanced benchmark and 86 per cent attained at least the low benchmark, and in the Northern Territory the performance of Year 4 students is just a little poorer, with three per cent reaching the advanced international benchmark and 84 per cent of students reaching at least the low benchmark in mathematics.



**Figure 3.7A** Percentages of students reaching the international benchmarks for mathematics achievement by state, Year 4

Figure 3.7B presents the achievement at each of the international benchmarks for each state at Year 8. Figure 3.7B shows that 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

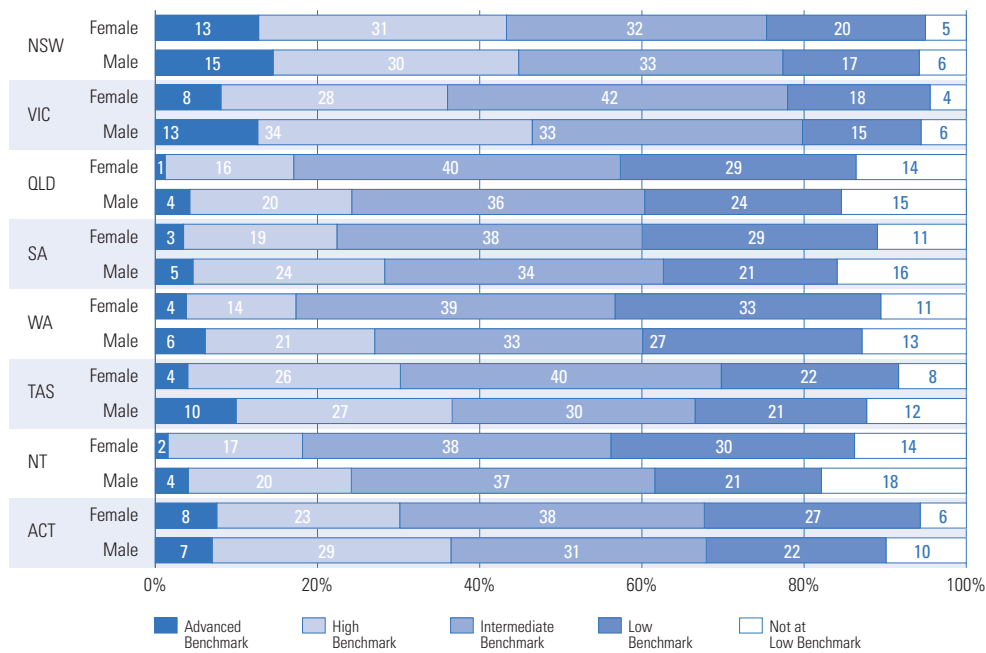
achieving at least the high benchmark (34%), closely followed by New South Wales (27%) and Victoria (26%). The proportion of students achieving at least the low benchmark ranged between 84 and 93 per cent, in the Northern Territory and Victoria, respectively.



**Figure 3.7B** Percentages of students reaching the international benchmarks for mathematics achievement by state, Year 8

### Performance at the international benchmarks by gender within states

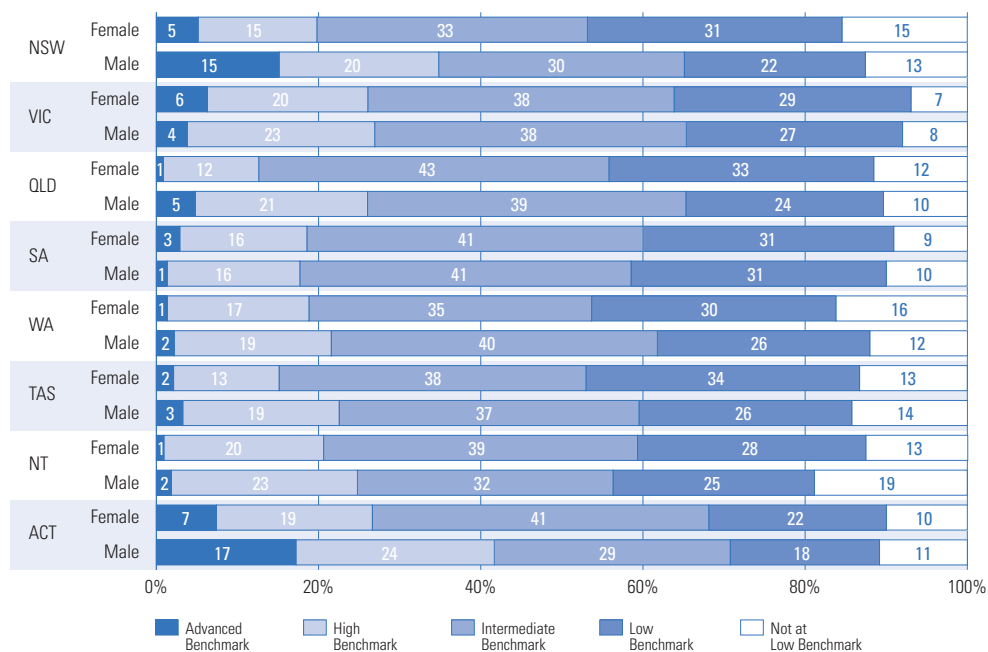
Figure 3.8A shows the proportion of students by gender in Year 4 in each state at each of the international benchmarks in mathematics. A higher proportion of males than females achieved the international advanced benchmark in each of the states except for the Australian Capital Territory. New South Wales had the highest proportion of males reaching the international advanced benchmark, followed by Victoria. In all states, however, the proportion of female students who achieved at least the low benchmark was greater than the proportion of male students who met this minimum standard. The largest gender differences were in the Northern Territory, South Australia, Tasmania and Western Australia. In a number of states the proportion of male students (in particular) not achieving the low benchmark is of some concern, as can be seen in Figure 3.8A. In the Northern Territory, 18 per cent of males; in South Australia, 16 per cent of males; in Queensland, 15 per cent of males; in Western Australia, 13 per cent of males; and in Tasmania, 12 per cent of males failed to reach the low benchmark in mathematics at Year 4.



**Figure 3.8A** Percentages of students reaching the international benchmarks for mathematics achievement by gender within states, Year 4

Figure 3.8B shows the proportion of Year 8 students by gender at each of the international benchmarks in mathematics in each state. Figure 3.8B shows that at this year level there is considerable variation in the direction and size of the differences at each of the international benchmarks across the states. In the Australian Capital Territory and New South Wales there were considerable differences in the percentage of females and males achieving the advanced benchmark, with approximately 10 per cent more males than females achieving this benchmark in both states. In contrast, both South Australia and Victoria had small differences in favour of females. Of some concern, however, is that only one per cent of female students in Queensland, Western Australia and the Northern Territory and one per cent of male students in South Australia managed to attain the advanced level at Year 8.

At the lower performance levels, most of the gender differences were small, in the range of one or two percentage points. In the Northern Territory, however, there was a slightly larger difference in the proportions of students achieving the low benchmark, with 87 per cent of females achieving the low benchmark, compared to 81 per cent of males.



**Figure 3.8B** Percentages of students reaching the international benchmarks for mathematics achievement by gender within states, Year 8

### Performance of Indigenous students

The educational attainment of Australia’s Indigenous students in core subject areas such as mathematics is an important policy issue, and previous TIMSS studies have provided a picture of Indigenous achievement in mathematics and science. Indigenous status in TIMSS is based on students’ self-reports. As shown in Tables 3.2A and 3.2B, about five per cent of the TIMSS sample identified as Indigenous.

The mean scores for overall mathematics achievement for Indigenous and non-Indigenous students in Year 4 are shown in Table 3.2A. At 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. Australian Indigenous students’ average mathematics score was also significantly lower than the international scale average (by 69 score points).

**Table 3.2A** Average mathematics achievement by Indigenous status, Year 4

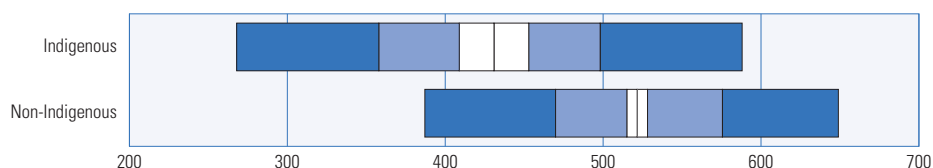
	Percentage of students	Mean	SE
Indigenous	5	431	(11.2)
Non-Indigenous	95	522	(3.3)

The mean scores for overall mathematics achievement for Indigenous and non-Indigenous students in Year 8 are shown in Table 3.2B. As for Year 4, the results clearly show that Indigenous students at the Year 8 level did not perform as well as their non-Indigenous counterparts. At Year 8, Indigenous students achieved an average score of 431, 70 score points less than the average score for non-Indigenous students of 501 score points. Year 8 Australian Indigenous students’ average mathematics score was also significantly lower than the international scale average.

**Table 3.2B** Average mathematics achievement by Indigenous status, Year 8

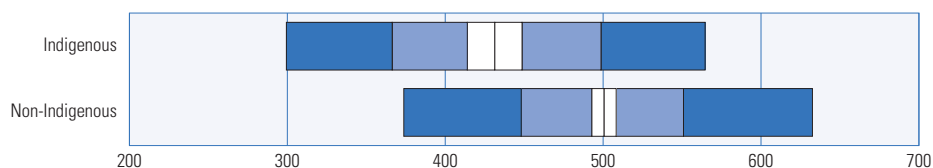
	Percentage of students	Mean	SE
Indigenous	5	431	(8.8)
Non-Indigenous	95	501	(4.0)

Figure 3.9A shows the spread of scores for Indigenous students in mathematics achievement at Year 4 (between the 5<sup>th</sup> and 95<sup>th</sup> percentile) was 320 score points, substantially larger than that of non-Indigenous students (242 score points). That the spread in scores is large for Indigenous students shows that performance of Indigenous students covers a wide range of abilities from very poor to above average.



**Figure 3.9A** Distribution of mathematics achievement scores by Indigenous status, Year 4

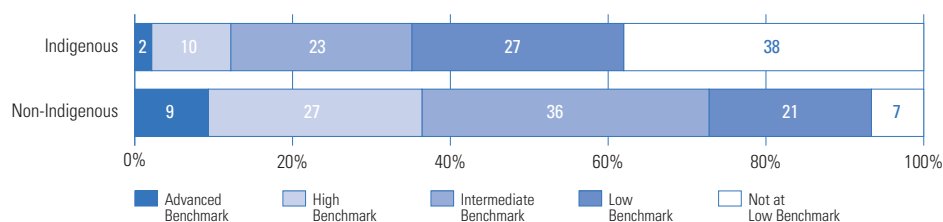
Figure 3.9B shows that the average mathematics achievement of Year 8 Indigenous students is also significantly below that of their non-Indigenous counterparts. However, while lower on the scale, the spread of scores is similar for both groups – around 260 score points between the 5<sup>th</sup> and the 95<sup>th</sup> percentiles.



**Figure 3.9B** Distribution of mathematics achievement scores by Indigenous status, Year 8

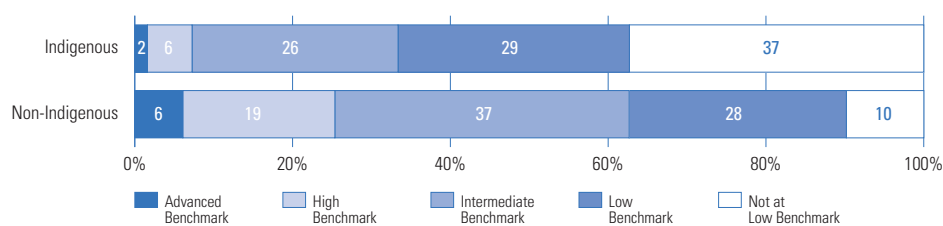
Figure 3.10A adds to the picture of performance by presenting the proportion of Indigenous and non-Indigenous students in Year 4 at each of the international benchmarks for mathematics.

Almost two-thirds of Indigenous students were performing at the lower levels, with 27 per cent reaching the low international benchmark and 38 per cent not able to achieve the low international benchmark. In contrast, seven per cent of non-Indigenous students were performing at a level below the low international benchmark, while 21 per cent achieved at the low benchmark. At the high end of the achievement spectrum, the differences are also sizable. While some Indigenous students did achieve scores above the international mean score of 500, only 12 per cent achieved the high international benchmark, and two per cent achieved the advanced international benchmark compared to 36 per cent and nine per cent, respectively, of non-Indigenous students.



**Figure 3.10A** Percentages of students reaching the international benchmarks for mathematics achievement by Indigenous status, Year 4

Figure 3.10B shows the percentage of Year 8 Indigenous students at each of the international benchmarks. Thirty-seven per cent of Year 8 Indigenous students did not reach the low benchmark, 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. That is, while the international median at the high benchmark was 15 per cent, only eight per cent of Australian Indigenous students reached this benchmark or higher; at the intermediate benchmark, the international median was 46 per cent, compared to 34 per cent for Australian Indigenous students; and for the low benchmark, the international median was 75 per cent, 12 per cent more than for Australian Indigenous students at Year 8.



**Figure 3.10B** Percentages of students reaching the international benchmarks for mathematics achievement by Indigenous status, Year 8

### Performance by geographic location of the school

In the 1900s more than half of Australia's population lived in rural areas (Squires, 2003). This figure dropped to about 20 per cent towards the end of the 20<sup>th</sup> century and continues to decline. As a result, rural schools face problems attracting and retaining qualified teachers, maintaining services and in sending staff to participate in professional development (Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006). It is also estimated that average household income in remote areas is substantially lower than the national average (Squires, 2003).

To undertake the analyses in this section of the report, school addresses were coded using the MCEETYA Schools Geographic Location Classification (see the Reader's Guide). Only the broad categories – Metropolitan, Provincial and Remote – are used in these analyses. The average performance of students attending schools in the three location categories are presented in Tables 3.3A and 3.3B. It should be noted that students in remote schools make up a small proportion of the student sample (only one or two per cent) and therefore the level of uncertainty around the estimate of the mean will be large, resulting in large standard errors (see the Reader's Guide).

The differences shown in Table 3.3A are statistically significant. The differences between the scores of Year 4 students in remote schools and those in other areas are particularly large – 93 score points separate students attending schools in remote areas and those attending metropolitan schools.

Compared to the national results for Australia, the average mathematics score of students in provincial and remote schools was significantly lower (by 20 score points and 83 score points respectively). In comparison, Australian students attending metropolitan schools achieved an average score 10 points higher than the national average. Students in remote schools also achieved an average mathematics score that was significantly lower than the international average by 67 score points.

**Table 3.3A** Average mathematics achievement by geographic location, Year 4

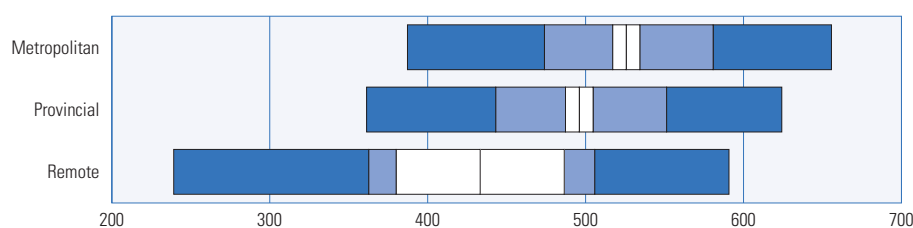
	Percentage of students	Mean	SE
Metropolitan	72	526	(4.4)
Provincial	26	496	(4.5)
Remote	2	433	(27.2)

Table 3.3B presents the average mathematics achievement of Year 8 students according to geographic location. The distribution of achievement differs somewhat to that of the lower year level, with metropolitan students performing at a similar level to provincial students and remote students scoring about 30 score points lower than this. However, due to the large standard error, the average performance of remote students was not statistically different from that of the other students. In turn, due to the large standard error, the achievement of Year 8 students in provincial and remote locations was also not significantly different from the national or international averages.

**Table 3.3B** Average mathematics achievement by geographic location, Year 8

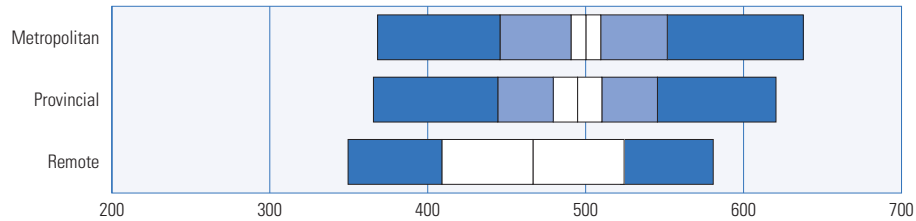
	Percentage of students	Mean	SE
Metropolitan	71	498	(4.8)
Provincial	28	493	(7.9)
Remote	1	464	(29.4)

Figure 3.11A shows the spread of scores in mathematics achievement at Year 4 by geographic location. The spread of scores between the 5<sup>th</sup> and 95<sup>th</sup> percentile for metropolitan schools was 269 score points, and for provincial schools was only slightly lower (263 score points). For remote schools the spread of scores was substantially larger at 352 score points.



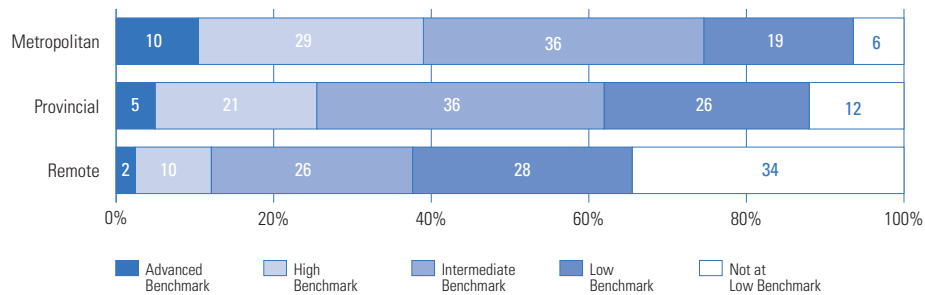
**Figure 3.11A** Distribution of mathematics achievement scores by geographic location, Year 4

Figure 3.11B shows the spread of scores in mathematics achievement for Year 8 students according to geographic location. Due to the large standard error of the estimate of the mean for remote students, the 95% confidence interval extends beyond the 25<sup>th</sup> and 75<sup>th</sup> percentiles. However, it can be seen that, as well as lower achievement, Year 8 students in remote schools had a narrower range of achievement (between the 5<sup>th</sup> and 95<sup>th</sup> percentiles) on the TIMSS 2007 scale than either metropolitan or provincial students.



**Figure 3.11B** Distribution of mathematics achievement scores by geographic location, Year 8

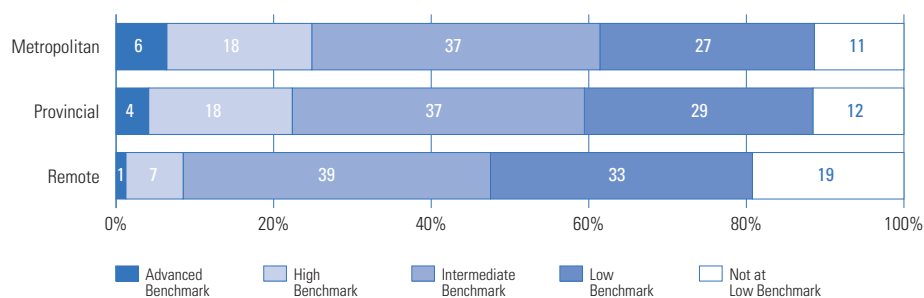
Figure 3.12A shows the proportion of Year 4 students in each of the international benchmarks in mathematics by geographic location. Almost two-thirds of students in remote schools did not attain the intermediate international benchmark, with 28 per cent achieving just the low international benchmark and a further 34 per cent of students from remote schools performing below this level. In contrast, only 12 per cent of students from provincial schools and six per cent of students from metropolitan schools were performing at a level below that of the low international benchmark. The differences in achievement become more pronounced at the high end of the achievement spectrum. While some students from remote schools did achieve scores above the international mean score of 500, only two per cent achieved at the advanced international benchmark compared with five per cent of students from provincial schools and 10 per cent of students from metropolitan schools. As well, the proportions of provincial students who were performing at each of the international benchmarks was quite similar to the international average, but fewer students from remote schools were performing at the higher benchmarks, and a greater proportion of students from metropolitan schools were achieving the higher benchmarks.



**Figure 3.12A** Percentages of students reaching the international benchmarks for mathematics achievement by geographic location, Year 4

Figure 3.12B shows the percentage of Year 8 students at each of the international benchmarks according to geographic location. About six per cent of metropolitan students reached the advanced benchmark, compared to four per cent of provincial students and one per cent of remote students. In contrast, about 19 per cent of Year 8 students in remote schools did not reach the low benchmark, compared to 11 per cent of metropolitan students and 12 per cent of provincial students.

The proportion of metropolitan and provincial students at each of the benchmarks was very similar to that of the proportion for Australia as a whole. The proportions of Year 8 students in remote schools achieving the advanced and high benchmarks were lower than the international median (1% and 9% compared to 2% and 15% respectively), whereas the proportions were higher for the intermediate and low benchmarks (48% and 81% compared to 46% and 75% respectively).



**Figure 3.12B** Percentages of students reaching the international benchmarks for mathematics achievement by geographic location, Year 8

### Performance by language background

How often English is spoken at home is a factor that is associated with achievement, both in past cycles of TIMSS and in similar studies. Students that come from homes where English is not spoken frequently have less exposure to the language of instruction and the test, which could disadvantage them. In most of the TIMSS 2007 countries, students in both Years 4 and 8 who did not speak the language of the test regularly had lower average mathematics achievement than those that spoke the language of the test always or almost always (henceforth referred to as students with an English-speaking background).

Table 3.4A shows the mean scores and associated standard errors in mathematics at Year 4 for English-speaking students and for non-English speaking students. At the Year 4 level students who spoke English at home achieved 30 score points higher on average than students who spoke a language other than English at home, and this difference was statistically significant.

**Table 3.4A** Average mathematics achievement by language background, Year 4

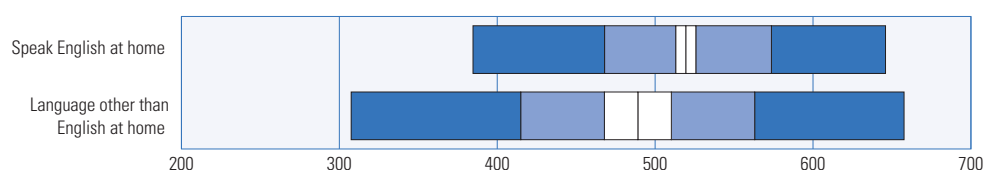
	Percentage of students	Mean	SE
Speak English at home	90	519	(3.3)
Language other than English at home	10	489	(10.8)

Table 3.4B presents mean scores and associated standard errors in mathematics of Year 8 students according to language spoken at home. English-speaking students had slightly higher average mathematics achievement than students who spoke a language other than English at home. However, this difference was not statistically significant.

**Table 3.4B** Average mathematics achievement by language background, Year 8

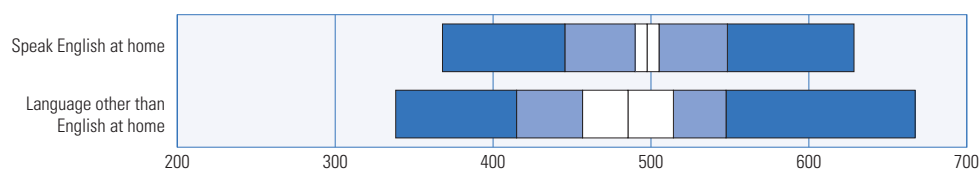
	Percentage of students	Mean	SE
Speak English at home	96	498	(3.9)
Language other than English at home	4	485	(14.7)

Figure 3.13A shows the distribution of Year 4 mathematics mean scores and percentiles by language background. The difference in scores between the 5<sup>th</sup> and 95<sup>th</sup> percentiles was 261 score points for English-speaking students and 351 for those who do not speak English at home.



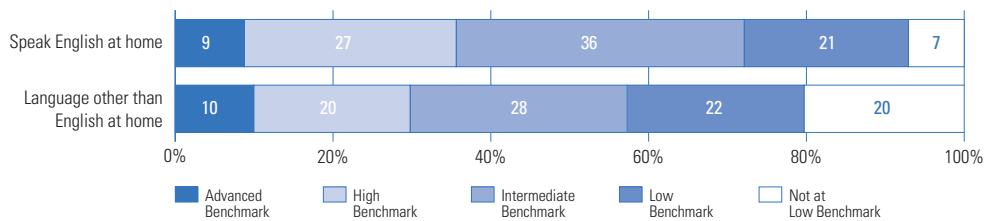
**Figure 3.13A** Distribution of mathematics achievement scores by language background, Year 4

Figure 3.13B shows that the distribution of scores for students who do not speak English at home is much larger than that of English-speaking students. That is, the distribution ranges from 338 for the 5<sup>th</sup> percentile to 667 for the 95<sup>th</sup> percentile (329 score points), compared to 368 to 629 for English-speaking students (261 score points).



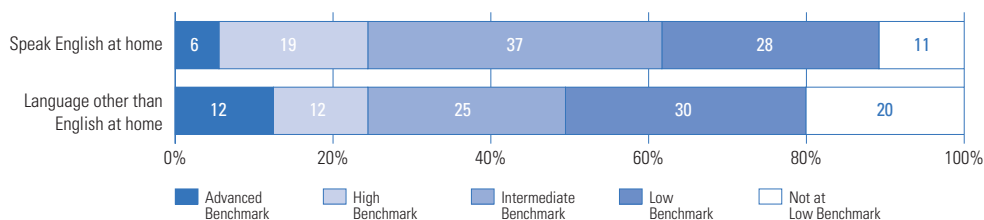
**Figure 3.13B** Distribution of mathematics achievement scores by language background, Year 8

Prior findings about the lower average performance of students from a non-English speaking background can be confirmed by examining the proportion of students at each of the international benchmarks, shown in Figure 3.14A. At the higher levels, 36 per cent of English-speaking Year 4 students compared with 30 per cent of those with a language background other than English were found to be achieving at or above the high international benchmark in Year 4 mathematics. At the other end of the scale, 20 per cent of students with a language background other than English were found to be achieving below the low international benchmark, in contrast with just seven per cent of English-speaking students. Irrespective of language background an equal proportion of students in Year 4 were achieving at the low international benchmark level.



**Figure 3.14A** Percentages of students reaching the international benchmarks for mathematics achievement by language background, Year 4

The spread of scores for Year 8 students speaking a language other than English at home is mirrored in the pattern of achievement at the international benchmarks, as shown in Figure 3.14B. That is, amongst students that speak a language other than English at home there is a relatively large proportion (12%) who reached the advanced benchmark as well as a large proportion who failed to reach the low benchmark (20%). Only six per cent of students who speak English at home achieved the advanced benchmark, although 89 per cent reached the low benchmark.



**Figure 3.14B** Percentages of students reaching the international benchmarks for mathematics achievement by language background, Year 8

### Performance by level of parental education

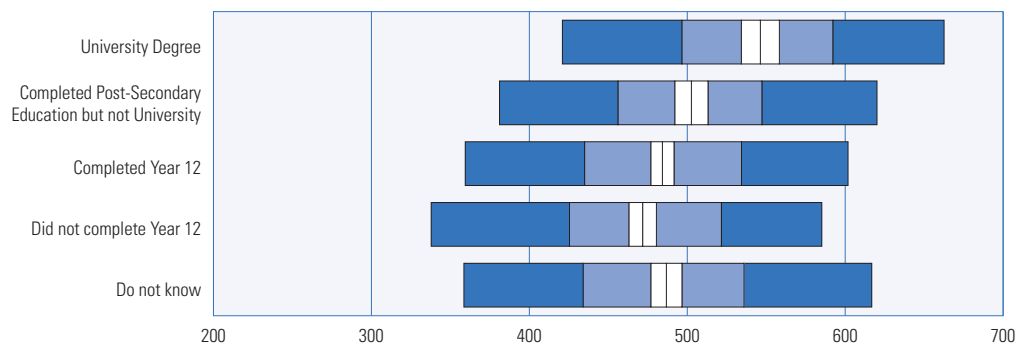
Parental education has often been found to be strongly related to student achievement. Year 8 students who participated in TIMSS 2007 were asked to indicate the highest level of education attained by each of their parents or guardians (refer to the Reader's Guide for more information). Across almost all of the participating countries, higher parental education was associated with higher average mathematics achievement. However, in Australia (and in nine other countries), there was a high level of "Do not know" responses – about 28 per cent of Australian Year 8 students were unable to provide a response to this question.

Table 3.5 shows the mean scores and associated standard errors in mathematics for Year 8 Australian students according to the highest level of education attained by either parent. As can be seen in Table 3.5, the mean score increases as the level of parental education increases, with students who have at least one parent with a university degree having an average mathematics score about 74 points higher than that of students whose parents did not complete secondary school. All differences are statistically significant, except for the comparison of students who had at least one parent complete secondary school with those students that did not know what education level their parents had completed.

**Table 3.5** Average mathematics achievement by parental education, Year 8

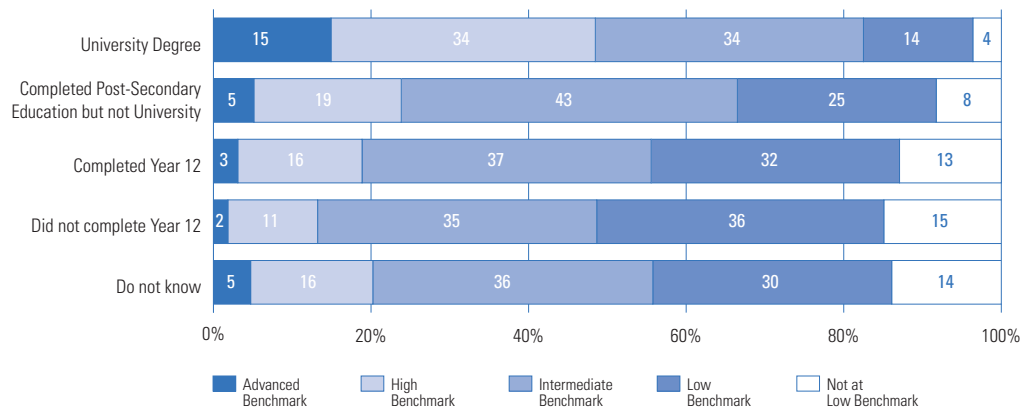
	Percentage of students	Mean	SE
Completed a University Degree	19	546	(6.1)
Completed Post-Sec Education but not University	23	503	(5.4)
Completed Upper Secondary Education	16	484	(3.8)
Did not complete Upper Secondary Education	15	472	(4.5)
Do not Know	28	487	(5.0)

Figure 3.15 shows the spread of scores in mathematics achievement of Year 8 students for the different parental education groups. The spread of scores between the 5<sup>th</sup> and 95<sup>th</sup> percentiles are not greatly different for these groups, ranging between 239 score points for students with at least one parent that had completed post-secondary education (but not university) to 258 score points for students who did not know what education level their parents had completed.



**Figure 3.15** Distribution of mathematics achievement scores by parental education, Year 8

Figure 3.16 shows the percentage of Year 8 students at each of the international benchmarks for the parental education groups. Fifteen per cent of students who had at least one parent complete a university degree reached the advanced benchmark compared to five per cent or less for all other groups. In comparison, 15 per cent of students whose parents did not complete secondary school did not even reach the low benchmark, compared to four per cent of students with parents holding university degrees.



**Figure 3.16** Percentages of students reaching the international benchmarks for mathematics achievement by parental education, Year 8

## Achievement in the TIMSS content and cognitive domains

As outlined in Chapter 2, the TIMSS mathematics assessment can be described in terms of content and cognitive domains. The content domain outlines the subject matter to be assessed: at Year 4, *number, geometric shapes and measures, and data display*; and at Year 8, *number, algebra, geometry, and data and chance*. The cognitive dimension details the thinking processes that students will need to use. At both year levels the cognitive domains are *knowing, applying* and *reasoning*. Each item is associated with a single content domain and a single cognitive domain. This allows student performance to be described in terms of achievement in each of the domains.

To simplify comparisons of student achievement across the domains, the content and cognitive achievement scales at each year level were constructed to have the same average difficulty (see the Reader's Guide). Tables 3.6A and 3.6B present the average achievement in each of the content and cognitive domains for Year 4 and 8 students in each of the participating countries. Countries are displayed in alphabetical order, and to provide a basis for comparison, symbols indicate whether a country's performance is statistically above or below the TIMSS scale average of 500<sup>2</sup>.

Table 3.6A shows Year 4 mathematics content and cognitive domain means for Australia and internationally. At Year 4 level Singapore was the highest achieving country in *number* (611) and *data display* (583), while Hong Kong was the highest achieving country in *geometric shapes and measures* (599). Tunisia was the lowest achieving country in *data display* with an average domain score of 307, while Qatar achieved the lowest in both *geometric shapes and measures* (296) and *number* (292). The performance for both of these countries was significantly lower than the TIMSS scale average for these content domains.

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2 Note that this refers to the mid-point of the TIMSS achievement scale, and not the average of the country means (or the international average).

**Table 3.6A** Average achievement in the mathematics content and cognitive domains by country, Year 4

Country	Average Scale Scores for Mathematics Content Domains						Average Scale Scores for Mathematics Cognitive Domains					
	Data Display		Geometric Shapes and Measures		Number		Knowing		Applying		Reasoning	
Algeria	361	(5.2) ▼	383	(4.5) ▼	391	(5.0) ▼	384	(5.4) ▼	376	(5.2) ▼	387	(4.7) ▼
Armenia	458	(4.3) ▼	483	(4.7) ▼	522	(4.0) ▲	518	(4.8) ▲	493	(4.1)	489	(4.7) ▼
<b>Australia</b>	<b>534</b>	<b>(3.1) ▲</b>	<b>536</b>	<b>(3.1) ▲</b>	<b>496</b>	<b>(3.7)</b>	<b>509</b>	<b>(4.2) ▲</b>	<b>523</b>	<b>(3.5) ▲</b>	<b>516</b>	<b>(3.4) ▲</b>
Austria	508	(2.6) ▲	509	(2.4) ▲	502	(2.2)	505	(2.0) ▲	507	(1.8) ▲	506	(2.1) ▲
Chinese Taipei	567	(2.0) ▲	556	(2.2) ▲	581	(1.9) ▲	584	(1.7) ▲	569	(1.7) ▲	566	(1.9) ▲
Colombia	363	(5.9) ▼	361	(4.8) ▼	360	(4.3) ▼	360	(5.2) ▼	357	(5.1) ▼	372	(4.9) ▼
Czech Republic	493	(3.3) ▼	494	(2.8) ▼	482	(2.8) ▼	473	(2.4) ▼	496	(2.7)	493	(3.4) ▼
† Denmark	529	(3.4) ▲	544	(2.6) ▲	509	(2.9) ▲	513	(2.7) ▲	528	(2.5) ▲	524	(2.1) ▲
El Salvador	367	(3.5) ▼	333	(4.3) ▼	317	(3.9) ▼	312	(4.1) ▼	339	(3.7) ▼	356	(4.0) ▼
England	547	(2.5) ▲	548	(2.7) ▲	531	(3.2) ▲	544	(3.6) ▲	540	(3.1) ▲	537	(3.1) ▲
1 Georgia	414	(4.6) ▼	415	(4.8) ▼	464	(3.8) ▼	450	(4.0) ▼	433	(4.5) ▼	437	(4.2) ▼
Germany	534	(3.1) ▲	528	(2.0) ▲	521	(2.2) ▲	514	(2.0) ▲	531	(2.2) ▲	528	(2.5) ▲
Hong Kong SAR	585	(2.7) ▲	599	(3.1) ▲	606	(3.8) ▲	617	(3.5) ▲	599	(3.4) ▲	589	(3.5) ▲
Hungary	504	(3.5)	510	(3.3) ▲	510	(3.7) ▲	511	(3.4) ▲	507	(3.5) ▲	509	(3.8) ▲
Iran, Islamic Rep. of	400	(4.0) ▼	429	(3.3) ▼	398	(3.6) ▼	410	(3.6) ▼	405	(3.7) ▼	410	(3.8) ▼
Italy	506	(3.4)	509	(3.0) ▲	505	(3.2)	514	(3.2) ▲	501	(2.9)	509	(3.1) ▲
Japan	578	(2.8) ▲	566	(2.2) ▲	561	(2.2) ▲	565	(2.1) ▲	566	(2.0) ▲	563	(2.1) ▲
1 Kazakhstan	522	(5.8) ▲	542	(7.4) ▲	556	(6.6) ▲	559	(7.3) ▲	547	(7.2) ▲	539	(6.1) ▲
¿ Kuwait	318	(4.7) ▼	316	(3.6) ▼	321	(3.5) ▼	326	(4.6) ▼	305	(4.1) ▼	+	+
1 Latvia	536	(3.0) ▲	532	(2.6) ▲	536	(2.1) ▲	530	(2.2) ▲	540	(2.5) ▲	537	(2.5) ▲
1 Lithuania	530	(2.9) ▲	518	(2.4) ▲	533	(2.3) ▲	520	(2.8) ▲	539	(2.4) ▲	526	(2.5) ▲
Morocco	316	(6.1) ▼	365	(4.3) ▼	353	(4.7) ▼	354	(4.8) ▼	346	(4.7) ▼	+	+
‡ Netherlands	543	(2.3) ▲	522	(2.3) ▲	535	(2.2) ▲	525	(2.2) ▲	540	(2.0) ▲	534	(2.4) ▲
New Zealand	513	(2.6) ▲	502	(2.3)	478	(2.7) ▼	482	(2.5) ▼	495	(2.3) ▼	503	(2.8)
Norway	487	(2.6) ▼	490	(3.0) ▼	461	(2.8) ▼	461	(2.9) ▼	479	(2.8) ▼	489	(2.7) ▼
Qatar	326	(1.6) ▼	296	(1.4) ▼	292	(1.2) ▼	293	(1.3) ▼	296	(1.2) ▼	+	+
Russian Federation	530	(4.9) ▲	538	(5.1) ▲	546	(4.4) ▲	538	(4.5) ▲	547	(4.8) ▲	540	(4.8) ▲
† Scotland	516	(2.2) ▲	503	(2.6)	481	(2.6) ▼	489	(2.6) ▼	500	(2.4)	497	(2.2)
Singapore	583	(3.2) ▲	570	(3.6) ▲	611	(4.3) ▲	620	(4.0) ▲	590	(3.7) ▲	578	(3.8) ▲
Slovak Republic	492	(4.2)	499	(4.3)	495	(3.9)	492	(3.9) ▲	498	(4.0)	499	(4.0)
Slovenia	518	(2.5) ▲	522	(1.8) ▲	485	(1.9) ▼	497	(1.8)	504	(1.9) ▲	505	(2.1) ▲
Sweden	529	(2.7) ▲	508	(2.3) ▲	490	(2.5) ▼	482	(2.5) ▼	508	(2.2) ▲	519	(2.5) ▲
Tunisia	307	(4.8) ▼	334	(4.5) ▼	352	(4.5) ▼	343	(4.9) ▼	329	(4.8) ▼	+	+
Ukraine	462	(3.2) ▼	457	(2.8) ▼	480	(2.9) ▼	472	(3.0) ▼	466	(3.1) ▼	474	(3.2) ▼
2† United States	543	(2.4) ▲	522	(2.5) ▲	524	(2.7) ▲	541	(2.6) ▲	524	(2.6) ▲	523	(2.2) ▲
Yemen	+	+	+	+	+	+	+	+	+	+	+	+
<b>TIMSS Scale Avg.</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>

▲ Country average significantly higher than TIMSS scale average

▼ Country average significantly lower than TIMSS scale average

† 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.

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.

A plus (+) sign indicates average achievement could not be accurately estimated.

Australian Year 4 students' achievement in *geometric shapes and measures* and *data display* was significantly higher than the TIMSS scale average. At Year 4, the weakest area for Australian students was *number*.

Table 3.6A also illustrates the broad range of achievement across the countries in the cognitive domains. At Year 4 level, Hong Kong achieved the highest average scale score for mathematics in the *applying* and *reasoning* cognitive domains and Singapore achieved the highest scale score in the *knowing* cognitive domain. Of all the countries participating in TIMSS 2007, 14 achieved their highest average scale score in the *knowing* cognitive domain, while 12 (including Australia) achieved their highest average scale score in the *applying* cognitive domain, and 10 countries achieved their highest average scale score in the *reasoning* cognitive domain. Of the countries achieving their highest scale score in the reasoning cognitive domain, only two countries achieved significantly higher than the TIMSS scale average score. In the *knowing* and *applying* cognitive domains nine countries achieved significantly higher than the TIMSS scale average.

At the lower end of the scale Qatar was the lowest achieving country in the cognitive domains of *knowing* and *applying*, with scores of 293 and 296 respectively, while El Salvador was the lowest achieving country in *reasoning* (356). The cognitive domain scores for both of these countries were significantly lower than the TIMSS scale average.

In terms of the cognitive domains, Australian Year 4 students performed at a level that was statistically significantly higher than the TIMSS scale average in all three cognitive domains.

Table 3.6B shows that, for Year 8 (as at Year 4), the countries scoring highest on the overall mathematics assessment tended also to be the highest-scoring countries in each of the content and cognitive domains, and the lowest-scoring countries overall tended to be those with the lowest scores in the content and cognitive domains.

In the *number* content area, Singapore had the highest average achievement. In *algebra*, Chinese Taipei had the highest achievement, and Chinese Taipei and Korea shared the highest average achievement in *geometry*. In *data and chance*, the highest performing countries were Korea and Singapore. Australian students' performance varied over the different content domains, with the average score in both *algebra* and *geometry* significantly lower than the TIMSS scale averages while the performance in *data and chance* was, as in previous cycles, significantly higher than the TIMSS scale average. There was no statistical difference between the Australian Year 8 students' performance in *number* and the TIMSS scale average for this content domain.

Chinese Taipei was a top-performer across the cognitive domains. Achievement in the *knowing* domain was led by Korea and Chinese Taipei. In the *applying* domain, the three highest achieving countries were Korea, Singapore, and Chinese Taipei.

In terms of the cognitive domains, Australian Year 8 students performed at a similar level to the TIMSS scale average in *applying* and *reasoning*, and lower than the TIMSS scale average in *knowing*.

**Table 3.6B** Average achievement in the mathematics content and cognitive domains by country, Year 8

Country	Average Scale Scores for Mathematics Content Domains				Average Scale Scores for Mathematics Cognitive Domains					
	Algebra	Data and Chance	Number	Geometry	Knowing	Applying	Reasoning			
Algeria	349 (2.4) ▼	371 (1.7) ▼	403 (1.7) ▼	432 (2.1) ▼	371 (1.9) ▼	412 (2.0) ▼	+	+		
Armenia	532 (2.5) ▲	427 (3.9) ▲	492 (3.1) ▼	493 (4.1)	507 (3.1) ▲	493 (3.8)		489 (3.8) ▼		
<b>Australia</b>	<b>471 (3.7) ▼</b>	<b>525 (3.2) ▲</b>	<b>503 (3.7)</b>	<b>487 (3.6) ▼</b>	<b>487 (3.3) ▼</b>	<b>500 (3.4)</b>		<b>502 (3.3)</b>		
Bahrain	403 (1.8) ▼	418 (2.1) ▼	388 (2.0) ▼	412 (2.1) ▼	395 (1.7) ▼	403 (1.9) ▼		413 (2.1) ▼		
Bosnia and Herzegovina	475 (3.2) ▼	437 (2.3) ▼	451 (3.0) ▼	451 (3.5) ▼	478 (2.9) ▼	440 (2.6) ▼		452 (2.9) ▼		
Botswana	394 (2.2) ▼	384 (2.6) ▼	366 (2.9) ▼	325 (3.2) ▼	376 (2.1) ▼	351 (2.6) ▼	+	+		
Bulgaria	476 (5.1) ▼	440 (4.7) ▼	458 (4.7) ▼	468 (5.0) ▼	477 (4.7) ▼	458 (4.8) ▼		455 (4.7) ▼		
Chinese Taipei	617 (5.4) ▲	566 (3.6) ▲	577 (4.2) ▲	592 (4.6) ▲	594 (4.5) ▲	592 (4.2) ▲		591 (4.1) ▲		
Colombia	390 (3.1) ▼	405 (3.8) ▼	369 (3.5) ▼	371 (3.3) ▼	364 (3.4) ▼	384 (3.7) ▼		416 (3.3) ▼		
Cyprus	468 (2.0) ▼	464 (1.6) ▼	464 (1.6) ▼	458 (2.7) ▼	468 (1.6) ▼	465 (1.8) ▼		461 (2.1) ▼		
Czech Republic	484 (2.4) ▼	512 (2.8) ▲	511 (2.5) ▲	498 (2.7)	502 (2.5)	504 (2.7)		500 (2.6)		
Egypt	409 (3.3) ▼	384 (3.1) ▼	393 (3.1) ▼	406 (3.4) ▼	392 (3.6) ▼	393 (3.6) ▼		396 (3.4) ▼		
El Salvador	331 (3.7) ▼	362 (3.0) ▼	355 (3.0) ▼	318 (3.7) ▼	336 (3.1) ▼	347 (3.3) ▼	+	+		
† England	492 (4.6)	547 (5.0) ▲	510 (5.0)	510 (4.4) ▲	503 (4.0)	514 (4.9) ▲		518 (4.3) ▲		
1 Georgia	421 (6.6) ▼	373 (4.3) ▼	421 (5.6) ▼	409 (6.7) ▼	427 (5.8) ▼	401 (5.5) ▼		389 (5.8) ▼		
Ghana	358 (3.6) ▼	321 (3.6) ▼	310 (3.9) ▼	275 (4.9) ▼	313 (4.6) ▼	297 (4.2) ▼	+	+		
† Hong Kong SAR	565 (5.6) ▲	549 (4.7) ▲	567 (5.6) ▲	570 (5.5) ▲	574 (5.4) ▲	569 (5.9) ▲		557 (5.6) ▲		
Hungary	503 (3.6)	524 (3.3) ▲	517 (3.6) ▲	508 (3.6) ▲	518 (3.3) ▲	513 (3.1) ▲		513 (3.2) ▲		
Indonesia	405 (3.5) ▼	402 (3.6) ▼	399 (3.7) ▼	395 (4.5) ▼	397 (4.0) ▼	398 (3.7) ▼		405 (3.3) ▼		
Iran, Islamic Rep. of	408 (3.9) ▼	415 (3.5) ▼	395 (3.9) ▼	423 (4.4) ▼	403 (4.1) ▼	402 (4.2) ▼		427 (3.5) ▼		
3 Israel	470 (3.9) ▼	465 (4.4) ▼	469 (3.2) ▼	436 (4.3) ▼	473 (3.7) ▼	456 (4.1) ▼		462 (4.1) ▼		
Italy	460 (3.2) ▼	491 (3.1) ▼	478 (2.8) ▼	490 (3.1) ▼	476 (3.0) ▼	483 (2.9) ▼		483 (2.8) ▼		
Japan	559 (2.5) ▲	573 (2.2) ▲	551 (2.3) ▲	573 (2.2) ▲	560 (2.2) ▲	565 (2.2) ▲		568 (2.4) ▲		
Jordan	448 (4.1) ▼	425 (3.8) ▼	416 (4.3) ▼	436 (3.9) ▼	432 (4.2) ▼	422 (4.1) ▼		440 (3.6) ▼		
Korea, Rep. of	596 (3.0) ▲	580 (2.0) ▲	583 (2.4) ▲	587 (2.3) ▲	596 (2.5) ▲	595 (2.8) ▲		579 (2.3) ▲		
ι Kuwait	354 (3.0) ▼	366 (3.5) ▼	347 (3.1) ▼	385 (2.8) ▼	347 (3.1) ▼	361 (2.7) ▼	+	+		
Lebanon	465 (3.2) ▼	407 (4.4) ▼	454 (3.4) ▼	462 (4.0) ▼	464 (3.9) ▼	448 (4.6) ▼		429 (4.0) ▼		
1 Lithuania	483 (2.7) ▼	523 (2.3) ▲	506 (2.7) ▲	507 (2.6) ▲	508 (2.5) ▲	511 (2.4) ▲		486 (2.5) ▼		
Malaysia	454 (4.3) ▼	469 (4.1) ▼	491 (5.1)	477 (5.6) ▼	477 (4.8) ▼	478 (4.9) ▼		468 (3.8) ▼		
Malta	473 (1.4) ▼	487 (1.4) ▼	496 (1.3) ▼	495 (1.1) ▼	490 (1.6) ▼	492 (1.0) ▼		475 (1.3) ▼		
¶ Morocco	362 (4.0) ▼	371 (3.4) ▼	389 (3.4) ▼	396 (3.6) ▼	365 (4.4) ▼	389 (3.3) ▼		383 (3.5) ▼		
Norway	425 (2.8) ▼	505 (2.5) ▼	488 (2.0) ▼	459 (2.3) ▼	458 (1.8) ▼	477 (2.2) ▼		475 (2.3) ▼		
Oman	391 (3.2) ▼	389 (3.0) ▼	363 (2.7) ▼	387 (3.0) ▼	372 (3.5) ▼	368 (3.0) ▼		397 (3.3) ▼		
Palestinian Nat'l Auth.	382 (3.4) ▼	371 (2.9) ▼	366 (3.2) ▼	388 (3.8) ▼	365 (3.8) ▼	371 (3.4) ▼		381 (3.5) ▼		
Qatar	312 (1.5) ▼	305 (1.6) ▼	334 (1.6) ▼	301 (1.8) ▼	307 (1.4) ▼	305 (1.4) ▼	+	+		
Romania	478 (4.6) ▼	429 (3.7) ▼	457 (3.5) ▼	466 (4.0) ▼	470 (4.2) ▼	462 (4.0) ▼		449 (4.6) ▼		
Russian Federation	518 (4.5) ▲	487 (3.8) ▼	507 (3.8)	510 (4.1) ▲	521 (3.9) ▲	510 (3.7) ▲		497 (3.6)		
Saudi Arabia	344 (2.8) ▼	348 (2.2) ▼	309 (3.3) ▼	359 (2.6) ▼	308 (2.6) ▼	335 (2.3) ▼	+	+		
† Scotland	467 (3.7) ▼	517 (3.5) ▲	489 (3.7) ▼	485 (3.9) ▼	481 (3.3) ▼	489 (3.7) ▼		495 (3.3)		
12 Serbia	500 (3.2)	458 (3.0) ▼	478 (2.9) ▼	486 (3.6) ▼	500 (3.2)	478 (3.3) ▼		474 (3.3) ▼		
Singapore	579 (3.7) ▲	574 (3.9) ▲	597 (3.5) ▲	578 (3.4) ▲	581 (3.4) ▲	593 (3.6) ▲		579 (4.1) ▲		
Slovenia	488 (2.4) ▼	511 (2.3) ▲	502 (2.3)	499 (2.4)	500 (2.2)	503 (2.0)		496 (2.5)		
Sweden	456 (2.4) ▼	526 (3.0) ▲	507 (1.8) ▲	472 (2.5) ▼	478 (2.0) ▼	497 (2.0)		490 (2.6) ▼		
Syrian Arab Republic	406 (3.7) ▼	387 (2.7) ▼	393 (3.4) ▼	417 (3.4) ▼	393 (4.2) ▼	401 (3.4) ▼		396 (3.4) ▼		
Thailand	433 (5.0) ▼	453 (4.1) ▼	444 (4.8) ▼	442 (5.3) ▼	436 (4.8) ▼	446 (4.7) ▼		456 (4.4) ▼		
Tunisia	423 (2.6) ▼	411 (2.3) ▼	425 (2.6) ▼	437 (2.6) ▼	421 (2.6) ▼	423 (2.4) ▼		425 (2.3) ▼		
Turkey	440 (5.1) ▼	445 (4.4) ▼	429 (4.0) ▼	411 (5.1) ▼	439 (4.8) ▼	425 (4.5) ▼		441 (4.2) ▼		
Ukraine	464 (3.9) ▼	458 (3.5) ▼	460 (3.7) ▼	467 (3.6) ▼	471 (3.5) ▼	464 (3.5) ▼		445 (3.8) ▼		
2† United States	501 (2.7)	531 (2.8) ▲	510 (2.7) ▲	480 (2.5) ▼	514 (2.6) ▲	503 (2.9)		505 (2.4) ▲		
<b>TIMSS Scale Avg.</b>	<b>500 (0.0)</b>	<b>500 (0.0)</b>	<b>500 (0.0)</b>	<b>500 (0.0)</b>	<b>500 (0.0)</b>	<b>500 (0.0)</b>		<b>500 (0.0)</b>		

- ▲ Country average significantly higher than TIMSS scale average
- ▼ Country average significantly lower than TIMSS scale average

† Met 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%).

ι 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.

A plus (+) sign indicates average achievement could not be accurately estimated.

## Achievement in the content and cognitive domains by state

Tables 3.7A and 3.7B present the means by state for the content and cognitive domains.

Table 3.7A shows the average achievement for each of the states in each of the Year 4 mathematics content and cognitive domains. Students in New South Wales scored significantly higher than students in all states other than Victoria and the Australian Capital Territory in *data display* and *number*, while students in New South Wales and Victoria scored significantly higher than students in all states other than the Australian Capital Territory in *geometric shapes and measures*. Overall, the order of the states in their performance in each of the content and cognitive domains was almost the same, with only very minor shifts depending on the domain.

**Table 3.7A** Average achievement in the mathematics content and cognitive domains by state, Year 4

	Average Scale Scores for Mathematics Content Domains						Average Scale Scores for Mathematics Cognitive Domains					
	Data Display		Geometric Shapes and Measures		Number		Knowing		Applying		Reasoning	
NSW	551	(5.4)	551	(5.9)	516	(6.8)	531	(7.2)	540	(6.3)	531	(5.9)
VIC	544	(7.1)	551	(6.9)	514	(8.3)	526	(9.2)	537	(8.0)	529	(8.0)
QLD	507	(4.4)	507	(5.3)	462	(6.7)	471	(7.6)	494	(6.5)	489	(5.8)
SA	517	(8.2)	518	(8.3)	468	(9.6)	485	(9.5)	502	(7.9)	499	(7.3)
WA	514	(5.6)	516	(5.3)	473	(7.1)	484	(6.4)	502	(6.4)	500	(5.8)
TAS	526	(6.6)	531	(5.2)	489	(6.5)	500	(6.5)	515	(5.3)	513	(4.5)
NT	510	(11.2)	508	(9.4)	460	(12.3)	473	(9.9)	491	(8.4)	490	(8.3)
ACT	532	(10.4)	532	(9.1)	494	(8.9)	505	(11.4)	519	(8.9)	515	(8.8)

Table 3.7B shows the average achievement for each of the states in each of the Year 8 mathematics content and cognitive domains. For each domain, the Australian Capital Territory had the highest mean score and the Northern Territory the lowest, with the order of the states in-between shifting slightly depending on the domain. However, as for the overall mathematics achievement score, none of the differences between the states were statistically significant.

**Table 3.7B** Average achievement in the mathematics content and cognitive domains by state, Year 8

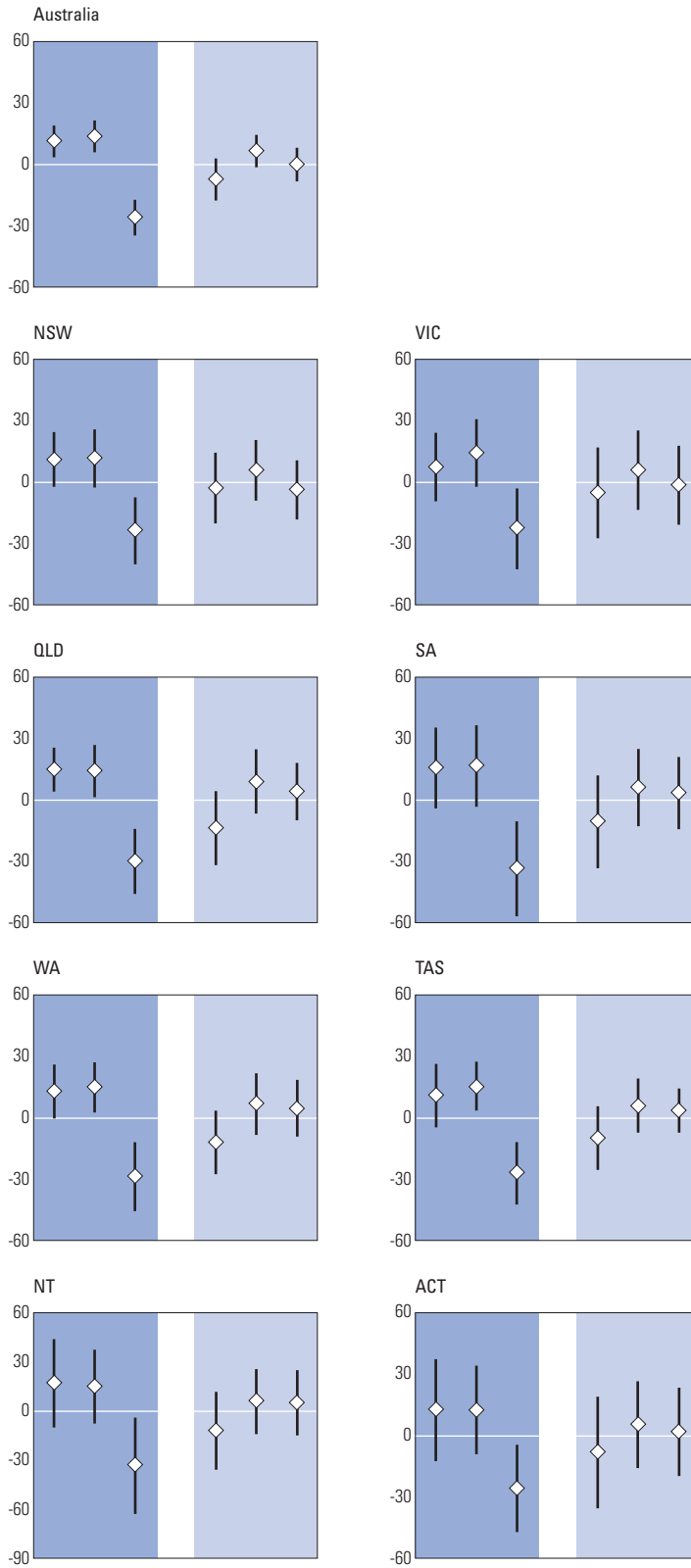
	Average Scale Scores for Mathematics Content Domains								Average Scale Scores for Mathematics Cognitive Domains					
	Algebra		Data and Chance		Number		Geometry		Knowing		Applying		Reasoning	
NSW	474	(9.7)	527	(8.4)	504	(9.4)	490	(9.2)	492	(8.7)	502	(9.0)	504	(8.3)
VIC	480	(8.8)	530	(8.3)	511	(8.5)	493	(7.2)	494	(7.3)	508	(7.3)	506	(7.6)
QLD	465	(4.8)	523	(4.6)	499	(4.9)	483	(5.0)	483	(4.2)	495	(5.0)	498	(4.3)
SA	462	(7.0)	522	(6.7)	500	(5.9)	481	(6.6)	481	(5.5)	495	(5.1)	495	(6.0)
WA	459	(7.5)	518	(8.1)	493	(8.3)	479	(7.7)	475	(7.5)	488	(8.1)	495	(7.3)
TAS	459	(6.1)	520	(6.4)	494	(6.5)	480	(6.4)	476	(6.1)	491	(6.3)	497	(6.3)
NT	457	(13.8)	514	(14.1)	491	(14.8)	476	(10.3)	473	(13.7)	485	(13.3)	490	(10.8)
ACT	491	(21.3)	542	(21.1)	526	(22.1)	509	(21.4)	506	(18.9)	521	(20.2)	521	(20.2)

Figures 3.17A and 3.17B highlight relative strengths and weaknesses in the mathematics content and cognitive domains for each of the states, and for Australia as a whole, by profiling average achievement in these domains relative to the overall mathematics achievement for that state. Relative performance is calculated as the difference between average performance in each mathematics content (or cognitive) domain and the average across the content (or cognitive domains). This relative performance is presented in Figures 3.17A and 3.17B as the difference from zero (the average across content or cognitive domains) and is represented by a small circle, with a bar extending above and below the circle to denote the 95% confidence interval.

Figure 3.17A shows the average and confidence intervals for each of the Year 4 mathematics content areas (*data display, geometric shapes and measures* and *number*) and cognitive domains (*knowing, applying* and *reasoning*) for each of the Australian states. For Australia as a whole, Year 4 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.

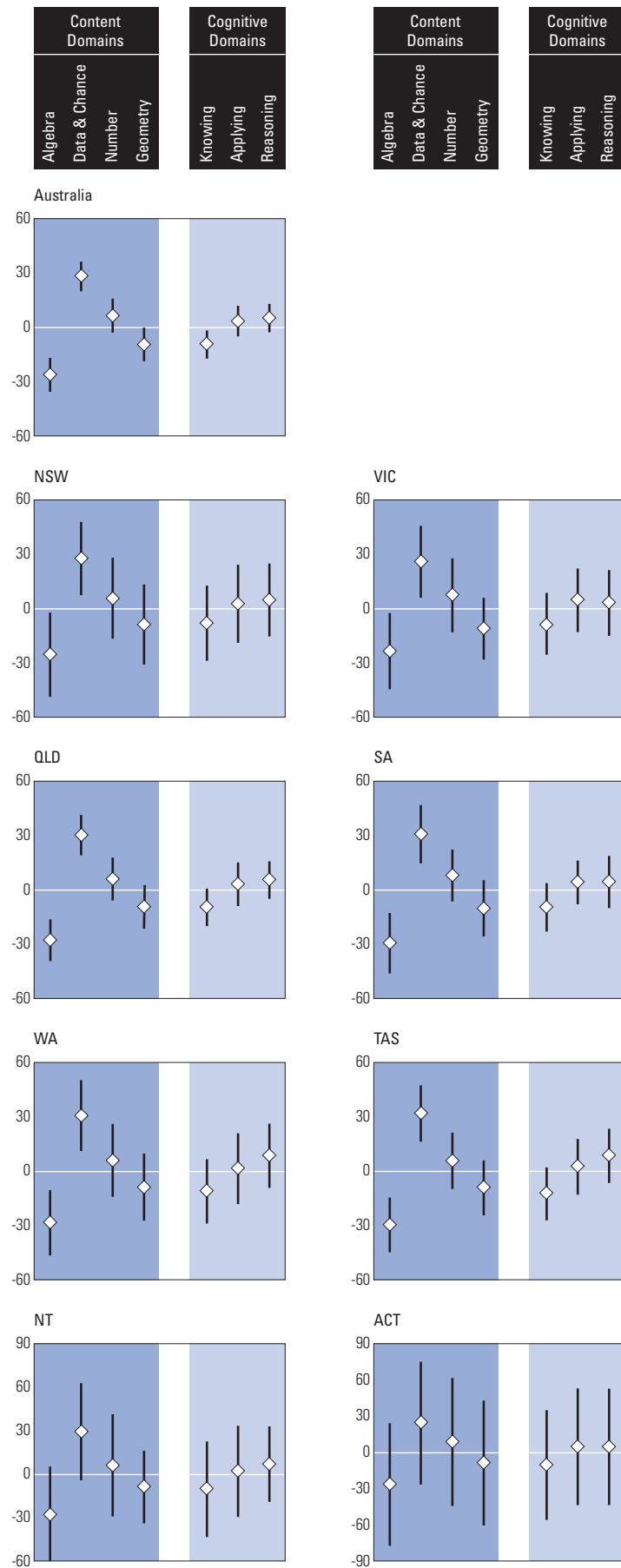
Content Domains	Cognitive Domains	Content Domains	Cognitive Domains
Data Display Geometric Shapes & Measures Number	Knowing Applying Reasoning	Data Display Geometric Shapes & Measures Number	Knowing Applying Reasoning



**Figure 3.17A** Profiles of relative performance in the mathematics content and cognitive domains within Australia and the states, Year 4

When viewed together, Figure 3.17A and 3.17B indicate that the same pattern of strengths and weaknesses in the mathematics content and cognitive domains at both Year 4 and Year 8 can be found in each of the states, and for Australia as a whole. For example, Year 8 students in each of the states performed less well in *algebra* while they performed relatively better in *data and chance*, and this performance pattern was also evident for Australia as a whole.

In terms of the cognitive domains, Year 8 students in Australia and across the states performed relatively equally across all domains. While *knowing* appears to be the relatively weaker domain, this difference was not significant.



**Figure 3.17B** Profiles of relative performance in the mathematics content and cognitive domains within Australia and the states, Year 8

## Achievement in the content and cognitive domains by gender

Males and females have different strengths and weaknesses across the content and cognitive domains. Tables 3.8A and 3.8B provide the average performance in each of the content and cognitive domains for males and females, across the states.

At the Year 4 level, nationally, males scored significantly higher than females in *number*, while females significantly outperformed males in *data display*. However, there were no statistically significant gender differences within states in the mathematics content domains.

In terms of cognitive domains, nationally, males performed at a significantly higher level than females in the *applying* cognitive domain; however, within states there were no significant differences.

**Table 3.8A** Average achievement in the mathematics content and cognitive domains by gender within states, Year 4

	Average Scale Scores for Mathematics Content Domains											
	Data Display				Geometric Shapes and Measures				Number			
	Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	554	(6.1)	547	(6.3)	551	(6.5)	552	(6.7)	512	(7.4)	521	(7.9)
VIC	545	(7.8)	543	(8.3)	548	(8.1)	554	(8.1)	506	(8.2)	523	(10.5)
QLD	509	(5.9)	505	(5.0)	507	(6.1)	506	(7.0)	454	(8.5)	471	(8.2)
SA	522	(7.5)	512	(10.7)	522	(8.4)	514	(9.6)	465	(8.9)	470	(13.7)
WA	517	(6.1)	512	(6.3)	515	(5.4)	517	(7.2)	462	(8.3)	483	(7.2)
TAS	528	(8.3)	525	(7.6)	532	(6.2)	529	(6.8)	482	(8.5)	495	(8.3)
NT	512	(11.6)	508	(14.1)	507	(8.0)	509	(12.2)	454	(10.7)	466	(17.6)
ACT	535	(12.7)	529	(10.0)	533	(12.2)	531	(6.9)	487	(13.8)	502	(7.1)
Australia	536	(3.7)	531	(3.1)	535	(3.8)	536	(3.3)	491	(3.9)	503	(4.3)
International Average	483	(0.6)	478	(0.7)	483	(0.6)	479	(0.7)	477	(0.6)	482	(0.7)

	Average Scale Scores for Mathematics Cognitive Domains											
	Knowing				Applying				Reasoning			
	Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	530	(8.0)	533	(7.6)	536	(7.1)	545	(6.7)	530	(6.9)	532	(5.9)
VIC	521	(10.0)	530	(10.1)	530	(7.7)	544	(9.8)	527	(8.6)	532	(9.1)
QLD	467	(9.2)	476	(8.3)	488	(7.9)	500	(7.2)	489	(7.4)	490	(6.3)
SA	485	(9.0)	486	(13.4)	499	(7.0)	504	(11.3)	500	(7.2)	498	(10.3)
WA	476	(7.4)	491	(8.3)	496	(7.6)	509	(6.6)	497	(7.6)	502	(5.6)
TAS	498	(8.8)	502	(8.0)	512	(7.0)	519	(7.5)	516	(6.0)	511	(6.7)
NT	471	(10.3)	475	(15.5)	489	(8.1)	493	(12.7)	490	(7.7)	490	(11.2)
ACT	503	(15.5)	509	(8.9)	516	(12.8)	522	(6.8)	514	(12.2)	517	(6.6)
Australia	506	(5.0)	512	(4.1)	518	(4.0)	528	(3.7)	515	(3.8)	517	(3.4)
International Average	480	(0.7)	480	(0.7)	480	(0.7)	481	(0.7)	501	(0.7)	502	(0.7)

The results presented in Table 3.8B suggest a pattern of apparent higher performance for male students in most states across the content and cognitive domains. Conversely in three states, female students appeared to be performing better than their male counterparts. Further exploration revealed that the only state in which gender differences in performance were statistically significant was Queensland, in which males performed better than females in all content domains apart from *algebra*.

For Australia as a whole, the gender difference in favour of males was statistically significant for the content domains *data and chance* and *number*, and for *applying* in the cognitive domains. This is in contrast to the situation internationally, in which females performed better than males on average in all domains except for *number*, where there was no significant difference between the genders.

**Table 3.8B** Average achievement in the mathematics content and cognitive domains by gender within states, Year 8

	Average Scale Scores for Mathematics Content Domains															
	Algebra				Data and Chance				Number				Geometry			
	Girls		Boys		Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	461	(15.7)	486	(11.6)	510	(15.1)	542	(10.5)	485	(15.5)	523	(12.7)	478	(14.2)	501	(11.8)
VIC	484	(12.3)	477	(9.7)	527	(11.3)	532	(8.4)	507	(12.1)	515	(8.9)	493	(9.8)	493	(7.6)
QLD	457	(7.9)	472	(4.7)	509	(6.9)	535	(4.7)	483	(6.8)	513	(4.8)	474	(6.9)	492	(5.7)
SA	470	(7.6)	456	(7.5)	523	(8.6)	522	(8.0)	499	(7.2)	500	(7.3)	485	(7.8)	478	(6.7)
WA	457	(10.6)	462	(8.7)	512	(9.5)	524	(10.3)	486	(10.2)	501	(10.4)	474	(8.4)	484	(10.2)
TAS	457	(6.9)	460	(8.8)	516	(7.9)	523	(8.0)	483	(7.0)	503	(9.0)	475	(7.1)	483	(9.1)
NT	461	(13.1)	453	(15.7)	517	(11.7)	511	(18.6)	491	(14.9)	490	(17.3)	482	(7.9)	471	(13.3)
ACT	480	(24.7)	503	(27.3)	532	(24.6)	552	(24.6)	511	(25.5)	542	(27.2)	494	(25.5)	524	(26.5)
Australia	466	(5.6)	475	(5.2)	516	(4.8)	534	(4.8)	492	(5.3)	514	(5.6)	481	(4.8)	493	(5.3)
International Average	457	(0.6)	444	(0.6)	453	(0.5)	449	(0.6)	448	(0.6)	453	(0.6)	454	(0.6)	448	(0.6)

	Average Scale Scores for Mathematics Cognitive Domains											
	Knowing				Applying				Reasoning			
	Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	478	(15.2)	504	(11.0)	486	(15.6)	517	(11.9)	489	(14.7)	519	(10.4)
VIC	495	(9.8)	493	(7.9)	507	(10.1)	508	(7.7)	509	(10.0)	504	(8.3)
QLD	474	(6.0)	491	(4.5)	484	(7.2)	505	(5.3)	487	(6.6)	507	(5.3)
SA	485	(6.9)	478	(6.0)	497	(6.3)	494	(6.6)	498	(8.1)	493	(6.0)
WA	473	(9.1)	478	(9.1)	481	(9.4)	495	(10.6)	490	(8.6)	500	(9.3)
TAS	472	(6.7)	479	(7.7)	483	(7.0)	497	(8.2)	494	(6.7)	499	(8.6)
NT	478	(11.9)	469	(15.9)	487	(11.2)	484	(16.2)	493	(10.6)	488	(12.7)
ACT	494	(22.1)	519	(24.2)	506	(23.6)	537	(25.4)	510	(21.1)	533	(24.3)
Australia	481	(4.9)	493	(4.9)	491	(4.9)	508	(5.2)	495	(4.8)	508	(4.9)
International Average	454	(0.6)	447	(0.6)	452	(0.6)	450	(0.6)	471	(0.6)	465	(0.7)

## Summary

This chapter has examined Australian Year 4 and Year 8 students' achievements in mathematics overall, in the content and cognitive domains at both Year 4 and Year 8, and according to background characteristics of interest. In mathematics overall, Year 4 students performed significantly above the TIMSS scale average but Year 8 students performed at a similar level to the TIMSS scale average.

At Year 4, Hong Kong and Singapore outscored all other participating countries. Australia's mean score of 516 was similar to three countries, significantly lower than that of 12 countries, and significantly higher than that of 20 countries and the TIMSS scale average. Australia's average Year 4 mathematics score in TIMSS 2007 was significantly higher than its equivalent score in 2003.

While the proportion of Australian Year 4 students at each of the international benchmarks was higher than the international median, the nine per cent reaching the advanced benchmark was considerably less than that of the highest scoring countries. The proportion reaching the low benchmark was, however, fairly similar to the highest performing countries.

Across the states there were some significant differences in Year 4 mathematics performance. Students in New South Wales performed significantly better than students in all other states. 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.

In terms of performance at each of the international benchmarks, there was relatively little difference across the states, although a larger proportion of students from New South Wales and Victoria than the other states performed at the advanced benchmark.

There was no significant gender difference in the Year 4 mathematics performance of Australian students. This was similar to the results internationally, in which males and females performed equally well at this level. In Australia, a slightly higher proportion of males achieved at the advanced benchmark, while a similar proportion of males and females achieved at the low benchmark. There were no gender differences across the states.

Students who identified themselves as Indigenous performed at a significantly lower level than both non-Indigenous students and the TIMSS scale average. The proportion of Australian Indigenous students performing at each of the international benchmarks was also less than the international median.

The geographic location of schools had a significant impact on mathematics achievement at Year 4 such that metropolitan students performed better than provincial students, who in turn performed better than students in remote schools. Lower proportions of students from remote schools achieved at each of the higher benchmarks, compared to metropolitan and provincial students.

Students in Year 4 who spoke a language other than English at home achieved significantly lower on average in mathematics than students who predominantly spoke English. In addition, a smaller proportion of students who did not speak English as their main language at home reached the high benchmark and a greater proportion of these students, compared to predominantly English-speaking students, failed to reach the low benchmark.

In terms of the mathematics content domains, Australian Year 4 students were strongest in *geometric shapes and measures* and *data display*, rather than in *number*. This pattern of strengths and weaknesses was apparent for all states in the content domains, and in the cognitive domains Year 4 students were strongest in *applying* and *reasoning* rather than *knowing*. The only significant gender differences were in favour of males in the *number* content domain and the *applying* cognitive domain.

At Year 8, Australia's mean score in mathematics was 496, not significantly different from the TIMSS scale average of 500. Nine countries achieved scores higher than Australia, including the highest scoring countries, Chinese Taipei, Korea and Singapore. Eight countries scored similarly to Australia, while Australia scored significantly higher than 31 countries. Australia's average Year 8 mathematics score in 2007 was significantly lower than in 1995, but not statistically different from the 2003 average score.

Six per cent of Australia's Year 8 students reached the advanced benchmark, which was higher than the international median, and 11 per cent of Australian Year 8 students failed to achieve the low benchmark.

At Year 8 nationally, there was a substantial and significant gender difference in favour of males. More males than females achieved the higher benchmark levels, yet similar proportions of females and males failed to achieve at the low benchmark level. The gender difference in favour of males was only significant in Queensland.

There was little variation and no significant differences between the states in terms of average Year 8 scores. As for performance at each of the benchmarks, there was little variation across the states except for the substantially larger proportion of students achieving the advanced benchmark in the Australian Capital Territory and New South Wales than in the other states.

Year 8 students who identified as Indigenous performed at a significantly lower level than both non-Indigenous students and the TIMSS scale average. The performance of Australian Indigenous students at each of the international benchmarks was also similar to or less than the international median.

The geographic location of schools had limited impact on mathematics achievement at Year 8. There was no significant difference in the average performance of students from metropolitan, provincial or remote areas. However, smaller proportions of remote students compared to metropolitan and provincial students achieved each of the benchmarks.

At Year 8, there was no significant difference in mean mathematics scores according to language background. However, there was a much larger spread of scores for those that spoke a language other than English at home. The proportions of these students who were performing at the advanced benchmark or who were failing to attain the low benchmark was greater than the proportions of English-speaking students at each of these levels.

Parental education was also significantly related to mathematics achievement, with mean mathematics achievement increasing as parental education increased. The proportion of students achieving the advanced and high benchmarks was considerably higher for students with at least one parent completing a university degree than for any other group.

At Year 8, Australian students' performance in both algebra and geometry was significantly lower than the TIMSS scale average, while performance in *number* was equivalent, and *data and chance* was, as in previous cycles, found to be a strength. In terms of the cognitive domains, Australian Year 8 students performed at a similar level to the TIMSS scale average in *applying* and *reasoning*, and lower in *knowing*. This pattern of strengths and weaknesses was also apparent for all states. In addition, the gender bias in favour of males was found to be significant for *data and chance*, *number* and *applying*.

The next chapter will examine Australian Year 4 and Year 8 students' achievements in science overall, and in the specific content and cognitive domains.

# Australian students' achievement in science

This chapter presents the international and national results for science, firstly for science overall and then for the content and cognitive domains described in Chapter 2. The reporting of these results includes both mean scores and percentages achieving the international benchmarks, as both are important to policy makers.

## Overall achievement in science

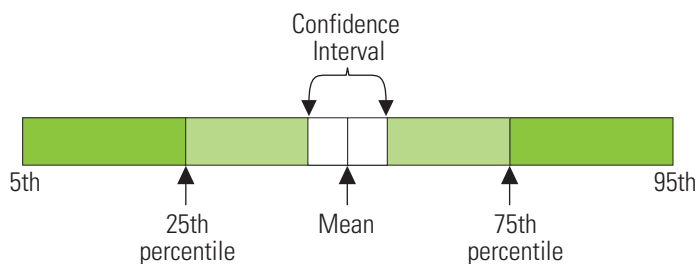
### An international perspective

Figures 4.1A and 4.1B<sup>1</sup> provide a summary of the overall performance of students in Years 4 and 8 across different countries on the combined science scale, in terms of the mean scores achieved by students in each country, and the range of scores achieved between the 5<sup>th</sup> and 95<sup>th</sup> percentiles.

Typically changes in mean performance of students from one cycle of an assessment to the next are used to assess improvement in the quality of schools and education systems. However, the mean level of performance does not provide the complete picture of student achievement and can mask significant variation within an individual class, school or education system. Countries aim not only to encourage high performance but also to minimise internal disparities in performance. Therefore, as well as a high mean score, a limited range of scores is also desirable.

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<sup>1</sup> Generally throughout the report, figures and tables are presented in pairs, with the Year 4 graph or table followed by its corresponding Year 8 figure or table. To facilitate reading of the report the figures and tables have been labelled with an A to indicate a Year 4 figure or table and B to indicate a Year 8 figure or table.



### READING THE GRAPHS

Each country's results are represented in horizontal bars with various colours. On the left end of the bar is the 5<sup>th</sup> percentile – this is the score below which 5 per cent of the students have scored. The next line indicates the 25<sup>th</sup> percentile. The next line at the left of the white band is the lower limit of the confidence interval for the mean – i.e. we are 'confident' that the mean will lie within this white band. The line in the centre of the white band is the mean. The lines to the right of the white band indicate the 75<sup>th</sup> and 95<sup>th</sup> percentiles.

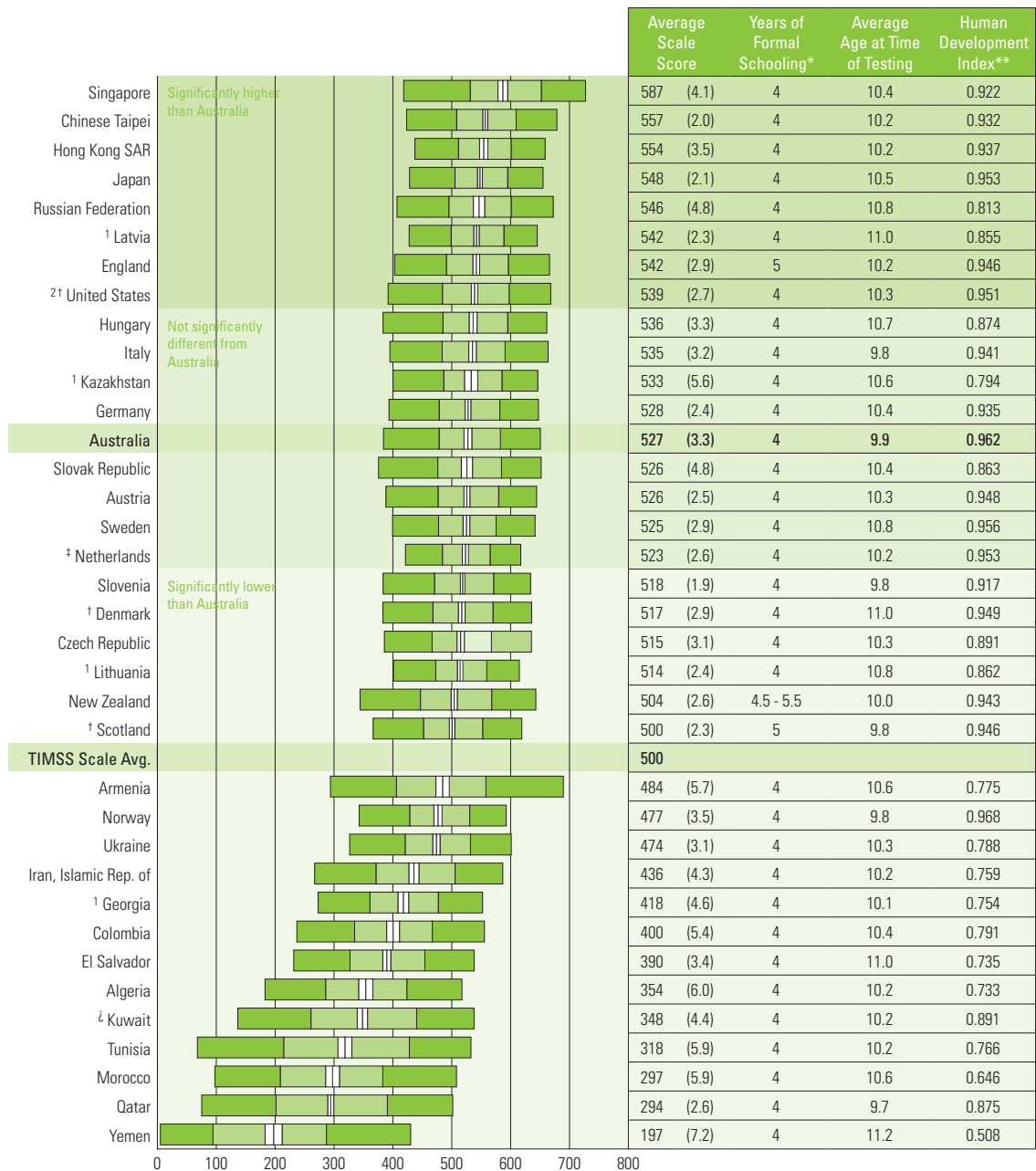
Results for the states are presented vertically; however, the interpretation is the same.

At Year 4, 23 of the TIMSS countries (Singapore through to Scotland) scored higher than the TIMSS scale average in science (500). Singapore outperformed all other countries, and Chinese Taipei outperformed all other countries other than Singapore. The achievement levels of Hong Kong and Japan were significantly higher than that of the countries below them in Table 4.1A. These four countries were followed by a group of four countries: the Russian Federation, Latvia, England, and the United States, all of which achieved a significantly higher average score than Australia. Australia's achievement level in science was significantly higher than the international scale average, and was not significantly different to that of Hungary, Italy, Kazakhstan, Germany, the Slovak Republic, Austria, Sweden, and the Netherlands. Australia's performance was significantly higher than that of 19 countries, including Denmark and New Zealand.

As might be expected, the results reveal substantial differences in science achievement between the highest and lowest performing countries (587 in Singapore to 197 in Yemen at Year 4). Singapore, along with the highest overall level of achievement, also had a reasonably large range of achievement of 309 scale points between the 5<sup>th</sup> and 95<sup>th</sup> percentiles. The largest range was 465 scale points for Tunisia, one of the lowest achieving countries. The smallest range was 196 scale points in the Netherlands. Australia's range was about midway between these at 267 score points.

As in Chapter 3, the average years of schooling and average age of students at the time of testing, and the Human Development Index (HDI) value for each country are provided in Figure 4.1A. With the exception of Norway, all of the countries with a HDI value over 0.9 achieved an average scale score in science above the TIMSS scale average. However, not all countries performing above the TIMSS average had an index value as high as 0.9. Kazakhstan and the Russian Federation, for example, both had national average science scores close to the TIMSS average but HDI averages of around 0.8.

At Year 4, 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 but this was not significant.



\* 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.

<sup>†</sup> Met guidelines for sample participation rates only after replacement schools were included.

<sup>‡</sup> Nearly satisfied guidelines for sample participation rates only after replacement schools were included.

<sup>1</sup> National Target Population does not include all of the International Target Population defined by TIMSS.

<sup>2</sup> National Defined Population covers 90% to 95% of National Target Population.

<sup>‡</sup> 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.

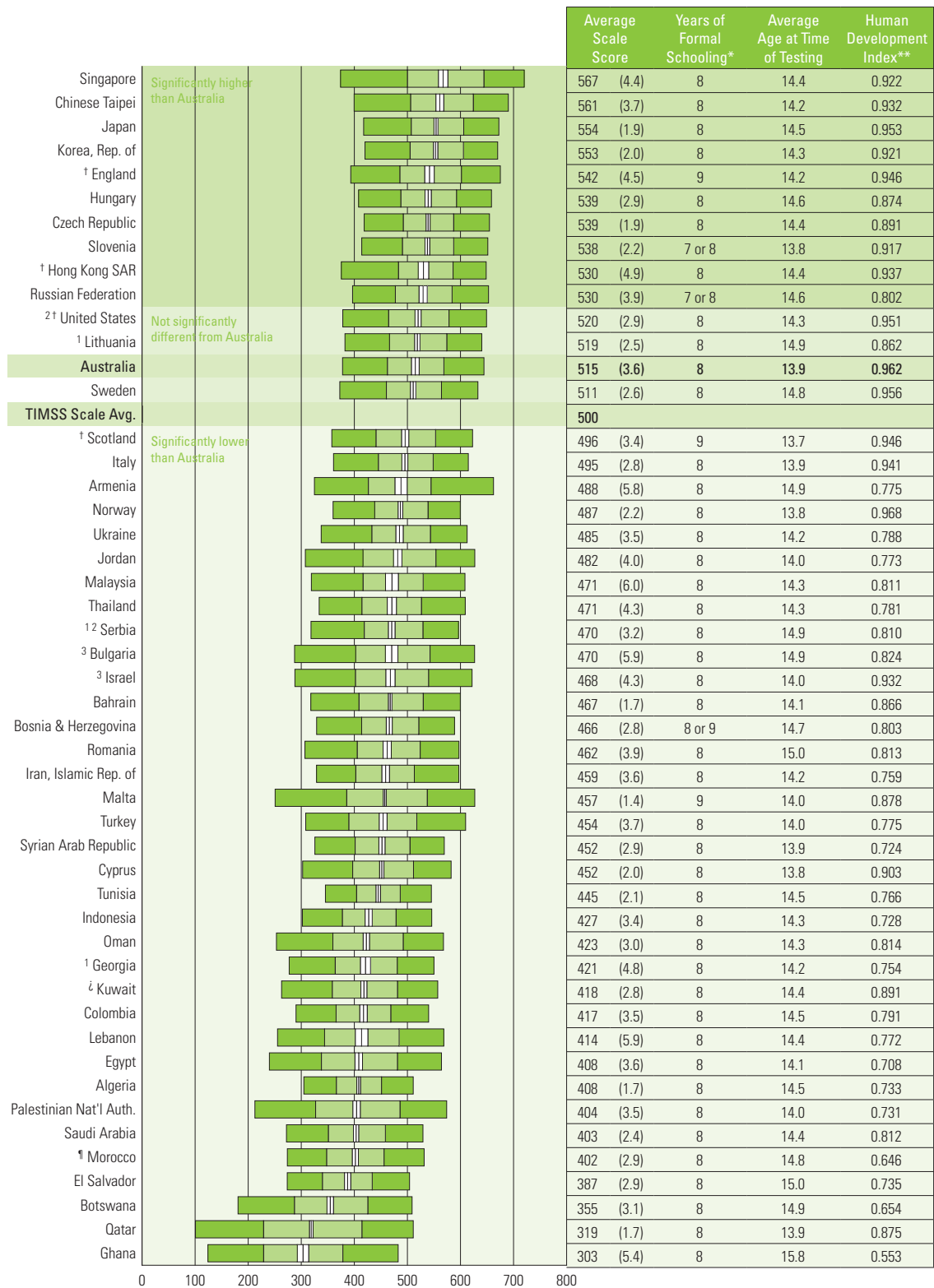
**Figure 4.1A** Distribution of science achievement scores by country, Year 4

At Year 8, 14 of the TIMSS countries (Singapore through to Sweden) scored significantly higher than the TIMSS scale average of 500, including Australia. Singapore and Chinese Taipei had the highest average achievement in science with averages more than 60 points above the TIMSS scale average. Singapore had higher achievement than all of the other countries except Chinese Taipei, which, in turn, outperformed all countries except Singapore, Japan, and Korea. Japan and Korea in turn had higher average achievement than all countries except Singapore and Chinese Taipei. England, Hungary, the Czech Republic, Slovenia, Hong Kong SAR, and the Russian Federation also achieved significantly higher mean science scores than Australia and 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 all remaining countries, including Scotland, Italy, Armenia and Norway.

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.

As at Year 4, the results reveal substantial differences in science achievement at Year 8 between the highest and lowest performing countries (567 in Singapore to 303 in Ghana). The percentiles shown in Figure 4.1B also highlight the wide range of achievement within countries. The difference between the 5<sup>th</sup> and 95<sup>th</sup> percentiles within countries is, on average, about 275 scale points. Qatar, which has one of the lowest mean scores, has one of the largest ranges in achievement with 410 scale points between the 5<sup>th</sup> and 95<sup>th</sup> percentiles. The smallest range is that of 200 scale points in Tunisia. Australia's range is 266 score points.

As at Year 4, many of the TIMSS countries with Human Development Index values greater than 0.9 achieved an average scale score above the TIMSS scale average. Exceptions to this pattern included Scotland, Italy, Norway, Israel, and Cyprus, all countries with an index value above 0.9 yet with an average achievement below the TIMSS scale average, and Hungary, the Czech Republic, the Russian Federation, and Lithuania, all of which scored above the TIMSS scale average despite index values below 0.9.



\* 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.

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¿ 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 4.1B Distribution of science achievement scores by country, Year 8

## Performance at the international benchmarks

In addition to comparing mean scores, it is possible to use the international benchmarks described in Chapter 2 to gain further insight into student achievement in science. Figures 4.2A and 4.2B provide the proportion of students in each country at each of the international benchmarks for Years 4 and 8. Countries are presented in order according to the percentage of students achieving the advanced benchmark. As a point of reference, the international median for science in TIMSS 2007 (see Reader's Guide) is provided for each of the international benchmarks. By definition, half the countries will have a percentage above the median and half below.

At Year 4, students at the advanced benchmark in science demonstrated the ability to apply their knowledge and understanding of scientific processes and relationships in beginning scientific inquiry. In contrast, those at the low benchmark demonstrated only some elementary knowledge of life science and physical science.

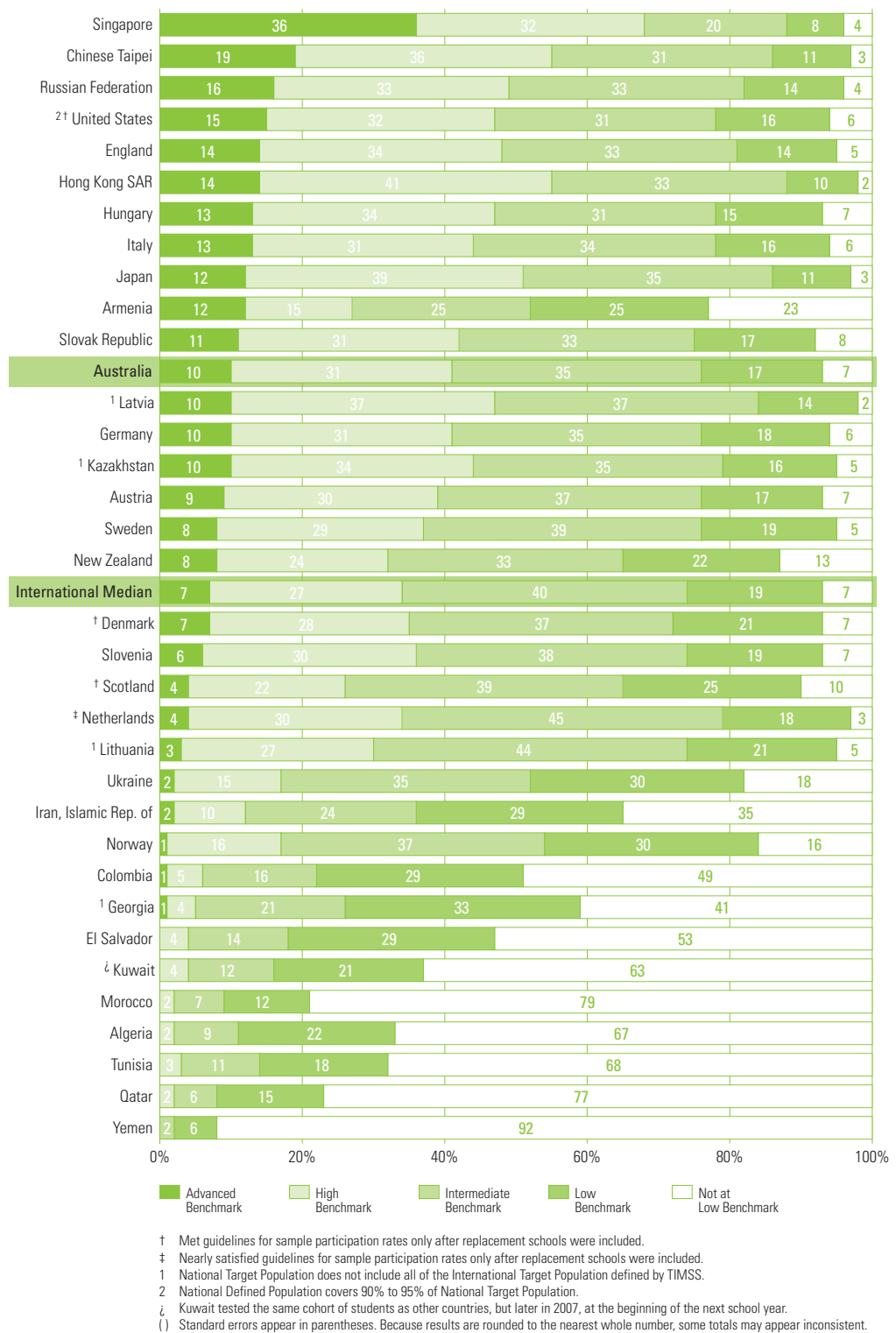
Australia performed reasonably well at some levels against the international benchmarks. Ten per cent of Australian students achieved the advanced benchmark, compared with an international median of seven per cent, and 41 per cent achieved the high benchmark, compared with 34 per cent internationally. 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. Figure 4.2A shows the proportion of students at each of the international benchmarks for all TIMSS 2007 countries.

Singapore had the highest proportion of students achieving the advanced international benchmark, with 36 per cent of students in Year 4 attaining this level. This figure was higher than the 25 per cent of students in Singapore who attained the advanced international benchmark in TIMSS 2003. The percentage of students in Singapore reaching the advanced benchmark was nearly double the percentage of students from Chinese Taipei who attained the advanced international benchmark (19%). The Russian Federation also stood out as one of the highest achieving countries with 16 per cent of Year 4 students attaining the advanced international benchmark, followed by the United States (15%), England and Hong Kong (14%). What is particularly impressive about achievement in these countries is the fact that almost all (94% to 98%) of the students in Year 4 in these high achieving countries performed at or above the low international benchmark. Almost all students in these countries demonstrated a strong grasp of the basic levels of science achievement.

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.

In 11 of the 36 countries participating in TIMSS 2007 at the Year 4 level, more than 95 per cent of students achieved at or above the low international benchmark in science.



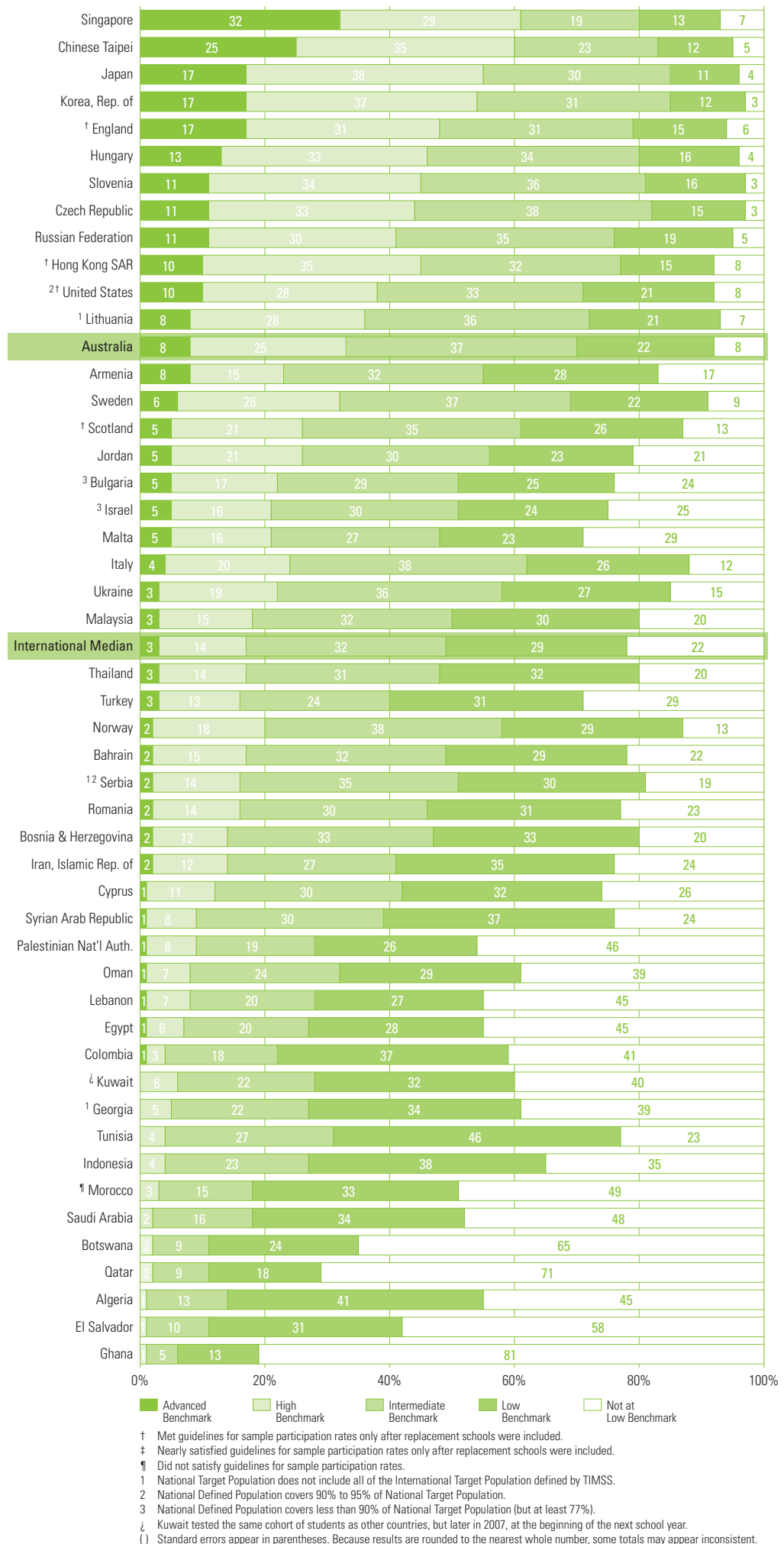
**Figure 4.2A** Percentages of students reaching the international benchmarks for science achievement by country, Year 4

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 recognised some basic facts from the life and physical sciences.

Figure 4.2B displays the percentage of Year 8 students in each country that reached each international benchmark in science. It shows that Singapore, the highest scoring country, is also the country with the highest percentage (32%) of students who achieved at the advanced benchmark. Twenty-five per cent of students in Chinese Taipei reached the advanced benchmark, a stark comparison to the international median of only three per cent. 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.

The substantial variation in achievement at the advanced international benchmark was repeated at each of the other benchmarks. For example, the high benchmark was reached by more than 50 per cent of students in Singapore, Chinese Taipei, Japan, and Korea, but by only one per cent of students in Ghana, El Salvador, and Algeria. Across countries, the proportions of students who achieved the intermediate benchmark ranged from 85 per cent in Japan and Korea, to six per cent in Ghana. Ninety-five per cent or more of students reached the low benchmark in seven countries – Chinese Taipei, Japan, Korea, Hungary, the Czech Republic, Slovenia, and the Russian Federation. However, several countries had less than half of students reaching the low benchmark, including El Salvador (42%), Botswana (35%), Qatar (29%), and Ghana (19%).

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 that eight per cent of Australian Year 8 students did not reach the minimum standards in science as defined by the international benchmarks.

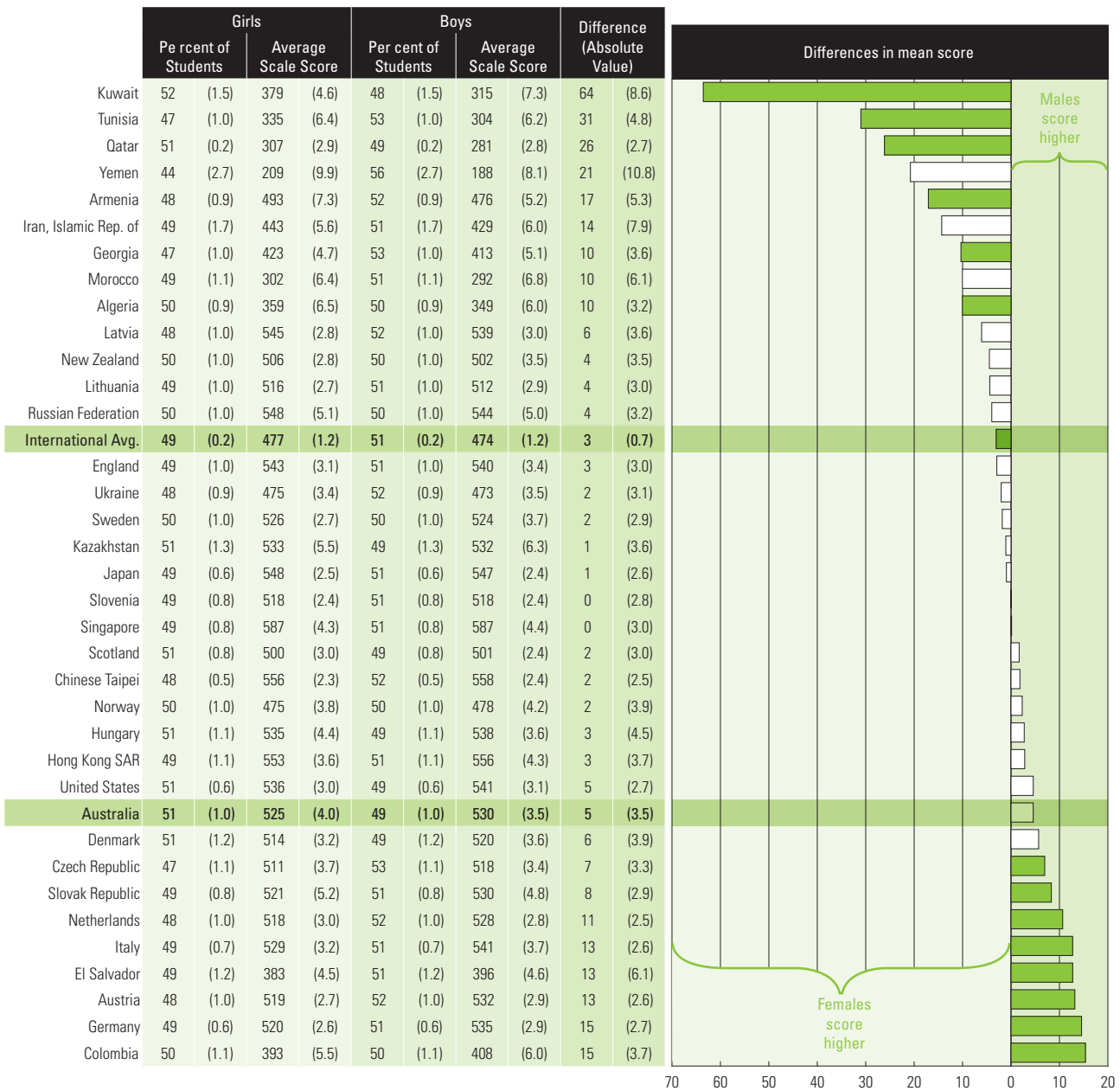


**Figure 4.2B** Percentages of students reaching the international benchmarks for science achievement by country, Year 8

## Performance by gender

Figures 4.3A and 4.3B show the performance of male and female Year 4 and 8 students in science achievement across the countries participating in TIMSS 2007. These figures present average achievement separately for females and males, as well as the difference between the averages. Gender differences are shown by a bar indicating the size and direction of the difference (in favour of males or females) and whether the difference was statistically significant (indicated by a darkened bar). Countries are shown in increasing order of this difference in average achievement in favour of males; that is, countries in which the average score of males was significantly greater than that of females will appear towards the right-hand side of the figure.

On average, there was a statistically significant gender difference in the average score for science across all TIMSS 2007 countries at Year 4, with females scoring higher than males. Females scored significantly higher than males in Algeria, Georgia, Armenia, Qatar, Tunisia and Kuwait. These differences ranged from ten score points in favour of females in Algeria and Georgia, to 64 score points in favour of females in Kuwait. Not all countries followed this pattern of higher female achievement. Males significantly outperformed females in the Czech Republic, the Slovak Republic, the Netherlands, Italy, El Salvador, Austria, Germany and Colombia. The significant differences in favour of males ranged in size from seven score points in the Czech Republic to 15 score points in Colombia. In Australia, Year 4 males scored on average five points higher than females, but this difference was not statistically significant.



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

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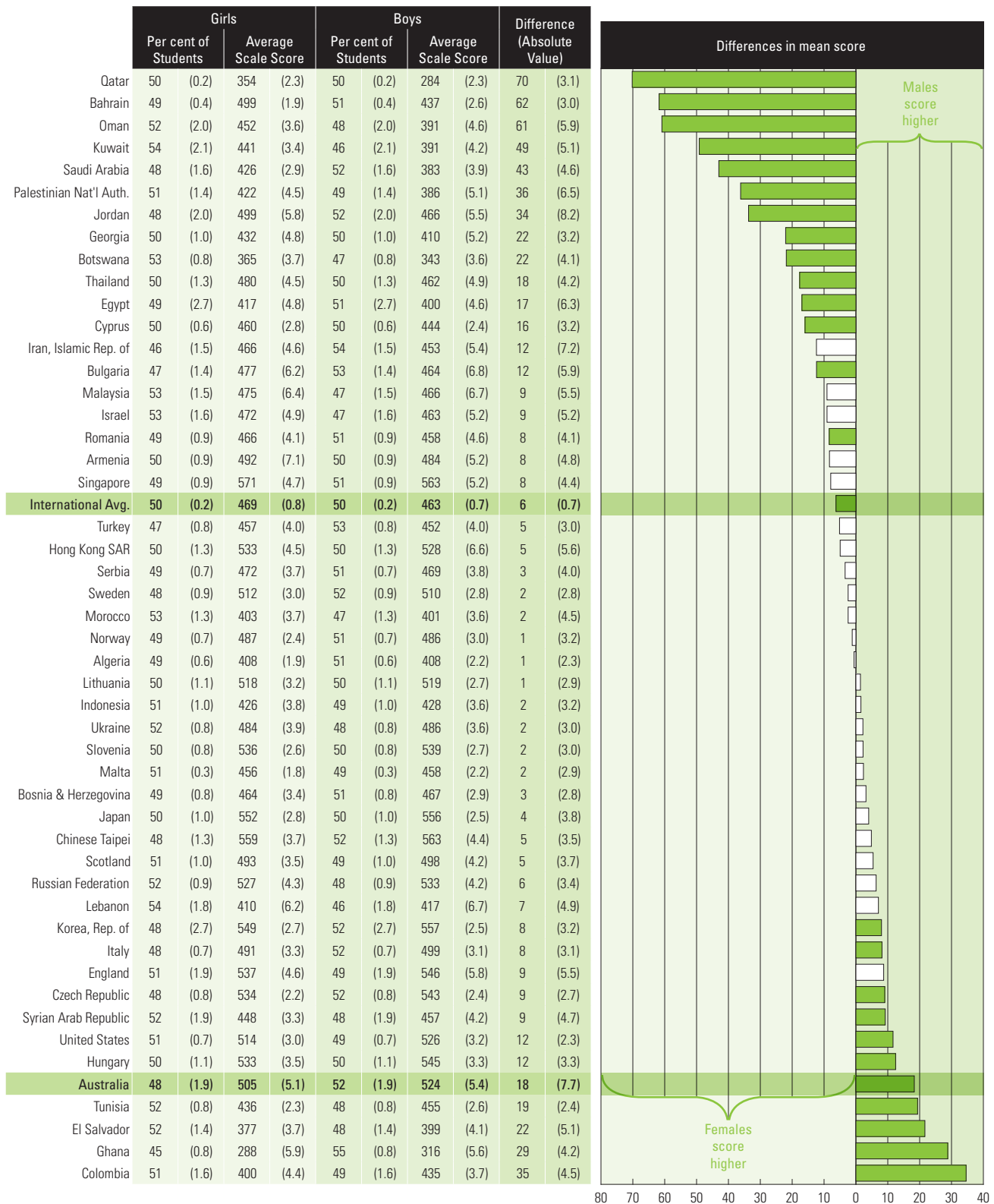
ι Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

■ Difference statistically significant  
□ Difference not statistically significant

**Figure 4.3A** Average science achievement by gender within country, Year 4

Figure 4.3B shows that on average across the TIMSS 2007 countries, females in Year 8 achieved a significantly higher score in science than males. Females achieved significantly higher average scores than males in 14 of the participating countries, including many of the countries located in the Middle East. The significant differences in favour of females ranged in size from eight score points in Romania to 70 score points in Qatar. Males achieved significantly higher average scores than females in 11 countries, including Australia. Across the participating countries, the significant differences in favour of males ranged in size from eight score points in Korea to 35 score points in Colombia. In Australia, males outperformed females by 18 score points, a substantial, as well as significant, difference. Interestingly, in 24 countries there was no significant difference between females and males.



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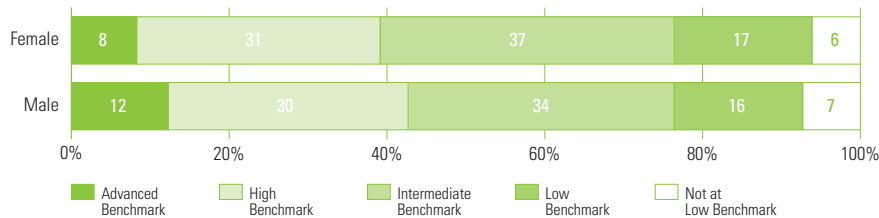
() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

■ Difference statistically significant  
□ Difference not statistically significant

**Figure 4.3B** Average science achievement by gender within country, Year 8

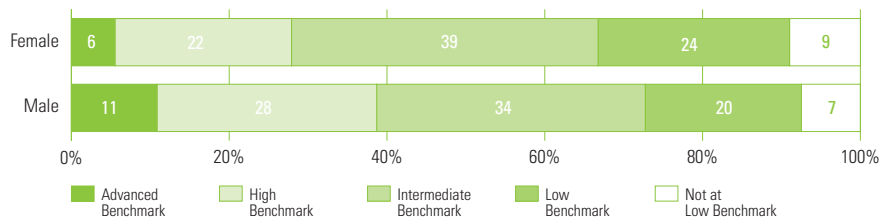
Figure 4.4A shows the proportion of male and female Year 4 Australian students achieving at each of the international benchmarks in science.

In Australia, a slightly higher proportion of males than females reached the advanced benchmark, while similar proportions of males and females achieved at the high benchmark. The distribution of female achievement tended to clump around the middle bands of achievement, with a slightly higher proportion of females than males performing at the intermediate and low benchmark levels. Around the same proportion of males and females failed to reach the low benchmark at Year 4 in science.



**Figure 4.4A** Percentages of Australian students reaching the international benchmarks for science achievement by gender, Year 4

Figure 4.4B shows the corresponding proportions for Year 8 students. Eleven per cent of Australian Year 8 males achieved the advanced benchmark, compared to only six per cent of females. The proportions of males and females performing at or above the low benchmark were quite similar, with 93% of males and 91% of females achieving at this level, suggesting that the gender difference in average scores may be due to fewer females achieving at advanced levels than males.



**Figure 4.4B** Percentages of Australian students reaching the international benchmarks for science achievement by gender, Year 8

### Performance by state

Figures 4.5A and 4.5B present the distribution of science performance for each of the Australian states for Year 4 and Year 8 in a similar way to that of the international results in Figures 4.1A and 4.2B. To place the state results in perspective, the means and distributions for Australia as a whole, and for the highest achieving country at that year level, are also included in each figure. The states are shown in order from highest to lowest mean scores.

Figures 4.5A and 4.5B should be read in conjunction with Tables 4.1A and 4.1B (respectively), which present the multiple comparisons of average performance between the states.

Figure 4.5A shows that for all states there was a wide range in achievement scores in science at the Year 4 level. The Northern Territory had the widest range from the 5<sup>th</sup> to 95<sup>th</sup> percentile of 286 score points, whilst the ranges for the two highest performing states, Victoria and New South Wales, were 247 and 260 score points respectively. All states in Australia had mean scores higher than the TIMSS scale average in science at Year 4.



**Figure 4.5A** Distribution of science achievement scores by state, Year 4

Figure 4.5B presents the distribution of Year 8 achievement for each of the states. For TIMSS 2007, the Australian Capital Territory had the highest average achievement (538 score points). The Australian Capital Territory also displayed the widest distribution of scores, along with New South Wales, with a range of approximately 300 score points between the 5<sup>th</sup> and 95<sup>th</sup> percentiles. South Australia had the narrowest range, with only 220 score points separating the 5<sup>th</sup> and 95<sup>th</sup> percentiles.



**Figure 4.5B** Distribution of science achievement scores by state, Year 8

Figure 4.5A and Table 4.1A together show that at Year 4, the spread of average scores across the states was not large, being in the order of nearly half a standard deviation, or 43 score points. The average performance of students in Victoria and New South Wales was not statistically different to that of Tasmania or the Australian Capital Territory, but was significantly higher than that of Western Australia, South Australia, the Northern Territory and Queensland.

**Table 4.1A** Multiple comparisons of average science achievement by state, Year 4

			VIC	NSW	TAS	ACT	WA	SA	NT	QLD
		Mean	544	538	533	527	512	512	503	501
		SE	(8.3)	(6.1)	(6.0)	(8.6)	(4.9)	(10.5)	(9.9)	(6.0)
State	Mean	SE	VIC	NSW	TAS	ACT	WA	SA	NT	QLD
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 row to compare a state's performance with the performance of each state listed in the column heading.

▲ Average performance statistically significantly higher than in comparison state.

● No statistically significant difference from comparison state.

▼ Average performance statistically significantly lower than in comparison state.

Figure 4.5B and Table 4.1B together show that variation across the states in average science achievement at Year 8 was smaller than that found in Year 4 (an overall range of 36 score points, from 502 for the Northern Territory to 538 for the Australian Capital Territory), with none of the differences between the states reaching statistical significance. This is due, in part, to the large standard errors for some states (see the Reader's Guide).

**Table 4.1B** Multiple comparisons of average science achievement by state, Year 8

			ACT	NSW	VIC	QLD	SA	TAS	WA	NT
		Mean	538	521	513	513	512	507	506	502
		SE	(20.1)	(9.4)	(7.9)	(4.3)	(6.1)	(7.1)	(7.8)	(11.2)
State	Mean	SE	ACT	NSW	VIC	QLD	SA	TAS	WA	NT
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 row to compare a state's performance with the performance of each state listed in the column heading.

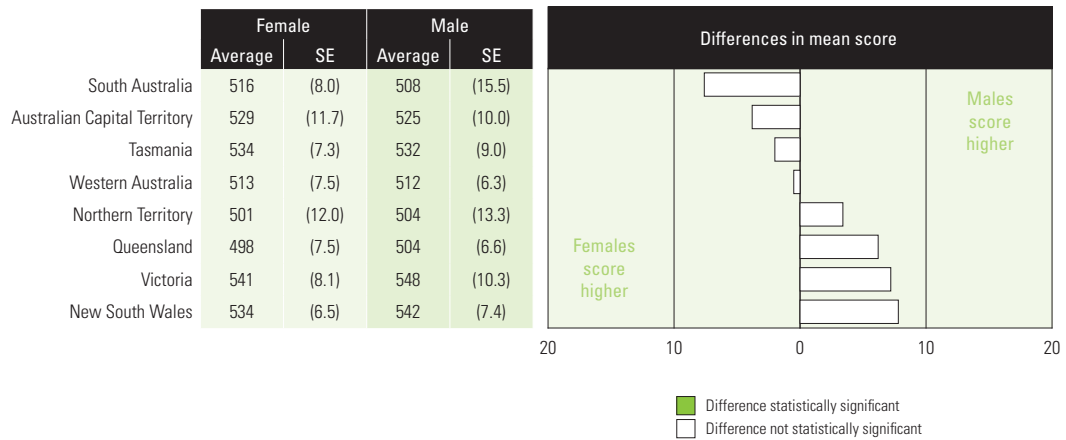
▲ Average performance statistically significantly higher than in comparison state.

● No statistically significant difference from comparison state.

▼ Average performance statistically significantly lower than in comparison state.

### Gender differences by state

Figure 4.6A shows there were no statistically significant differences by gender in performance in science at the Year 4 level in any of the states. The largest difference in average science achievement scores between males and females was in New South Wales and South Australia (8 score points).



**Figure 4.6A** Average science achievement by gender within state, Year 4

Figure 4.6B shows the gender differences at Year 8 in each of the states. Given there is gender difference in favour of males for Australia as a whole, it would be expected that this difference would also be found in a majority of the states. Five states had a gender difference in favour of males. However, due to large standard errors (see the Reader's Guide), only the difference in Queensland was found to be statistically significant.

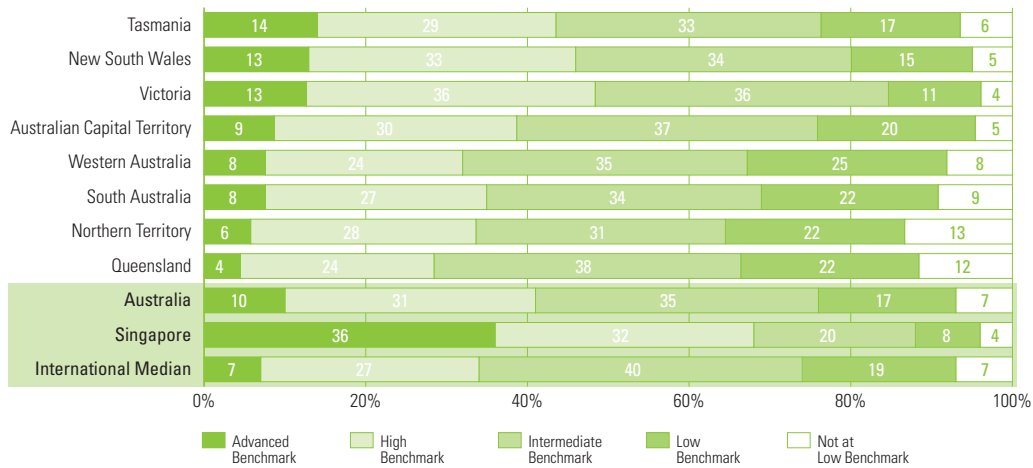


**Figure 4.6B** Average science achievement by gender within state, Year 8

### Performance at the international benchmarks by state

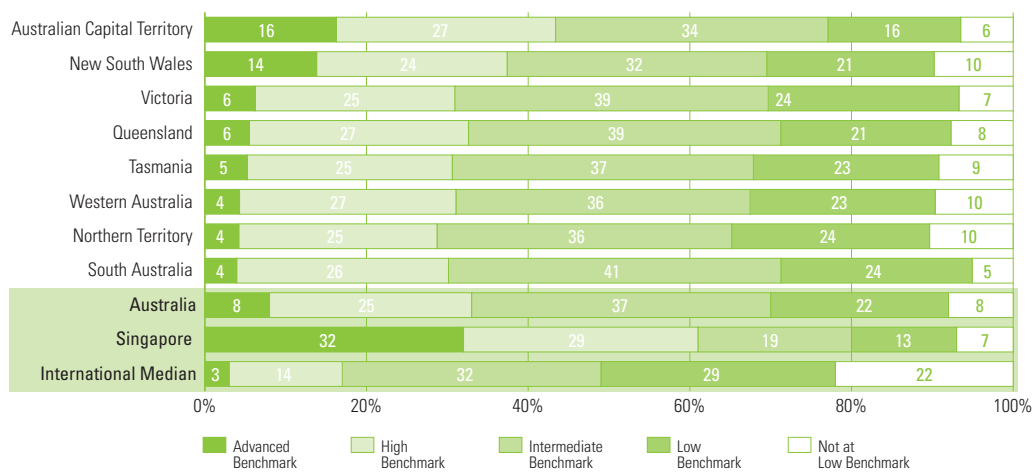
Figures 4.7A and 4.7B show the proportion of students in each state at each of the international benchmarks for Years 4 and 8, along with the corresponding proportions for the international median, Australia as a whole, and the highest scoring country at that year level, for comparison.

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.



**Figure 4.7A** Percentages of students reaching the international benchmarks for science achievement by state, Year 4

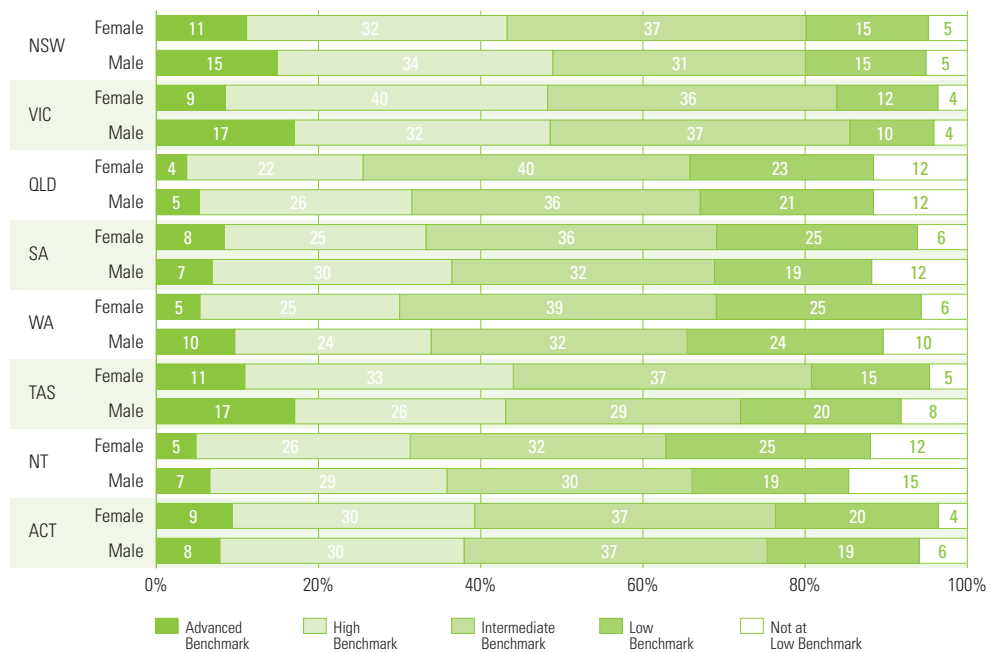
Figure 4.7B presents the achievement at each of the international benchmarks for each state at Year 8. Figure 4.7B shows that more than 10 per cent of Year 8 students in the Australian Capital Territory and New South Wales reached the advanced benchmark, but in all other states the proportion at this 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.



**Figure 4.7B** Percentages of students reaching the international benchmarks for science achievement by state, Year 8

### Performance at the international benchmarks by gender within states

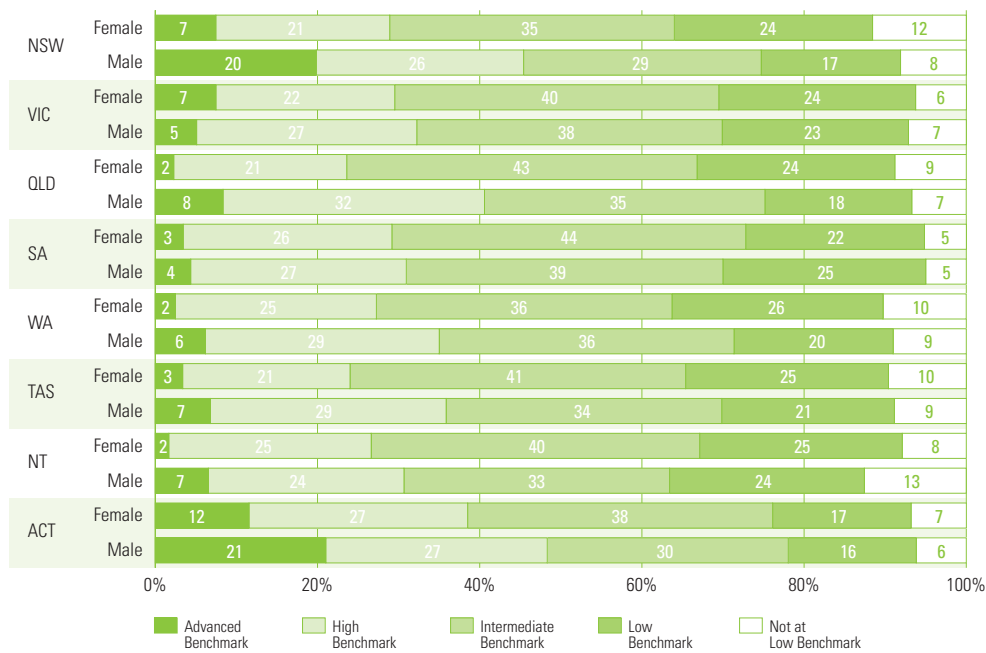
Figure 4.8A shows the proportion of students in Year 4, in each state, at each of the international benchmarks in science, by gender. In all states, with the exception of the Australian Capital Territory and South Australia, the proportion of males that performed at the advanced benchmark was greater than the proportion of females performing at this level. Victoria and Tasmania had the highest proportion of males reaching the international advanced benchmark followed by New South Wales. Greater proportions of female students were achieving at the low benchmark in all states apart from Tasmania and New South Wales, with the largest gender differences in South Australia and the Northern Territory. The proportions of male students who failed to reach the low benchmark in Year 4 science achievement is of concern in a number of states, with 12 per cent of male students in South Australia and Queensland and 15 per cent in the Northern Territory not attaining this minimum standard.



**Figure 4.8A** Percentages of students reaching the international benchmarks for science achievement by gender within states, Year 4

Figure 4.8B highlights the considerable variation in the direction and size of the differences in performance for male and females Year 8 students across the states. In the Australian Capital Territory and New South Wales, there were considerable differences in the percentage of females and males achieving the advanced benchmark, with approximately 10 per cent more males than females achieving this benchmark in both states. In contrast, there was a small but non-significant difference in Victoria in favour of females. Of concern is the small proportion (only 2%) of female students in Queensland, Western Australia and the Northern Territory who managed to attain the advanced benchmark at Year 8.

At the lower benchmarks, most of the gender differences were small, in the range of one or two percentage points. In the Northern Territory and New South Wales, however, there was a slightly larger difference in the number of students achieving the low benchmark. Ninety-two per cent of females in the Northern Territory performed at or above the low benchmark, compared to 87 per cent of males. While in New South Wales, 92 per cent of males, compared to 88 percent of females, performed at this level.



**Figure 4.8B** Percentages of students reaching the international benchmarks for science achievement by gender within states, Year 8

### Performance of Indigenous students

The educational attainment of Australia’s Indigenous students in core subject areas such as science is an important policy issue, and previous TIMSS studies have provided a picture of Indigenous achievement in mathematics and science. Indigenous status in TIMSS is based on students’ self-reports. As reported in Chapter 3, and shown in Tables 4.2A and 4.2B, about five per cent of the TIMSS sample identified as Indigenous.

The mean scores for overall science achievement for Indigenous and non-Indigenous students in Year 4 are shown in Table 4.2A. Year 4 Indigenous students achieved an average score of 441, which is 92 score points (almost one standard deviation) lower than the average score of non-Indigenous students of 533 points. Australian Indigenous students’ average science score was also significantly lower than the TIMSS scale average, by 59 score points.

**Table 4.2A** Average science achievement by Indigenous status, Year 4

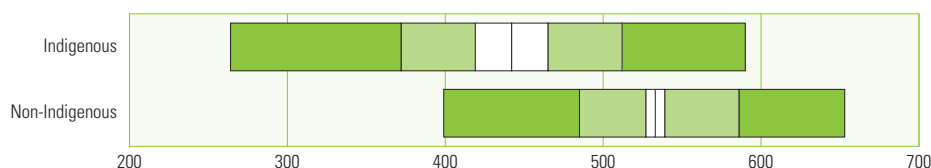
	Percentage of students	Average	SE
Indigenous	5	441	(11.8)
Non-Indigenous	95	533	(3.1)

The mean scores for overall science achievement for Indigenous and non-Indigenous students in Year 8 are shown in Table 4.2B. As for Year 4, the results clearly show that Indigenous students at the Year 8 level did not perform as well as their non-Indigenous counterparts. At Year 8 Indigenous students achieved an average score of 447, 72 score points less than the average score for non-Indigenous students of 519 score points. Year 8 Australian Indigenous students’ average science score was also significantly lower than the TIMSS scale average.

**Table 4.2B** Average science achievement by Indigenous status, Year 8

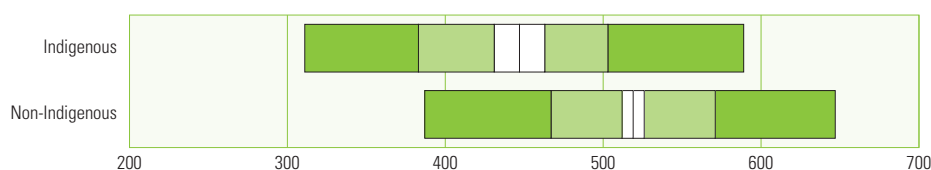
	Percentage of students	Average	SE
Indigenous	5	447	(8.1)
Non-Indigenous	95	519	(3.6)

Figure 4.9A shows the spread of scores for Indigenous students in science achievement at Year 4 (between the 5<sup>th</sup> and 95<sup>th</sup> percentile) was 325 score points, substantially larger than that for non-Indigenous students (254 score points). The spread in scores is large for Indigenous students and reinforces the understanding that performance of Indigenous students covers a wide range from very poor to above average.



**Figure 4.9A** Distribution of science achievement scores by Indigenous status, Year 4

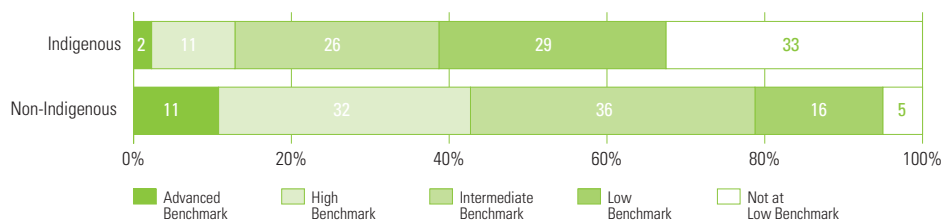
Figure 4.9B shows that the average science achievement of Year 8 Indigenous students is also significantly below that of their non-Indigenous counterparts. In addition, the spread of scores is slightly larger than that of non-Indigenous students – around 280 score points (compared to 260) between the 5<sup>th</sup> and the 95<sup>th</sup> percentiles.



**Figure 4.9B** Distribution of science achievement scores by Indigenous status, Year 8

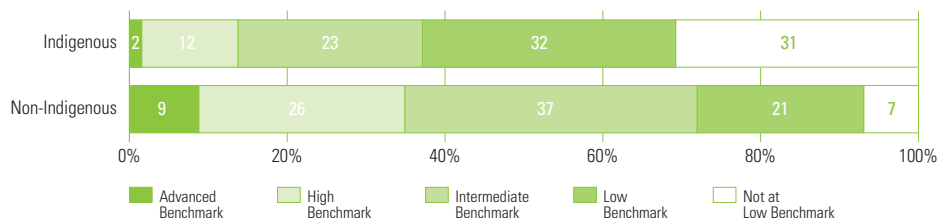
Figure 4.10A adds to the picture of science performance by showing the proportion of Indigenous students and non-Indigenous students in Year 4 in each of the international benchmarks for science.

Thirty-three per cent of Indigenous students were not able to reach the international low benchmark, 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. In contrast, five per cent of non-Indigenous students were performing at a level below the low international benchmark, while 16 per cent achieved the low benchmark in science. At the high end of the achievement spectrum, the differences are also stark. While some Indigenous students did score above the TIMSS scale score of 500, only 11 per cent achieved the high international benchmark and two per cent achieved the advanced international benchmark, compared to 32 per cent and 11 per cent, respectively, of non-Indigenous students.



**Figure 4.10A** Percentages of students reaching the international benchmarks for science achievement by Indigenous status, Year 4

Figure 4.10B shows the percentage of Year 8 Indigenous students at each of the international benchmarks. Thirty-one per cent of Year 8 Indigenous students did not reach the low benchmark, 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; that is, while the international median at the high benchmark was 17 per cent, 14 per cent of Australian Indigenous students reached this benchmark or higher. Across the TIMSS 2007 countries, 78 per cent of students achieved at or above the low benchmark, nine per cent more than the corresponding proportion of Australian Indigenous students at this level.



**Figure 4.10B** Percentages of students reaching the international benchmarks for science achievement by Indigenous status, Year 8

### Performance by geographic location of the school

To undertake the analyses in this section of the report, school's addresses were coded using the MCEETYA Schools Geographic Location Classification (see the Reader's Guide). Only the broad categories – Metropolitan, Provincial and Remote – are used in these analyses. The means and standard errors of students attending schools in the three location categories are shown in Tables 4.3A and 4.3B. It should be noted that the percentage of students in remote schools is very small (only one or two per cent) and therefore the level of uncertainty around the estimate of the mean will be large, resulting in large standard errors (see the Reader's Guide).

The means and standard errors of students attending schools in the three location categories are shown in Tables 4.3A and 4.3B. The differences shown in Table 4.3A are all statistically significant. The gaps between the scores of students in remote schools and those in other schools are particularly large – with a 77 score point difference in the average science achievement of students attending schools in remote areas and those attending metropolitan schools.

Compared to the national results for Australia, the average science score of students in provincial and remote schools was below the national average (by 12 score points and 70 score points, respectively). In comparison, Australian students attending metropolitan schools achieved seven score points higher than the national average. Students in remote schools also achieved an average science score 43 score points below the TIMSS scale average, a statistically significant difference.

**Table 4.3A** Average science achievement by geographic location, Year 4

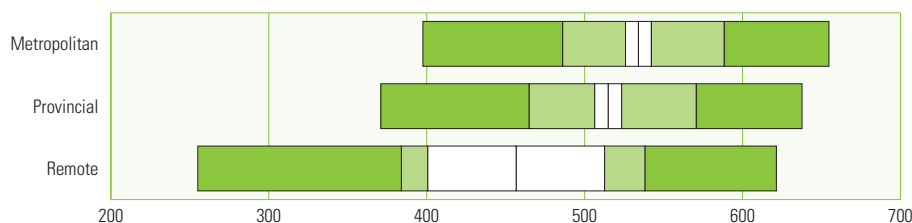
	Percentage of students	Average	SE
Metropolitan	72	534	(4.2)
Provincial	26	515	(4.4)
Remote	2	457	(28.6)

Table 4.3B presents the average science achievement of Year 8 students according to geographic location of their school. The distribution of achievement is quite different to that of the lower grade, with metropolitan students performing at the same level as provincial students (at the same level as the national average), whereas remote students scored about 35 score points lower than the national average. Due to the large standard error for average science achievement for remote students, this difference was not significant.

**Table 4.3B** Average science achievement by geographic location, Year 8

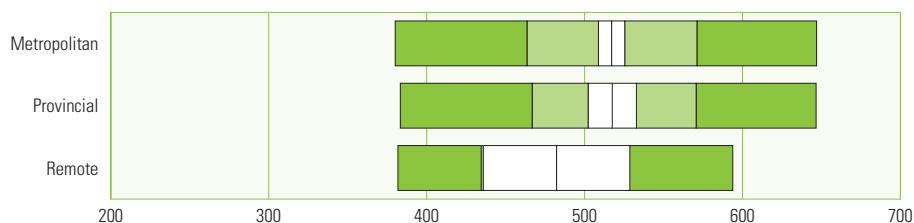
	Percentage of students	Average	SE
Metropolitan	71	515	(4.2)
Provincial	28	515	(7.8)
Remote	1	480	(23.7)

Figure 4.11A shows the spread of scores in science achievement at Year 4 by geographic location. The spread of scores between the 5<sup>th</sup> and 95<sup>th</sup> percentile for metropolitan schools was 257 score points, and for provincial schools was slightly higher, at 267 score points. For remote schools, the spread of scores was substantially larger at 366 score points.



**Figure 4.11A** Distribution of science achievement scores by geographic location, Year 4

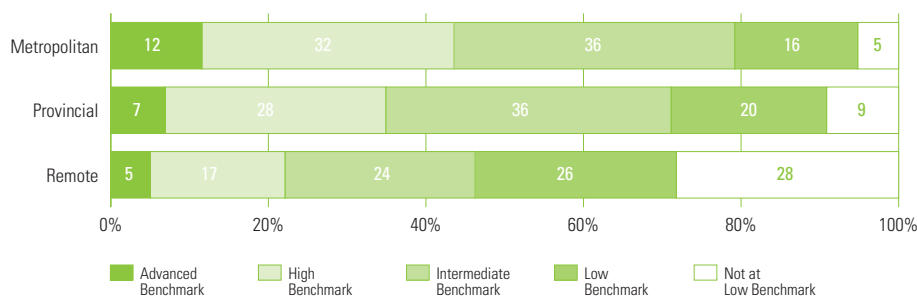
Figure 4.11B shows the spread of scores in science achievement for Year 8 students according to geographic location. Due to the large standard error of the estimate of the mean for remote students, the 95% confidence interval extends beyond the 25<sup>th</sup> and 75<sup>th</sup> percentiles. However, it can be seen that, as well as lower mean achievement, Year 8 students in remote schools had a narrower range of achievement scores (between the 5<sup>th</sup> and 95<sup>th</sup> percentiles) on the TIMSS 2007 scale than either metropolitan or provincial students.



**Figure 4.11B** Distribution of science achievement scores by geographic location, Year 8

Figure 4.12A shows the proportion of Year 4 students in each of the international science benchmarks by geographic location. More than half of students in remote schools were doing very poorly, with 28 per cent of students from remote schools not achieving the low international benchmark and a further 26 per cent performing at the low international benchmark. In contrast, nine per cent of students from provincial schools and five per cent of students from metropolitan schools were performing at a level below the low international benchmark.

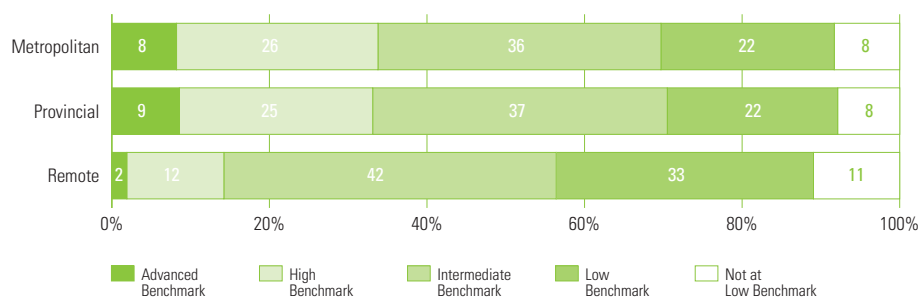
The differences in achievement become more pronounced at the high end of the achievement spectrum. While some students from remote schools did achieve scores above the TIMSS scale mean of 500, only five per cent achieved at the advanced international benchmark, compared with seven per cent of students from provincial schools and 12 per cent of students from metropolitan schools.



**Figure 4.12A** Percentages of students reaching the international benchmarks for science achievement by geographic location, Year 4

Figure 4.12B shows the percentage of Year 8 students at each of the international benchmarks according to geographic location. Eight per cent of metropolitan students and nine per cent of provincial students reached the advanced benchmark, compared to two per cent of remote students. Close to 11 per cent of Year 8 students in remote schools did not reach the low benchmark, compared to eight per cent of metropolitan and provincial students.

The proportions of metropolitan and provincial students at each of the benchmarks were very similar to those for Australia as a whole and to the international median. The proportions of Year 8 students in remote schools achieving the advanced and high benchmarks, however, were lower than the international median (2% and 14% compared to 3% and 17%, respectively), whereas the proportions were comparatively higher at the intermediate and low benchmarks (56% and 89% compared to 49% and 78%, respectively).



**Figure 4.12B** Percentages of students reaching the International Benchmarks for science achievement by geographic location, Year 8

## Performance by language background

How often English is spoken at home is a factor that is associated with achievement, both in past cycles of TIMSS and in other similar studies. Students who come from homes where English is not spoken frequently have less exposure to the language of instruction and the test, which may place them at a disadvantage. In 2007, across most participating countries, students in both Year 4 and Year 8 who did not speak the language of the test had lower average science achievement than those who spoke the language of the test always or almost always.

Table 4.4A shows the mean scores and associated standard errors for science at Year 4 for those students whose language background is English and for those students for whom this was not the case. At the Year 4 level, students who spoke English at home achieved 53 score points higher on average than students who spoke a language other than English at home, a statistically significant difference.

**Table 4.4A** Average science achievement by language background, Year 4

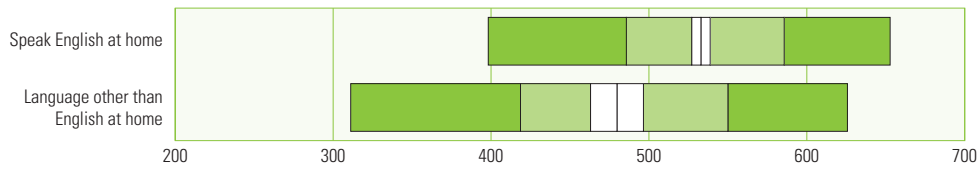
	Percentage of students	Average	SE
Speak English at home	90	533	(3.0)
Language other than English at home	10	480	(8.6)

Table 4.4B presents mean scores and associated standard errors for science achievement of Year 8 students according to the language spoken at home. English-speaking students had a significantly higher average science achievement (517 score points) than students who spoke a language other than English at home (478 score points).

**Table 4.4B** Average science achievement by language background, Year 8

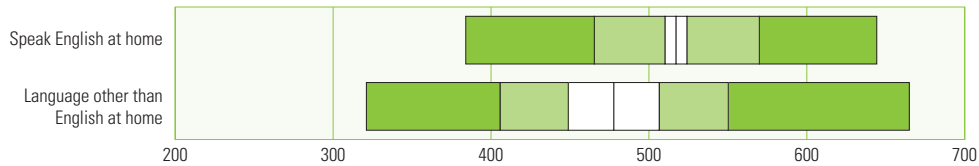
	Percentage of students	Average	SE
Speak English at home	96	517	(3.5)
Language other than English at home	4	478	(14.7)

Figure 4.13A shows the distribution of Year 4 science mean scores and percentiles by language background. The difference in scores between the 5<sup>th</sup> and 95<sup>th</sup> percentiles is 255 score points for those students who spoke English at home and 315 for those who did not speak English at home.



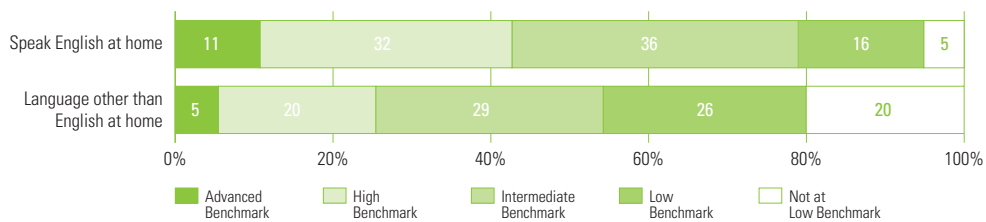
**Figure 4.13A** Distribution of science achievement scores by language background, Year 4

Figure 4.13B shows that, as well as the lower average achievement of Year 8 students who spoke a language other than English at home, the distribution of scores for these students is much larger than that of English-speaking students. That is, the distribution ranges from 321 for the 5<sup>th</sup> percentile to 665 for the 95<sup>th</sup> percentile (344 score points), compared to 384 to 644 for English-speaking students (a range of 260 score points).



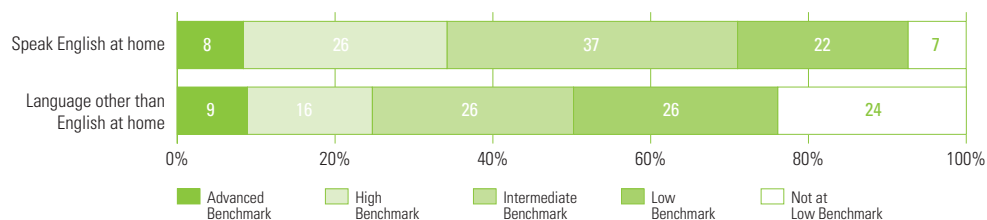
**Figure 4.13B** Distribution of science achievement scores by language background, Year 8

Prior findings about the poor performance of students from a non-English speaking background can be confirmed by examining the proportion of students at each of the international benchmarks, shown in Figure 4.14A. At the higher levels, 43 per cent of English-speaking students compared with 25 per cent of those with a language background other than English were found to be achieving at or above the high international benchmark in Year 4 science. At the other end of the spectrum, 20 per cent of students with a language background other than English were found to be achieving below the low international benchmark, compared to only five per cent of English-speaking students. Just over one-quarter of students with a language background other than English reached the low international benchmark compared to 16 per cent of English-speaking students.



**Figure 4.14A** Percentages of students reaching the international benchmarks for science achievement by language background, Year 4

As seen in Figure 4.14B, while similar proportions of Year 8 students who spoke English at home and those who spoke a language other than English achieved the advanced benchmark (8% and 9%, respectively), larger proportions of English-speaking students performed at each of the other benchmarks. Strikingly, 24 per cent of students who spoke a language other than English at home did not reach the low benchmark, compared to only seven per cent of English-speaking students who did not meet this minimum standard.



**Figure 4.14B** Percentages of students reaching the international benchmarks for science achievement by language background, Year 8

### Performance by level of parental education

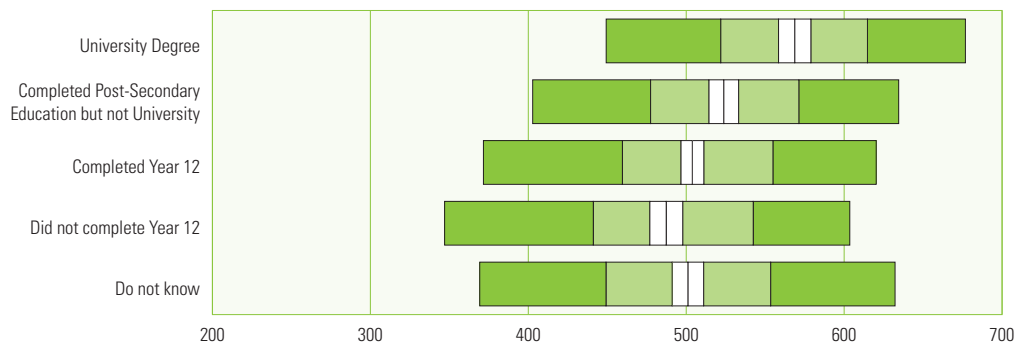
Parental education has often been found to be highly related to student achievement. Year 8 students who participated in TIMSS 2007 were asked to indicate the highest level of education attained by each of their parents or guardians (refer to the Reader's Guide for more information). Across almost all of the participating countries, higher parental education was associated with higher average science achievement. However, as reported in Chapter 3, in Australia (and in nine other countries), there was a high level of "Do not know" responses – about 28 per cent of Australian Year 8 students were unable to provide a response to this question.

Table 4.5 shows the mean scores and associated standard errors in science for Year 8 Australian students according to the highest level of education attained by either parent. The mean score increases as the level of parental education increases, with students who have at least one parent with a university degree having an average science score about 82 points higher than that of students whose parents did not complete secondary school. Most differences are statistically significant.

**Table 4.5** Average science achievement by parental education, Year 8

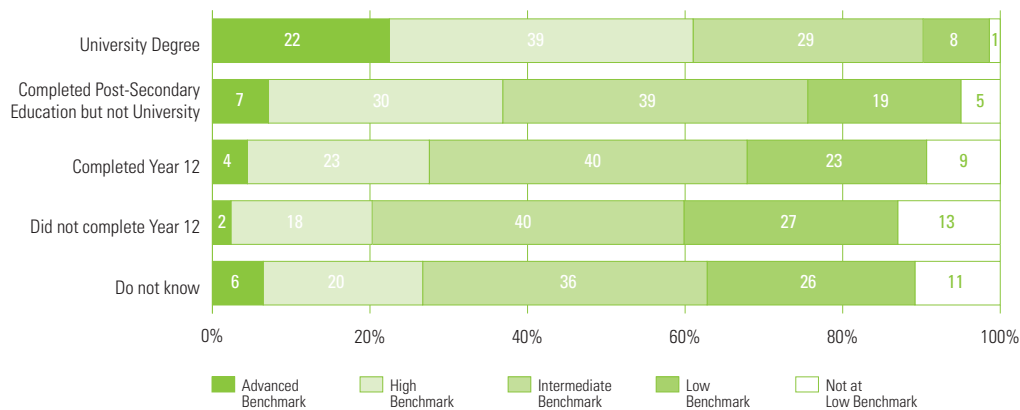
	Percentage of students	Average	SE
University Degree	19	569	(5.2)
Completed Post-Secondary Education but not University	23	524	(4.8)
Completed Year 12	16	504	(3.7)
Did not complete Year 12	15	487	(5.3)
Do not know	28	501	(5.1)

Figure 4.15 shows the spread of scores in science achievement for Year 8 students according to parental education. The spread of scores between the 5<sup>th</sup> and 95<sup>th</sup> percentiles are not greatly different for these groups, ranging between 227 score points for students with at least one parent that had completed a university degree to 262 score points for students who do not know what education level their parents had completed.



**Figure 4.15** Distribution of science achievement scores by parental education, Year 8

Figure 4.16 shows the percentage of Year 8 students at each of the international benchmarks according to parental education. Twenty-two per cent of students who had at least one parent complete a university degree reached the advanced benchmark compared to seven per cent or less for all other parental education groups. In comparison, 13 per cent of students whose parents did not complete secondary school did not reach the low benchmark, compared to only one per cent of those with at least one parent holding a university degree.



**Figure 4.16** Percentages of students reaching the international benchmarks for science achievement by parental education, Year 8

## Achievement in the TIMSS content and cognitive domains

As outlined in Chapter 2, the TIMSS science assessment can be described in terms of content and cognitive domains. The content domains outline the subject matter to be assessed. At Year 4 the content domains are *life science*, *physical science* and *Earth science*. At Year 8 the content domains are *biology*, *chemistry*, *physics* and *Earth science*. The cognitive domain details the thinking processes that students will need to employ in responding to the questions. At both year levels, the cognitive domains are *knowing*, *applying* and *reasoning*. Each item is associated with a single content domain and a single cognitive domain.

To simplify comparisons of student achievement across the domains, the content and cognitive achievement scales at each year level were constructed to have the same average difficulty (see the Reader's Guide). Tables 4.6A and 4.6B present the average achievement in each of the content and cognitive domains for Years 4 and 8, in each of the participating countries. Countries are displayed in alphabetical order, and to provide a basis for comparison, symbols indicate whether a country's performance is statistically above or below the TIMSS scale average of 500<sup>2</sup>.

Table 4.6A shows science content and cognitive domain means for Australia and the other TIMSS 2007 countries. At Year 4 level, Singapore was the highest achieving country in *life science* (582) and *physical science* (585), while Hong Kong was the highest achieving country in *Earth science* (560). Qatar was the lowest achieving country in *life science* (291) and *physical science* (305), while Morocco was the lowest achieving country in *Earth science* (293). Both of these results were significantly lower than the TIMSS scale average.

Australian Year 4 students' achievement in all three content areas was significantly higher than the TIMSS scale average. At Year 4, the weakest area for Australia was *physical science*, although this result was still significantly higher than the international average. In contrast, Australian students in Year 4 performed the best in *Earth science*. Overall, 13 countries achieved their highest average scale scores in the *physical science* content domain, with a similar number of countries (11) achieving their best in *life science* or *Earth science*.

Table 4.6A also highlights the broad range of achievement across countries in the cognitive domains. At Year 4 level, Singapore achieved the highest average scale score for science in the *knowing* and *applying* cognitive domains, and Chinese Taipei achieved the highest scale score in the *reasoning* cognitive domain. Twenty-one countries achieved significantly higher than the TIMSS scale average in the *reasoning* domain, while in the *applying* domain 21 countries achieved significantly higher than the TIMSS scale average, and 23 countries achieved significantly higher than the scale average in the *knowing* cognitive domain. Australian Year 4 students performed at a level statistically significantly higher than the TIMSS scale average for all three of the cognitive domains.

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<sup>2</sup> Note that this refers to the mid-point of the TIMSS achievement scale and not the average of the country means.

**Table 4.6A** Average achievement in the science content and cognitive domains by country, Year 4

Country	Average Scale Scores for Science Content Domains						Average Scale Scores for Science Cognitive Domains					
	Earth Science		Life Science		Physical Science		Knowing		Applying		Reasoning	
Algeria	365	(5.7) ▼	351	(6.2) ▼	377	(5.3) ▼	350	(5.8) ▼	379	(5.7) ▼	357	(5.8) ▼
Armenia	479	(5.5) ▼	489	(5.9) ▼	492	(5.1) ▼	486	(5.2) ▼	487	(5.6) ▼	484	(5.3) ▼
<b>Australia</b>	<b>534</b>	<b>(3.2) ▲</b>	<b>528</b>	<b>(3.4) ▲</b>	<b>522</b>	<b>(3.1) ▲</b>	<b>529</b>	<b>(3.1) ▲</b>	<b>523</b>	<b>(3.3) ▲</b>	<b>530</b>	<b>(3.4) ▲</b>
Austria	532	(1.9) ▲	526	(2.0) ▲	514	(2.4) ▲	529	(2.0) ▲	526	(2.2) ▲	513	(2.3) ▲
Chinese Taipei	553	(1.9) ▲	541	(2.1) ▲	559	(2.5) ▲	536	(2.5) ▲	556	(2.1) ▲	571	(2.4) ▲
Colombia	401	(5.6) ▼	408	(5.2) ▼	411	(4.9) ▼	409	(5.5) ▼	404	(5.4) ▼	409	(5.1) ▼
Czech Republic	518	(2.6) ▲	520	(2.9) ▲	511	(2.8) ▲	520	(2.7) ▲	516	(3.1) ▲	510	(2.9) ▲
† Denmark	522	(2.7) ▲	527	(2.4) ▲	502	(2.5) ▲	516	(2.9) ▲	515	(2.6) ▲	525	(3.8) ▲
El Salvador	393	(3.3) ▼	410	(3.6) ▼	392	(3.8) ▼	410	(3.9) ▼	393	(3.6) ▼	376	(4.0) ▼
England	538	(2.9) ▲	532	(2.7) ▲	543	(2.7) ▲	543	(2.9) ▲	536	(2.7) ▲	537	(2.7) ▲
1 Georgia	432	(5.0) ▼	427	(3.5) ▼	414	(4.0) ▼	434	(3.8) ▼	424	(4.1) ▼	388	(4.9) ▼
Germany	524	(2.4) ▲	529	(2.0) ▲	524	(2.5) ▲	527	(2.2) ▲	526	(2.2) ▲	525	(2.3) ▲
Hong Kong SAR	560	(3.2) ▲	532	(3.5) ▲	558	(3.5) ▲	546	(3.2) ▲	549	(3.0) ▲	561	(4.4) ▲
Hungary	517	(3.5) ▲	548	(2.8) ▲	529	(3.3) ▲	540	(3.0) ▲	531	(3.2) ▲	529	(3.7) ▲
Iran, Islamic Rep. of	433	(4.1) ▼	442	(4.4) ▼	454	(4.2) ▼	437	(4.3) ▼	451	(4.3) ▼	436	(4.3) ▼
Italy	526	(3.0) ▲	549	(3.0) ▲	521	(3.1) ▲	530	(3.9) ▲	539	(3.1) ▲	526	(3.8) ▲
Japan	529	(2.7) ▲	530	(2.0) ▲	564	(2.3) ▲	528	(2.2) ▲	542	(2.7) ▲	567	(2.1) ▲
1 Kazakhstan	534	(5.2) ▲	528	(5.0) ▲	528	(5.8) ▲	534	(5.8) ▲	536	(4.9) ▲	519	(5.3) ▲
¿ Kuwait	363	(3.8) ▼	353	(4.9) ▼	345	(5.2) ▼	360	(3.9) ▼	338	(4.3) ▼	331	(5.4) ▼
1 Latvia	536	(2.2) ▲	535	(2.1) ▲	544	(2.4) ▲	540	(2.2) ▲	535	(2.4) ▲	551	(2.7) ▲
1 Lithuania	511	(2.5) ▲	516	(1.8) ▲	514	(1.4) ▲	511	(1.7) ▲	515	(2.8) ▲	524	(2.4) ▲
Morocco	293	(6.2) ▼	292	(6.8) ▼	324	(5.5) ▼	291	(5.8) ▼	311	(6.3) ▼	318	(5.4) ▼
‡ Netherlands	524	(2.5) ▲	536	(2.2) ▲	503	(2.3) ▲	518	(2.5) ▲	525	(2.4) ▲	525	(2.3) ▲
New Zealand	515	(2.6) ▲	506	(2.5) ▲	498	(2.5) ▲	511	(2.5) ▲	500	(2.2) ▲	505	(2.9) ▲
Norway	497	(2.9) ▲	487	(2.5) ▼	469	(2.7) ▼	485	(2.4) ▼	478	(2.8) ▼	480	(3.2) ▼
Qatar	305	(2.2) ▼	291	(1.4) ▼	303	(2.1) ▼	304	(2.3) ▼	283	(2.7) ▼	293	(2.9) ▼
Russian Federation	536	(4.3) ▲	539	(4.1) ▲	547	(4.6) ▲	542	(4.8) ▲	546	(4.7) ▲	542	(4.6) ▲
† Scotland	508	(2.5) ▲	504	(2.2) ▲	499	(1.9) ▲	511	(2.0) ▲	494	(2.4) ▼	501	(2.2) ▲
Singapore	554	(3.3) ▲	582	(4.1) ▲	585	(3.9) ▲	587	(4.1) ▲	579	(3.7) ▲	568	(3.7) ▲
Slovak Republic	530	(4.8) ▲	532	(4.0) ▲	513	(4.6) ▲	527	(4.4) ▲	527	(4.4) ▲	513	(4.9) ▲
Slovenia	517	(2.5) ▲	511	(2.2) ▲	530	(1.6) ▲	511	(1.6) ▲	525	(2.1) ▲	527	(1.8) ▲
Sweden	535	(2.7) ▲	531	(2.5) ▲	508	(2.7) ▲	526	(2.5) ▲	521	(2.9) ▲	527	(3.5) ▲
Tunisia	325	(5.8) ▼	323	(5.6) ▼	340	(6.4) ▼	316	(5.9) ▼	329	(6.3) ▼	349	(5.3) ▼
Ukraine	474	(3.1) ▼	482	(2.5) ▼	475	(2.7) ▼	476	(2.4) ▼	477	(3.2) ▼	478	(3.0) ▼
2† United States	533	(2.6) ▲	540	(2.5) ▲	534	(2.3) ▲	541	(2.3) ▲	533	(2.8) ▲	535	(2.6) ▲
Yemen	+	+	+	+	+	+	+	+	+	+	+	+
<b>TIMSS Scale Avg.</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>

Country average significantly higher than TIMSS scale average

▼ Country average significantly lower than TIMSS scale average

† 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.

A plus (+) sign indicates average achievement could not be accurately estimated.

Table 4.6B shows that, for Year 8 (as at Year 4), the countries scoring highest on the overall science assessment tended also to be the highest-scoring countries in each of the content and cognitive domains, and the lowest-scoring countries overall tended to be those with the lowest scores in the content and cognitive domains.

In the content area of *biology*, Singapore had the highest average achievement. In *chemistry*, Chinese Taipei had the highest achievement, and Singapore and Korea had the highest average achievement in *physics*. In *Earth science*, the highest performing countries were Chinese Taipei, Slovenia, Singapore and Korea. Australian students' performance in both *Earth science* and *biology* was significantly higher than the TIMSS scale average, while Year 8 students' performance in *chemistry* and *physics* was not statistically different from the TIMSS scale average.

In the *knowing* domain, the top performer was Chinese Taipei, followed by Singapore. Singapore and Chinese Taipei had the highest achievement in the *applying* domain. Singapore, Japan and Korea were the top performers in the *reasoning* domain.

Australian Year 8 students performed higher than the TIMSS scale average in *applying* and *reasoning*, while their average performance in the *knowing* domain was at a similar level to the TIMSS scale average.

**Table 4.6B** Average achievement in the science content and cognitive domains by country, Year 8

Country	Average Scale Scores for Science Content Domains								Average Scale Scores for Science Cognitive Domains					
	Chemistry		Earth Science		Biology		Physics		Knowing		Applying		Reasoning	
Algeria	414	(1.7) ▼	413	(1.6) ▼	411	(1.9) ▼	397	(2.2) ▼	409	(1.9) ▼	410	(2.4) ▼	414	(1.9) ▼
Armenia	478	(6.3) ▼	475	(5.8) ▼	490	(5.9) ▼	503	(5.6) ▼	493	(6.4) ▼	502	(5.4) ▼	459	(6.5) ▼
<b>Australia</b>	<b>505</b>	<b>(3.6)</b>	<b>519</b>	<b>(3.8)</b> ▲	<b>518</b>	<b>(3.4)</b> ▲	<b>508</b>	<b>(4.2)</b>	<b>501</b>	<b>(3.1)</b>	<b>510</b>	<b>(3.2)</b> ▲	<b>530</b>	<b>(3.6)</b> ▲
Bahrain	468	(2.4) ▼	465	(2.4) ▼	473	(2.0) ▼	466	(1.5) ▼	469	(2.1) ▼	468	(2.1) ▼	469	(2.0) ▼
Bosnia and Herzegovina	468	(2.9) ▼	469	(3.4) ▼	464	(3.0) ▼	463	(3.1) ▼	486	(3.7) ▼	463	(2.8) ▼	452	(3.1) ▼
Botswana	371	(2.4) ▼	361	(4.0) ▼	359	(2.9) ▼	351	(3.2) ▼	361	(2.9) ▼	358	(3.2) ▼	362	(2.7) ▼
3 Bulgaria	472	(6.1) ▼	480	(5.5) ▼	467	(6.0) ▼	466	(5.6) ▼	489	(5.8) ▼	471	(6.1) ▼	448	(6.1) ▼
Chinese Taipei	573	(4.2) ▲	545	(2.9) ▲	549	(3.4) ▲	554	(3.7) ▲	565	(3.5) ▲	560	(3.4) ▲	541	(3.5) ▲
Colombia	420	(3.1) ▼	407	(3.9) ▼	434	(3.7) ▼	407	(3.5) ▼	418	(4.0) ▼	417	(3.1) ▼	428	(2.7) ▼
Cyprus	452	(2.5) ▼	457	(2.3) ▼	447	(1.9) ▼	458	(2.8) ▼	438	(2.6) ▼	456	(2.0) ▼	460	(2.3) ▼
Czech Republic	535	(2.7) ▲	534	(2.0) ▲	531	(2.1) ▲	537	(2.1) ▲	533	(2.1) ▲	539	(1.9) ▲	534	(2.3) ▲
Egypt	413	(4.0) ▼	426	(3.8) ▼	406	(3.4) ▼	413	(3.3) ▼	434	(3.9) ▼	404	(3.6) ▼	395	(3.4) ▼
El Salvador	377	(3.2) ▼	400	(2.9) ▼	398	(3.0) ▼	380	(3.5) ▼	394	(3.2) ▼	388	(3.2) ▼	384	(3.4) ▼
† England	534	(4.0) ▲	529	(4.3) ▲	541	(4.4) ▲	545	(4.0) ▲	530	(4.9) ▲	538	(4.0) ▲	547	(4.0) ▲
1 Georgia	418	(4.6) ▼	425	(4.1) ▼	423	(3.9) ▼	416	(5.8) ▼	440	(5.1) ▼	422	(4.5) ▼	394	(4.6) ▼
Ghana	342	(4.9) ▼	294	(5.8) ▼	304	(4.9) ▼	276	(5.8) ▼	316	(5.7) ▼	291	(5.5) ▼	+	+
† Hong Kong SAR	517	(4.6) ▲	532	(4.5) ▲	527	(4.6) ▲	528	(4.8) ▲	532	(4.5) ▲	522	(4.9) ▲	533	(5.0) ▲
Hungary	536	(3.5) ▲	531	(2.9) ▲	534	(2.7) ▲	541	(3.2) ▲	524	(3.0) ▲	549	(3.0) ▲	530	(3.0) ▲
Indonesia	421	(3.4) ▼	442	(3.3) ▼	428	(3.1) ▼	432	(3.1) ▼	426	(3.6) ▼	425	(3.1) ▼	438	(3.2) ▼
Iran, Islamic Rep. of	463	(3.5) ▼	476	(3.7) ▼	449	(3.6) ▼	470	(3.6) ▼	468	(3.9) ▼	454	(3.8) ▼	462	(3.8) ▼
3 Israel	467	(4.6) ▼	462	(4.1) ▼	472	(4.2) ▼	472	(4.6) ▼	456	(5.0) ▼	472	(4.2) ▼	481	(4.2) ▼
Italy	481	(2.9) ▼	503	(3.1) ▼	502	(3.0) ▼	489	(3.1) ▼	494	(3.3) ▼	498	(2.9) ▼	493	(2.6) ▼
Japan	551	(1.9) ▲	533	(2.5) ▲	553	(1.9) ▲	558	(1.9) ▲	534	(2.2) ▲	555	(2.0) ▲	560	(2.0) ▲
Jordan	491	(4.1) ▼	484	(3.6) ▼	478	(3.8) ▼	479	(4.2) ▼	491	(4.5) ▼	485	(4.1) ▼	471	(4.1) ▼
Korea, Rep. of	536	(2.4) ▲	538	(2.2) ▲	548	(1.9) ▲	571	(2.4) ▲	543	(2.0) ▲	547	(2.0) ▲	558	(2.0) ▲
¿ Kuwait	418	(3.8) ▼	410	(3.0) ▼	419	(2.6) ▼	438	(2.8) ▼	430	(2.5) ▼	417	(2.9) ▼	411	(2.9) ▼
Lebanon	447	(5.5) ▼	389	(6.4) ▼	405	(6.2) ▼	431	(5.1) ▼	403	(5.9) ▼	422	(5.8) ▼	420	(5.6) ▼
1 Lithuania	507	(2.3) ▲	515	(2.5) ▲	527	(2.3) ▲	505	(2.9) ▼	513	(2.4) ▲	512	(2.2) ▲	527	(2.5) ▲
Malaysia	479	(5.0) ▼	463	(5.4) ▼	469	(5.8) ▼	484	(5.7) ▼	458	(6.5) ▼	473	(5.9) ▼	487	(4.9) ▼
Malta	461	(2.1) ▼	456	(1.5) ▼	453	(1.7) ▼	470	(1.7) ▼	436	(1.5) ▼	462	(1.6) ▼	473	(1.4) ▼
¶ Morocco	416	(3.0) ▼	397	(3.8) ▼	395	(3.5) ▼	405	(3.1) ▼	396	(3.1) ▼	400	(3.3) ▼	413	(3.0) ▼
Norway	483	(2.2) ▼	502	(2.5) ▼	487	(2.3) ▼	475	(3.0) ▼	486	(2.0) ▼	486	(2.3) ▼	491	(2.8) ▼
Oman	416	(3.6) ▼	439	(2.5) ▼	414	(3.1) ▼	443	(2.9) ▼	428	(3.5) ▼	423	(3.2) ▼	428	(3.5) ▼
Palestinian Nat'l Auth.	413	(4.2) ▼	408	(3.7) ▼	402	(4.1) ▼	414	(3.7) ▼	407	(3.5) ▼	412	(4.0) ▼	396	(3.8) ▼
Qatar	322	(1.8) ▼	312	(1.9) ▼	318	(1.7) ▼	347	(2.1) ▼	325	(1.7) ▼	322	(1.5) ▼	+	+
Romania	463	(4.0) ▼	471	(3.3) ▼	459	(3.2) ▼	458	(3.4) ▼	451	(4.2) ▼	470	(3.5) ▼	460	(3.5) ▼
Russian Federation	535	(3.7) ▲	525	(3.4) ▲	525	(3.6) ▲	519	(4.0) ▲	534	(4.3) ▲	527	(3.8) ▲	520	(3.7) ▲
Saudi Arabia	390	(2.5) ▼	423	(2.3) ▼	407	(2.4) ▼	408	(2.3) ▼	417	(2.1) ▼	403	(2.7) ▼	395	(2.5) ▼
† Scotland	497	(3.2) ▼	498	(3.2) ▼	495	(3.2) ▼	494	(3.7) ▼	480	(3.9) ▼	495	(3.1) ▼	511	(3.6) ▲
12 Serbia	467	(3.7) ▼	466	(3.8) ▼	474	(3.2) ▼	467	(3.0) ▼	485	(2.8) ▼	469	(3.6) ▼	455	(3.5) ▼
Singapore	560	(4.1) ▲	541	(4.1) ▲	564	(4.2) ▲	575	(3.9) ▲	554	(4.5) ▲	567	(4.2) ▲	564	(4.1) ▲
Slovenia	539	(2.5) ▲	542	(2.2) ▲	530	(2.3) ▲	524	(2.0) ▲	533	(2.0) ▲	533	(2.2) ▲	538	(2.2) ▲
Sweden	499	(2.4) ▼	510	(3.0) ▲	515	(2.4) ▲	506	(2.7) ▲	505	(2.3) ▲	509	(2.7) ▲	517	(2.6) ▲
Syrian Arab Republic	450	(2.9) ▼	448	(3.2) ▼	459	(2.7) ▼	447	(2.7) ▼	474	(2.9) ▼	445	(3.0) ▼	440	(2.7) ▼
Thailand	462	(4.1) ▼	488	(3.8) ▼	478	(4.5) ▼	458	(4.2) ▼	473	(4.4) ▼	472	(4.1) ▼	473	(4.0) ▼
Tunisia	458	(2.5) ▼	447	(1.8) ▼	452	(2.2) ▼	432	(2.5) ▼	441	(2.0) ▼	445	(2.3) ▼	458	(2.9) ▼
Turkey	435	(5.2) ▼	466	(3.3) ▼	462	(3.4) ▼	445	(4.3) ▼	462	(3.6) ▼	450	(3.6) ▼	462	(3.4) ▼
Ukraine	490	(3.3) ▼	482	(4.0) ▼	477	(3.4) ▼	492	(3.9) ▼	477	(3.8) ▼	488	(3.7) ▼	488	(3.9) ▼
2† United States	510	(2.7) ▲	525	(3.1) ▲	530	(2.8) ▲	503	(2.7) ▼	512	(2.9) ▲	516	(2.7) ▲	529	(2.9) ▲
<b>TIMSS Scale Avg.</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>	<b>500</b>	<b>(0.0)</b>

▲ Country average significantly higher than TIMSS scale average  
▼ Country average significantly lower than TIMSS scale average

† Met 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 (see Appendix A).

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.

A plus (+) sign indicates average achievement could not be accurately estimated.

## Achievement in the content and cognitive domains by state

Tables 4.7A and 4.7B present the average content and cognitive domain scores for the states.

Table 4.7A shows the average achievement for each of the states in each of the Year 4 science content and cognitive domains. For each domain, Victoria had the highest mean score. In contrast, the Northern Territory achieved the lowest mean scores, with the exception being in the content domain of *life science* and the cognitive domains of *applying* and *reasoning*, in which Queensland achieved slightly lower than the Northern Territory. Overall, the order of the states in their performance in each domain was fairly similar, with only minor shifts depending on the domain.

**Table 4.7A** Average achievement in the science content and cognitive domains by state, Year 4

	Average Scale Scores for Science Content Domains						Average Scale Scores for Science Cognitive Domains					
	Earth Science		Life Science		Physical Science		Knowing		Applying		Reasoning	
NSW	541	(6.0)	536	(5.4)	532	(5.2)	537	(6.0)	533	(5.5)	539	(6.0)
VIC	549	(6.7)	544	(7.6)	534	(6.7)	544	(7.7)	537	(8.7)	545	(8.5)
QLD	514	(6.7)	505	(6.7)	502	(5.9)	507	(6.0)	498	(6.5)	507	(6.6)
SA	523	(8.1)	516	(8.8)	511	(8.2)	519	(9.5)	513	(9.6)	515	(8.2)
WA	523	(6.2)	517	(4.4)	506	(4.2)	516	(5.2)	508	(6.0)	518	(5.5)
TAS	537	(5.8)	536	(5.0)	527	(5.8)	535	(6.5)	529	(6.0)	537	(6.8)
NT	509	(9.3)	508	(9.0)	498	(11.3)	506	(9.9)	500	(10.8)	510	(9.3)
ACT	533	(8.7)	525	(8.3)	520	(8.3)	527	(9.1)	522	(8.9)	533	(9.6)

Table 4.7B shows the average achievement for each of the states on each of the Year 8 science content and cognitive domains. For each domain, the Australian Capital Territory had the highest mean score. The Northern Territory had the lowest mean score in most domains, except for *chemistry* where Western Australia had the equal lowest score, and *Earth science* where Western Australia was lowest. However, as for the overall science achievement score, none of the between-state comparisons were statistically significant.

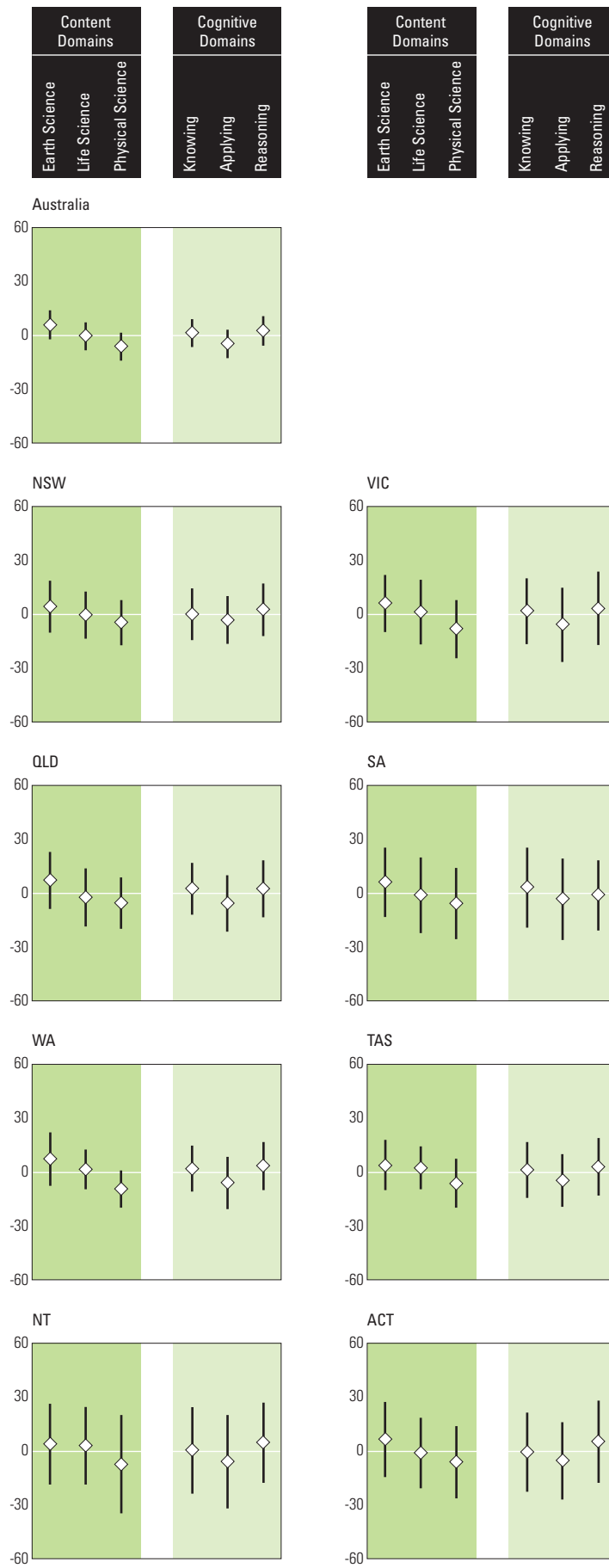
**Table 4.7B** Average achievement in the science content and cognitive domains by state, Year 8

	Average Scale Scores for Science Content Domains								Average Scale Scores for Science Cognitive Domains					
	Chemistry		Earth Science		Biology		Physics		Knowing		Applying		Reasoning	
NSW	512	(9.0)	526	(9.5)	524	(9.0)	512	(9.4)	508	(8.4)	515	(8.0)	537	(8.7)
VIC	502	(6.4)	515	(8.2)	517	(7.3)	504	(8.0)	498	(6.3)	507	(6.9)	528	(7.3)
QLD	501	(4.6)	517	(5.2)	516	(4.6)	506	(4.3)	496	(3.9)	508	(4.2)	525	(5.3)
SA	504	(6.3)	519	(7.1)	517	(6.4)	507	(6.6)	497	(6.2)	510	(6.0)	531	(7.6)
WA	496	(6.6)	511	(8.0)	512	(7.7)	503	(7.8)	494	(8.4)	505	(7.3)	523	(8.7)
TAS	498	(6.6)	515	(6.2)	510	(6.2)	503	(7.2)	494	(5.8)	503	(6.3)	527	(7.3)
NT	496	(10.5)	513	(11.1)	505	(11.1)	498	(9.5)	488	(10.0)	501	(8.8)	516	(9.8)
ACT	529	(17.4)	547	(18.8)	538	(19.0)	530	(19.7)	523	(17.9)	532	(18.5)	554	(20.3)

Figures 4.17A and 4.17B highlight relative strengths and weaknesses in the science content and cognitive domains for each of the states, and for Australia as a whole, by profiling average achievement in these domains relative to the overall science achievement for that state. Relative performance is calculated as the difference between the average performance in each science content (or cognitive) domain and the average across the content (or cognitive domains). This relative performance is presented in Figures 4.17A and 4.17B as the difference from zero (the average across content or cognitive domains) and is represented by a small circle, with a bar extending above and below the circle to denote the 95% confidence interval around this value.

Figure 4.17A shows the average and confidence intervals for each of the Year 4 science content areas (*life science*, *physical science* and *Earth science*) and cognitive domains (*knowing*, *applying* and *reasoning*) for each of the Australian states. For Australia as a whole, Year 4 students performed less well in *physical science* and *life science*, while they performed considerably better in *Earth science*.

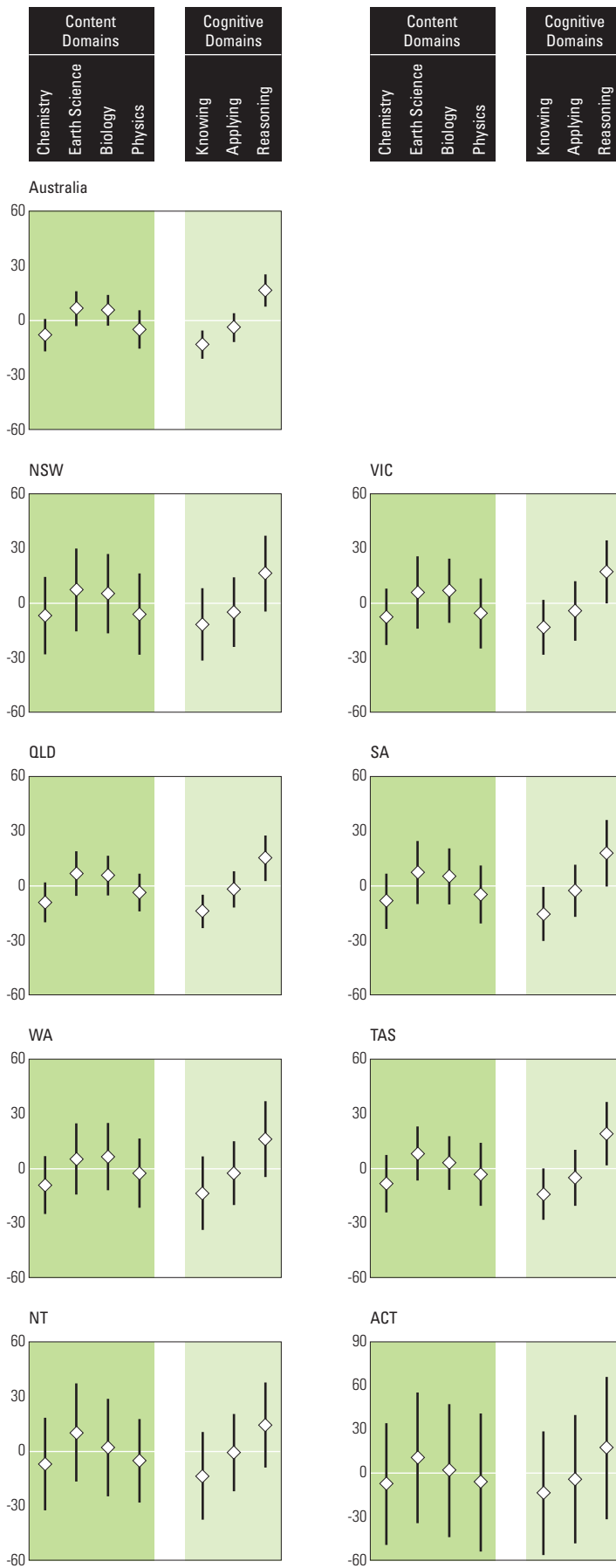
In terms of the cognitive domains, Australian Year 4 students performed less well in the *applying* domain while they performed better in the *reasoning* and *knowing* domains.



**Figure 4.17A** Profiles of relative performance in the science content and cognitive domains within Australia and the states, Year 4

Figure 4.17A and 4.17B show that, at both Year 4 and Year 8, the same pattern of strengths and weaknesses in the science content and cognitive domains can be found in each of the states, mirroring the strengths and weaknesses identified for Australia as a whole. Thus, across the states, as well as for Australia as a whole, Year 8 students 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.



**Figure 4.17B** Profiles of relative performance in the science content and cognitive domains within Australia and the states, Year 8

## Achievement in the content and cognitive domains by gender

Males and females have different strengths and weaknesses across the content and cognitive domains. Tables 4.8A and 4.8B provide the average performance in each of the content and cognitive domains for males and females across the states.

At the Year 4 level there were some apparent variations in performance across the states in the different content areas; however, there were no statistically significant gender differences in the content domains.

Similarly in terms of cognitive domains, while there was some variation in scores, the only significant difference was in *applying* for Australia as a whole.

**Table 4.8A** Average achievement in the science content and cognitive domains by gender within state, Year 4

	Average Scale Scores for Science Content Domains											
	Earth Science				Life Science				Physical Science			
	Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	535	(7.1)	546	(7.4)	534	(5.3)	538	(7.1)	527	(5.5)	537	(6.9)
VIC	546	(6.7)	552	(9.0)	541	(7.4)	546	(9.6)	532	(6.6)	537	(9.5)
QLD	510	(9.0)	519	(6.4)	505	(8.8)	504	(6.8)	499	(8.7)	504	(5.4)
SA	522	(7.8)	524	(12.3)	519	(7.6)	513	(12.5)	511	(7.9)	511	(11.5)
WA	524	(7.5)	522	(7.8)	519	(6.4)	515	(6.0)	507	(5.4)	505	(5.8)
TAS	534	(5.6)	539	(9.0)	538	(6.4)	534	(7.9)	527	(8.1)	527	(7.8)
NT	505	(12.9)	513	(14.0)	509	(12.8)	507	(16.3)	499	(12.8)	496	(16.7)
ACT	535	(10.4)	531	(9.5)	528	(9.0)	522	(8.1)	523	(9.0)	517	(9.1)
Australia	531	(4.3)	538	(3.6)	528	(3.7)	529	(4.0)	520	(3.4)	525	(3.6)
International Average	483	(0.7)	485	(0.7)	487	(0.7)	483	(0.8)	486	(0.7)	482	(0.7)

	Average Scale Scores for Science Cognitive Domains											
	Knowing				Applying				Reasoning			
	Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	534	(6.1)	540	(8.1)	526	(7.0)	541	(7.7)	539	(6.7)	539	(8.2)
VIC	541	(7.1)	547	(10.5)	530	(9.0)	543	(10.7)	549	(9.2)	541	(10.1)
QLD	503	(8.5)	510	(5.8)	491	(8.8)	506	(6.3)	510	(8.2)	503	(7.0)
SA	521	(6.9)	517	(13.9)	511	(8.1)	514	(13.6)	525	(6.9)	506	(12.0)
WA	516	(7.6)	516	(6.9)	507	(8.3)	510	(6.4)	528	(7.3)	508	(8.2)
TAS	535	(7.9)	535	(9.8)	524	(9.5)	534	(8.2)	545	(10.4)	529	(8.3)
NT	505	(11.6)	507	(13.7)	498	(15.7)	501	(13.4)	520	(11.8)	501	(13.3)
ACT	529	(10.4)	524	(9.6)	522	(11.9)	522	(8.1)	540	(12.0)	523	(11.6)
Australia	527	(3.3)	531	(3.9)	517	(4.2)	529	(4.0)	534	(4.2)	526	(4.0)
International Average	484	(0.7)	485	(0.7)	485	(0.7)	484	(0.7)	490	(0.7)	478	(0.7)

Table 4.8B shows that, for Australia as a whole, the gender differences in favour of males are statistically significant for *chemistry*, *Earth science* and *physics* in the content domains, and for *knowing* and *applying* in the cognitive domains. This is in contrast to the situation internationally, in which females performed better on average than males in *chemistry* and *biology*, while males performed significantly better than females in *physics*. There was no gender difference in achievement internationally in the *Earth science* content domain.

At the state level, all of the significant differences were in favour of males. The gender difference in favour of males was significant in all domains in Queensland. In addition, the gender difference in favour of males for the domains of *Earth science*, *physics* and *knowing* were also significant in New South Wales and Tasmania.

**Table 4.8B** Average achievement in the science content and cognitive domains by gender within state, Year 8

	Average Scale Scores for Science Content Domains															
	Chemistry				Earth Science				Biology				Physics			
	Girls		Boys		Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	496	(13.3)	526	(12.4)	505	(15.5)	546	(11.5)	513	(14.7)	534	(12.0)	489	(14.8)	534	(11.7)
VIC	503	(8.8)	501	(7.9)	510	(11.5)	521	(7.7)	523	(10.1)	511	(7.8)	496	(10.1)	512	(8.6)
QLD	488	(5.4)	512	(5.8)	498	(8.0)	533	(5.7)	507	(6.8)	523	(5.6)	488	(5.2)	522	(5.7)
SA	505	(7.9)	503	(5.4)	515	(10.1)	523	(5.9)	523	(8.0)	512	(5.6)	499	(8.5)	514	(6.1)
WA	492	(7.7)	501	(7.7)	499	(9.0)	522	(10.9)	509	(9.1)	515	(9.7)	491	(8.2)	515	(9.7)
TAS	491	(7.6)	504	(8.2)	502	(7.7)	525	(8.0)	506	(6.8)	513	(8.7)	489	(9.3)	515	(8.5)
NT	497	(11.4)	495	(12.0)	508	(9.9)	517	(14.0)	510	(10.4)	500	(13.2)	494	(11.6)	501	(11.0)
ACT	520	(24.0)	537	(21.7)	533	(21.6)	560	(23.2)	533	(26.3)	543	(21.5)	514	(23.1)	546	(24.0)
Australia	497	(4.3)	512	(5.6)	505	(5.6)	532	(5.2)	515	(5.0)	522	(5.1)	492	(5.5)	522	(5.6)
International Average	471	(0.6)	460	(0.6)	466	(0.5)	466	(0.6)	471	(0.6)	460	(0.6)	464	(0.6)	468	(0.6)

	Average Scale Scores for Science Cognitive Domains											
	Knowing				Applying				Reasoning			
	Girls		Boys		Girls		Boys		Girls		Boys	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
NSW	489	(14.3)	527	(11.1)	500	(12.1)	530	(10.8)	524	(14.3)	548	(11.5)
VIC	494	(9.0)	502	(6.9)	506	(9.5)	508	(7.6)	533	(9.8)	524	(8.2)
QLD	481	(5.4)	510	(5.2)	496	(5.8)	519	(5.0)	515	(7.4)	534	(5.3)
SA	492	(8.1)	502	(6.4)	508	(8.0)	512	(5.8)	536	(10.6)	527	(6.6)
WA	483	(8.2)	505	(10.5)	498	(7.4)	512	(9.3)	520	(9.0)	527	(11.3)
TAS	481	(7.9)	505	(7.7)	494	(8.3)	511	(8.2)	522	(7.8)	531	(9.8)
NT	483	(10.8)	493	(13.7)	502	(8.0)	501	(12.6)	521	(8.7)	512	(12.9)
ACT	510	(23.0)	535	(19.8)	522	(23.2)	542	(22.2)	548	(26.2)	559	(23.2)
Australia	488	(4.6)	512	(4.9)	501	(4.3)	519	(4.9)	525	(5.2)	535	(5.2)
International Average	468	(0.6)	464	(0.6)	468	(0.6)	463	(0.6)	477	(0.6)	467	(0.7)

## Summary

This chapter has described Australian Year 4 and Year 8 students' achievements in science overall, in the content and cognitive domains, and according to background characteristics of interest. Australian students acquitted themselves well in science, with the performance of Australian students at both year levels above the TIMSS scale average, although significantly below that of the highest scoring countries.

At Year 4, Singapore outscored all other participating countries. Australia's mean score of 527 was similar to eight countries, significantly lower than that of eight countries, and significantly higher than that of 19 countries and the TIMSS scale average. Australia's mean score in this cycle of TIMSS has slightly increased since 2003.

While the proportion of Australian Year 4 students at each of the international benchmarks was higher than the international median, the 10 per cent reaching the advanced benchmark was less than that of the highest scoring countries. The proportion reaching the low benchmark was, however, fairly similar to the highest performing countries.

Across the states there were some significant differences in Year 4 performance. 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.

In terms of performance at each of the international benchmarks, there was relatively little difference across the states, except for a larger proportion of students achieving the advanced benchmark in Tasmania, Victoria and New South Wales than in the other states.

At Year 4, there was no significant difference between the average performance of males and females in across the states in Australia. This is different to the results internationally where females outperformed males on average. In Australia, a higher proportion of males achieved at the advanced benchmark, while a similar proportion of males and females achieved at the low benchmark. There was no difference across the states in terms of the performance of male and female students.

Students who identified themselves as Indigenous performed at a significantly lower level than both non-Indigenous students and the TIMSS scale average. The performance of Australian Indigenous students at each of the international benchmarks was also less than the international median.

The geographic location of schools had a significant impact on science achievement at Year 4, such that metropolitan students performed better than provincial students, who similarly performed better than students in remote schools. Students from remote schools were much less likely to achieve at each of the benchmarks.

Students in Year 4 who spoke a language other than English at home achieved significantly lower on average in science than students who spoke English only. This was related to a lower proportion of students who spoke a language other than English reaching the advanced benchmark, and far more students who spoke a language other than English not reaching the low benchmark.

In terms of the content domains, Australian Year 4 students were strongest in *Earth science* and *life science* rather than in *physical science*. In the cognitive domains, performance in the areas of *reasoning* and *knowing* was relatively strong, while *applying* was the weakest area. This pattern of strengths and weaknesses was apparent for all states. There were no significant gender differences in performance in each of the three content domains.

At Year 8, Singapore and Chinese Taipei outscored all other participating countries. Australia's mean score of 515 was similar to three countries, significantly lower than that of 10 countries and significantly higher than that of 35 countries and the TIMSS scale average. However, Australia's mean score has decreased significantly since 2003.

While the proportion of Australian Year 8 students at each of the international benchmarks was higher than the international median, the eight per cent reaching the advanced benchmark was much less than that of the highest scoring countries. The proportion reaching the low benchmark was, however, similar to the proportions of students performing at this level in the highest scoring countries.

Performance across the states was fairly uniform at Year 8, with no significant differences in mean scores. There was very little variation in attainment at each of the benchmarks across the states except for the substantially larger proportion of students achieving the advanced benchmark in the Australian Capital Territory and New South Wales than in the other states.

At Year 8, there was a substantial and significant gender difference in favour of males in Australia, while internationally it was female students, on average, who outperformed males. In Australia, the higher performance of males is apparent mainly at the higher benchmarks – there is little difference in the proportion of females and males achieving at the low benchmark. At the state level, the only significant gender difference (in favour of males) was found in Queensland.

Indigenous students performed at a significantly lower level in Year 8 than both non-Indigenous students and the TIMSS scale average. The proportion of Australian Indigenous students performing at each of the international benchmarks was also smaller than the international median.

The geographic location of schools had little impact on science achievement at Year 8. Students in metropolitan and provincial schools performed at the same level, and remote students, while less likely to achieve at the higher benchmarks, were not significantly different from their metropolitan and provincial peers at other levels.

Speaking a language other than English at home was related, on average, to lower achievement in science. However, the spread of scores for these students was quite large, with the proportion of students reaching the advanced benchmark similar to that of English-speaking students, but far more not reaching the low benchmark.

Parental education was also significantly related to science achievement, with mean science achievement increasing as parental education increased. The proportion of students achieving the advanced benchmark was strikingly higher for students with at least one parent completing a university degree compared to all other parental education groups.

In terms of the content domains, Australian Year 8 students were strongest in *Earth science* and *biology* rather than in *physics* and *chemistry*. In the cognitive domains, *reasoning* was a strength, while *knowing* was an area of relative weakness. This pattern of strengths and weaknesses was apparent for all of the states. The gender difference in overall science achievement in favour of males was also found to be significant in most of the content and cognitive domains, except for *biology* and *reasoning*. The gender difference was largest (around 30 score points) for *Earth science* and *physics*.

The next chapter will explore trends over time in the mathematics and science achievement of Australian students.



# Trends in mathematics and science achievement

This chapter examines trends in mathematics and science achievement over the TIMSS cycles since 1995. Providing these results is somewhat complicated due to changes in methodology over the years since TIMSS was first conducted, and it is worthwhile noting some of these changes.

Firstly, the results presented in this chapter from TIMSS 1995 are quite different to those presented in the original TIMSS 1995 reports. The TIMSS 1995 data were rescaled after the TIMSS 1999 assessment, with the scores computed using a different psychometric model (a 3-parameter model) from the one originally used (a 1-parameter model), and set on a scale that has been used to measure trends in mathematics and science in subsequent TIMSS assessments. In essence, this means that comparisons between the original and re-scaled 1995 proficiency scores are not appropriate because of this difference in the scale metric<sup>1</sup>.

For TIMSS 1995, students were selected from the two adjacent year levels containing the largest number of nine-year-olds for Population 1 and 13-year-olds for Population 2. However at this time school entry age was not standard in Australia, nor was the year level into which students start school or move from primary schooling to secondary schooling, which meant that a range of year levels had to be selected from which to sample students. Due to these differences, data collection for TIMSS 1995 was undertaken at the following year levels:

- Years 3 and 4 and Years 7 and 8 in the ACT, NSW, Victoria and Tasmania; and
- Years 4 and 5 and Years 8 and 9 in Queensland, SA, WA and the NT.

TIMSS 1999 was a partial repeat of TIMSS 1995 conducted only at Year 8, so there is no Year 4 data. The target population for TIMSS 1999 was defined as the upper of the two adjacent year levels identified in TIMSS 1995 as Population 2. In Australia, this was interpreted as Year 8 in the ACT, NSW, Victoria and Tasmania, and Year 9 in Queensland, SA, WA and the NT, and students were sampled from these year levels. As such, this sample is not directly comparable with the samples of 1995, 2003 and 2007.

Summing up, comparisons for Australia will be made between TIMSS 1995, TIMSS 2003 and TIMSS 2007 for Year 4 and Year 8 using rescaled data from TIMSS 1995, and original data from TIMSS 2003 and TIMSS 2007.

Also, in previous years the international average has been reported, but as noted in the Reader's Guide data, are now referenced to the TIMSS scale score of 500.

<sup>1</sup> For further details, a full explanation can be found in the TIMSS 1999 Technical report (Martin, Gregory & Stemler, 2000, p. 251)

## International trends in Year 4 mathematics

In 2003 Singapore outperformed all other countries in mathematics at Year 4, and Hong Kong outperformed all countries other than Singapore. Australia's score of 499 was not significantly different to the TIMSS scale average. Australia was outperformed by all of the Asian countries other than the Philippines, plus England and the United States. The scores for New Zealand and Scotland were similar to those of Australia. Table 5.1 provides the 2003 to 2007 differences and the 1995 to 2007 differences in mathematics achievement for all participating Year 4 countries. It also provides each country's relative position to Australia in each of the assessments.

In TIMSS 2007, as was shown in Chapter 3, Australia's score in mathematics at Year 4 has increased significantly to 516 score points, and the overall increase since 1995 is about 22 score points.

At Year 4, eight countries showed higher average mathematics achievement in 2007 than in 1995. Three of these countries had significant improvement from 1995 together with significant improvement from 2003 to 2007—Hong Kong, England, and Slovenia—suggesting a sustained improvement over the 12-year period from 1995 to 2007. For the United States, Australia and Iran, the improvement in 2007 compared to 1995 largely reflects recent gains between 2003 and 2007.

Latvia and New Zealand also had higher average achievement in 2007 than 1995, but not between the two most recent assessments, indicating that the gains were essentially between 1995 and 2003. Norway appears to have recovered from an early decline, such that significant improvement between 2003 and 2007 resulted in essentially no change from 1995. Chinese Taipei and Armenia showed increased average achievement between 2003 and 2007, the two assessments they participated in.

At Year 4, four countries had lower average mathematics achievement in 2007 than in 1995. Of these, Austria and the Czech Republic have previous data only from 1995. In Hungary, the decrease reflects a recent decline between 2003 and 2007 that overshadowed an upward shift between 1995 and 2003, whereas the Netherlands has shown a relatively steady decline from assessment to assessment. Tunisia participated in 2003 and 2007 and declined between the two assessments. In Singapore, Japan, and Scotland, average mathematics achievement has remained essentially the same since 1995. The Russian Federation, Lithuania, Italy, and Morocco do not have comparable data from 1995, but average mathematics achievement did not change significantly between 2003 and 2007.

**Table 5.1** Trends in Year 4 mathematics achievement

Country	2007 Average Scale Score *		2003 to 2007 Difference**		Position relative to Australia in 2003*	1995 to 2007 Difference **		Position relative to Australia in 1995*
	Mean	SE		SE			SE	
Hong Kong	607	(3.6)	<b>32</b>	<b>(4.8)</b>	▲	<b>50</b>	<b>(5.4)</b>	▲
Singapore	599	(3.7)	5	(6.7)	▲	9	(5.9)	▲
Chinese Taipei	576	(1.7)	<b>12</b>	<b>(2.5)</b>	▲	-	-	-
Japan	568	(2.1)	4	(2.6)	▲	1	(2.8)	▲
Kazakhstan	549	(7.1)	-	-	-	-	-	-
Russian Federation	544	(4.9)	12	(6.8)	▲	-	-	-
England	541	(2.9)	<b>10</b>	<b>(4.7)</b>	▲	<b>57</b>	<b>(4.4)</b>	▼
Latvia	537	(2.3)	4	(3.8)	▲	<b>38</b>	<b>(5.1)</b>	▼
Netherlands	535	(2.1)	-5	(3.0)	▲	<b>-14</b>	<b>(3.7)</b>	▲
Lithuania	530	(2.4)	-4	(3.7)	▲	-	-	-
United States	529	(2.4)	<b>11</b>	<b>(3.4)</b>	▲	<b>11</b>	<b>(3.8)</b>	●
Germany	525	(2.3)			-			-
Denmark	523	(2.4)			-			-
<b>Australia</b>	<b>516</b>	<b>(3.5)</b>	<b>17</b>	<b>(5.3)</b>		<b>22</b>	<b>(4.9)</b>	
Hungary	510	(3.5)	<b>-19</b>	<b>(4.8)</b>	▲	<b>-12</b>	<b>(5.1)</b>	●
Italy	507	(3.1)	4	(4.8)	●			-
Austria	505	(2.0)			-	<b>-25</b>	<b>(3.5)</b>	▲
Sweden	503	(2.5)			-			-
Slovenia	502	(1.8)	<b>23</b>	<b>(3.2)</b>	▼	<b>40</b>	<b>(3.6)</b>	●
<b>TIMSS Scale average</b>	<b>500</b>				●			●
Armenia	500	(4.3)	<b>44</b>	<b>(5.5)</b>	▼			-
Slovak Republic	496	(4.5)			-			-
Scotland	494	(2.2)	4	(3.9)	●	1	(4.7)	▼
New Zealand	492	(2.3)	-3	(3.2)	●	<b>23</b>	<b>(5.0)</b>	▼
Czech Republic	486	(2.8)			-	<b>-54</b>	<b>(4.0)</b>	▲
Norway	473	(2.5)	<b>22</b>	<b>(3.5)</b>	▼	-3	(4.1)	▼
Ukraine	469	(2.9)			-			-
Georgia	438	(4.2)			-			-
Iran, Islamic Rep.	402	(4.1)	<b>13</b>	<b>(5.7)</b>	▼	<b>15</b>	<b>(6.6)</b>	▼
Algeria	378	(5.2)			-			-
Colombia	355	(5.0)			-			-
Morocco	341	(4.7)	-6	(6.7)	▼			-
El Salvador	330	(4.1)			-			-
Tunisia	327	(4.5)	<b>-13</b>	<b>(6.5)</b>	▼			-
Kuwait	316	(3.6)			-			-
Qatar	296	(1.0)			-			-
Yemen	224	(6.0)			-			-

\* ▲ or ● score statistically higher than Australia    ▼ or ● score statistically lower than Australia

● Score not significantly different to that of Australia

\*\* Figures in bold are significant    - Did not participate in this cycle

In terms of relative position internationally, Australia was still outperformed at Year 4 in 2007 by all of the Asian countries other than the Philippines (which did not participate in TIMSS 2007), as well as England and the United States. This is the same position as 2003, and the primary difference to 1995 was that Australia outscored England and Latvia in that assessment. Because of the increase in Australia's score at Year 4, in 2007 Australian average achievement was significantly higher than the TIMSS scale average and also the average achievement of both Scotland and New Zealand.

In terms of benchmarks, nine per cent of Australian students scored at the advanced international benchmark in 2007, a significant increase from the five per cent in 2003 and the six per cent in 1995. Thirty-five per cent of students in Australia also scored at or above the high international

benchmark, which was again a significant improvement on the 26 per cent who scored at this level in 2003 and the 27 per cent who achieved it in 1995. Corresponding to the increase in the proportion of students at the higher benchmarks, a lower proportion of students just achieved the low benchmark, and 91 per cent of Australian students achieved at least the low international benchmark in 2007, compared with 88 per cent in 2003 and 86 per cent in 1995. Both these latter differences were significant.

## International trends in Year 8 mathematics

In 2003 Singapore's score was significantly higher than that of any other country. Australia's score of 505 was not significantly different to the TIMSS scale average, and while being significantly outperformed by Chinese Taipei, Korea, Singapore, Hong Kong and Japan, Australia's score was not significantly different to that of England, the United States, Scotland and New Zealand.

Table 5.2 provides the 2003 to 2007 differences and the 1995 to 2007 differences in mathematics achievement for all participating Year 8 countries, as well as each country's relative position to Australia in each of the assessments.

In TIMSS 2007, as shown in Chapter 3, Australia's score was 496, which while not a significant decrease from TIMSS 2003, is significantly lower than the score for TIMSS 1995 by some 13 score points.

At Year 8, five countries had higher average mathematics achievement in 2007 than in 1995. Korea, England, the United States and Lithuania participated in all four assessments without having any significant declines between assessments, showing generally upward progress over the 12-year period. Average achievement also increased in Columbia from 1995 to 2007, although it did not participate in any of the intervening assessments. After no change from 1995 to 2003, Slovenia improved between 2003 and 2007. Chinese Taipei also showed significant improvement between 2003 and 2007.

Several countries participating at Year 8 have had compensating increases and decreases in average mathematics achievement from assessment to assessment. For example, after an initial increase, Hong Kong had lower average achievement in 2007 than 2003 so that achievement is essentially the same as in 1995.

At Year 8, 10 countries had lower average mathematics achievement in 2007 than in 1995. In Singapore, Hungary and Romania the decreases were primarily more recent, between 2003 and 2007. Not all countries with declines between 1995 and 2007 showed declines between 2003 and 2007. For example, Japan showed no change between 2003 and 2007 perhaps stemming the earlier downward trend and Norway had higher average achievement in 2007 than 2003 (but not enough to recover from its previous decline). Malaysia's score in 2007 was significantly lower than that of Australia after being the same in 2003.

In terms of relative position internationally, Australia was still outperformed by all of the Asian countries other than Indonesia, but the increased scores of England, the United States and Lithuania in combination with the decrease in Australia's score, resulted in those countries significantly outperforming Australia in 2007.

**Table 5.2** Trends in Year 8 mathematics achievement

Country	2007 Average Scale Score *		2003 to 2007 Difference**		Position relative to Australia in 2003*	1995 to 2007 Difference **		Position relative to Australia in 1995*
	Mean	SE		SE			SE	
Chinese Taipei	598	(4.5)	<b>13</b>	<b>(6.4)</b>	▲			-
Korea, Rep. of	597	(2.7)	<b>8</b>	<b>(3.1)</b>	▲	<b>17</b>	<b>(3.4)</b>	▲
Singapore	593	(3.8)	<b>-13</b>	<b>(5.2)</b>	▲	<b>-16</b>	<b>(5.6)</b>	▲
Hong Kong	572	(5.8)	<b>-14</b>	<b>(6.6)</b>	▲	4	(8.4)	▲
Japan	570	(2.4)	0	(3.1)	▲	<b>-11</b>	<b>(2.8)</b>	▲
Hungary	517	(3.5)	<b>-12</b>	<b>(4.7)</b>	▲	<b>-10</b>	<b>(4.7)</b>	●
England	513	(4.8)	<b>15</b>	<b>(6.7)</b>	●	<b>16</b>	<b>(5.6)</b>	▼
Russian Federation	512	(4.1)	4	(5.5)	●	-12	(6.7)	●
United States	508	(2.8)	4	(4.4)	●	<b>16</b>	<b>(5.5)</b>	▼
Lithuania	506	(2.3)	4	(3.4)	●	<b>34</b>	<b>(4.7)</b>	▼
Czech Republic	504	(2.4)			-	<b>-42</b>	<b>(5.1)</b>	▲
Slovenia	501	(2.1)	<b>9</b>	<b>(3.0)</b>	▼	7	(3.6)	●
TIMSS Scale average	<b>500</b>				●			▼
Armenia	499	(3.5)	<b>21</b>	<b>(4.6)</b>	▼			-
<b>Australia</b>	<b>496</b>	<b>(3.9)</b>	<b>-8</b>	<b>(6.1)</b>		<b>-13</b>	<b>(5.4)</b>	
Sweden	491	(2.3)	<b>-8</b>	<b>(3.4)</b>	●	<b>-48</b>	<b>(4.8)</b>	●
Malta	488	(1.2)			-			-
Scotland	487	(3.7)	-10	(5.2)	●	-6	(6.8)	▼
Serbia	486	(3.3)	<b>9</b>	<b>(4.1)</b>	▼			-
Italy	480	(3.0)	-4	(4.3)	▼			-
Malaysia	474	(5.0)	<b>-34</b>	<b>(6.5)</b>	●			-
Norway	469	(2.0)	<b>8</b>	<b>(3.2)</b>	▼	<b>-29</b>	<b>(2.9)</b>	▼
Cyprus	465	(1.6)	<b>6</b>	<b>(2.3)</b>	▼	-2	(2.9)	▼
Bulgaria	464	(5.0)	<b>-13</b>	<b>(6.5)</b>	▼	<b>-63</b>	<b>(7.6)</b>	●
Israel	463	(3.9)	<b>-32</b>	<b>(5.2)</b>	●			●
Ukraine	462	(3.6)			-			-
Romania	461	(4.1)	<b>-14</b>	<b>(6.4)</b>	▼	<b>-12</b>	<b>(6.2)</b>	▼
Bosnia & Herzegovina	456	(2.7)			-			-
Lebanon	449	(4.0)	<b>16</b>	<b>(4.9)</b>	▼			-
Thailand	441	(5.0)			-			-
Turkey	432	(4.8)			-			-
Jordan	427	(4.1)	3	(5.8)	▼			-
Tunisia	420	(2.4)	<b>10</b>	<b>(3.2)</b>	▼			-
Georgia	410	(5.9)			-			-
Iran, Islamic Rep. of	403	(4.1)	-8	(4.8)	▼	<b>-15</b>	<b>(5.6)</b>	▼
Bahrain	398	(1.6)	-3	(2.2)	▼			-
Indonesia	397	(3.8)	-5	(6.6)	▼			-
Syrian Arab Republic	395	(3.8)			-			-
Egypt	391	(3.6)	<b>-16</b>	<b>(4.9)</b>	▼			-
Algeria	387	(2.1)			-			-
Morocco	381	(3.0)			▼			-
Colombia	380	(3.6)			-	<b>47</b>	<b>(6.7)</b>	▼
Oman	372	(3.4)			-			-
Palestinian Nat'l Auth.	367	(3.5)	<b>-23</b>	<b>(4.6)</b>	▼			-
Botswana	364	(2.3)	-3	(3.3)	▼			-
Kuwait	354	(2.3)			-			-
El Salvador	340	(2.8)			-			-
Saudi Arabia	329	(2.9)			▼			-
Ghana	309	(4.4)	<b>34</b>	<b>(6.2)</b>	▼			-
Qatar	307	(1.4)			-			-

\* ▲ or ● score statistically higher than Australia    ● or ▼ score statistically lower than Australia

● Score not significantly different to that of Australia

\*\* Figures in bold are significant    - Did not participate in this cycle

In terms of benchmarks, there was no change in the proportion of students achieving the advanced international benchmark in mathematics at Year 8. However, the proportion of students at or above the high international benchmarks declined significantly from 1995, from 33 per cent of students to 24 per cent of students. Correspondingly the proportion of students who only achieved at the low international benchmark increased from 22 per cent in 1995 to 28 per cent in 2007, but the proportion of students not achieving the low international benchmark remained about the same at around 10 per cent of students.

## International trends in Year 4 science

At Year 4 in TIMSS 2003, Singapore outperformed all other countries, and Chinese Taipei outperformed all countries other than Singapore. Australian Year 4 students' achievement in science was significantly higher than the TIMSS scale average, and was not significantly different to that of Hungary, the Russian Federation, the Netherlands, New Zealand, Belgium (Flemish), Italy and Lithuania. Australia's performance was significantly lower than that of all of the Asian countries other than the Philippines (which did not participate in TIMSS 2007), and England, the United States and Latvia, and significantly higher than that of 10 other countries, including Scotland and the Philippines.

Table 5.3 displays the 2003 to 2007 differences and the 1995 to 2007 differences in science achievement for all participating Year 4 countries, as well as each country's relative position to Australia in each of the assessments.

At Year 4, seven countries showed higher average science achievement in 2007 than in 1995. Singapore, Hong Kong and Latvia showed significant improvement from 1995 together with significant improvement from 2003 to 2007—suggesting a sustained improvement over the 12-year period from 1995 to 2007. England and Hungary also had higher average achievement in 2007 than 1995, but not between the two most recent assessments, indicating that the gains were essentially between 1995 and 2003. Chinese Taipei showed increased average achievement between 2003 and 2007, the two assessments they participated in, and the Russian Federation also showed increased achievement between 2003 and 2007. In New Zealand, there was an increase between 1995 and 2003 that was offset by a decline between 2003 and 2007. In the United States, Australia, and the Netherlands average science achievement has remained essentially the same since 1995.

Australia's relative position in 2007 was much the same as in 2003. As previously noted Australia's performance in science at this year level is relatively unchanged since 1995. Australia was still outperformed in 2007 by all of the Asian countries, and by England, Latvia and the United States. The Russian Federation's increase has also resulted in a score significantly higher than Australia in 2007. On the other hand, the decline in New Zealand's score has resulted in a score significantly lower than that of Australia. In terms of trends since 1995, Hong Kong, Latvia and Hungary all scored significantly lower than Australia in 1995 but Hong Kong and Latvia significantly outscored Australia in 2007, and Hungary scored at the same level. Singapore, England and the United States all performed on approximately the same level as Australia in 1995 but outscored Australia in 2007.

**Table 5.3** Trends in Year 4 science achievement

Country	2007 Average Scale Score *		2003 to 2007 Difference**		Position relative to Australia in 2003*	1995 to 2007 Difference **		Position relative to Australia in 1995*
	Mean	SE		SE			SE	
Singapore	587	(4.1)	<b>22</b>	<b>(6.8)</b>	▲	<b>63</b>	<b>(6.4)</b>	●
Chinese Taipei	557	(2.0)	<b>5</b>	<b>(2.6)</b>	▲			-
Hong Kong	554	(3.5)	<b>12</b>	<b>(4.6)</b>	▲	<b>46</b>	<b>(4.8)</b>	▼
Japan	548	(2.1)	4	(2.5)	▲	<b>-5</b>	<b>(2.6)</b>	▲
Russian Federation	546	(4.8)	<b>20</b>	<b>(7.0)</b>	●			-
Latvia	542	(2.3)	<b>12</b>	<b>(3.5)</b>	▲	<b>56</b>	<b>(5.4)</b>	▼
England	542	(2.9)	1	(4.4)	▲	<b>14</b>	<b>(4.2)</b>	●
United States	539	(2.7)	3	(3.5)	▲	-3	(4.3)	●
Hungary	536	(3.3)	6	(4.5)	●	<b>28</b>	<b>(4.8)</b>	▼
Italy	535	(3.2)	<b>20</b>	<b>(4.9)</b>	●			-
Kazakhstan	533	(5.6)			-			-
Germany	528	(2.4)			-			-
<b>Australia</b>	<b>527</b>	<b>(3.3)</b>	<b>7</b>	<b>(5.3)</b>		<b>6</b>	<b>(4.9)</b>	
Slovak Republic	526	(4.8)			-			-
Austria	526	(2.5)			-	<b>-12</b>	<b>(4.4)</b>	▲
Sweden	525	(2.9)			-			-
Netherlands	523	(2.6)	-2	(3.1)	●	-7	(4.0)	●
Slovenia	518	(1.9)	<b>28</b>	<b>(3.2)</b>	▼	<b>54</b>	<b>(3.6)</b>	▼
Denmark	517	(2.9)			-	-	-	-
Czech Republic	515	(3.1)			-	<b>-17</b>	<b>(4.3)</b>	▲
Lithuania	514	(2.4)	2	(3.7)	●			-
New Zealand	504	(2.6)	<b>-19</b>	<b>(3.5)</b>	●	-1	(5.9)	▼
Scotland	500	(2.3)	-2	(3.6)	▼	<b>-14</b>	<b>(5.0)</b>	▼
<b>TIMSS Scale average</b>	<b>500</b>				▼			▼
Armenia	484	(5.7)	<b>48</b>	<b>(7.1)</b>	▼			-
Norway	477	(3.5)	<b>10</b>	<b>(3.5)</b>	▼	<b>-27</b>	<b>(5.2)</b>	▼
Ukraine	474	(3.1)			-			-
Iran, Islamic Rep. of	436	(4.3)	<b>22</b>	<b>(5.9)</b>	▼	<b>55</b>	<b>(6.3)</b>	▼
Georgia	418	(4.6)			-			-
Colombia	400	(5.4)			-			-
El Salvador	390	(3.4)			-			-
Algeria	354	(6.0)			-			-
Kuwait	348	(4.4)			-			-
Tunisia	318	(5.9)	3	(8.1)	▼			-
Morocco	297	(5.9)	-7	(9.0)	▼			-
Qatar	294	(2.6)			-			-
Yemen	197	(7.2)			-			-

\* ▲ or ▲ score statistically higher than Australia    - or ▼ score statistically lower than Australia

● Score not significantly different to that of Australia

\*\* Figures in bold are significant                      - Did not participate in this cycle

In the international benchmarks for science at Year 4 there was no significant change in the proportion of students achieving either of the top two benchmarks. About 10 per cent of students achieved the advanced benchmark and about 40 per cent achieved at least the high international benchmark. A higher proportion of students achieved at least the low international benchmark, with 93 per cent achieving this level in 2007 compared with 89 per cent in 1995.

## International trends in Year 8 science

In 2003 the achievement levels of students in Singapore and Chinese Taipei were significantly higher than those of students in any other country. As well as these two countries, Korea, Hong Kong, Japan and England were among the countries whose achievement scores were significantly higher than those of Australian students. Australia's score was significantly higher than the TIMSS scale average, and our performance was statistically similar to that of the Netherlands, the United States, Sweden, Slovenia, New Zealand and Lithuania. Australia's achievement level was significantly higher than that of 21 other countries, including Scotland, Malaysia, Indonesia and the Philippines.

Table 5.4 provides the 2003 to 2007 differences and the 1995 to 2007 differences in science achievement for all participating Year 8 countries, as well as each country's relative position to Australia in each of the assessments.

At Year 8 Korea, Hong Kong, the Russian Federation and Lithuania had higher average science achievement in 2007 than in 1995. Slovenia improved from 1995 to 2003 and from 2003 to 2007. Indonesia also participated in three assessments, but showed improvement mainly from 2003 to 2007. Average science achievement at this year level remained relatively constant across assessments in Singapore, Japan, England, and the United States.

Several countries participating at Year 8 have had compensating increases and decreases in average science achievement from assessment to assessment. For example, after an initial increase in 1999, Hungary had a decrease in 2003 that essentially balanced it out. Australia had an increase between 1995 and 2003 that was balanced out by a decrease in 2007.

Only three countries had lower average science achievement in 2007 than in 1995—the Czech Republic, Sweden, and Norway. In the Czech Republic, the decrease was almost entirely from 1995 to 1999, while in Sweden and Norway there were declines from both 1995 and 2003. Chinese Taipei and Scotland had decreases from 2003 to 2007, Thailand had a decrease between 1999 and 2007, and Malaysia has had successively lower average achievement with each assessment since 1999.

As discussed, Australia's average score has declined by 12 score points in Year 8 science since TIMSS 2003. This combined with significant improvements by the Russian Federation and Slovenia has moved Australia a little downwards in relative terms. The same Asian countries: Singapore, Chinese Taipei, Korea, Hong Kong and Japan, outperformed Australia, as did England, the Czech Republic and Hungary. In 2007 the Russian Federation and Slovenia also significantly outperformed Australia; in 2003 the Russian Federation scored lower than Australia and Slovenia the same as Australia. Australia still performed on a par with the United States and outperformed Scotland.

From 1995, the only major changes that have affected Australia have been the increases in scores of both Hong Kong, which in 1995 scored at a lower level than Australia but outperformed Australia in 2007, and Lithuania, which in 1995 scored at a lower level than Australia but at the same level in TIMSS 2007.

**Table 5.4** Trends in Year 8 science achievement

Country	2007 Average Scale Score *		2003 to 2007 Difference**		Position relative to Australia in 2003*	1995 to 2007 Difference **		Position relative to Australia in 1995*
	Mean	SE		SE			SE	
Singapore	567	(4.4)	-11	(6.2)	▲	-13	(7.1)	▲
Chinese Taipei	561	(3.7)	<b>-10</b>	<b>(5.0)</b>	▲			-
Japan	554	(1.9)	2	(2.6)	▲	-1	(2.5)	▲
Korea, Rep. of	553	(2.0)	<b>-5</b>	<b>(2.6)</b>	▲	<b>7</b>	<b>(2.9)</b>	▲
England	542	(4.5)	-2	(6.1)	▲	8	(5.7)	●
Hungary	539	(2.9)	-4	(4.0)	▲	2	(4.2)	●
Czech Republic	539	(1.9)			-	<b>-16</b>	<b>(4.9)</b>	▲
Slovenia	538	(2.2)	<b>17</b>	<b>(2.8)</b>	●	<b>24</b>	<b>(3.5)</b>	●
Hong Kong	530	(4.9)	<b>-26</b>	<b>(5.9)</b>	▲	<b>20</b>	<b>(7.6)</b>	▼
Russian Federation	530	(3.9)	<b>16</b>	<b>(5.3)</b>	▼	7	(6.0)	●
United States	520	(2.9)	-7	(4.3)	●	7	(6.3)	●
Lithuania	519	(2.5)	-1	(3.3)	●	<b>55</b>	<b>(4.8)</b>	▼
<b>Australia</b>	<b>515</b>	<b>(3.6)</b>	<b>-12</b>	<b>(5.3)</b>		1	(5.3)	
Sweden	511	(2.6)	<b>-14</b>	<b>(3.6)</b>	●	<b>-42</b>	<b>(5.1)</b>	●
<b>TIMSS Scale average</b>	<b>500</b>				▼			▼
Scotland	496	(3.4)	<b>-16</b>	<b>(4.8)</b>	▼	-5	(6.5)	▼
Italy	495	(2.8)	4	(4.1)	▼			-
Armenia	488	(5.8)	<b>27</b>	<b>(6.7)</b>	▼			-
Norway	487	(2.2)	<b>-7</b>	<b>(3.0)</b>	▼	<b>-28</b>	<b>(3.4)</b>	▼
Ukraine	485	(3.5)			-			-
Jordan	482	(4.0)	7	(5.5)	▼			-
Malaysia	471	(6.0)	<b>-40</b>	<b>(7.0)</b>	▼			-
Thailand	471	(4.3)			-			-
Serbia	470	(3.2)	3	(3.9)	▼			-
Bulgaria	470	(5.9)	*	*	▼			-
Israel	468	(4.3)	<b>-20</b>	<b>(5.3)</b>	▼			-
Bahrain	467	(1.7)	<b>29</b>	<b>(2.2)</b>	▼			-
Bosnia & Herzegovina	466	(2.8)			-			-
Romania	462	(3.9)	-8	(6.2)	▼	-9	(6.5)	▼
Iran, Islamic Rep. of	459	(3.6)	6	(4.2)	▼	-4	(5.2)	▼
Malta	457	(1.4)			-			-
Turkey	454	(3.7)			-			-
Syrian Arab Republic	452	(2.9)			-			-
Cyprus	452	(2.0)	<b>10</b>	<b>(2.6)</b>	▼	0	(2.9)	▼
Tunisia	445	(2.1)	<b>41</b>	<b>(2.8)</b>	▼			-
Indonesia	427	(3.4)	<b>13</b>	<b>(5.6)</b>	▼			-
Oman	423	(3.0)			-			-
Georgia	421	(4.8)			-			-
Kuwait	418	(2.8)			-			-
Colombia	417	(3.5)			-	<b>52</b>	<b>(7.1)</b>	▼
Lebanon	414	(5.9)	<b>20</b>	<b>(7.3)</b>	▼			-
Egypt	408	(3.6)	<b>-13</b>	<b>(5.3)</b>	▼			-
Algeria	408	(1.7)			-			-
Palestinian Nat'l Auth.	404	(3.5)	<b>-31</b>	<b>(4.7)</b>	▼			-
Saudi Arabia	403	(2.4)			▼			-
Morocco	402	(2.9)			▼			-
El Salvador	387	(2.9)			-			-
Botswana	355	(3.1)	<b>-10</b>	<b>(3.9)</b>	▼			-
Qatar	319	(1.7)			-			-
Ghana	303	(5.4)	<b>48</b>	<b>(7.9)</b>	▼			-

\* ▲ or ▲ score statistically higher than Australia    ▼ or ▼ score statistically lower than Australia

● Score not significantly different to that of Australia

\*\* Figures in bold are significant    - Did not participate in this cycle

\* Data is not available

At Year 8 in science, the proportion of students achieving at the advanced international benchmark has remained about the same as in previous cycles. However the proportion of students achieving at least the high international benchmark declined from 40 per cent of students in 2003 to 33 per cent of students in 2007. There was also a decline in the proportion of students achieving at least the intermediate international benchmark in 2003 (70% of students in 2007 compared to 76% of students in 2003) and the low international benchmark, although this difference was smaller – 92 per cent in 2007 compared to 95 per cent in 2003. However, the proportion of Year 8 students reaching the low international benchmark was significantly higher than the proportion of students achieving at least this level in 1995 (89%).

## State trends in Year 4 mathematics

The next four tables provide the average scores in Year 4 and Year 8 mathematics and science for each state, the 2003 to 2007 difference in scores and the 1995 to 2007 difference in scores. Also provided in this table is an indication of whether the difference is significant or not.

Table 5.5 shows that there has been change in scores for some of the states in mathematics at Year 4 since 1995 and also since 2003. In New South Wales, the increase in 38 points has been a sustained increase since 1995, with a significant increase of 24 score points, on average, between 2003 and 2007 and an overall increase of 38 score points since 1995. Victoria, on the other hand, also had a significant increase of 24 score points between 2003 and 2007, but the improvement scores from 1995 to 2007 largely reflects these more recent gains.

Scores in Western Australia showed a significant improvement between 2003 and 2007, with essentially no change from 1995. Tasmania also showed small gains from 2003 to 2007 but cumulatively a significant gain of 24 score points since 1995. In the other states there were no significant changes either from 2003 or from 2005.

**Table 5.5** State trends in Year 4 mathematics achievement

	TIMSS 2007		2003 - 2007 difference			1995 - 2007 difference		
	Mean	SE	Mean	SE		Mean	SE	
NSW	534	(6.4)	24	(11.2)	▲	38	(9.3)	▲
VIC	532	(8.2)	24	(10.7)	▲	25	(11.3)	▲
QLD	485	(6.7)	1	(9.8)		1	(10.2)	
SA	493	(8.5)	8	(11.9)		8	(11.0)	
WA	493	(5.4)	21	(9.5)	▲	10	(9.3)	
TAS	510	(6.0)	13	(14.5)		24	(10.4)	▲
NT	484	(9.6)	5	(17.7)		-7	(12.8)	
ACT	513	(7.7)	-10	(15.7)		-14	(9.7)	

▲ score statistically higher than Australia  
▼ score statistically lower than Australia

## State trends in Year 8 mathematics

Table 5.6 shows fewer significant differences in Year 8 mathematics achievement across the states. In South Australia and Western Australia the differences showed a significant decline over the 12-year period from 1995 to 2007, of 23 score points and 42 score points respectively. In both states, but more noticeably in Western Australia, this decline seems to be largely over the period 1995 – 2003, with less of a decline between 2003 and 2007. In the other states there was little change from either 1995 or 2003.

**Table 5.6** State trends in Year 8 mathematics achievement

	TIMSS 2007		2003 - 2007 difference		1995 - 2007 difference			
	Mean	SE	Mean	SE	Mean	SE		
NSW	500	(10.0)	-30	(15.6)		-12	(13.2)	
VIC	503	(8.5)	8	(10.6)		3	(10.7)	
QLD	491	(4.9)	1	(7.8)		-15	(9.8)	
SA	490	(6.7)	-11	(13.1)		-23	(8.7)	▼
WA	485	(8.3)	-2	(11.3)		-42	(10.7)	▼
TAS	485	(6.8)	8	(14.1)		-11	(13.4)	
NT	483	(13.9)	34	(19.9)		13	(24.3)	
ACT	518	(22.4)	11	(24.4)		-10	(25.1)	

▲ score statistically higher than Australia

▼ score statistically lower than Australia

## State trends in Year 4 science

Table 5.7 shows even fewer differences in Year 4 science achievement across the states. Scores in the ACT were lower across the 12-year span, a large proportion of which was a decline from 2003 to 2007. In the other states scores changed, but not significantly.

**Table 5.7** State trends in Year 4 science achievement

	TIMSS 2007		2003 - 2007 difference		1995 - 2007 difference			
	Mean	SE	Mean	SE	Mean	SE		
NSW	538	(6.1)	12	(11.8)		16	(8.6)	
VIC	544	(8.3)	16	(10.7)		15	(13.5)	
QLD	501	(6.0)	-12	(9.8)		-2	(9.7)	
SA	512	(10.5)	-3	(13.5)		-7	(12.7)	
WA	512	(4.9)	10	(8.8)		-15	(7.9)	
TAS	533	(6.0)	16	(13.1)		10	(10.6)	
NT	503	(9.9)	0	(17.0)		-9	(15.0)	
ACT	527	(8.6)	-20	(13.0)		-30	(10.5)	▼

▲ score statistically higher than Australia

▼ score statistically lower than Australia

## State trends in Year 8 science

Similarly in most of the states there were non-significant changes in scores: only in Western Australia was there a significant change in scores and in this case it was a decline of around 25 points from 1995 to 2007 (Table 5.8).

**Table 5.8** State trends in Year 8 science achievement

	TIMSS 2007		2003 - 2007 difference		1995 - 2007 difference			
	Mean	SE	Mean	SE	Mean	SE		
NSW	521	(9.4)	-26	(13.4)		4	(12.5)	
VIC	513	(7.9)	-3	(9.5)		16	(10.0)	
QLD	513	(4.3)	-3	(7.4)		3	(9.4)	
SA	512	(6.1)	-12	(12.5)		2	(8.5)	
WA	506	(7.8)	-14	(10.4)		-25	(10.3)	▼
TAS	507	(7.1)	3	(13.7)		11	(12.9)	
NT	502	(11.2)	20	(17.7)		36	(20.2)	
ACT	538	(20.1)	0	(22.1)		9	(23.8)	

▲ score statistically higher than Australia

▼ score statistically lower than Australia

## International cohort comparisons

Because TIMSS is conducted on a four-year cycle, the cohort of students that was assessed in Year 4 in 2003 had reached Year 8 by 2007, and thus was assessed as the Year 8 sample in 2007. This enables the 17 countries that assessed both year levels in both assessments to examine how their performance relative to each other changed as the Year 4 students of 2003 became the Year 8 students of 2007. The results are presented in Figure 5.1, which shows average mathematics achievement as a difference from the TIMSS scale average (500) for the Year 4 students in 2003 and the Year 8 students in 2007 (right-hand panel), and in Figure 5.2 which provides the same information for science achievement.

TIMSS 2003 mathematics Year 4				TIMSS 2007 mathematics Year 8			
Country		Difference From TIMSS Scale Avg.		Country		Difference From TIMSS Scale Avg.	
Singapore	94	(5.6)	▲	Chinese Taipei	98	(4.5)	▲
Hong Kong	75	(3.2)	▲	Singapore	93	(3.8)	▲
Japan	65	(1.6)	▲	Hong Kong	72	(5.8)	▲
Chinese Taipei	64	(1.8)	▲	Japan	70	(2.4)	▲
Lithuania	34	(2.8)	▲	Hungary	17	(3.5)	▲
Russian Federation	32	(4.7)	▲	England	13	(4.8)	▲
England	31	(3.7)	▲	Russian Federation	12	(4.1)	▲
Hungary	29	(3.1)	▲	United States	8	(2.8)	▲
United States	18	(2.4)	▲	Lithuania	6	(2.3)	▲
Italy	3	(3.7)		Slovenia	1	(2.1)	
Australia	-1	(3.9)		Armenia	-1	(3.5)	
Scotland	-10	(3.3)	▼	Australia	-4	(3.9)	
Slovenia	-21	(2.6)	▼	Scotland	-13	(3.7)	▼
Armenia	-44	(3.5)	▼	Italy	-20	(3.0)	▼
Norway	-49	(2.3)	▼	Norway	-31	(2.0)	▼
Iran, Islamic Rep. of	-111	(4.2)	▼	Tunisia	-80	(2.4)	▼
Tunisia	-161	(4.7)	▼	Iran, Islamic Rep. of	-97	(4.1)	▼
TIMSS Scale Avg.	500	(0.0)		TIMSS Scale Avg.	500	(0.0)	

▲ country average significantly higher than TIMSS scale average  
▼ country average significantly lower than TIMSS scale average

**Figure 5.1** International cohort comparison: 2003 Year 4 students in Year 8 2007, mathematics

Nine countries (Singapore, Hong Kong, Japan, Chinese Taipei, Lithuania, the Russian Federation, England, Hungary, and the United States) performed above the scale average in mathematics at Year 4 in 2003 and again at Year 8 in 2007 (although not in the same order of average achievement). Australia had achievement similar to the scale average in both 2003 and 2007. Scotland, Norway, Iran, and Tunisia also retained the same relative position, performing below the scale average at Year 4 in 2003 and again at Year 8 in 2007. In comparison, Slovenia and Armenia moved from being below the scale average at Year 4 in 2003 to having achievement similar to the scale average at Year 8 in 2007. Italy had achievement at Year 4 similar to the scale average in 2003, but below it at Year 8 in 2007.

TIMSS 2003 science Year 4			
Country		Difference From TIMSS Scale Avg.	
Singapore	65	(5.5)	▲
Chinese Taipei	51	(1.7)	▲
Japan	43	(1.5)	▲
Hong Kong	42	(3.1)	▲
England	40	(3.6)	▲
United States	36	(2.5)	▲
Hungary	30	(3.0)	▲
Russian Federation	26	(5.2)	▲
Australia	21	(4.2)	▲
Italy	16	(3.8)	▲
Lithuania	12	(2.6)	▲
Scotland	2	(2.9)	
Slovenia	-10	(2.5)	▼
Norway	-34	(2.6)	▼
Armenia	-63	(4.3)	▼
Iran, Islamic Rep. of	-86	(4.1)	▼
Tunisia	-186	(5.7)	▼
TIMSS Scale Avg.	500	(0.0)	

TIMSS 2007 science Year 8			
Country		Difference From TIMSS Scale Avg.	
Singapore	67	(4.4)	▲
Chinese Taipei	61	(3.7)	▲
Japan	54	(1.9)	▲
England	42	(4.5)	▲
Hungary	39	(2.9)	▲
Slovenia	38	(2.2)	▲
Hong Kong	30	(4.9)	▲
Russian Federation	30	(3.9)	▲
United States	20	(2.9)	▲
Lithuania	19	(2.5)	▲
Australia	15	(3.6)	▲
Scotland	-4	(3.4)	
Italy	-5	(2.8)	
Armenia	-12	(5.8)	▼
Norway	-13	(2.2)	▼
Iran, Islamic Rep. of	-41	(3.6)	▼
Tunisia	-55	(2.1)	▼
TIMSS Scale Avg.	500	(0.0)	

▲ country average significantly higher than TIMSS scale average  
▼ country average significantly lower than TIMSS scale average

**Figure 5.2** International cohort comparison: 2003 Year 4 students in Year 8 2007, science

Ten countries (Singapore, Chinese Taipei, Japan, Hong Kong, England, the United States, Hungary, the Russian Federation, Australia, and Lithuania) performed above the scale average in science at Year 4 in 2003 and again at Year 8 in 2007 (although not in the same order of average achievement). Scotland had achievement similar to the scale average in both 2003 and 2007. Armenia, Norway, Iran, and Tunisia also retained the same relative position, performing below the scale average in Year 4 in 2003 and again at Year 8 in 2007. In comparison, Slovenia moved from being below the scale average at Year 4 in 2003 to being above it at Year 8 in 2007. Italy had achievement above the scale average in 2003 at Year 4, but similar to it in 2007 at Year 8.

## State cohort comparisons

Figure 5.3 and Figure 5.4 present the cohort comparisons for the Australian states. Students in Year 4 in 2003 in all of the states other than Queensland and Western Australia achieved at the TIMSS scale average in 2003, and all but students in Tasmania did so again when they were in Year 8 in 2007. Students in Tasmania went from equivalent to the TIMSS scale average in 2003 to significantly below the scale average in 2007. In contrast, students in Queensland and Western Australia went from below the scale average in 2003 to equal to the scale average in 2007.

TIMSS 2003 mathematics Year 4			
State	Difference From TIMSS Scale Avg.		
	Mean	SE	
ACT	23	(13.7)	
NSW	10	(9.2)	
VIC	8	(6.8)	
TAS	-3	(13.2)	
SA	-15	(8.3)	
QLD	-16	(7.1)	▼
NT	-21	(14.9)	
WA	-28	(7.8)	▼
TIMSS Scale Avg.	500	(0.0)	

TIMSS 2007 mathematics Year 8			
State	Difference From TIMSS Scale Avg.		
	Mean	SE	
ACT	18	(22.4)	
VIC	3	(8.5)	
NSW	0	(10.0)	
QLD	-9	(4.9)	
SA	-10	(6.7)	
WA	-15	(8.3)	
TAS	-15	(6.8)	▼
NT	-17	(13.9)	
TIMSS Scale Avg.	500	(0.0)	

▲ state average significantly higher than TIMSS scale average  
▼ state average significantly lower than TIMSS scale average

**Figure 5.3** Australian cohort comparison: 2003 Year 4 students in Year 8 2007, mathematics

There was a little more movement in science between Year 4 and Year 8. Students in three states: the Australian Capital Territory, Victoria and New South Wales, scored higher than the TIMSS scale score in 2003. All of the other states scored at a level equal to the scale average. In 2007, New South Wales students again scored higher than the TIMSS scale average, however, the performance of those in the Australian Capital Territory and Victoria had slipped back to be equal to the scale average. Students in Queensland and South Australia, in contrast, moved from positions equivalent to the scale average to positions significantly higher than the scale average.

TIMSS 2003 science Year 4			
State	Difference From TIMSS Scale Avg.		
	Mean	SE	
ACT	47	(9.7)	▲
VIC	28	(6.8)	▲
NSW	26	(10.1)	▲
TAS	17	(11.6)	
SA	15	(8.5)	
QLD	13	(7.7)	
NT	3	(13.8)	
WA	2	(7.3)	
TIMSS Scale Avg.	500	(0.0)	

TIMSS 2007 science 2007 Year 8			
State	Difference From TIMSS Scale Avg.		
	Mean	SE	
ACT	38	(20.1)	
NSW	21	(9.4)	▲
VIC	13	(7.9)	
QLD	13	(4.3)	▲
SA	12	(6.1)	▲
TAS	7	(7.1)	
WA	6	(7.8)	
NT	2	(11.2)	
TIMSS Scale Avg.	500	(0.0)	

▲ state average significantly higher than TIMSS scale average  
▼ state average significantly lower than TIMSS scale average

**Figure 5.4** Australian cohort comparison: 2003 Year 4 students in Year 8 2007, science

## Trends in achievement by gender

Table 5.9 shows changes in average achievement separately for males and females for mathematics and science in Australia. At Year 4, changes are shown between 2003 and 2007 and between 1995 and 2007.

### Mathematics

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. Also, females in Armenia, Chinese Taipei, Norway, and the Russian Federation had higher average mathematics achievement in 2007 than in 2003. Females had decreased average achievement across the 12-year period in Austria and the Czech Republic. In the Netherlands, Year 4 females showed increasing declines in average mathematics achievement across the assessments.

Year 8 males often showed increases or decreases in achievement in the same countries as females, indicating overall trends typically were 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. Also, between 2003 and 2007 the improvement in the Russian Federation was significant for females and not for males, whereas in the decline in Tunisia was significant for males and not for females. In Australia there was a significant decline in the scores for females but no corresponding decline in the scores for males.

## Science

In science, Year 4 females showed improvement in seven countries (England, Hong Kong, Hungary, Iran, Latvia, Singapore, and Slovenia) compared to 1995. In three of these countries, Latvia, Singapore, and Slovenia, there also was improvement from 2003 to 2007. Females in Armenia, Chinese Taipei, Italy, Japan, the Russian Federation, and Tunisia had higher average science achievement in 2007 than in 2003. Females had decreased average achievement across the 12-year period in Austria, the Czech Republic, Norway, and Scotland, and from 2003 to 2007 in New Zealand.

Year 4 males often showed increases or decreases in achievement in the same countries as females, indicating overall trends typically were reflected in trends for both sexes. The most notable exceptions to this pattern were in Japan and the Netherlands, where males showed decreases between 1995 and 2007 compared to no change for females, and Tunisia, where males had no change from 2003 while the score for females increased. In Australia, there were no significant changes 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). 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.

**Table 5.9** Trends in mathematics and science achievement by gender

	Females								Males							
	2007 Average scale score		2003 – 2007 difference		1995 – 2007 difference		2007 Average scale score		2003 – 2007 difference		1995 – 2007 difference					
	Mean	SE	Diff	SE	Diff	SE	Mean	SE	Diff	SE	Diff	SE				
<b>Year 4</b>																
Mathematics	513	(4.2)	16	(6.1)	▲	20	(5.7)	▲	519	(3.6)	19	(5.6)	▲	23	(5.4)	▲
Science	525	(4.0)	3	(5.5)		6	(5.4)		530	(3.5)	11	(6.5)		6	(6.0)	
<b>Year 8</b>																
Mathematics	488	(5.5)	-10	(8.0)		-23	(6.9)	▼	504	(5.4)	-7	(7.9)		-4	(7.2)	
Science	505	(5.1)	-12	(6.9)		-2	(6.4)		524	(5.4)	-14	(7.1)		4	(7.6)	

## Trends for Indigenous students

Table 5.10 shows trends in the achievement of Indigenous students from 1995 to 2007 and from 2003 to 2007. There are no significant differences in the performance of Indigenous students – either from 1995 or from 2003.

Also shown is the difference in scores in each cycle of TIMSS. This shows several differences in the achievement levels of Indigenous and non-Indigenous students. In 2003 and 1995 the score difference was between 60 and 70 score points in Year 4 mathematics, however, in 2007 an increase in the scores of non-Indigenous students and a decline in the scores of Indigenous students resulted in a gap of more than 90 score points. Similarly in Year 4 science, the score differential increased sharply in 2007, with a difference of around 90 score points compared to 54 score points in 2003 and 77 score points in 1995.

In contrast, the score differences for Year 8, in both mathematics and science, have remained fairly consistent, at between 70 and 80 score points.

**Table 5.10<sup>2</sup>** Trends in mathematics and science achievement by Indigenous status

	2007 Average scale score		2003 - 2007 difference			1995 - 2007 difference		
	Mean	SE	Mean	SE		Mean	SE	
<b>Year 4 Mathematics</b>								
Indigenous	431	(11.2)	-13	(16.0)		1	(15.6)	
Not Indigenous	522	(3.3)	18	(4.7)	▲	23	(4.7)	▲
Difference	91		60			69		
<b>Year 4 Science</b>								
Indigenous	441	(11.8)	-31	(16.5)		-8	(16.7)	
Not Indigenous	533	(3.1)	7	(4.6)		7	(4.8)	
Difference	92		54			77		
<b>Year 8 Mathematics</b>								
Indigenous	431	(8.8)	2	(11.6)		-8	(11.3)	
Not Indigenous	501	(4.0)	-7	(6.0)		-12	(5.5)	▼
Difference	70		79			74		
<b>Year 8 Science</b>								
Indigenous	447	(8.1)	-11	(10.7)		3	(10.8)	
Not Indigenous	519	(3.6)	-11	(5.2)	▼	5	(5.2)	
Difference	72		72			70		

<sup>2</sup> The data for TIMSS 2002 in this table are different to those in the National Report for that cycle. The data in the previous report were those for Aboriginal students only, as there was an inconsistency in responses to the relevant question on the student survey. All responses are included in this table for comparability across cycles.

## Summary

This chapter has examined the trends in mathematics and science achievement between 1995 and 2007 and 2003 and 2007.

In Year 4 mathematics, Australia's score has increased significantly by 17 score points since 2003 and by 22 score points since 1995. In terms of relative position internationally, Australia was outperformed in 2007, as in 2003, by all of the Asian countries as well as England and the United States. However, Australia's score in 2007 was significantly higher than the TIMSS scale average and also the scores of both Scotland and New Zealand.

In Year 8 mathematics, Australia's score remained unchanged from 2003 and decreased significantly from that of 1995. Australia was outperformed by all of the Asian countries other than Indonesia (as in 2003), but the increased scores of England, the United States and the Russian Federation, in combination with the decrease in Australia's score, resulted in those countries also significantly outperforming Australia in 2007.

In Year 4 science, Australia's score has remained relatively unchanged between assessments. Australia's relative position in 2007 was also much the same as in 2003. Australia was outperformed in 2007 by all of the Asian countries, and by England and the United States. The Russian Federation's increase has also resulted in a score significantly higher than Australia in 2007. On the other hand, the decline in New Zealand's score has resulted in a score significantly lower than that of Australia.

In Year 8 science, Australia's average score has declined by 12 score points since TIMSS 2003, and is relatively unchanged since 1995. This combined with significant improvements by the Russian Federation and Slovenia has moved Australia a little downwards in relative terms. The same Asian countries (Singapore, Chinese Taipei, Korea, Hong Kong and Japan) outperformed Australia, as did England, the Czech Republic and Hungary. In 2007, the Russian Federation and Slovenia also significantly outperformed Australia. Australia still performed on a par with the United States and outperformed Scotland.

There was little movement in terms of achievement levels within the states. In Year 4 mathematics, New South Wales and Victoria had a significant increase in scores from 2003 to 2007, and New South Wales showed a sustained increase over the 12-year period from 1995. Scores in Western Australia were significantly higher in 2007 than 2003, while in Tasmania there was a slower but sustained growth over the 12-year period from 1995 resulting in a significant increase in scores from TIMSS 1995.

In Year 8 mathematics, the only changes in scores were a significant decline in the scores of South Australia and Western Australia over the period since 1995, most of which seems to have occurred in the period 1995 – 2003, with less of a decline in recent years. In science, there were fewer changes; a decline of 30 score points from 1995 – 2007 in the Australian Capital Territory at Year 4 and a decline of 25 score points in Western Australia at Year 8 over the same time span.

The increased score for Australia for Year 4 mathematics was the result of a significant increase in the scores of both males and females, but the only other change over time found was a significant decline in the score of Year 8 mathematics for females over the 1995 – 2007 time span.

For Australia's Indigenous students there were no significant changes in achievement in either subject at either year level. However, significant changes in the scores of non-Indigenous students coupled with changes in the scores for Indigenous has resulted in a widening gap between the mathematics achievement of Indigenous and non-Indigenous students – to about 90 score points at Year 4.

The next chapter of this report will provide background information about the TIMSS students – their background characteristics, attitudes and aspirations, and the relationship between these factors and achievement.



# Student home background factors, attitudes, aspirations and their relationship to achievement

This chapter looks at student-level factors, such as home background and student activities and attitudes that are potentially related to student achievement. In particular, this chapter presents detailed information about students' resources for learning at home, homework, their attitude toward mathematics and science, the value they place on mathematics and science, their self-confidence in learning mathematics and science, their attitudes toward school in general, and their educational aspirations.

## Educational resources in the home

The presence or absence of educational resources in the home reflects potential advantage or disadvantage for students that may either reflect the ability of parents to provide materially for their children or possibly indicate differences in practical and psychological support for academic achievement. In a relatively wealthy country like Australia, the majority of children have access to material possessions like computers, such that the absence of them is often associated with poverty and material deprivation. In these circumstances there are likely to be any number of associated causes of educational disadvantage. It is these, rather than the actual physical presence of the computer, that are likely to contribute to low academic achievement (although having access to a computer at home would undoubtedly remove obstacles to completion of certain tasks that may contribute to success at school). In contrast, in poorer countries, where computer ownership is not the norm, those that do have access to a computer at home may have other advantages that contribute to their academic success.

The relationship of actual patterns of computer use, and even the number of books in the home, to academic achievement is likely to be more complicated, reflecting a complex interplay between beliefs and actions on the part of parents and also, in the case of computer use, school policies.

In this report, the focus is on a particular set of educational resources: having books, computers, and Internet connections at home; and computer use at home and elsewhere.

## Books in the home

Earlier cycles of TIMSS have shown that students from homes with abundant literacy resources have higher achievement, on average, in mathematics and science than students from less well-endowed homes, both internationally and in Australia. This pattern continues to be true for both Year 4 and Year 8 in the current cycle.

At Year 4, Australia was one of only a handful of countries (including Denmark, England, Georgia, Germany, Hungary, New Zealand, Norway, Qatar, Scotland, Singapore, Sweden and the United States) with over 30 per cent of students reporting that they had over 100 books in the home. As shown in Table 6.1, 22 per cent of Australian Year 4 students reported having more than 200

books at home, while only 6 per cent reported having fewer than 10 books. In comparison, the average internationally was 12 per cent of students reporting more than 200 books at home and 20 per cent with no more than 10 books. In contrast to Australia, more than half the students in Algeria, El Salvador, Iran, Morocco, and Yemen reported having no more than 10 books in the home.

**Table 6.1** Number of books in the home – Percentage of Australian students, average mathematics achievement and average science achievement, Year 4 and Year 8

	Year 4									
	2007 Per cent of Students		Difference in per cent from 2003			Average Mathematics Achievement		Average Science Achievement		
More than 200 Books	22	(1.0)	-2	(1.6)		531	(5.1)	550	(5.6)	
101-200 Books	22	(1.0)	-1	(1.5)		540	(5.3)	551	(3.8)	
26-100 Books	36	(0.9)	2	(1.4)		517	(3.3)	526	(3.1)	
11-25 Books	13	(0.8)	0	(1.2)		486	(5.8)	494	(5.7)	
0-10 Books	6	(0.6)	0	(1.0)		458	(8.1)	464	(7.7)	

	Year 8									
	2007 Per cent of Students		Difference in per cent from 2003			Average Mathematics Achievement		Average Science Achievement		
More than 200 Books	22	(1.1)	-9	(1.8)	▼	532	(5.9)	553	(5.3)	
101-200 Books	22	(0.8)	-1	(1.2)		516	(4.7)	541	(4.3)	
26-100 Books	32	(1.1)	2	(1.4)		492	(4.4)	510	(3.6)	
11-25 Books	15	(1.0)	4	(1.2)	▲	464	(4.9)	480	(5.0)	
0-10 Books	9	(0.6)	4	(0.8)	▲	438	(5.5)	440	(5.8)	

Note: Due to the use of independent scales, the scores provided for average mathematics and science achievement should not be compared across domains (i.e. mathematics cannot be compared with science) nor should they be compared across year levels. Please refer to the Reader's Guide for further explanation.

In several countries there was an increase from 2003 in the percentage of students from homes with many books. For example, Hong Kong and Morocco had increased percentages of students in the *more than 200* and the *101–200* categories. In contrast, Latvia, the Netherlands, and Norway experienced decreases in both of these categories. There was no change from 2003 in the percentage of Australian Year 4 students according to number of books in the home (see Table 6.1).

Year 4 students from homes with more than 100 books had higher average mathematics and science achievement than those from homes with fewer books. This was true for Australian Year 4 students, as well as on average across the participating countries.

In Australia, the average mathematics achievement of Year 4 students from homes with more than 200 books (531 score points, on average) and from homes with 101–200 books (540 score points) was significantly higher than that of students from homes with 26–100 books (517 score points), with 11–25 books (486 score points), and with 0–10 books (458 score points), all of which were also significantly different from each other.

The average science achievement for Year 4 Australian students from homes with more than 200 books was 550 score points and 551 score points for those students from homes with 101–200 books. These achievement levels were significantly higher than the average of students from homes with 26–100 books (at 526 score points). This was again higher than that of students reporting having 11–25 books (at 494 score points), which was also significantly higher than that of students with 0–10 books at home (at 464 score points).

At Year 8 similar patterns are also seen. Internationally, on average, 12 per cent of students reported having more than 200 books at home and 20 per cent of students reported 10 books or fewer. Australia was one of nine countries (including Bulgaria, Georgia, Hungary, Israel, Italy, Korea, Norway and Sweden) that had over 20 per cent of students reporting more than 200 books in the home.

Table 6.1 shows that, in Australia, 22 per cent of Year 8 students reported having more than 200 books at home and only 9 per cent reported no more than 10 books. The percentage of students having 200 books or more decreased by 9 per cent from 2003, with a similar increase in the proportion of students reporting 25 or fewer books in the home.

As with Year 4 students, there was a positive association between average Year 8 mathematics and science achievement and the number of books in the home. In Australia, average mathematics and science achievement of Year 8 students from homes with more than 200 books was significantly higher than that of students with fewer books in the home, up to around 100 score points higher than for students in homes with fewer than 10 books.

### Computers and Internet access in the home

More and more, schools are integrating computers and information and communication technology (ICT) into the curriculum. In addition, the Internet provides access to a vast amount of information not previously available to students. Therefore, students with access to computers and the Internet at home have opportunities both for greater familiarity with common learning tools but also for extra learning experiences outside the school.

Table 6.2 shows that Australia had a relatively high percentage of students at both Year 4 and Year 8 that reported having a computer at home. At Year 4, 95 per cent of Australian students reported that they had a computer at home and 84 per cent reported also having an Internet connection. In Australia, at Year 8, 97 per cent of students reported that they had a computer at home and 89 per cent reported also having an Internet connection.

**Table 6.2** Computer and Internet access in the home – Percentage of Australian students, average mathematics achievement and average science achievement, Year 4 and Year 8

	Year 4					
	Per cent of Students		Average Mathematics Achievement		Average Science Achievement	
Have Computer	95	(0.6)	521	(3.3)	532	(3.1)
Do Not Have Computer	5	(0.6)	446	(11.0)	464	(10.3)
Have Internet Connection	84	(0.8)	527	(3.3)	537	(3.1)
Do Not Have Internet Connection	16	(0.8)	470	(6.0)	485	(6.6)

	Year 8					
	Per cent of Students		Average Mathematics Achievement		Average Science Achievement	
Have Computer	97	(0.3)	499	(4.0)	517	(3.6)
Do Not Have Computer	3	(0.3)	425	(9.3)	449	(14.5)
Have Internet Connection	89	(0.7)	503	(3.9)	521	(3.5)
Do Not Have Internet Connection	11	(0.7)	443	(6.2)	467	(7.9)

Note: Due to the use of independent scales, the scores provided for average mathematics and science achievement should not be compared across domains (i.e. mathematics cannot be compared with science) nor should they be compared across year levels. Please refer to the Reader's Guide for further explanation.

In comparison, 70 per cent of students across all participating countries, at both year levels, reported having a computer at home, and about half (56% at Year 4, 50% at Year 8) had an Internet connection. Other countries in which at least 90 per cent of Year 4 students reported having a computer at home were Austria, the Czech Republic, Denmark, England, Germany, Hong Kong, the Netherlands, New Zealand, Norway, Scotland, Singapore, Sweden and the United States. In addition, in Denmark, the Netherlands, Norway and Sweden, more than 90 per cent of students reported having an Internet connection. At Year 8, Australia was one of 18 countries where 90 per cent or more of students reported that they had a computer at home. The vast majority of students in these 18 countries also reported having an Internet connection for the computer.

Although having a computer at home is clearly very common in many countries, there also are countries where relatively few students come from computer-equipped homes, and even fewer from homes with computers connected to the Internet. More than 60 per cent of Year 4 students in Algeria, Colombia, El Salvador, Georgia, Iran, Kazakhstan, and Yemen (as well as Armenia, Botswana, Colombia, El Salvador, Georgia, Ghana, Indonesia, and Tunisia at Year 8) were from homes without a computer, and about 80 per cent (or more) did not have a computer connected to the Internet.

At both year levels, on average across countries, students with a computer at home had higher average mathematics and science achievement than students without a computer, and students with an Internet-connected computer had higher achievement than students that did not. These achievement differences may be at least partly a reflection of socioeconomic differences, since, in many countries, computers and Internet connections require significant financial outlay.

Table 6.2 shows that at both year levels in Australia the difference in average mathematics achievement between students from homes with a computer and those from homes without a computer was about 75 score points, and about 60 points between students from homes with an Internet-connected computer and those from homes without such a facility.

For science the pattern was similar, with a difference of about 70 score points between students from homes with a computer and those from homes without a computer, and a difference of about 50 points between students from homes with an Internet-connected computer and those from homes without such a facility.

### Computer use at home and at school

At Year 4, on average across countries, 38 per cent of students reported using a computer both at home and at school and a further 31 per cent at home but not at school. Just nine per cent reported using a computer at school but not at home, five per cent only at places other than home and school, and 17 per cent reported not using a computer at all. Australia was one of a small number of countries where more than 70 per cent of Year 4 students reported using a computer both at home and at school. Other countries in this category included Chinese Taipei, Scotland, England, Hong Kong, the Netherlands, and Denmark. As a contrast, 40 per cent or more of Year 4 students in Morocco (46%), El Salvador (40%), Yemen and Algeria (55%), the Ukraine (40%), Georgia (42%), and Iran (75%) reported never using a computer.

Table 6.3 shows that, in Australia, 79 per cent of Year 4 students reported using a computer both at home and at school, whereas 13 per cent reported using a computer at home but not at school and seven per cent reported using a computer at school but not at home. Only one per cent reported using a computer only at places other than home and school, and one per cent reported not using a computer at all.

At Year 4, computer use increased in a number of countries between 2003 and 2007. Students reported increases in using computer both at home and school in Italy, Hungary, Tunisia, Latvia, and the Russian Federation, and in using the computer at home but not in school in 16 countries. In Australia, the percentage of students using a computer at home but not at school increased

significantly from 2003, with a parallel decrease in the percentage of students using a computer at school but not at home.

Average achievement at the international level was highest among those reporting using a computer at home and at school and at home only, perhaps reflecting an economic advantage for those with a computer at home, and lowest among those reporting that they do not use a computer at all or use one only at places other than home and school.

**Table 6.3** Computer use at home and at school – Percentage of Australian students, average mathematics achievement and average science achievement, Year 4 and Year 8

	Year 4								
	2007 Per cent of Students		Difference in per cent from 2003			Average Mathematics Achievement		Average Science Achievement	
Use computer both at home and at school	79	(1.4)	-2	(2.1)		525	(3.7)	537	(3.6)
Use computer at home but not at school	13	(1.2)	7	(1.5)	▲	493	(6.2)	506	(6.1)
Use computer at school but not at home	7	(0.6)	-4	(1.2)	▼	471	(8.9)	480	(9.0)
Use computer only at places other than home and school	1	(0.2)	-1	(0.3)		~	~	~	~
Do not use computer at all	1	(0.2)	0	(0.2)		~	~	~	~

	Year 8								
	2007 Per cent of Students		Difference in per cent from 2003			Average Mathematics Achievement		Average Science Achievement	
Use computer both at home and at school	77	(1.0)	-6	(1.4)	▼	506	(4.0)	523	(3.7)
Use computer at home but not at school	17	(0.9)	7	(1.3)	▲	480	(5.8)	503	(5.1)
Use computer at school but not at home	4	(0.4)	-1	(0.6)		435	(9.4)	456	(13.2)
Use computer only at places other than home and school	1	(0.2)	0	(0.3)		~	~	~	~
Do not use computer at all	0	(0.1)	0	(0.2)		~	~	~	~

Note: Due to the use of independent scales, the scores provided for average mathematics and science achievement should not be compared across domains (i.e. mathematics cannot be compared with science) nor should they be compared across year levels. Please refer to the Reader's Guide for further explanation.

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

Average achievement in both mathematics and science amongst Australian Year 4 students (Table 6.3) was highest among those reporting using a computer at home and at school, and next highest among those using a computer at home only, with the lowest average score achieved by those using a computer at school only. The differences between each of these groups were statistically significant. Average achievement for those reporting they do not use a computer at all or use one only at places other than home and school was not reported because of the very small sample size for these groups and the consequent uncertainty around the estimate of average achievement.

On average internationally at Year 8, 42 per cent of students reported using a computer both at home and at school and 25 per cent at home only. Compared to Year 4, relatively more students (16% compared to 9%) reported using a computer at school but not at home and relatively fewer reported not using a computer at all (10% compared to 17%).

As at Year 4, Australia was one of the small number of Year 8 TIMSS participants with very high percentages of students (more than 70%) using a computer both at home and at school. Other countries with similarly high percentages included Chinese Taipei, Hong Kong, Malta, England, the Czech Republic, Cyprus and Scotland. Lowest levels of computer use were reported in Ghana, Georgia, Algeria and Iran, where 40 per cent or more of Year 8 students reported never using a computer.

In Australia, 77 per cent of Year 8 students reported using a computer both at home and at school, 17 per cent used computers at home but not at school, four per cent reported using a computer at school but not at home, one per cent only at places other than home and school, and fewer than one per cent of students reported not using a computer at all.

Similar to the findings at Year 4, the proportion of students using computers increased at Year 8 between 2003 and 2007 in a substantial number of countries. Students in 16 countries reported more use both at home and at school, and in 11 of those countries there were increases in use at home but not at school. Students in an additional 15 countries also reported increases in use at home but not at school. However, in nine of these countries the increase in use at home corresponded to a decrease in the use both at home and at school category. In Australia, the percentage of students using a computer at home but not at school increased significantly from 2003, with a concurrent decrease in the percentage of students using a computer both at home and at school.

Compared with Year 4, there was a stronger association between using a computer and mathematics and science achievement at Year 8 internationally, with highest average achievement among students using a computer both at home and at school, next highest among those using a computer at home but not at school and a somewhat similar level of achievement among those using a computer at school but not at home and those using a computer only at places other than home and school. Average achievement was lowest among those not using a computer at all.

In Australia, the pattern of average achievement in both mathematics and science was very similar at Year 8 to that for Year 4 (Table 6.3). That is, achievement was significantly higher among students that reported using a computer at home and at school compared to that of students using a computer at home only. The average achievement in both of these groups was significantly higher than the average score achieved by students using a computer at school only.

## Time spent on mathematics and science homework

Homework provides an opportunity for students to extend and consolidate what they have learned in school, and for teachers to extend the time for learning beyond what is available during the hours of formal schooling. Consequently, it might be expected that students who are assigned homework and who spend substantial time on it would have higher achievement than students who do little or no homework. However, the situation is not as straightforward as that. The tradition of assigning homework and expecting students to devote a portion of their after-school time to completing this assignment varies from country to country and from year level to year level. In some countries and especially at Year 4, homework is rarely assigned, and when students spend time on homework it often can be for remedial purposes, to enable them to catch up on material not fully mastered during class. Under these circumstances, lower achievement is associated with more time spent on homework. Also, even when homework is regularly assigned as a means of extending classroom learning, the more able students may accomplish the assignment more expeditiously, resulting in a situation where high achievement is associated with less time spent on homework.

To summarise the amount of time typically devoted to mathematics or science homework in each country, TIMSS constructed an index for each subject that assigns students to a high, medium, or low level on the basis of the frequency of mathematics (or science) homework they are assigned each week and the amount of time they spend on it. Students at the high level of the Index of Time Spent Doing Mathematics Homework (TMH) or the Index of Time Spent Doing Science Homework (TSH) reported that they were assigned mathematics (or science) homework at least 3–4 times a week and spend more than 30 minutes on each assignment. Students at the low level reported being assigned homework no more than twice a week and spending no more than 30 minutes on each assignment. The medium level included all other response combinations.

Table 6.4 shows that on average across countries, Year 4 students generally reported that they spent relatively little time on mathematics homework, with 21 per cent of students at the low level of the TMH index and 58 per cent at the medium level. However, 21 per cent were at the high level of the index. Countries with one-third or more students at the high level of the index included Kazakhstan, the Russian Federation, the Ukraine, Algeria, Latvia, Iran, Singapore, and Tunisia. The highest percentages of students at the low level of the index (50% or more) were in Australia, New Zealand, Sweden, England, Scotland, and the Netherlands. Across countries, average mathematics achievement was highest among students at the medium level of the homework index (479 points), and about the same for students at the high and low levels (469 and 468 respectively).

In Australia, 51 per cent of Year 4 students were at the low level of the TMH index and 42 per cent were at the medium level. Only seven per cent reported levels of mathematics homework that would be considered high. Table 6.4 shows that students reporting a low level of homework had higher achievement (525 score points) than students reporting a medium level (517 score points) or a high level of homework (508 score points), although the differences were not statistically significant.

Table 6.4 shows there were some differences between the states in terms of the amount of mathematics homework students reported they were assigned on average each week. Noticeable differences are the greater number of Victorian and Tasmanian students reporting low levels of mathematics homework, compared to Queensland where far more students report medium or high levels of mathematics homework.

At Year 8, 27 per cent of students, on average across countries, were at the high level of the mathematics homework index and 20 per cent at the low level. Countries with the greatest homework emphasis (40% or more at the high level) included Romania, the Russian Federation, El Salvador, Tunisia, Italy, Syrian Arab Republic, Singapore, Malaysia, and the Ukraine. In contrast, 40 per cent or more of students were at the low level of the index in Australia, Japan, Scotland, Korea, the Czech Republic, England, and Sweden. As shown in Table 6.4, in contrast to Year 4, average mathematics achievement across countries was lower among students at the low level of the index than among students at the medium or high levels.

**Table 6.4** Time spent on mathematics homework – Percentage of students and average mathematics achievement, Year 4 and Year 8

	Year 4											
	High TMH				Medium TMH				Low TMH			
	Per cent of Students		Average Mathematics Achievement		Per cent of Students		Average Mathematics Achievement		Per cent of Students		Average Mathematics Achievement	
NSW	10	(1.6)	538	(15.0)	44	(2.9)	537	(7.6)	46	(3.8)	538w	(7.4)
VIC	2	(0.8)	~	~	31	(2.6)	536	(7.7)	67	(2.4)	535	(8.8)
QLD	7	(0.9)	462	(10.6)	54	(4.2)	490	(5.8)	38	(4.2)	499	(8.3)
SA	7	(1.9)	496	(16.3)	43	(4.1)	488	(8.5)	50	(4.5)	515	(8.7)
WA	5	(1.2)	467	(17.5)	36	(4.0)	488	(6.7)	59	(4.7)	504	(6.1)
TAS	2	(0.6)	~	~	36	(2.3)	512	(6.3)	63	(2.5)	517	(7.3)
NT	10	(3.2)	450	(20.7)	42	(4.1)	491	(11.0)	47	(5.6)	491	(10.2)
ACT	7	(1.8)	511	(17.0)	37	(6.0)	536	(16.8)	56	(5.6)	511	(7.5)
Australia	7	(0.7)	508	(10.6)	42	(1.5)	517	(3.9)	51	(1.8)	525	(4.4)
International Average	21	(0.2)	469	(1.0)	58	(0.2)	479	(0.7)	21	(0.2)	468	(1.5)

	Year 8											
	High TMH				Medium TMH				Low TMH			
	Per cent of Students		Average Mathematics Achievement		Per cent of Students		Average Mathematics Achievement		Per cent of Students		Average Mathematics Achievement	
NSW	18	(2.2)	539	(11.5)	47	(3.0)	526	(14.2)	36	(4.5)	463	(10.9)
VIC	18	(3.1)	522	(14.8)	43	(3.3)	505	(8.2)	40	(4.6)	503	(10.2)
QLD	13	(1.7)	498	(7.7)	47	(3.2)	510	(4.3)	41	(4.2)	473	(7.6)
SA	11	(1.6)	496	(12.1)	42	(3.3)	495	(6.5)	47	(3.8)	491	(8.7)
WA	10	(3.3)	519	(13.0)	36	(3.9)	489	(10.9)	54	(5.6)	484	(10.0)
TAS	5	(1.8)	515	(19.5)	34	(5.3)	505	(11.0)	62	(5.8)	481	(6.7)
NT	8	(2.7)	520	(18.2)	43	(9.0)	507	(19.9)	49	(11.4)	468	(12.2)
ACT	8	(3.3)	534	(43.2)	50	(5.0)	532	(20.9)	43	(6.6)	509	(27.5)
Australia	15	(1.1)	523	(6.6)	44	(1.5)	511	(5.2)	42	(2.0)	481	(4.6)
International Average	27	(0.2)	458	(0.9)	53	(0.2)	457	(0.7)	20	(0.2)	441	(1.1)

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

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

In Australia, 42 per cent of Year 8 students were at the low level of the TMH index and 44 per cent were at the medium level. Only 15 per cent reported levels of mathematics homework that would be considered high. Students reporting a high level of homework had higher achievement (523 score points) than students reporting a medium level (511 score points) or low level of homework (481). All differences were statistically significant.

Table 6.4 shows there was some variation amongst the states in how much mathematics homework was being assigned to Year 8 students on a weekly basis. Interestingly, Victoria (as well as New South Wales) had the largest percentage of students reporting high levels of mathematics homework. This is quite different to the situation at Year 4, in which Victoria (along with Tasmania) had the largest percentage of students reporting low levels of mathematics homework. In contrast, Tasmania has the largest percentage of Year 8 students reporting low levels of mathematics homework.

At Year 4, students generally reported that they spent less time on science homework than on mathematics homework, with 57 per cent of students, on average across countries, at the low level

of the TSH index (30 minutes or less no more than twice a week) and just nine per cent at the high level. The countries with the highest percentages of students doing relatively little homework were Denmark, Austria, Norway, the Czech Republic, Australia, Sweden, Japan, England, Scotland and the Netherlands. In these countries, at least 80 per cent of students reported being at the low level of this index. Countries with the greatest percentages of students at the high level of the index (20% or more) included Colombia (23%), Yemen (21%), and El Salvador (20%). Average science achievement was highest among students at the low level of the homework index (488 score points), next highest at the medium level (474 score points), and lowest among students at the high level (446 score points).

In Australia, 81 per cent of Year 4 students were at the low level of the TSH index and 17 per cent were at the medium level, as shown in Table 6.5. Only one per cent of students reported levels of science homework that would be considered high. Students reporting a low level of homework had significantly higher achievement (536 score points) than students reporting a medium level of homework (520 score points). The sample size for students reporting a high level of homework was too small to report average achievement.

Table 6.5 shows that there were some differences between the states in terms of the amount of science homework students reported that they were assigned on average each week. Noticeable differences are the smaller number of Northern Territory and Australian Capital Territory Year 4 students reporting low levels of science homework, compared to all other states.

Twenty-nine countries (including Australia) taught science as a single subject at Year 8. On average across these countries, 14 per cent of students were at the high level of the TSH index, 45 per cent at the medium level, and 41 per cent at the low level. Countries with the greatest homework emphasis (20% or more at the high level) included El Salvador, Colombia, Malaysia, Egypt, Ghana, Jordan, Singapore, and Thailand. In contrast, 50 per cent or more of students were at the low level of the index in Israel, the United States, Tunisia, England, Australia, Korea, Scotland and Japan. Average science achievement was lower among students at the high level of the index than among students at the medium or low levels.

In Australia, as shown in Table 6.5, 62 per cent of Year 8 students reported doing little science homework and only six per cent reported levels of science homework that would be considered high. In contrast to the international results, students reporting a high or medium level of homework had significantly higher achievement (539 and 529 score points, respectively) than those reporting a low level of homework (511 score points).

**Table 6.5** Time spent on science homework – Percentage of students and average science achievement, Year 4 and Year 8

		Year 4											
		High TSH				Medium TSH				Low TSH			
		Per cent of Students		Average Science Achievement		Per cent of Students		Average Science Achievement		Per cent of Students		Average Science Achievement	
NSW	1	(0.4)	~	~	20	(2.2)	525	(10.2)	79	(2.3)	549	(5.9)	
VIC	1	(0.5)	~	~	18	(3.4)	546	(11.4)	82	(3.5)	547	(8.1)	
QLD	2	(0.6)	~	~	14	(2.3)	482	(9.6)	84	(2.7)	512	(5.4)	
SA	2	(0.8)	~	~	17	(2.9)	504	(21.7)	81	(3.2)	520	(9.4)	
WA	1	(0.6)	~	~	14	(2.9)	494	(11.8)	85	(3.2)	523	(5.2)	
TAS	0	(0.3)	~	~	16	(2.0)	534	(12.3)	84	(2.1)	538	(6.0)	
NT	2	(1.1)	~	~	28	(6.5)	482	(24.8)	70	(6.4)	518	(10.5)	
ACT	2	(0.7)	~	~	24	(2.8)	528	(22.1)	73	(2.8)	532	(7.6)	
Australia	1	(0.2)	~	~	17	(1.5)	520	(6.9)	81	(1.6)	536	(3.1)	
International Average	9	(0.1)	446	(2.2)	35	(0.2)	474	(1.2)	57	(0.3)	488	(1.2)	

		Year 8											
		High TSH				Medium TSH				Low TSH			
		Per cent of Students		Average Science Achievement		Per cent of Students		Average Science Achievement		Per cent of Students		Average Science Achievement	
NSW	6	(1.2)	555	(22.9)	29	(2.3)	547	(11.7)	65	(2.9)	515	(9.5)	
VIC	6	(1.2)	520	(14.0)	35	(2.5)	515	(8.8)	59	(3.1)	513	(9.5)	
QLD	7	(1.2)	542	(9.0)	36	(3.1)	532	(6.7)	57	(3.2)	504	(5.6)	
SA	7	(1.4)	530	(12.2)	31	(3.2)	513	(8.2)	62	(3.6)	517	(6.0)	
WA	8	(1.9)	537	(15.1)	29	(2.6)	514	(11.0)	63	(3.3)	506	(7.4)	
TAS	4	(1.3)	524	(33.0)	26	(2.7)	532	(10.3)	70	(3.7)	503	(7.6)	
NT	3	(1.4)	516	(41.0)	26	(4.5)	508	(12.8)	72	(3.9)	505	(13.6)	
ACT	3	(0.8)	581	(24.7)	29	(4.4)	566	(20.8)	68	(4.3)	532	(20.5)	
Australia	6	(0.6)	539	(8.9)	32	(1.1)	529	(4.3)	62	(1.4)	511	(4.1)	
International Average	14	(0.2)	455	(1.2)	45	(0.2)	466	(0.8)	41	(0.3)	464	(0.9)	

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

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

Table 6.5 shows that, similar to the results for Year 4, there was some variation amongst the states in how much science homework was being assigned to Year 8 students on a weekly basis. Queensland had the largest percentage of students receiving medium or high levels of homework, whereas the Northern Territory had the smallest percentage.

## Students' attitudes toward mathematics and science

Developing positive attitudes toward mathematics and science is an important goal of the curriculum in many countries. To summarise information about progress toward these goals, TIMSS examined students' general attitudes toward mathematics and science, the value they place on mathematics and science as a way of improving their lives, and their self-confidence in learning mathematics and science.

### Students' positive affect toward mathematics and science

To investigate how students feel about mathematics, TIMSS created an Index of Students' Positive Affect Toward Mathematics (PATM), based on students' responses to three statements about mathematics:

- I enjoy learning mathematics;
- Mathematics is boring (reverse scored);
- I like mathematics.

Students were asked to indicate their level of agreement with each statement. Students who *agreed a little* or *a lot* on average with all three statements were assigned to the high level of the index (i.e. have a positive attitude toward mathematics), while those who *disagreed a little* or *a lot* (on average) were assigned to the low level of the index. The medium level includes all other response combinations. Table 6.6 shows the percentage of students at each level of the index, any change in the percentage at each level since 1995, and the average mathematics achievement of students at each level, for both Australian students and the international average.

At an international level, Year 4 students generally had very positive attitudes toward mathematics, with 72 per cent, on average across countries, at the high level of the index. There were 14 per cent of students at the medium level and 14 per cent at the low level. The highest percentages of students at the high level of the index (85% or more) were in Georgia, Kazakhstan, Morocco, the Ukraine, Colombia, and Tunisia, while countries with proportionately more students with less positive attitudes included the Netherlands and Chinese Taipei, where more than 25 per cent of students were at the low level. No participants had increased percentages of students at the high level in 2007 compared to 1995, whereas 11 countries had lower percentages of students at this level, including Australia. Fourteen countries, including Australia, had small but statistically significant increases at the low level. Across countries, Year 4 students at the high level of the PATM index had higher average mathematics achievement than students at the medium or low level.

In Australia, 66 per cent of Year 4 students were at the high level of the PATM index, compared to 16 per cent at the medium level and 18 per cent at the low level. Table 6.6 shows that the percentage of students at the high level had significantly decreased by seven percentage points since 1995, with the corresponding increase spread over the medium and low levels (the increase was significant at both levels). Year 4 students at the high level of the index had higher average mathematics achievement (525 score points) than students at the medium (512 score points) and low levels (494 score points). All differences were statistically significant.

For Year 8 students, on average across countries, 54 per cent were at the high level of the PATM index, compared with 21 per cent at the medium level and 26 per cent at the low level. Countries with the most students expressing positive attitudes included Algeria, Egypt, Botswana, Oman, and Morocco, where 75 per cent or more were at the high index level. In contrast, in 22 countries less than half the students were at the high level of the index. Only the Russian Federation and Lithuania from 1995 and Korea from 1999 showed increased percentages at the high level in 2007, while 19 countries (including Australia) had declines at this level since 1995, 1999, or both previous cycles. As shown in Table 6.6, average mathematics achievement across countries was highest among students at the high index level (471 points), next highest among those at the medium level (441 points), and lowest at the low level (428 points).

**Table 6.6** Index of Students' Positive Affect Toward Mathematics – Percentage of students and average mathematics achievement, Year 4 and Year 8

	Year 4																				
	High PATM						Medium PATM						Low PATM								
	2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 1995				
Australia	66	(1.4)	525	(3.6)	-7	(1.7)	▼	16	(0.8)	512	(4.6)	3	(1.0)	▲	18	(1.1)	494	(5.1)	4	(1.2)	▲
International Average	72	(0.2)	483	(0.6)				14	(0.1)	457	(1.1)				14	(0.1)	454	(1.3)			

	Year 8																				
	High PATM						Medium PATM						Low PATM								
	2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 1995				
Australia	34	(1.3)	521	(6.2)	-10	(1.8)	▼	27	(0.8)	498	(3.7)	-1	(1.0)		39	(1.2)	476	(4.1)	11	(1.5)	▲
International Average	54	(0.2)	471	(0.6)				21	(0.1)	441	(0.7)				26	(0.1)	428	(0.7)			

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

In Australia, 34 per cent of Year 8 students were at the high level of the PATM index, compared to 27 per cent at the medium level and 39 per cent at the low level. Table 6.6 shows that the percentage of students at the high level had significantly decreased by 10 percentage points since 1995, with a corresponding increase at the low level. Year 8 students at the high level of the index had higher average mathematics achievement (521 score points) than students at the medium (498 score points) and low levels (476 score points). All differences were significant.

As for mathematics, TIMSS created an Index of Students' Positive Affect Toward Science (PATS), based on students' responses to three statements about science:

- I enjoy learning science;
- Science is boring (reverse scored);
- I like science.

Table 6.7 shows the percentage of students at each level of the index, any change in the percentage at each level since 1995, and the average science achievement of students at each level, for both Australian students and the international average.

Internationally, Year 4 students generally had very positive attitudes toward science, with an average of 77 percent of students at the high level of the index. There were 13 per cent of students at the medium level and just 11 per cent at the low level. The largest percentage of students at the high level of the index was in Kazakhstan (90%), while countries with proportionately more students with less positive attitudes included the Netherlands, the Czech Republic, England, and Denmark, where more than 20 per cent of students were at the low level. Australia, Austria, and Latvia had increased percentages of students at the high level in 2007 compared to 1995, whereas Singapore, Slovenia, the Czech Republic, and England showed declines. Across countries, Year 4 students at the high level of the PATS index had higher average science achievement than students at the medium or low level.

**Table 6.7** Index of Students' Positive Affect Toward Science – Percentage of students and average science achievement, Year 4 and Year 8

	Year 4																			
	High PATS						Medium PATS						Low PATS							
	2007 Per cent of Students		Average Science Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 1995			
Australia	78	(1.3)	534	(3.6)	4	(1.7)	▲	11	(0.8)	513	(5.8)	-1	(1.0)	11	(0.8)	505	(5.1)	-2	(1.1)	▼
International Average	77	(0.2)	485	(0.7)				13	(0.1)	456	(1.2)			11	(0.1)	452	(1.3)			

	Year 8																			
	High PATS						Medium PATS						Low PATS							
	2007 Per cent of Students		Average Science Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 1995		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 1995			
Australia	47	(1.4)	535	(4.7)	-2	(1.7)		22	(0.8)	504	(4.2)	-1	(1.1)	31	(1.1)	494	(4.3)	3	(1.4)	
International Average	65	(0.2)	476	(0.7)				19	(0.1)	442	(0.9)			16	(0.2)	436	(1.3)			

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

In Australia, 78 per cent of Year 4 students were at the high level of the PATS index, compared to 11 per cent at the medium level and 11 per cent at the low level. Table 6.7 shows that the percentage of students at the high level had significantly increased by four percentage points since 1995, with a corresponding decrease at the low level. Year 4 students at the high level of the index had significantly higher average science achievement (534 score points) than students at the medium (513 score points) and low levels (505 score points).

At Year 8, on average across countries where science was taught as a single subject, 65 per cent of students were at the high level of the PATS index, compared with 19 per cent at the medium level and 16 per cent at the low level. Countries with the most students expressing positive attitudes included Tunisia, Botswana, Colombia, Oman, Egypt, and Ghana, where 80 per cent or more were at the high index level. Less than half the students in Italy, Australia, Japan, Chinese Taipei, and Korea were at the high level of the index. Only Korea (from 1999 and 1995) and Japan (from 1995) showed increased percentages at the high level in 2007, while many countries had declines. As shown in Table 6.7, average science achievement was higher among students at the high index level (476 points) than among those at the medium level (442 points) or the low level (436 points).

In Australia, 47 per cent of Year 8 students were at the high level of the PATS index, compared to 22 per cent at the medium level and 31 per cent at the low level. Table 6.7 shows that the percentage of students at the different levels had not changed since 1995. Year 8 students at the high level of the index had higher average science achievement (535 score points) than students at the medium (504 score points) and low levels (494 score points). All differences were statistically significant.

## Students' valuing of mathematics and science

In addition to having a positive attitude toward mathematics and science, students may be more attracted to mathematics and science and more motivated to learn if they perceive mathematics and science achievement as advantageous to their future education and the world of work. The TIMSS Index of Students Valuing Mathematics (SVM) is based on Year 8 students' responses to four statements about mathematics:

- I think learning mathematics will help me in my daily life;
- I need mathematics to learn other school subjects;
- I need to do well in mathematics to get into the university of my choice; and
- I need to do well in mathematics to get the job I want.

Students were asked their level of agreement with each statement. Students who *agreed a little* or *a lot* on average with all four statements were assigned to the high level of the index (i.e. placed a high value on mathematics), while those who *disagreed a little* or *a lot* (on average) were assigned to the low level of the index. The medium level includes all other response combinations. As these questions are not relevant to younger children, Year 4 students were not asked these items. Table 6.8 shows the percentage of students and their average mathematics achievement at each level of the SVM index, for Australia and the international average.

Year 8 students generally placed a high value on mathematics, with 78 per cent of students, on average across countries, at the high level of the SVM index. More than 90 per cent of students in Indonesia, Ghana, Oman, Thailand, Algeria, Jordan, Tunisia, and El Salvador reported a high level of valuing mathematics, and it is notable that all of these are lower performing countries. In contrast, less than half the students reported a high level in two of the highest performing countries on the TIMSS assessment: Chinese Taipei and Japan. Despite this, Year 8 average mathematics achievement internationally was generally higher among students at the high level of the SVM index than at the medium level or the low level (Table 6.8).

Since 2003 the percentage of students at the high level of the index has increased in 19 countries, compared to declines in only five countries.

**Table 6.8** Index of Students Valuing Mathematics – Percentage of students and average mathematics achievement, Year 8

	High SVM				Medium SVM				Low SVM			
	2007 Per cent of Students		Average Mathematics Achievement		2007 Per cent of Students		Average Mathematics Achievement		2007 Per cent of Students		Average Mathematics Achievement	
Australia	75	(1.1)	502	(4.4)	19	(0.9)	484	(3.8)	6	(0.4)	470	(7.0)
International Average	78	(0.1)	458	(0.5)	17	(0.1)	438	(0.9)	5	(0.1)	435	(1.3)

Table 6.8 shows that 75 per cent of Australian Year 8 students placed a high value on mathematics, with 19 at the medium level and six per cent at the low level. The percentages of Australian students at each of the levels of the SVM index have not changed since 2003. Year 8 students at the high level of the index had significantly higher average science achievement (502 score points) than students at the medium (484 score points) and low levels (470 score points).

As for mathematics, TIMSS constructed the Index of Students Valuing Science (SVS) based on Year 8 students' responses to four statements about science:

- I think learning science will help me in my daily life;
- I need science to learn other school subjects;
- I need to do well in science to get into the university of my choice; and
- I need to do well in science to get the job I want.

Students were asked to indicate if they *agreed a lot*, *agreed a little*, *disagreed a little*, or *disagreed a lot* with each statement. Students who *agreed a little* or *a lot* on average with all four statements

were assigned to the high level of the index (i.e. placed a high value on science), while those who *disagreed a little* or *a lot* (on average) were assigned to the low level of the index. The medium level includes all other response combinations. Table 6.9 shows the percentage of students, and their average science achievement, at each level of the SVS index for Australia and the international average.

Year 8 students in countries teaching science as a single subject generally placed a high value on science, with 66 per cent of students, on average in these countries, at the high level of the SVS index and just 11 per cent at the low level. More than 90 per cent of students in Ghana and Oman, both low-scoring countries, reported high levels on the SVS index (both countries also had very high proportions of students at the high level of the SVM index). In contrast, less than half the students placed a high value on science in Israel, Norway, Australia, Korea, Chinese Taipei, Italy, and Japan, several of which are among the highest performing countries on the TIMSS 2007 assessment. Again, despite these seeming contradictions, Table 6.9 shows that generally Year 8 science achievement was higher among students at the high level of the SVS index (471 points) than at the medium level (449 points) or the low level (441 points).

There was an increase from 2003 in the percentage of students at the high level of the index in Ghana, Egypt, Tunisia, Bahrain, Iran, Hong Kong, England, Norway, Korea, and Japan, and declines in Botswana and Malaysia.

**Table 6.9** Index of Students Valuing Science – Percentage of students and average science achievement, Year 8

	High SVS				Medium SVS				Low SVS			
	2007 Per cent of Students		Average Science Achievement		2007 Per cent of Students		Average Science Achievement		2007 Per cent of Students		Average Science Achievement	
Australia	42	(1.2)	531	(5.1)	30	(0.8)	511	(4.3)	28	(0.9)	496	(3.7)
International Average	66	(0.2)	471	(0.7)	23	(0.1)	449	(1.0)	11	(0.1)	441	(1.6)

Table 6.9 shows that a much lower proportion of Australian students placed a high value on science, with just 42 per cent of students reporting high levels of valuing science and 28 per cent reporting low levels. These proportions have not changed since 2003. In Australia as internationally, Year 8 students at the high level of the SVS index had higher average science achievement (531 score points) than students at the medium (511 score points) and low levels (496 score points). All differences were statistically significant.

### Students' self-confidence in learning mathematics and science

Regardless of how much students like or value mathematics and science for how these subjects can help them in their lives, students' confidence in their ability to learn mathematics and science is based to some extent on their past experience in learning the subjects. This, in turn, is likely to be determined by the perceived difficulty of the subject as well as the individual student's own learning ability.

To investigate students' beliefs about their abilities in mathematics, TIMSS created an Index of Students' Self-confidence in Learning Mathematics (SCM), based on students' responses to four statements about their mathematics ability:

- I usually do well in mathematics;
- Mathematics is harder for me than for many of my classmates (reverse scored);
- I am just not good at mathematics (reverse scored); and
- I learn things quickly in mathematics.

Students were asked to indicate their level of agreement with each statement. Students who *agreed a little* or *a lot* on average with all four statements (i.e. are confident about their mathematics ability) were assigned to the high level of the index, while those who *disagreed a little* or *a lot* (on

average) were assigned to the low level of the index. The medium level includes all other response combinations. Table 6.10 shows the percentage of students at each level of the SCM index, any change in the percentage at each level since 2003, and the average mathematics achievement of students at each level, for both Australian students and the international average.

At Year 4, on average across the countries, students expressed considerable self-confidence in their mathematics ability, with 57 per cent at the high level of the SCM index, and a further 32 per cent at the medium level and just 11 per cent at the low level of the index. Highest levels of self-confidence were reported in Sweden, Austria, Germany, and Denmark, with 70 per cent or more at the high level of the index, and lowest levels in El Salvador, Chinese Taipei, and Yemen, all with less than 40 per cent of students at the high level of the index. Ten countries showed an increase since 2003 in the percentage of students at the high level of the SCM index, and five countries showed a decrease.

As expected and shown in Table 6.10, there was a positive association between level of self-confidence in learning mathematics and mathematics achievement at Year 4. Achievement was highest among students at the high level of the SCM index (500 points, on average), next highest among students at the medium level (449 points), and lowest among those at the low level (429 points).

**Table 6.10** Index of Students' Self-confidence in Learning Mathematics – Percentage of students and average mathematics achievement, Year 4 and Year 8

	Year 4																	
	High SCM					Medium SCM					Low SCM							
	2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 2003	
Australia	64	(1.3)	542	(2.8)	0	(1.6)	26	(0.9)	480	(3.8)	1	(1.2)	10	(0.8)	457	(6.7)	-1	(1.1)
International Average	57	(0.2)	500	(0.6)			32	(0.2)	449	(0.8)			11	(0.1)	429	(1.2)		

	Year 8																			
	High SCM					Medium SCM					Low SCM									
	2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Mathematics Achievement		Difference in per cent from 2003			
Australia	45	(1.2)	539	(4.8)	-5	(2.1)	▼	35	(0.8)	472	(4.1)	5	(1.3)	▲	19	(0.9)	445	(3.7)	0	(1.5)
International Average	43	(0.2)	492	(0.6)			37	(0.1)	433	(0.6)			20	(0.1)	412	(0.7)				

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

Table 6.10 shows that Australian students generally exhibit higher levels of self-confidence than the average internationally. In Australia, 64 per cent of Year 4 students reported a high level of self-confidence in learning mathematics while just 10 per cent reported low self-confidence. The percentages of Australian students at each of the levels of the SCM index have not changed since 2003. Amongst Australian students as well as internationally, mathematics achievement was highest among students with high levels of mathematics self-confidence (542 points, on average), next highest among students with medium levels (480 points), and lowest among those reporting low levels of self-confidence (457 points). All differences were statistically significant.

Internationally, students' confidence in learning mathematics was generally lower at Year 8 than at Year 4, with just 43 per cent of students at the high level of the SCM index and 20 per cent at the low level. Self-confidence levels were highest in Israel, Jordan, Qatar, and Egypt (at least 55% of students at the high level), and lowest in Korea, Indonesia, Malaysia, Chinese Taipei, Thailand, and Japan (fewer than 30% of students at the high level). There were increased percentages since 2003 at the high level in 10 countries, compared to decreases in only three countries (including

Australia). As at Year 4, there was a positive association between self-confidence in learning mathematics and mathematics achievement at Year 8.

Similar to the finding for Year 4, there was a positive association at Year 8 between achievement and self-confidence, with students at the high level of the SCM index having the highest average mathematics achievement (492 points), followed by students at the medium level (433 points), and students at the low index level with the lowest achievement scores (412 points).

The proportions of Australian Year 8 students at each level of the SCM index were very similar to the international proportions. In Australia, 45 per cent of Year 8 students reported a high level of self-confidence in learning mathematics, with another 35 per cent in the medium category and 19 per cent in the low category. The percentage of students at the high level decreased significantly (by 5 percentage points) from 2003, with a corresponding increase at the medium level. Mathematics achievement was again highest among students at the high level of the SCM index (539 points, on average), next highest among students at the medium level (472 points), and lowest among those at the low level (445 points). All differences were statistically significant.

As for mathematics, TIMSS created an Index of Students' Self-confidence in Learning Science (SCS), based on students' responses to four statements about their science ability:

- I usually do well in science;
- Science is harder for me than for many of my classmates (reverse scored);
- I am just not good at science (reverse scored); and
- I learn things quickly in science.

Students were asked to indicate their level of agreement with each statement. Students who *agreed a little* or *a lot* on average with all four statements (i.e. are confident about their science ability) were assigned to the high level of the SCS index, while those who *disagreed a little* or *a lot* (on average) were assigned to the low level of the index. The medium level includes all other response combinations. Table 6.11 shows the percentage of students at each level of the index, any change in the percentage at each level since 2003, and the average science achievement of students at each level, for both Australian students and the international average.

As Table 6.11 shows, at Year 4, on average across the countries, students expressed considerable self-confidence in their science ability, with 61 per cent at the high level of the SCS index, and just eight per cent, on average, at the low level of the index. Highest levels of self-confidence were reported in Austria, Germany, Sweden, Iran, Kazakhstan, and Lithuania, with 70 per cent or more of students at the high level of the index, and lowest levels in Morocco, Yemen, El Salvador, and Singapore, all with less than 50 per cent of students at the high level of the index. A number of countries showed an increase since 2003 in the percentage of students at the high level of the SCS index, including Iran, the United States, Scotland, Chinese Taipei, Japan, New Zealand, and Singapore, while countries with a decrease included the Netherlands, Slovenia, Hungary, and Hong Kong.

As with mathematics, there was a positive association between level of self-confidence in learning science and science achievement at Year 4. Achievement was highest among students at the high level of the SCS index (497 points, on average), next highest among students at the medium level (453 points), and lowest among those at the low level (437 points).

In Australia, 63 per cent of Year 4 students reported a high level of self-confidence in learning science, with another 28 per cent in the medium category and nine per cent in the low category. Table 6.11 shows that the percentages of Australian students at the low level of the SCS index have increased significantly by two per cent since 2003. Again, science achievement was highest among students at the high level of the SCS index (543 points, on average), next highest among students at the medium level (509 points), and lowest among those at the low level (483 points). All differences were statistically significant.

**Table 6.11** Index of Students' Self-confidence in Learning Science – Percentage of students and average science achievement, Year 4 and Year 8

	Year 4																		
	High SCS						Medium SCS						Low SCS						
	2007 Per cent of Students		Average Science Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 2003		
Australia	63	(1.0)	543	(3.0)	-3	(1.6)	28	(0.7)	509	(4.4)	1	(1.3)	9	(0.7)	483	(6.7)	2	(0.8)	▲
International Average	61	(0.2)	497	(0.7)			30	(0.2)	453	(0.9)			8	(0.1)	437	(1.5)			

	Year 8																				
	High SCS						Medium SCS						Low SCS								
	2007 Per cent of Students		Average Science Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 2003		2007 Per cent of Students		Average Science Achievement		Difference in per cent from 2003				
Australia	41	(1.3)	549	(4.9)	-7	(2.0)	▼	39	(1.0)	496	(3.7)	4	(1.5)	▲	20	(1.0)	483	(4.3)	3	(1.3)	▲
International Average	48	(0.2)	492	(0.7)				38	(0.2)	439	(0.7)				13	(0.1)	427	(1.3)			

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

Students' confidence in learning science at Year 8 was lower than at Year 4 on average, with just 48 per cent of students internationally at the high level of the index (compared with 61% at Year 4). At the medium level, there were 38 per cent of students, on average, and 13 per cent at the low level. Self-confidence levels were highest in Tunisia, Jordan, Colombia, and Egypt (60% or more at the high level), and lowest in Malaysia, Korea, Chinese Taipei, and Japan (less than 30% at the high level). There were increased percentages since 2003 at the high level in Jordan, Iran, Botswana, and Korea, and decreases in Egypt, Italy, the Palestinian National Authority, Scotland, Australia, Singapore, Malaysia, and Chinese Taipei. As at Year 4, there was a positive association between self-confidence in learning science and science achievement at Year 8. Students at the high level of the SCS index had the highest average science achievement (492 points), followed by students at the medium level (439 points), and students at the low index level (427 points).

In Australia, 41 per cent of Year 8 students reported a high level of self-confidence in learning science, with another 39 per cent in the medium category and 20 per cent in the low category. The percentage of students at the high level had significantly decreased by seven percentage points since 2003, with the corresponding increase spread over the medium and low levels (the increase was significant at both levels). Science achievement was highest among Australian students at the high level of the SCS index (549 points, on average), next highest among students at the medium level (496 points), and lowest among those at the low level (483 points). All differences were statistically significant.

### Gender and self-confidence in learning mathematics and science

Across the participating TIMSS countries, more males than females at Year 4 reported having self-confidence in learning mathematics. On average across countries, 54 per cent of females compared to 60 per cent of males were at the high level of the SCM index. Internationally, there were only four countries in which a higher proportion of females than males reported high levels of self-confidence in mathematics, compared to 22 countries in which males reported higher levels of self-confidence than females. In contrast, more females than males had medium and low levels of self-confidence. More females than males reported low levels of self-confidence in 19 countries, and more males than females in only four countries.

Table 6.12 shows the percentage of male and female students in Australia and their average mathematics achievement at each level of the Index of Students' Self-Confidence in Learning Mathematics.

The international trend of more males reporting self-confidence in learning mathematics is mirrored in Australia. Table 6.12 shows that for Year 4, 68 per cent of males compared to 60 per cent of females were at the high level of the SCM index, whereas 30 per cent of females were at the medium level compared to 23 per cent of males. There was no significant difference between males and females at the low level of the index.

**Table 6.12** Index of Students' Self-confidence in Learning Mathematics – Percentage of males and females, and average mathematics achievement in Australia, Year 4 and Year 8

		Year 4											
		High SCM				Medium SCM				Low SCM			
		2007 Per cent of Students		Average Mathematics Achievement		2007 Per cent of Students		Average Mathematics Achievement		2007 Per cent of Students		Average Mathematics Achievement	
Females		60	(1.7)	539	(3.7)	30	(1.2)	482	(4.5)	11	(1.1)	465	(7.8)
Males		68	(1.7)	545	(3.3)	23	(1.3)	478	(5.0)	9	(0.9)	447	(8.7)

		Year 8											
		High SCM				Medium SCM				Low SCM			
		2007 Per cent of Students		Average Mathematics Achievement		2007 Per cent of Students		Average Mathematics Achievement		2007 Per cent of Students		Average Mathematics Achievement	
Females		39	(1.8)	533	(7.2)	37	(1.3)	470	(5.7)	24	(1.5)	445	(5.0)
Males		51	(1.5)	543	(6.4)	34	(1.5)	474	(5.2)	15	(0.8)	446	(5.1)

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

At Year 8, the international pattern was similar to that at Year 4, with males having higher self-confidence in learning mathematics than females. On average across countries, 45 per cent of males were at the high level of the SCM index, compared to 41 per cent of females, while 22 per cent of females were at the low level, compared to 18 per cent of males. At the high level of the SCM index, there were higher percentages of males than females in 27 countries, compared to higher percentages of females in just 4 countries. At the low level, the pattern was reversed, with higher percentages of females in 29 countries, and higher percentages of males in just two countries.

In Australia (see Table 6.12), 51 per cent of Year 8 males compared to 39 per cent of females were at the high level of the SCM index, whereas 24 per cent of females were at the low level compared to 15 per cent of males.

Table 6.12 also indicates there is little difference in average mathematics achievement between males and females within each level of the index. This situation contrasts with the gender difference found for the entire Australian Year 8 cohort. Given this, it is possible that the gender difference in mathematics achievement is related to the greater self-confidence of males. A regression analysis (see the Reader's Guide) was conducted in which both gender and self-confidence in learning mathematics were regressed on mathematics achievement<sup>1</sup>. In this regression the effect of gender was not significant whereas self-confidence in learning mathematics was. This suggests that the effect of gender on mathematics achievement is substantially explained by the differences in self-confidence in learning mathematics.

<sup>1</sup>  $R^2 = 0.23$ ,  $F(2,74) = 137.87$ ,  $p < 0.01$ ; Intercept = 574.4 (SE=13.7),  $B_{\text{gender}} = 5.8$  (SE=7.3),  $B_{\text{SCM}} = -49.5$  (SE=3.0).

Internationally, there was little difference between females and males at Year 4 in self-confidence in learning science. On average across countries, the percentage of females and males at each level of the SCS index was similar, although there was a slight difference favouring females at the high level and slightly more males at the low level. Across the countries, there were nine countries with a difference in favour of females at the high index level and six countries with a difference in favour of males. At the medium level, there was a greater percentage of females than males in seven countries and a greater percentage of males in three countries. Males were more strongly represented at the low level of the SCS index with higher percentages of males in 10 countries and of females in only five countries.

Table 6.13 shows the percentage, and the average science achievement, of male and female students in Australia at each level of the Index of Students' Self-confidence in Learning Science.

**Table 6.13** Index of Students' Self-Confidence in Learning Science – Percentage of males and females, and average science achievement in Australia, Year 4 and Year 8

		Year 4											
		High SCS				Medium SCS				Low SCS			
		2007 Per cent of Students		Average Science Achievement		2007 Per cent of Students		Average Science Achievement		2007 Per cent of Students		Average Science Achievement	
Females		64	(1.7)	539.6	(3.9)	28	(1.4)	506.2	(5.9)	8	(0.9)	481.4	(7.4)
Males		62	(1.4)	546.8	(3.8)	28	(1.2)	512.3	(5.3)	10	(1.0)	484.4	(9.8)

		Year 8											
		High SCS				Medium SCS				Low SCS			
		2007 Per cent of Students		Average Science Achievement		2007 Per cent of Students		Average Science Achievement		2007 Per cent of Students		Average Science Achievement	
Females		36	(1.5)	539.6	(3.9)	40	(1.4)	506.2	(5.9)	24	(1.2)	481.4	(7.4)
Males		46	(1.6)	546.8	(3.8)	38	(1.1)	512.3	(5.3)	15	(1.1)	484.4	(9.8)

Note: Due to the use of independent scales, the scores provided for average achievement should not be compared across year levels. Please refer to the Reader's Guide for further explanation.

In Australia there were virtually no significant gender differences in self-confidence in learning science at Year 4.

At Year 8, among countries teaching science as a single subject, males generally reported higher self-confidence in learning science than females. On average across these countries, 50 per cent of males were at the high level of the SCS index, compared to 47 per cent of females, while 15 per cent of females were at the low level, compared to 11 per cent of males. At the high level of the index, there were higher percentages of males than females in 11 countries, but higher percentages of females in just four countries. At the low level, the pattern was reversed, with higher percentages of females in 12 countries, and higher percentages of males in just two countries.

In Australia the difference was more substantial. Forty-six per cent of Year 8 males compared to 36 per cent of females reported high levels of self-confidence in science, whereas 24 per cent of females compared to 15 per cent of males reported low levels.

Table 6.13 also indicates that, similar to the trend observed for mathematics, there was little difference in average science achievement between males and females within each level of the SCS index. As this is in contrast to the gender difference in science achievement for the entire Australian Year 8 cohort, it is possible that the gender difference in science achievement was related to the greater self-confidence of males. A regression analysis (see the Reader's Guide) was conducted in which both gender and self-confidence in learning science were regressed on

science achievement<sup>2</sup>. As was the case for mathematics, the effect of gender was not found to be significant whereas self-confidence in learning science was. This suggests that the effect of gender on science achievement is substantially explained by the differences in self-confidence in learning science such that males, having on average greater self-confidence, perform better in science.

## Students' attitudes toward school

Students' attitudes to school in general may be related to mathematics and science achievement, both as a possible cause and as a possible effect of the level of achievement. TIMSS 2007 asked students whether they agree with the statement "I like being in school", which directly taps into whether students find school a positive experience. TIMSS 2007 also asked Year 8 students how far in education they intended to go, which is a less direct assessment of attitudes toward school as it also includes ideas about what job aspirations students have and other motivations that may counter negative affect toward school.

## Students' positive affect toward school

Table 6.14 shows the percentage of students that *agreed a lot*, *agreed a little*, *disagreed a little* and *disagreed a lot* with the statement "I like being in school", as well as average mathematics and science achievement for each response, for Australian Year 4 and Year 8 students.

**Table 6.14** Positive affect toward school – Percentage of Australian students, and average mathematics and science achievement, Year 4 and Year 8

I like being in school.	Year 4					
	Per cent of Students		Average Mathematics Achievement		Average Science Achievement	
Agree a lot	44	(1.2)	512	(5.0)	520	(1.2)
Agree a little	36	(1.2)	530	(3.6)	544	(1.2)
Disagree a little	11	(0.9)	519	(5.4)	532	(0.9)
Disagree a lot	9	(0.8)	488	(6.4)	500	(0.8)

I like being in school.	Year 8					
	Per cent of Students		Average Mathematics Achievement		Average Science Achievement	
Agree a lot	24	(1.2)	506	(6.7)	527	(6.7)
Agree a little	51	(1.1)	500	(3.7)	517	(3.7)
Disagree a little	16	(0.9)	495	(5.2)	511	(5.0)
Disagree a lot	9	(0.6)	462	(8.6)	486	(8.3)

Note: Due to the use of independent scales, the scores provided for average mathematics and science achievement should not be compared across domains (i.e. mathematics cannot be compared with science) nor should they be compared across year levels. Please refer to the Reader's Guide for further explanation.

From Table 6.14 it can be seen that, at both Year 4 and 8, the majority of Australian students (80% and 75%, respectively) agreed that they like being in school. However, the percentage of Year 4 students agreeing a lot that they liked being in school was almost double that of the percentage of Year 8 students. At both year levels, the mathematics and science achievement of those that disagreed a lot was significantly lower than that of students in the other three categories.

<sup>2</sup>  $R^2 = 0.12$ ,  $F(2,74) = 81.22$ ,  $p < 0.01$ ; Intercept = 559.1 (SE=13.4),  $B_{\text{gender}} = 12.3$  (SE=7.3),  $B_{\text{scs}} = -35.0$  (SE=2.8).

## Students' educational aspirations

Table 6.15 shows the percentage of students according to the highest education level they thought that they would achieve, as well as the average mathematics and science achievement for each response group. Only Year 8 students were asked this question.

**Table 6.15** Students' educational aspirations – Percentage of Australian students, and average mathematics and science achievement, Year 8

How far in education do you expect to go?	Per cent of Students		Average Mathematics Achievement		Average Science Achievement	
Finish Secondary School	13	(0.7)	453	(4.1)	469	(4.8)
Finish a TAFE Training Certificate	15	(0.8)	460	(4.6)	480	(4.6)
Finish a TAFE or College Diploma	21	(0.9)	500	(4.1)	520	(3.8)
Finish a Bachelor's Degree	17	(0.9)	539	(6.0)	558	(5.1)
Further than a Bachelor's Degree	14	(0.9)	543	(7.1)	565	(6.8)
I don't know	19	(0.8)	492	(5.3)	507	(5.1)

Note: Due to the use of independent scales, the scores provided for average mathematics and science achievement should not be compared across domains (i.e. mathematics cannot be compared with science). Please refer to the Reader's Guide for further explanation.

Table 6.15 shows that 13 per cent of Year 8 students reported they intended to just finish secondary school, while 31 per cent reported that they intended to gain at least an undergraduate degree. Table 6.15 also shows there is a clear positive relationship between mathematics and science achievement and the educational aspirations of Australian Year 8 students.

## Summary

This chapter examined student-level factors, such as home background and student activities and attitudes, and their relationship to student achievement.

In terms of educational resources in the home, Australia was amongst a small number of countries with high levels of educational resources in the home. At both Year 4 and Year 8, Australia had very high percentages (relative to other countries) of students who reported having over 100 books in the home. High percentages of Australian Year 4 and Year 8 students also had a computer and Internet connection. Both internationally and within Australia, a higher number of books in the home, the presence of a computer and an Internet connection were associated with higher mathematics and science achievement at Years 4 and 8.

Students in Australia were also far more likely than students in many of the participating countries to use a computer at both home and school. At both year levels, students using a computer at home and at school had higher mathematics and science achievement than students using a computer at home but not at school or at school but not at home.

Australian students tended to receive less mathematics and science homework at both Year 4 and Year 8 than students in other countries. On average, at both year levels, Australian students tended to receive less science homework than mathematics homework. At Year 4, Australian students who indicated they received low amounts of mathematics and science homework had higher achievement than those receiving medium or high amounts of homework, perhaps reflecting that much of the homework given at the Year 4 level had a remedial focus. However, at Year 8, students completing high amounts of mathematics and science homework had the highest average achievement. This reflects the different role of homework at Year 8, where it can provide an extension as well as remediation.

Both internationally and within Australia, Year 4 students tended to have a more favourable opinion of mathematics and science than Year 8 students. However, far fewer Australian Year 8 students had high positive affect toward mathematics and science than was the case

internationally. At both Year 4 and Year 8 the percentage of Australian students with high positive affect toward mathematics decreased significantly from 1995, while there was a slight increase in positive affect toward science at Year 4. At both year levels, higher positive affect toward mathematics and science was associated with higher achievement.

Australian Year 8 students placed a relatively high value on mathematics, similar to the international average. However, the percentage placing a high value on science was considerably lower than both the international average for science and the percentage placing a high value on mathematics. Students indicating that they placed a high value on mathematics or science had higher achievement than those who did not.

Both internationally and within Australia, Year 4 students tended to have higher self-confidence in learning mathematics and science than Year 8 students. The proportions of Australian students indicating high, medium and low self-confidence in learning mathematics and science were fairly similar to that of the international average at both year levels. Students with high self-confidence in learning mathematics and science had higher average achievement than those with medium or low self-confidence.

More males than females had high self-confidence in learning mathematics, both within Australia and internationally, and at both year levels. For science, however, there was no gender difference in self-confidence at Year 4, contrasting with a gender difference in favour of males at Year 8. Within Australia, the gender difference in self-confidence in learning mathematics and science appeared to explain the gender difference in achievement at Year 8.

A substantial proportion of both Year 4 and Year 8 students agree that they liked school. At both year levels, those that *disagree a lot* that they like school had significantly lower achievement than those that *disagree a little* or *agree* that they liked school.

Approximately one-third of Year 8 students intend to study at least an undergraduate degree, while 13 per cent expect only to finish secondary school. A clear positive relationship was found between mathematics and science achievement and students' educational aspirations.

The next chapter will examine the context for TIMSS students' learning in Australia in terms of characteristics of the schools that they attended and the teachers who were teaching them at the time of the testing.



# The contexts of learning mathematics and science in Australia: TIMSS schools and teachers

This chapter examines the context for TIMSS students' learning in Australia – the schools that they attended and the teachers who were teaching them at the time of the testing. The chapter presents teachers' reports about their background characteristics, education and training in teaching mathematics and science, and about how well-prepared they feel to teach these subjects.

The chapter draws on data collected for TIMSS 2007 through background questionnaires: two completed by teachers and one by the principals of the schools. The unit for sampling of students within schools was their mathematics class, so that one mathematics teacher per school was asked to complete a questionnaire. The mathematics teachers' responses to the questionnaire were not necessarily representative of those of all mathematics teachers, as these teachers were simply the teachers of a representative sample of students assessed as part of TIMSS 2007. The school questionnaires, however, should be representative of Australian schools as a whole due to the sampling procedures followed (see Chapter 1).

In the case of Year 8 classes, not all students in a mathematics class also attended the same science class. In such cases, more than one science teacher per school was asked to complete a questionnaire. Year 4 classes, on the other hand, generally had the same teacher for mathematics and science so only one teacher questionnaire per class was completed. As with mathematics, science teachers' responses to the questionnaire were not necessarily representative of those of Australian science teachers as a whole, as these teachers were simply the teachers of some of the students assessed as part of TIMSS 2007.

It is important to note that the data shown are the percentages of students whose teachers reported on various characteristics; that is, the student is the unit of analysis so that TIMSS can describe the classroom contexts of the students. The data are not representative of all teachers in the country, as TIMSS is essentially a student assessment and survey, not a survey of teachers.

The information in this chapter should be thought of as indicative, and is provided for the purposes of setting achievement in context. In Australia, responses were obtained from 97 per cent of teachers and 98 per cent of the schools of the Year 4 students. In Year 8, responses were obtained from 94 per cent of Year 8 mathematics teachers, 90 per cent of Year 8 science teachers and 97 per cent of the schools of the Year 8 students.

## Australian mathematics and science teachers and their preparation for teaching

This section presents information about the background characteristics of mathematics and science teachers, including gender, age, and years teaching experience.

### Age and gender

Across Australia, 80 per cent of Year 4 students had mathematics teachers who were female. This is around the same proportion as in TIMSS 2003 (75% female teachers). Table 7.1 shows the proportion of Year 4 and Year 8 students taught mathematics by male and female teachers by state, and Table 7.2 provides similar information for science.

Internationally, most Year 4 students were taught by females with 79 per cent of students taught mathematics by female teachers at Year 4. In a few countries this was not the case. In Yemen most Year 4 mathematics and science teachers were male (74% and 76%, respectively). In Hong Kong, the Netherlands and Iran a high proportion of Year 4 mathematics teachers were male (41%, 42% and 47% respectively). Similarly for Denmark, Morocco and Tunisia, most Year 4 science teachers were also male (55%, 53% and 44% respectively). However in Georgia, Hungary, Italy, Latvia, Lithuania, the Russian Federation, Slovenia and Ukraine, more than 95 per cent of Year 4 mathematics and science teachers were female.

In Australia, and in all states other than the Northern Territory, Tasmania and Western Australia, 80 per cent or more of Year 4 students were taught mathematics by females. In these other three states around two-thirds of the students were taught by female teachers.

There are some differences in the proportion of Year 4 students in Australia taught mathematics and science by female teachers. A slightly lower proportion of Year 4 students were taught science by female teachers, perhaps indicating a shift in primary schools to using specialist science teachers. This seems to occur mainly in New South Wales and Victoria.

In Australia, 49 per cent of Year 8 students were taught mathematics by female teachers. Internationally, however, more Year 8 students are taught by females than males.

Across the Australian states there is wide variation in the proportion of males and females teaching mathematics at Year 8. In South Australia, Western Australia and Tasmania between 40 and 45 per cent of students are taught by female teachers, while in Victoria, the Australian Capital Territory and the Northern Territory, this ranges from 56 per cent to 64 per cent.

**Table 7.1** Percentages of Year 4 and Year 8 mathematics teachers by gender and state

State	Year 4			Year 8		
	N of teachers	% of students taught by a female teacher	% of students taught by a male teacher	N of teachers	% of students taught by a female teacher	% of students taught by a male teacher
NSW	950	80 (6.2)	20 (6.2)	696	47 (8.0)	53 (8.0)
VIC	658	85 (5.8)	15 (5.8)	562	56 (9.5)	44 (9.5)
QLD	872	80 (6.9)	20 (6.9)	648	52 (6.9)	48 (6.9)
SA	543	80 (7.0)	20 (7.0)	540	40 (7.6)	60 (7.6)
WA	481	69 (9.9)	31 (9.9)	519	41 (8.2)	59 (8.2)
TAS	435	67 (10.1)	33 (10.1)	510	45 (10.1)	55 (10.1)
NT	209	65 (6.5)	35 (6.5)	215	64 (12.4)	36 (12.4)
ACT	269	86 (8.8)	14 (8.8)	271	62 (12.1)	38 (12.1)
Australia		80 (3.4)	20 (3.4)		49 (4.3)	51 (4.3)
International Average		79 (0.5)	21 (0.5)		57 (0.5)	43 (0.5)

In TIMSS 1995 in Australia, 58 per cent of students had Year 8 science teachers who were male and 42 per cent female; in TIMSS 2003 the national average changed slightly – 54 per cent of students

were taught by male teachers and 46 per cent by female teachers. In TIMSS 2007 (Table 7.2) the national average had equal proportions; 50 per cent of students at Year 8 were taught science by female teachers and 50 per cent by male teachers. Internationally, however, Year 8 students are taught science more often by females than males. Students in the Northern Territory are also taught by predominately female teachers (71%), but in South Australia and Queensland only 39 per cent and 44 per cent of students respectively were taught by female teachers.

**Table 7.2** Percentages of Year 4 and Year 8 science teachers by gender and state

State	Year 4			Year 8		
	N of teachers	% of students taught by a female teacher	% of students taught by a male teacher	N of teachers	% of students taught by a female teacher	% of students taught by a male teacher
NSW	950	73 (7.4)	27 (7.4)	698	50 (7.9)	50 (7.9)
VIC	658	81 (6.0)	19 (6.0)	551	55 (8.1)	46 (8.1)
QLD	872	81 (6.7)	19 (6.7)	637	44 (7.2)	56 (7.2)
SA	543	81 (6.6)	19 (6.6)	508	39 (9.6)	61 (9.6)
WA	481	69 (9.9)	31 (9.9)	488	54 (8.0)	46 (8.0)
TAS	435	67 (10.1)	33 (10.1)	437	56 (11.3)	44 (11.3)
NT	209	62 (6.9)	38 (6.9)	192	71 (10.6)	29 (10.6)
ACT	269	87 (8.5)	13 (8.5)	246	54 (14.5)	46 (14.5)
Australia		77 (3.7)	23 (3.7)		50 (3.6)	50 (3.6)
International Average		79 (0.5)	21 (0.5)		59 (0.4)	41 (0.4)

Table 7.3A shows the age distribution by state for Year 4 mathematics teachers and Table 7.3B shows the age distribution by state for Year 8 mathematics teachers. Tables 7.4A and 7.4B show the age distribution by state for science teachers, for Year 4 and 8 respectively.

On average, Australian teachers of both mathematics and science at Year 4 and Year 8 were highly experienced, with around one-and-a-half decades of teaching practice. These averages were similar to the international averages and also to the level of teaching experience in TIMSS 2003.

Given these years of experience, it follows that most students will be taught by teachers in their thirties and forties. This is certainly the case in Australia where around 50 per cent of both Year 4 and Year 8 students were taught mathematics and science by teachers in these two age groups. Internationally, around 60 per cent of both Year 4 and Year 8 students were taught by teachers in these two age groups.

If there were a regular replenishment of trained teachers, one would expect there would be approximately equivalent percentages of students taught by teachers in each age group. Relatively few students, 16 to 21 per cent on average internationally, were taught mathematics and science by younger teachers. Several countries did have the majority of their students taught by younger teachers (for example, Kuwait for Year 4 science, and Ghana and Oman for Year 8 mathematics). However, about one-quarter of students internationally (21–24%) were taught by teachers aged 50 or older.

In Australia, Year 4 students in the Northern Territory had the largest proportion of young teachers compared to other states, although still 44 per cent were taught by mathematics teachers in their forties and fifties. Around half of the Year 8 students in New South Wales, Queensland, South Australia and Victoria had mathematics teachers in their twenties or thirties.

Year 4 students in the Northern Territory also had the largest proportion (40%) of young teachers for science. In comparison, New South Wales only 14 per cent of students were taught science by young teachers with the highest proportion of teachers in their forties and fifties (64%). Around half of the Year 8 students in all states had science teachers in their twenties or thirties. In the Northern Territory, 69 per cent were in their twenties or thirties, with only 30 per cent of Year 8 students being taught science by teachers in their forties and fifties.

**Table 7.3A** Percentage of Year 4 mathematics teachers by age and state

State	Year 4 Mathematics			
	29 years or under	30–39 years	40–49 years	50 years or older
NSW	14 (6.3)	28 (6.8)	35 (7.3)	22 (5.4)
VIC	29 (7.8)	13 (5.1)	25 (6.9)	33 (7.2)
QLD	23 (5.6)	11 (5.4)	31 (7.8)	35 (7.9)
SA	18 (6.0)	6 (4.0)	23 (7.4)	53 (8.6)
WA	27 (7.7)	20 (4.2)	15 (6.6)	38 (9.7)
TAS	16 (7.3)	9 (5.0)	32 (9.7)	42 (9.3)
NT	40 (14.9)	16 (9.4)	18 (7.9)	26 (15.8)
ACT	24 (12.0)	34 (14.4)	16 (9.6)	25 (13.7)
Australia	21 (3.9)	18 (3.4)	29 (4.1)	32 (3.4)
International Average	16 (0.4)	31 (0.6)	29 (0.5)	24 (0.5)

**Table 7.3B** Percentage of Year 8 mathematics teachers by age and state

State	Year 8 Mathematics			
	29 years or under	30–39 years	40–49 years	50 years or older
NSW	18 (5.9)	34 (8.4)	19 (6.4)	28 (6.9)
VIC	21 (6.9)	27 (6.9)	30 (5.5)	22 (7.3)
QLD	28 (7.7)	19 (7.5)	13 (6.5)	40 (9.3)
SA	12 (6.0)	37 (9.6)	31 (8.5)	21 (6.3)
WA	13 (6.8)	30 (8.8)	19 (9.3)	38 (10.3)
TAS	14 (5.2)	29 (9.2)	23 (8.5)	33 (10.7)
NT	7 (7.7)	31 (17.9)	35 (14.8)	27 (14.3)
ACT	25 (12.5)	8 (0.3)	41 (11.5)	25 (13.2)
Australia	20 (3.2)	29 (3.7)	22 (3.2)	30 (3.2)
International Average	21 (0.4)	30 (0.5)	26 (0.5)	23 (0.4)

**Table 7.4A** Percentage of Year 4 science teachers by age and state

State	Year 4 Science			
	29 years or under	30–39 years	40–49 years	50 years or older
NSW	14 (6.0)	23 (6.2)	41 (8.1)	23 (5.7)
VIC	26 (7.3)	15 (5.3)	23 (6.8)	36 (7.4)
QLD	27 (6.6)	12 (5.5)	27 (7.3)	34 (8.1)
SA	20 (6.5)	8 (4.6)	18 (7.1)	54 (8.5)
WA	27 (7.7)	16 (4.4)	19 (7.7)	38 (9.7)
TAS	16 (7.3)	9 (5.0)	32 (9.7)	42 (9.3)
NT	40 (14.9)	9 (6.5)	18 (7.9)	33 (16.6)
ACT	24 (11.9)	33 (14.2)	16 (9.4)	28 (14.6)
Australia	21 (3.8)	17 (3.0)	30 (3.9)	32 (3.3)
International Average	16 (0.5)	30 (0.6)	30 (0.6)	24 (0.5)

**Table 7.4B** Percentage of Year 8 science teachers by age and state

State	Year 8 Science			
	29 years or Under	30–39 years	40–49 years	50 years or older
NSW	18 (3.9)	26 (6.5)	24 (5.7)	33 (7.0)
VIC	26 (8.6)	18 (6.9)	29 (7.0)	26 (7.4)
QLD	28 (6.4)	22 (7.0)	28 (7.5)	23 (7.1)
SA	31 (8.9)	25 (8.6)	12 (5.4)	31 (9.0)
WA	20 (7.7)	35 (7.9)	29 (7.9)	16 (6.7)
TAS	19 (6.0)	32 (7.4)	26 (12.7)	23 (8.9)
NT	15 (7.3)	54 (12.4)	11 (7.1)	19 (9.1)
ACT	23 (4.6)	19 (7.2)	25 (2.6)	34 (6.1)
Australia	23 (2.6)	24 (3.0)	26 (2.8)	27 (2.9)
International Average	21 (0.5)	32 (0.4)	27 (0.4)	21 (0.3)

## Qualifications and training

Table 7.5 presents teachers' highest level of education attained by Australian Year 4 and Year 8 mathematics and science teachers. On average internationally, 81 per cent of Year 4 students and 78 per cent of Year 8 students had mathematics teachers with a university or postgraduate university degree. For science, 70 per cent of the Year 4 students and 81 per cent of the Year 8 students had science teachers with a university or postgraduate university degree.

The Australian workforce is well-educated in terms of completion of university or a postgraduate university degree, with only seven to eight per cent of students in Australian primary schools taught mathematics or science by teachers with some form of post-secondary education that was not university. Nationally, in Year 8, only two per cent of students were taught mathematics or science by teachers with some form of post-secondary education that was not university. For most of these teachers, this would be in the form of teachers' college training, and it is generally the older teachers with this form of qualification. For younger teachers, a university degree is now the minimum qualification for being a teacher in Australia.

As shown in Table 7.5, internationally, 23 per cent of Year 4 mathematics and 17 per cent of Year 4 science teachers have postgraduate qualifications. For Australian teachers the average is more than twice this, with more than 40 per cent of mathematics and science teachers holding this level of qualification. Internationally, a little more than 20 per cent of Year 8 mathematics and science teachers held postgraduate qualifications, but in Australia more than one-half of the mathematics and science teachers surveyed held this level of qualification.

At Year 4, in both mathematics and science, more than half of the students in the Czech Republic, Georgia, the Slovak Republic, and the United States were taught by mathematics and science teachers having qualifications beyond their initial university degree. In contrast, 58 per cent of the students in Morocco were taught mathematics, and 55 per cent were taught science, by teachers who had only completed secondary school.

At Year 8, in both mathematics and science, more than half of the students in Armenia, Bulgaria, Czech Republic, Georgia, the Russian Federation, Sweden and the United States were taught by mathematics and science teachers with qualifications beyond their initial university degree, while in contrast, 58 per cent of students in Morocco were taught mathematics and 42 per cent were taught science by teachers who had only completed secondary school.

**Table 7.5** Percentages of Year 4 and Year 8 science and mathematics teachers by highest educational level

	FINISH post-secondary education but not university	FINISH university or equivalent	FINISH beyond initial university degree
<b>Year 4 mathematics teachers</b>			
Females	7 (1.6)	50 (4.6)	43 (4.5)
Males	9 (4.4)	55 (6.3)	36 (5.8)
Australia	7 (1.6)	51 (4.1)	42 (4.0)
International average	16 (0.3)	58 (0.4)	23 (0.3)
<b>Year 4 science teachers</b>			
Females	7 (1.6)	50 (5.2)	43 (5.2)
Males	11 (4.0)	56 (6.1)	34 (5.5)
Australia	8 (1.5)	52 (4.6)	41 (4.3)
International average	18 (0.4)	53 (0.5)	17 (0.3)
<b>Year 8 mathematics teachers</b>			
Females	4 (2.2)	41 (5.1)	55 (5.4)
Males	1 (0.6)	34 (5.7)	65 (5.7)
Australia	2 (1.1)	38 (3.9)	60 (4.1)
International average	18 (0.3)	57 (0.4)	21 (0.3)
<b>Year 8 science teachers</b>			
Females	2 (1.2)	34 (5.8)	64 (5.7)
Males	2 (1.7)	36 (4.7)	62 (4.6)
Australia	2 (1.0)	35 (3.6)	63 (3.4)
International average	16 (0.3)	58 (0.4)	23 (0.3)

Table 7.6 provides information about Australian teachers' educational emphasis in mathematics and science. Teachers all reported that they received specific preparation in how to teach the mathematics and science curriculum as part of pre-service education.

**Table 7.6** Australian teachers' educational emphasis on maths, science and teaching

	Percentage of Students by Their Teachers' Major Area of Study In Their Post-secondary Education	
	Australia	International Average
<b>Year 4 Mathematics teachers</b>		
Primary/Elementary Education with a Major or Specialisation in Mathematics	7 (1.7)	25 (0.5)
Primary/Elementary Education with a Major or Specialisation in Science but Not in Mathematics	5 (1.9)	4 (0.2)
Mathematics or Science Major or Specialisation Without a Major in Primary/ Elementary Education	1 (0.8)	14 (0.4)
Primary/ Elementary Education Without a Major or Specialisation in Mathematics or Science	84 (2.7)	43 (0.5)
Other	2 (0.9)	15 (0.4)
<b>Year 4 Science teachers</b>		
Primary/ Elementary Education with a Major or Specialisation in Science	12 (2.5)	24 (0.5)
Primary/ Elementary Education with a Major or Specialisation in Mathematics but Not in Science	2 (0.6)	6 (0.3)
Science or Mathematics Major or Specialisation Without a Major in Primary/ Elementary Education	2 (0.8)	13 (0.4)
Primary/ Elementary Education Without a Major or Specialisation in Science or Mathematics	82 (2.9)	42 (0.5)
Other	2 (1.0)	15 (0.4)
<b>Year 8 Mathematics teachers</b>		
Education – Mathematics	46 (4.0)	54 (0.5)
Mathematics	49 (3.6)	70 (0.5)
Education – Science	25 (3.6)	12 (0.3)
Science	34 (3.4)	19 (0.4)
Education – General	32 (3.2)	25 (0.4)
Other	39 (3.6)	22 (0.4)
<b>Year 8 Science teachers</b>		
Education- – Science	63 (3.3)	39 (0.5)
Biology, Physics, Chemistry, or Earth Science	85 (2.4)	81 (0.4)
Education – Mathematics	16 (2.3)	10 (0.3)
Mathematics	22 (2.6)	18 (0.3)
Education – General	39 (4.1)	24 (0.4)
Other	30 (3.3)	19 (0.4)

Internationally, about one-quarter of Year 4 students are taught by teachers with a qualification in primary or elementary education and a specialisation in either mathematics or science (or both). However, in Australia most students have teachers with a qualification in primary/elementary education without a major or specialisation in science or mathematics and only about seven per cent of students have teachers with a specialisation in mathematics (12% of the students have science teachers with a specialisation in science). This same pattern is also evident in Czech Republic, Lithuania and New Zealand.

In Year 4 mathematics and science there is a significant difference between the Australian average and international average of students who had teachers with primary/elementary education without a major specialisation in mathematics or science, with Australia having a significantly higher number of students with teachers without a specialisation in mathematics or science.

At Year 8, on average internationally, the majority of students had mathematics teachers that had studied mathematics education (54%) or mathematics (70%) or both (since teachers often reported that their study was focused in more than one area). In Australia, 46 per cent of students had mathematics teachers with a mathematics education qualification and 49 per cent with a mathematics qualification.

At Year 8, on average internationally, the majority of students had science teachers that had studied biology, physics, chemistry or Earth science (81%). In Australia, 85 per cent of Year 8 students had science teachers with a biology, physics, chemistry or Earth science qualification.

Table 7.7 shows Australian Year 8 mathematics teachers' educational emphasis on mathematics, science and teaching by state. There are several notable differences across states shown in this table.

**Table 7.7** Australian Year 8 mathematics teachers' educational emphasis on mathematics, science and teaching by state

	Percentage of Students by Their Teachers' Major Area of Study In Their Post-secondary Education							
	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
<b>Year 8 Mathematics teachers</b>								
Education- Mathematics	59 (7.8)	34 (8.1)	37 (9.9)	54 (9.4)	43 (9.7)	41 (8.7)	45 (8.9)	49 (12.1)
Mathematics	64 (7.9)	56 (5.6)	27 (9.0)	53 (10.0)	30 (10.5)	53 (11.2)	48 (15.2)	47 (8.5)
Education- Science	15 (5.1)	34 (10.0)	29 (6.9)	33 (9.6)	16 (8.0)	33 (8.3)	16 (9.6)	17 (10.0)
Science	11 (5.0)	50 (9.4)	56 (8.2)	36 (9.5)	26 (9.6)	51 (8.6)	26 (15.1)	25 (6.5)
Education- General	27 (7.2)	11 (5.4)	48 (9.1)	48 (10.1)	47 (10.0)	47 (9.8)	22 (13.2)	33 (15.8)
Other	35 (6.6)	32 (9.1)	52 (9.7)	50 (9.4)	32 (7.8)	58 (8.9)	48 (20.7)	47 (16.4)

The Australian Capital Territory and South Australia had about 50 per cent of students who had mathematics teachers with a focus on mathematics education as one of their primary foci in post-secondary education compared to other states. In New South Wales, 64 per cent of students had teachers with a focus on mathematics as their primary foci in post-secondary education compared to 27 per cent of students in Queensland. However, 56 per cent of students in Queensland had teachers with a focus on science compared to 11 per cent of students in New South Wales.

Table 7.8 shows Australian Year 8 science teachers' educational emphasis on mathematics, science and teaching by state.

**Table 7.8** Australian Year 8 science teachers' educational emphasis on mathematics, science and teaching by state

	Percentage of Students by Their Teachers' Major Area of Study In Their Post-secondary Education							
	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
<b>Year 8 Science teachers</b>								
Education – Science	73 (5.5)	60 (8.6)	56 (9.6)	58 (10.2)	56 (9.6)	60 (8.6)	21 (8.2)	68 (9.2)
Biology, Physics, Chemistry, or Earth Science	94 (2.6)	94 (4.0)	76 (8.2)	60 (10.2)	76 (8.6)	68 (7.5)	56 (11.1)	74 (4.7)
Education – Mathematics	7 (4.0)	16 (4.3)	27 (7.2)	28 (8.3)	12 (5.8)	40 (10.8)	26 (9.9)	8 (6.5)
Mathematics	16 (4.3)	24 (5.6)	28 (6.9)	29 (8.6)	10 (5.2)	31 (10.6)	31 (14.8)	22 (11.8)
Education – General	31 (6.1)	34 (8.8)	52 (8.9)	51 (10.6)	39 (10.4)	42 (9.9)	25 (10.7)	52 (10.7)
Other	25 (6.0)	30 (6.8)	28 (7.9)	51 (8.5)	24 (8.2)	46 (12.3)	28 (11.2)	48 (11.5)

In Victoria and Tasmania, 60 per cent of students had science teachers with a focus on science education as their primary focus in post-secondary education. Only 21 per cent of students in the Northern Territory had teachers with a science education focus, while 56 per cent of students had teachers with a specific focus on biology, physics, chemistry or Earth science. In both New South Wales and Victoria, 94 per cent of students had teachers with a focus on biology, physics, chemistry or Earth science.

## Formal professional development

### Mathematics

As well as having had opportunities to develop pedagogical expertise in their subject areas before they start to teach, it is important that teachers be provided with opportunities to continue to develop their expertise once they begin to teach. Teachers responding to the TIMSS surveys were asked to indicate the extent of opportunities for, and participation in, professional development activities. The areas of professional development in which these teachers participated are summarised in Table 7.9. Teachers' participation in the particular areas of professional development is predicated on what is offered to them. As shown by the differences in the Australian and international averages, Australian teachers participate in professional development to a greater extent than in many other TIMSS countries.

**Table 7.9** Participation in areas of professional development for Year 4 and Year 8 mathematics teachers, Australia and internationally

Area of professional development	Year 4 teachers (%)		Year 8 teachers (%)	
	Australia	International mean	Australia	International mean
Mathematics content	71 (3.1)	42 (0.6)	69 (3.8)	56 (0.5)
Mathematics pedagogy/instruction	63 (3.7)	47 (0.6)	61 (3.4)	59 (0.5)
Mathematics curriculum	73 (3.7)	40 (0.6)	69 (3.3)	51 (0.5)
Integrating information technology into mathematics	35 (3.9)	29 (0.5)	57 (3.2)	45 (0.5)
Improving students' critical thinking or problem solving skills	53 (4.3)	40 (0.6)	45 (3.7)	46 (0.5)
Mathematics assessment	52 (3.5)	37 (0.6)	59 (3.6)	48 (0.5)

Professional development for Australian teachers of Year 4 students was mainly in the area of mathematics content, mathematics curriculum, and mathematics pedagogy or instruction. Professional development aimed at integrating IT into mathematics was only undertaken by a little more than one-third of Year 4 mathematics teachers in Australia. This was similar to the pattern internationally.

For mathematics teachers teaching Year 8 students in Australia, professional development was mainly in the areas of mathematics curriculum and mathematics content. This is somewhat different from the international data, where the major areas of involvement in professional development were in the areas of mathematics pedagogy or instruction and mathematics content. Professional development in the area of improving students' critical thinking and problem solving skills had the least uptake amongst Year 8 teachers in Australia.

### Science

The areas of professional development in which Australian science teachers participated are summarised in Table 7.10.

Professional development in science for Australian teachers of Year 4 students was mainly in the area of science content, science curriculum and improving critical thinking or problem solving skills. Professional development about science assessment was only undertaken by 15 per cent of Year 4 teachers in Australia compared with 28 per cent internationally.

Australian Year 8 teachers participate in professional development to a similar extent as many other TIMSS countries. In the international data, the major areas of involvement in professional development were science content and pedagogy.

**Table 7.10** Participation in areas of professional development for Year 4 and Year 8 science teachers, Australia and internationally

Area of professional development	Year 4 teachers (%)		Year 8 teachers (%)	
	Australia	International average	Australia	International average
Science content	22 (3.0)	34 (0.6)	56 (3.7)	58 (0.5)
Science pedagogy/instruction	16 (2.5)	35 (0.6)	52 (3.5)	57 (0.5)
Science curriculum	24 (3.4)	31 (0.5)	57 (3.9)	51 (0.5)
Integrating information technology into science	20 (3.1)	24 (0.5)	57 (4.3)	45 (0.5)
Improving students' critical thinking or problem solving skills	36 (3.5)	33 (0.6)	51 (3.9)	46 (0.5)
Science assessment	15 (2.3)	28 (0.5)	54 (3.5)	47 (0.5)

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

TIMSS 2007 asked 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.

At Year 4, teachers were asked about:

- 20 topics in mathematics, including 10 topics in number, 7 topics in *geometric shapes and measures*, and 3 topics in *data display*.
- 22 topics in science, including 6 topics in *life science*, 9 topics in *physical science*, and 7 topics in *Earth science*.

Table 7.11 shows the percentage of students whose teachers reported feeling 'very well' prepared to teach Year 4 mathematics and science topics, for Australia and the international average.

**Table 7.11** Percentage of Year 4 students with teachers that reported feeling "very well" prepared to teach 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)

At Year 4, the international average across all mathematics topics was 72 per cent, meaning that 72 per cent of students had teachers who reported feeling 'very well' prepared to teach all topics. In Australia, the average was 81 per cent. In terms of the specific domains, Year 4 teachers in Australia were relatively confident (81%) of teaching *number* compared to *geometric shapes and measures* (72%). Given the results shown in Chapter 3 that number was the weakest content area, this may well be misplaced confidence. The average for *data display* was the highest, with 88 per cent of Year 4 students in Australia having teachers who reported that they were 'well-prepared' to teach the topics. Internationally, *data display* was one of the weaker areas (71 per cent). The average for *geometric shapes and measures* was weakest both internationally and in Australia.

In contrast, the international average across all Year 4 science topics was 54 per cent while in Australia this was 46 per cent. The average for *physical science* was the weakest area both in Australia and internationally. In comparison to the international average, fewer Australian Year 4 students had teachers who reported feeling 'well-prepared' to teach science topics in each domain.

At Year 8, teachers were asked about:

- 18 topics in mathematics, including 5 topics in *number*, 4 topics in *algebra*, 6 topics in *geometry*, and 3 topics in *data and chance*.
- 23 topics in science, including 7 topics in *biology*, 5 topics in *chemistry*, 6 topics in *physics*, and 5 topics in *Earth science*.

**Table 7.12** Percentage of Year 8 students with teachers that reported feeling “very well” prepared to teach 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, the average was 91 per cent. The average for *data and chance* was highest, followed by *number*, with 93 per cent and 92 per cent of students respectively in Australia having teachers who reported that they were ‘well-prepared’ to teach these topics. *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, the average 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.

Tables 7.13 and 7.14 show the percentage of students whose teachers reported feeling ‘very well’ prepared to teach the Year 4 and Year 8 mathematics and science topics, respectively, by state.

**Table 7.13** Percentage of Year 4 students with teachers that reported feeling “very well” prepared to teach TIMSS mathematics and science topics by state

Year 4	All mathematics	Number	Geometric shapes and measures	Data display
NSW	87 (2.5)	86 (2.5)	80 (3.4)	94 (3.1)
VIC	78 (4.6)	80 (4.7)	67 (5.8)	88 (4.9)
QLD	71 (4.3)	76 (3.9)	60 (5.3)	77 (5.2)
SA	82 (4.2)	79 (5.6)	77 (5.1)	89 (4.9)
WA	82 (5.2)	83 (5.4)	78 (4.0)	84 (7.2)
TAS	80 (3.5)	79 (5.0)	72 (4.9)	89 (3.5)
NT	68 (13.4)	63 (11.7)	65 (12.6)	74 (16.8)
ACT	88 (4.2)	86 (5.7)	87 (3.6)	91 (5.0)

Year 4	All science	Life science	Physical science	Earth science
NSW	47 (5.3)	53 (7.5)	37 (5.0)	53 (6.3)
VIC	43 (6.2)	42 (6.7)	39 (6.3)	47 (6.8)
QLD	44 (5.6)	46 (6.2)	34 (5.7)	50 (7.5)
SA	48 (5.7)	51 (6.7)	37 (7.2)	55 (6.4)
WA	53 (6.5)	53 (8.1)	42 (5.8)	62 (6.7)
TAS	47 (6.2)	46 (5.0)	38 (8.2)	56 (7.2)
NT	55 (4.2)	53 (5.7)	45 (4.6)	66 (7.2)
ACT	39 (7.0)	47 (7.1)	23 (6.9)	46 (8.8)

At Year 4, the average for *data display* was the highest for all states. In the Northern Territory, the average for *number* was the lowest, with 63 per cent of students having teachers who reported that they were 'well-prepared' to teach this topic, while *data display* was the highest at 74 per cent. The average for *geometric shapes and measures* was the lowest for most states.

The averages for Year 4 science are noticeably lower than Year 4 mathematics with students in Australia having teachers who reported that they were less 'well-prepared' to teach science topics than mathematics topics. In the Northern Territory, the average for *Earth Science* was highest, with 66 per cent students in Australia having teachers who reported that they were 'well-prepared' to teach *Earth science* topics. This was also higher than other states. *Physical science* was the weakest area across all states.

**Table 7.14** Percentage of Year 8 students with teachers that reported feeling "very well" prepared to teach TIMSS mathematics and science topics by state

Year 8	All mathematics	Number	Algebra	Geometry	Data and chance
NSW	90 (3.9)	92 (3.2)	92 (4.2)	85 (4.9)	93 (4.1)
VIC	91 (3.0)	94 (1.8)	87 (5.1)	89 (4.6)	92 (4.2)
QLD	91 (3.2)	89 (4.5)	86 (5.1)	91 (3.4)	97 (2.1)
SA	95 (1.8)	99 (1.2)	96 (2.5)	92 (2.8)	93 (3.6)
WA	88 (5.4)	89 (5.7)	85 (7.0)	87 (5.8)	92 (4.8)
TAS	89 (2.6)	93 (2.0)	85 (5.9)	87 (3.0)	92 (3.1)
NT	90 (5.7)	93 (5.5)	90 (5.0)	85 (7.0)	91 (6.4)
ACT	92 (4.4)	-	86 (9.1)	88 (3.2)	94 (6.1)

Year 8	All science	Biology	Chemistry	Physics	Earth science
NSW	85 (2.3)	85 (3.8)	92 (1.5)	82 (4.0)	83 (3.5)
VIC	69 (4.4)	78 (4.1)	75 (6.6)	63 (7.3)	61 (5.6)
QLD	64 (5.7)	66 (8.2)	67 (6.6)	62 (7.2)	62 (7.5)
SA	60 (5.0)	62 (6.3)	66 (5.7)	56 (6.1)	55 (6.2)
WA	76 (4.4)	79 (5.6)	84 (4.9)	70 (6.9)	72 (6.2)
TAS	62 (9.7)	58 (9.9)	69 (11.9)	58 (11.1)	71 (10.8)
NT	60 (8.0)	72 (7.1)	61 (9.4)	48 (10.8)	60 (9.5)
ACT	75 (2.4)	70 (3.7)	88 (6.6)	68 (4.3)	74 (5.1)

At Year 8 for mathematics, South Australia had the highest averages for most topics, including *number* and *algebra*, with 99 and 96 per cent of students having teachers who reported they were 'well-prepared' to teach these topics, respectively. The average for *geometry* was the weakest area in half the states. However, there were still more than 80 per cent of students that had teachers who felt 'well-prepared' to teach the topics in this content area.

In New South Wales, the average across *chemistry* topics was 92 per cent. In the Northern Territory, this was 61 per cent. *Physics* and *Earth science* were the weakest areas in most states.

Tables 7.15 and 7.16 show the percentage of students whose teachers reported feeling 'very well' prepared to teach Year 4 and Year 8 mathematics and science topics respectively, by gender.

**Table 7.15** Percentage of Year 4 students with teachers that reported feeling "very well" prepared to teach TIMSS mathematics and science topics by gender

Year 4	All mathematics	Number	Geometric shapes and measures	Data display
Female	81 (2.1)	82 (2.2)	72 (2.8)	90 (2.3)
Male	78 (5.2)	80 (4.6)	74 (5.4)	79 (6.3)

Year 4	All science	Life science	Physical science	Earth science
Female	47 (3.4)	52 (4.1)	36 (3.3)	52 (3.9)
Male	42 (4.1)	37 (5.3)	40 (4.8)	50 (4.5)

At Year 4, the average for *data display* for female teachers was highest (90%) with students in Australia having female teachers who reported that they were ‘well-prepared’ to teach these topics. For male teachers, the average for *number* was the highest, with 80 per cent of students in Australia having teachers who reported that they were ‘well-prepared’ to teach the topics. The average for *geometric shapes and measures* was the lowest for both male and female teachers.

At Year 4, the average for male teachers across *all science* topics was 42 per cent. In comparison, for Year 4 *Earth science* about 50 per cent of students in Australia had teachers, both male and female, who reported that they were ‘well-prepared’ to teach the topics.

**Table 7.16** Percentage of Year 8 students with teachers that reported feeling “very well” prepared to teach TIMSS mathematics and science topics by gender

Year 8	All mathematics	Number	Algebra	Geometry	Data and chance
Female	87 (2.9)	88 (2.8)	83 (4.1)	86 (3.3)	91 (3.3)
Male	94 (1.6)	96 (1.3)	94 (2.0)	90 (2.4)	96 (1.5)

Year 8	All science	Biology	Chemistry	Physics	Earth science
Female	72 (2.7)	81 (3.0)	77 (3.3)	62 (4.5)	68 (3.6)
Male	75 (2.9)	71 (4.1)	82 (3.2)	77 (3.3)	71 (3.9)

At Year 8, the average for *data and chance* and *number* for male teachers was highest at 96 per cent of students in Australia having male teachers who reported that they were ‘well-prepared’ to teach these topics. For male teachers, the averages across mathematics topics were generally higher than those for female teachers. At Year 8, the average for female teachers across *biology* topics was 81 per cent. For male teachers, this was 71 per cent.

## Classroom activities and characteristics

It is largely teachers and their practices that determine the implemented curriculum; that is, the mathematics and science that students are taught in their classrooms. The previous section of this chapter has examined the background of mathematics and science teachers in this study. This section examines classroom practices.

### Factors limiting instruction in mathematics and science

This chapter focuses on the instructional activities used in teaching and learning mathematics and science, and how these activities are supported with technology use, homework, and assessment.

Mathematics and science teachers were asked about the impact on instruction of five student-related factors: differing academic abilities, a wide range in backgrounds, students with special needs, uninterested students, and disruptive students. Responses to statements assessing these constructs were given on a four-point scale; *not at all*, *a little*, *some*, and *a lot*. Teachers’ responses were used to construct an Index of Teachers’ Reports on Teaching Mathematics (Science) Classes with Few or No Limitations on Instruction due to Student Factors (MCFL or SCFL)<sup>1</sup>. The results are presented in Table 7.18. Students were placed in the high category, if, on average, teachers reported their classrooms were impacted only a little (if at all), and in the low category, if, on average, these factors impacted instruction a lot. The remaining students fell in the medium category.

<sup>1</sup> Index based on teachers’ responses to five statements about student factors limiting mathematics instruction: 1) Students with different academic abilities; 2) Students who come from a wide range of backgrounds; 3) Students with special needs; 4) Uninterested students; and 5) Disruptive students. Average is computed across the five statements based on a 4-point scale: 1. Not at all/Not applicable; 2. A little; 3. Some; and 4. A lot. High level indicates average is less than or equal to 2. Medium level indicates average is greater than 2 and less than 3. Low level indicates average is greater than or equal to 3.

**Table 7.17A** Index of Year 4 Teachers' Reports on Teaching Mathematics (Science) Classes with Few or No Limitations on Instruction due to Student Factors (MCFL/SCFL) – Percentage of students and average mathematics and science achievement, Year 4

	High MCFL/SCFL (Few or No Limitations)		Medium MCFL/SCFL (Some Limitations)		Low MCFL/SCFL (A Lot of Limitations)	
	Percentage of students	Average achievement	Percentage of students	Average achievement	Percentage of students	Average achievement
<b>Year 4 Mathematics</b>						
Australia	46 (3.7)	535 (4.8)	40 (3.7)	501 (4.6)	15 (2.5)	500 (9.4)
International avg.	45 (0.6)	483 (1.0)	36 (0.6)	466 (1.0)	18 (0.5)	459 (1.7)
<b>Year 4 Science</b>						
Australia	62 (3.0)	536 (4.8)	24 (2.5)	517 (5.6)	13 (2.8)	510 (12.7)
International avg.	53 (0.6)	482 (1.5)	31 (0.6)	470 (1.6)	16 (0.5)	464 (2.0)

**Table 7.17B** Index of Year 8 Teachers' Reports on Teaching Mathematics (Science) Classes with Few or No Limitations on Instruction Due to Student Factors (MCFL/SCFL) – Percentage of students and average mathematics and science achievement, Year 8

	High MCFL/SCFL (Few or No Limitations)		Medium MCFL/SCFL (Some Limitations)		Low MCFL/SCFL (A Lot of Limitations)	
	Percentage of students	Average achievement	Percentage of students	Average achievement	Percentage of students	Average achievement
<b>Year 8 Mathematics</b>						
Australia	43 (4.4)	529 (6.8)	33 (3.7)	480 (5.7)	24 (3.2)	468 (8.0)
International avg.	38 (0.5)	466 (1.0)	39 (0.5)	445 (0.8)	23 (0.5)	433 (1.2)
<b>Year 8 Science</b>						
Australia	40 (3.3)	532 (6.7)	39 (4.1)	512 (7.2)	21 (3.4)	499 (6.6)
International avg.	37 (0.5)	477 (1.0)	41 (0.5)	462 (0.8)	22 (0.4)	451 (1.1)

The results show that at both Year 4 and Year 8 average mathematics and science achievement was related to the diversity of the students in the class and the instructional challenges involved. That is, students of teachers who reported that their classrooms were impacted only a little by these factors had higher average achievement than those whose teachers reported some limitations, and this latter group had higher average achievement than those students whose teachers reported a lot of limitations. Internationally at Year 4, 45 per cent of students had mathematics teachers who reported that their classrooms were impacted only a little by these factors (i.e. high MCFL) and 53 per cent of Year 4 students had science teachers who responded similarly (i.e. high SCFL). Internationally, for Year 8 mathematics classes, 38 per cent of the students had teachers who reported that their classrooms fell into the high MCFL category, and for science, this was 37 per cent (i.e. high SCFL). Internationally, 23 per cent of Year 8 students were in mathematics classes that were adversely impacted by such factors (i.e. low MCFL) as reported by teachers, and 22 per cent of students were in science classes within the same category (i.e. low SCFL). The students in both the low MCFL and low SCFL category had significantly lower average achievement in mathematics and science.

A similar pattern is evident in Australia. Forty-six per cent of students had mathematics teachers who reported that their classrooms were impacted only a little by these factors (i.e. high MCFL) and 62 per cent of Year 4 students had science teachers who reported within the same category (i.e. high SCFL). These students had higher achievement than students in classes where there were limitations to instruction. For Australian students in Year 8 mathematics and science, these differences are significant where students scored significantly higher than students with adversely impacted instruction. A higher percentage of students in Australia than internationally are taught by teachers who report few limitations on instruction.

## Student reports on mathematics content-related emphasis in classroom activities

TIMSS 2007 asked Year 4 and Year 8 students and their teachers how often they do the following activities in the classroom:

Year 4

- practise adding, subtracting, multiplying, and dividing without a calculator
- work on fractions and decimals
- learn about shapes, such as circles, triangles, rectangles and cubes
- measure things in the classroom and around the school
- make tables, charts or graphs.

Year 8

- practice adding, subtracting, multiplying, and dividing without a calculator
- work on fractions and decimals
- write equations and functions to represent relationships
- solve problems about geometric shapes, lines and angles
- interpret data in table, charts or graphs.

In Year 4 nationally, 76 per cent of students reported that half of the lessons were spent on practising adding, subtracting, multiplying and dividing without a calculator which was greater than the international average of 69 per cent. The category of measuring things in the classroom and around the school had the lowest percentage of students who reported that at least half of the lessons were spent on it (23%). This was similar to the international average (27%).

In Year 4 nationally, 83 per cent of teachers reported that half of the lessons or more were spent on practising adding, subtracting, multiplying and dividing without a calculator, which is similar to the international average (81%). Only eight per cent of teachers reported that half of the lessons or more were spent on the category 'measure things in the classroom and around the school', which was similar to the international average (10%).

In Year 8 nationally, there was less variation across topics according to student responses, with 39 per cent of students who reported that half of the lessons or more were spent on the category 'solve problems about geometric shapes, lines and angles' and the highest percentage (45%) of students who reported that half of the lessons or more were spent on 'practising, adding, subtracting, multiplying, and dividing without using calculator' and on 'write equations and functions to represent relationships'.

However in Year 8, 45 per cent of Australian teachers reported that half of the lessons or more were spent on 'practising adding, subtracting, multiplying, and dividing without using a calculator' whereas only six per cent and seven per cent of teachers reported spending half of the lessons or more on 'use knowledge of the properties of shapes, lines and angles to solve problems' and 'interpret data in the tables, charts or graphs' respectively.

## Problem-solving activities

An emphasis on problem-solving activities has been an important part of the mathematics curriculum for a number of years, and improving students' problem-solving skills continues to be a goal for educators. TIMSS asked Year 8 students and teachers how often students were asked to do the following:

- relate what was being learned in mathematics to their daily lives;
- explain their answers; and
- decide procedures for solving complex problems.

Both students and teachers were asked to nominate a percentage of time that was spent in their mathematics classes on each of these activities.

In Australia, being asked to explain answers was the most common of these activities in mathematics classes, with over two-thirds (71%) of students saying that at least half of their lessons involved this type of activity. Less than half of the students (40%) said they spent more than half of their time in mathematics classes deciding on procedures for solving complex problems, while 42 per cent of students reported spending at least half of their time in class on relating classroom mathematics to their daily lives. This is a slight improvement on TIMSS 2003 when only 37 per cent of students reported spending at least half of their time in class on this category.

Australian teachers were also asked the same questions, and there was agreement between teachers and students in relating classroom mathematics to daily lives where 47 per cent of teachers said that this was their main emphasis. An area in which Australian students and teachers differed was that 62 per cent of teachers said that they set more than half the class time for students to explain answers (compared to 71% of students). Another area in which Australian students and teachers widely differed was that 28 per cent of teachers said that they set more than half the class time for students to decide on procedures for solving complex problems (compared to 40 per cent of students).

In comparison, explaining answers received the most emphasis internationally, with 78 per cent of teachers and 70 per cent of students across countries reporting that they did this in at least half of their lessons. Relating mathematics in class to students' everyday lives was reported by 57 per cent of the teachers and 51 per cent of the students as occurring in at least half of their classes. Deciding on problem-solving procedures received the least attention internationally, with 42 per cent of teachers and 50 per cent of students saying that at least half of their lessons consisted of this type of activity.

### Scientific inquiry and investigations

Engaging students in scientific inquiry is an important part of the science curriculum in many countries. In order to investigate the emphasis placed on scientific investigations in the classroom, TIMSS asked Year 8 students and teachers how often students were asked to do the following:

- watch the teacher demonstrate an experiment or investigation;
- design or plan an experiment or investigation;
- conduct an experiment or investigation;
- work in a small group on an experiment or investigation;
- write an explanation about what was observed and why it happened; and
- relate what was being learned in science to their daily lives.

Both students and teachers were asked to nominate whether *every, or almost every, science lesson; about half the science lessons; or only some science lessons* were spent on each of these activities.

In Australia, the most common activities according to students (i.e. those in which students reported spending at least half of their class time) were working in small groups on an experiment (68%); watching the teacher demonstrate an experiment (60%); writing explanations about what was observed and why it happened (59%); conducting an experiment (59% of students); and designing an experiment (52%). The area of least attention was being asked to relate classroom science to their daily lives, for which 39 per cent of students reported spending at least half of their time in class.

According to teachers, the most common activities were conducting experiments (67%); students working together in small groups on experiments (60%); and writing explanations about what was observed and why it happened (68%).

This shows that there were differences in the level of emphasis reported by Australian students and teachers. Students saw the classroom as more teacher dominated than teachers did, while fewer teachers than students thought that most classes were spent with students watching teachers demonstrate an experiment (15%) or students designing experiments (16%). Seventy-three per cent of teachers thought that over half their classes emphasised relating what was learnt to students' daily lives (compared to 39% of students). This dissonance between teacher and student responses suggests that the implemented curriculum doesn't always connect with students as teachers may intend.

Internationally, the Year 8 student cohort was in agreement with their Australian counterparts, in that they felt that a large emphasis was on writing explanations (65% of students, internationally, reported that at least half their lessons involved this activity). However, more students internationally reported at least half their classes involved watching the teacher demonstrate an experiment (67%) and relating what they learnt to their daily lives (57%). Fewer students internationally (56%) than in Australia reported spending time in at least half their science classes working in small groups.

Compared with Australia, internationally, teachers put more emphasis on students watching them demonstrate an experiment (41%) and students designing experiments (27%), and less emphasis than Australian teachers on conducting experiments (47%) and working together in small groups on experiments (50%). The activity that received the most emphasis internationally was relating what was learnt to students' daily lives (79%).

## Instructional strategies

Mathematics textbooks and science textbooks are the foundation of instruction in both Year 4 and Year 8 in most countries in the TIMSS study, although less so for science at Year 4. Australia stands out amongst the countries surveyed at Year 4 as having almost 24 per cent of classes not using a textbook for mathematics. The proportion of classes not using a mathematics textbook in Year 4 was about 38 per cent in Kuwait, 21 per cent in England, and 16 per cent in Qatar. Other than in these countries, however, more than 85 per cent use a textbook, either as a primary basis or as a supplementary resource. Whereas, in Year 4 science, both Australia and New Zealand are amongst a small number of countries where around 80 per cent of classes do not use a textbook for science. In Scotland, just over two-thirds (68%) of the science classes do not use a textbook. The proportion of classes not using a science textbook in Year 4 is about 30 per cent in England and Germany, 17 per cent in the United States, and 15 per cent in the Netherlands. In all other countries more than 85 per cent of classes use a textbook, either as a primary basis or as a supplementary resource.

Of the 76 per cent of Australian Year 4 students with mathematics teachers who said they do use a textbook, 17 per cent of students had teachers who reported that they use it as their primary resource. Internationally, El Salvador, England and New Zealand were the only countries that used a textbook as a primary resource *less* than Australian Year 4 teachers. Of the 18 per cent of Australian Year 4 students had science teachers who said they do use a textbook, only four per cent use it as their primary resource. Internationally, New Zealand was the only country in which teachers use a textbook as a primary resource less than Australian Year 4 teachers.

In Australia, 16 per cent of Year 8 students had science teachers who reported that they do not use a textbook at all, 28 per cent of the students had teachers who use it as their primary basis for lessons, and over half (56%) of the students had teachers who reported that they use it as a supplementary resource.

At Year 8, Australian mathematics teachers use a textbook to a similar extent as teachers in most other countries. Only six per cent of students had teachers who reported that they do not use a text book at all. About one-half (53%) of students had teachers that use it as their primary basis for lessons, and 41 per cent use it as a supplementary resource. Australian teachers use a science textbook as a primary basis to a lesser extent than other countries.

## Instructional time in science and mathematics

On average, Australian Year 4 students spent about 18 per cent of their weekly instructional time on learning mathematics<sup>2</sup>. Of this time, about 57 per cent was spent on instruction in the area of *number*, 22 per cent in the area of *geometric shapes and measures*, and 15 per cent on *data display*. On average, Australian Year 4 students spent only about five per cent of their weekly instructional time on learning science<sup>3</sup>. Of this time, about 40 per cent<sup>4</sup> was spent on instruction in the area of *life science*, 25 per cent on *physical science*, and 28 per cent on *Earth science*.

Students in Year 8 on average spent about 13 per cent of their weekly instructional time on learning mathematics<sup>5</sup>. Of this time, about 29 per cent was spent on instruction in the area of *number*, 24 per cent in the area of *algebra*, 20 per cent on *geometry* and 17 per cent on *data and chance*. On average, Australian Year 8 students spent about 12 per cent<sup>6</sup> of their weekly instructional time on learning science. Of this time, about 29 per cent was spent on instruction in the area of *biology*, 25 per cent on *chemistry*, 25 per cent on *physics*, and 17 per cent on *Earth science*.

## Activities in mathematics and science classes

Year 4 students in Australia spend about half (53%) of their class time working on problems with and without teacher guidance. This is slightly more than the international average (43%), the United States (46%) and Singapore (35%), but around the same as England (56%), New Zealand (59%) and Scotland (59%). Only 12 per cent of Australian Year 4 students' class time is spent listening to teachers (listening to lecture-style presentations). The remaining quarter of class time was spent reviewing homework (5%), taking tests and quizzes (7%), participating in classroom management tasks unrelated to the lesson (5%) and other student activities (5%). These results are very similar to TIMSS 2003.

Australian mathematics students in Year 8 spend their time in a very similar manner to students in Year 4. About half (47%) of their time was taken up with working on problems with and without the teacher's help, which is slightly more than the international average (37%), the United States (36%), Japan (38%) and Singapore (33%). Another quarter of class time was spent listening to teachers, and the remaining time reviewing homework (7%), taking tests (7%), participating in classroom management tasks unrelated to the lesson (8%) and other student activities (4%).

According to science teachers, Year 8 students in Australia spend over one-third (36%) of their class time working on problems with and without teacher guidance. This is about the same as the international average (30%), the United States (33%) and Botswana (33%), but less than England (48%) and more than Singapore (24%) and Chinese Taipei (16%). Another 30 per cent of class time was spent listening to teachers (both in lecture-style presentations and to re-teach and clarify procedures), and the remaining time reviewing homework (7%), taking tests (7%), participating in classroom management tasks unrelated to the lesson (10%) and other student activities (12%).

## Calculators and computers

Calculator use in mathematics classes is widespread in Australian schools. At Year 4, 95 per cent of teachers allow their use in the classroom. The primary use is checking answers and solving complex problems, and exploring number concepts. On average internationally, only 46 per

2 In most cases, data are available for at least 70% but less than 85% of the students in Australia. This means the data are less reliable and conclusions should be drawn with caution.

3 In most cases, data are available for at least 50% but less than 70% of the students.

4 In most cases, data are available for at least 70% but less than 85% of the students in Australia. This means the data are less reliable and conclusions should be drawn with caution.

5 In most cases, data are available for at least 70% but less than 85% of the students in Australia.

6 In most cases, data are available for at least 50% but less than 70% of the students.

cent of classes use calculators. Use is particularly restricted in Singapore (2%), Ukraine (4%) and Slovenia (6%).

Calculator use is similarly widespread in Year 8, where 99 per cent of Australian students had teachers that allow their use. They are mostly used for routine computations, checking answers and solving complex problems. More than 95 per cent of the students in Year 8 in other countries such as Algeria, Hong Kong, Lithuania, Morocco, Norway, Oman, Palestinian National Authority, and Scotland are allowed the use of calculators, while in Malaysia, Malta and Sweden, all students are permitted to use calculators.

Seventy-eight per cent of Year 4 students in Australia also have access to a computer in their mathematics classroom. However, for mathematics at this year level there is moderate usage, with the majority of time being spent practising skills and procedures, which occurs in about half of the lessons, in about eight per cent of classrooms.

With mathematics at Year 8 level being mostly taught in general classrooms, only 51 per cent of Australian students had teachers who have access to a computer, and even given this moderate level of availability, only in three per cent of classrooms is there any use of computers for more than half of the lesson.

Seventy-eight per cent of Year 4 students in Australia have access to a computer in their science classroom. While access is high, the primary use for science is to look up ideas and information, which occurs in about half of the lessons, in about a quarter (29%) of Australian classrooms. Hong Kong, New Zealand and Scotland are the only countries to have a higher proportion of teachers reporting using a computer within at least half their science classes for looking up ideas and information.

In Year 8 science in Australia, 61 per cent<sup>7</sup> of students have access to a computer in their science classroom. Ten per cent of students reported that the primary use for science classes is to look up ideas and information.

## Homework and assessment

The amount of time students spend on homework, and the types of homework that teachers set, is an important consideration when examining opportunities to learn. TIMSS calculates a summary measure, an index of teachers' emphasis on mathematics homework (EMH), and science homework (ESH). The teachers of students in the high category gave longer homework assignments on a relatively frequent basis (in half the lessons or more). Teachers of students in the low category gave short assignments (less than 30 minutes) relatively infrequently (in less than half the lessons). The medium level includes all other possible combinations.

Internationally, 13 per cent of Year 4 mathematics students had teachers in the high EMH category, almost one-half reported giving a medium amount of homework, and 36 per cent of students had teachers that reported having low emphasis on mathematics homework. This varied enormously between countries, from 41 per cent of teachers in Armenia having a high emphasis on mathematics homework, through to Kuwait and the Slovak Republic, where no teachers are apparently in the high EMH category. In Australia, there were few teachers (5%) placing a high emphasis on homework, with the vast majority assigning little homework infrequently (78%).

Internationally in Year 4 science, seven per cent of students had teachers who were in the high category, while 65 per cent students had teachers that reported having low emphasis on science homework. This also varied enormously between countries, from 30 per cent of students in Italy placing teachers with a high emphasis on science homework, through to Sweden and New Zealand, in which no teachers were apparently in the high ESH category. In Australia, there were

<sup>7</sup> Data are available for at least 70% but less than 85% of the students.

no teachers<sup>8</sup> with a high emphasis on homework, with the vast majority again assigning little homework infrequently (98%).

At Year 8 level, school policy often prescribes the setting of mathematics homework. Internationally, 28 per cent of students had teachers that reported a high emphasis on mathematics homework, while about half (49%) of the students were in the medium category and 24 percent of the students were in the low category. The range, however, was extremely wide, from 70 per cent in the high category in Romania, through to two per cent in Kuwait. More than half of the students were in the low category in England (59%), Republic of Korea (56%), Sweden, (63%) and Scotland (55%). In Australia, five per cent of Year 8 students had teachers with a high emphasis on mathematics homework, 46 per cent were in the medium category, and 49 per cent in the low category.

Internationally, seven per cent of Year 4 science students were in the high ESH category, about a quarter (28%) had teachers that reported giving a medium amount of homework, and 65 per cent of students had teachers that reported placing low emphasis on science homework. Across countries, few students had science teachers in Year 4 that put a high emphasis on homework, the highest percentage being 30 per cent in Italy. Nine countries, including Australia, Sweden, New Zealand, Scotland, Germany, Hong Kong, Denmark, Austria and Japan had no teachers putting a high emphasis on science homework. In Australia, 98 per cent of Year 4 students had teachers that assigned little science homework infrequently.

At Year 8 level, 14 per cent of students were in classes with a high emphasis on science homework internationally, while about 39 per cent of students were in the medium category and 47 per cent in the low category. The range, however, was wide, from 42 per cent in the high category in Italy, through to one per cent in Scotland and none in the Czech Republic. More than three quarters of the students were in the low category in Serbia, Slovenia, Japan, Scotland and the Czech Republic. In Australia, nine per cent of Year 8 students had teachers that reported placing a high emphasis on science homework, 18 per cent were in the medium category, and 73 per cent were in the low category.

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<sup>8</sup> Data are available for at least 70% but less than 85% of the students.

## School contexts for mathematics and science learning

There are a number of factors at the school level that influence the way that teachers are able to prepare and deliver the curriculum, and the way in which students are able to learn what is taught. This section will describe the school level contexts in which children learn mathematics and science, internationally and within Australia.

### School size and location

In Australia, the average school size for TIMSS Year 4 students was around 322 students, and for Year 8 students it was around 747 students. The smallest school in the Year 4 assessment had 24 students and the largest 2150 students, while for Year 8 students the smallest school had 61 students and the largest 2173 students.

Figure 7.1A and Figure 7.1B shows the location of schools in the TIMSS study. Whilst the largest proportion of students live in urban regions of more than 500 000 people, there is a range of students that live in locations between 1001 and 15 000 people. Only 12 per cent of Year 4 and 5 per cent of Year 8 students live in rural areas where the population is fewer than 1000 people.

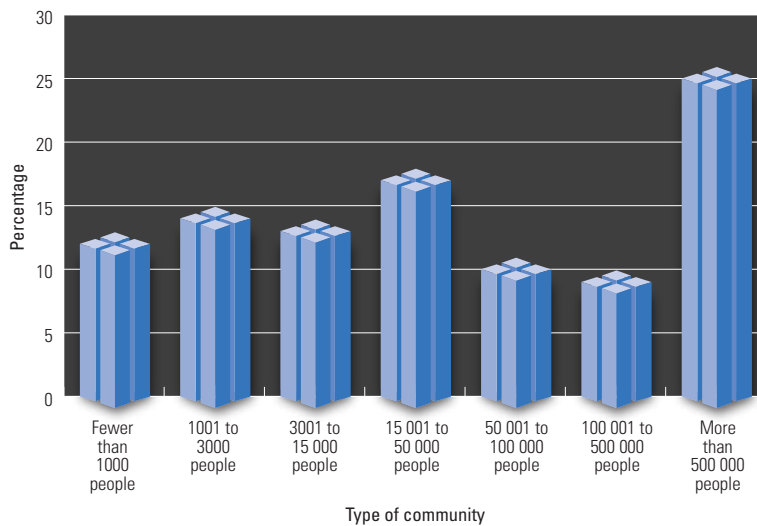


Figure 7.1A Location of schools for Year 4 students in Australia

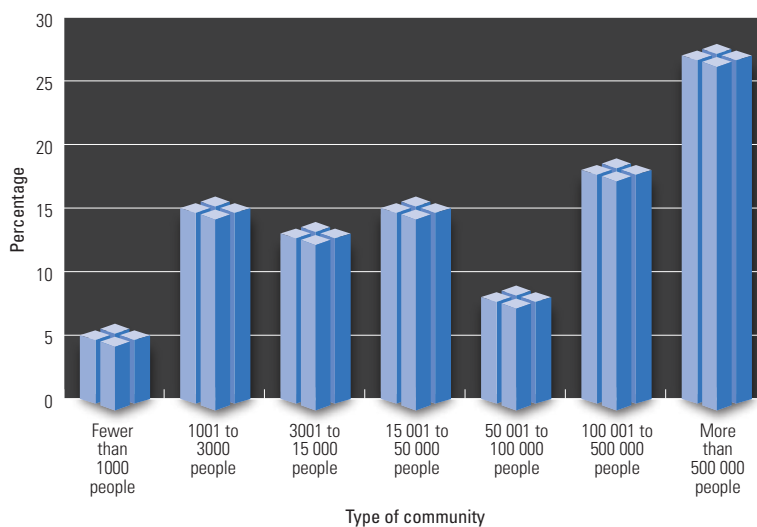


Figure 7.1B Location of schools for Year 8 students in Australia

## School socioeconomic composition

As well as examining student-level socio-educational background by asking students about their parents' educational level, TIMSS asks principals to report on the economic composition of their school, in particular by asking what percentage of students in the school (approximately) come from economically disadvantaged homes. Principals were asked to nominate a percentage from the following ranges: 0–10%, 11–25%, 26–50%, or more than 50%. A summary of the responses to this question for schools from both Australian populations is shown in Table 7.18. Clearly schools with fewer than 10 per cent of students from disadvantaged backgrounds will have greater resources and educational capital than schools with more than one-quarter of students from disadvantaged backgrounds.

About one-third of Australian students attend schools in which there are fewer than 10 per cent of students who come from economically disadvantaged homes. This is the same as the international average for Year 4 students and substantially greater than the international average for the Year 8 students, similar to the situation in TIMSS 2003. At the other end of the scale, 14 per cent of Year 4 students and 13 per cent of Year 8 students attend schools in which the principal believes that more than half of the students are from economically disadvantaged homes. At both year levels, but particularly at Year 8 level, these are much lower than the international averages.

This latter finding is to be expected given the much larger and less homogeneous range of countries that participated in TIMSS at Year 8. Indeed, the range at Year 8 is very large. There were a number of countries where more than half of the students attended schools in which there were few disadvantaged students: Chinese Taipei, Japan, Kuwait, Malta, Ukraine, and Singapore. There were also countries in which more than half of the students (50 – 85%) attended schools in which more than half of the students were from economically disadvantaged homes: Algeria, Egypt, El Salvador, Indonesia, Lebanon, Palestinian National Authority, Thailand, Turkey, Tunisia, and Morocco.

**Table 7.18** Principal's reports on the percentages of students in their schools coming from economically disadvantaged classrooms at Year 4 and Year 8, for Australia and selected comparison countries

	Schools with few (0–10%) economically disadvantaged students		Schools with between 11% and 25% economically disadvantaged students		Schools with between 26% and 50% economically disadvantaged students		Schools with more than 50% economically disadvantaged students	
	Year 4	Year 8	Year 4	Year 8	Year 4	Year 8	Year 4	Year 8
Australia	34 (4.5)	31 (3.3)	30 (3.0)	33 (4.0)	22 (4.4)	23 (4.3)	14 (3.1)	13 (2.6)
England	38 (4.0)	38 (3.5)	31 (3.5)	27 (4.0)	15 (3.3)	23 (3.8)	16 (3.0)	12 (2.6)
United States	19 (2.2)	16 (2.5)	21 (2.5)	23 (2.8)	18 (2.9)	26 (3.4)	42 (2.8)	35 (2.8)
Singapore	60 (0.0)	52 (0.0)	30 (0.0)	30 (0.0)	9 (0.0)	9 (0.0)	1 (0.0)	9 (0.0)
Chinese Taipei	63 (3.9)	59 (4.1)	27 (3.6)	29 (3.8)	7 (2.3)	5 (1.9)	3 (1.7)	7 (2.8)
Hong Kong, SAR	26 (4.1)	12 (2.6)	23 (4.3)	24 (3.6)	30 (4.5)	24 (3.8)	21 (3.7)	40 (4.2)
International Average	34 (0.6)	22 (0.4)	26 (0.6)	24 (0.5)	17 (0.5)	21 (0.5)	23 (0.5)	33 (0.5)

## What school resources are available to support school learning?

To provide information about the level of school resources available to schools for mathematics and science instruction and in particular about the impact of shortages of important resources, two indices were created based on principals' responses to questions about shortages affecting schools' general capacity to provide instruction, and to provide mathematics and science instruction in particular.

To create the Index of Availability of School Resources for Mathematics Instruction (ASRMI) and the Index of Availability of School Resources for Science Instruction (ASRSI), principals were asked the degree to which shortages or inadequacies in five areas affected their school's general capacity to provide instruction — instructional materials (textbooks, for example); budget for supplies (paper, pencils, etc.); school buildings and grounds; heating/cooling and lighting systems; and

instructional space (classrooms, for example). For the mathematics index they also responded to five questions about shortages affecting mathematics instruction, specifically — computers for mathematics instruction; computer software for mathematics instruction; calculators for mathematics instruction; library materials relevant to mathematics instruction; and audio-visual resources.

For the science index, principals also responded to six questions about shortages affecting science instruction, specifically — science laboratory equipment and supplies; computers for science instruction; computer software for science instruction; calculators for science instruction; library materials relevant to science instruction; and audio-visual resources.

Responses were coded on a four-point scale: 1 = none, 2 = a little, 3 = some, and 4 = a lot, and averages calculated across the five general questions and the five mathematics (or science) instruction questions for each principal. Students were assigned to one of three levels of the index on the basis of their school principals' average responses. The high level of the index indicates that both averages were lower than two, and the low level that both averages were at least three. The medium level includes all other possible combinations. Table 7.19 displays the percentage of students at the high, medium, and low levels of the ASRMI index for TIMSS participants, at both Year 4 and Year 8 levels, together with average mathematics achievement.

**Table 7.19** Index of Availability of School Resources for Mathematics Instruction (ASRMI) – Percentage of students and average mathematics achievement, at Year 4 and Year 8

Mathematics	High ASRMI		Medium ASRMI		Low ASRMI	
	Percentage of students	Average achievement	Percentage of students	Average achievement	Percentage of students	Average achievement
<b>Year 4</b>						
Australia	57 (4.9)	523 (3.1)	42 (4.9)	505 (8.0)	1 (0.5)	-
International avg.	36 (0.6)	480 (1.7)	55 (0.7)	472 (0.9)	9 (0.4)	429 (3.1)
<b>Year 8</b>						
Australia	55 (3.8)	514 (6.2)	43 (3.9)	476 (6.0)	2 (1.0)	-
International avg.	27 (0.5)	464 (1.4)	62 (0.5)	449 (0.9)	10 (0.4)	420 (2.8)

At Year 4, 36 per cent of students internationally, and 57 per cent of students in Australia, were at the high level of the ASRMI index, where principals reported that resource shortages were essentially not a problem. A further 55 per cent of students internationally, and 42 per cent of students in Australia, were at the medium level and just nine per cent internationally and one per cent of Australian students were at the low level of the ASRMI index. Internationally and in Australia, average mathematics achievement was highest among students at the high level of the index. In Australia at Year 4, mathematics achievement was the highest at the high level of the index (523 score points), and statistically lower at the medium level (505 score points). At the low level of the index, there are too few students in Australia to estimate achievement accurately.

At Year 8, the situation was similar, with 27 per cent of students internationally and 55 per cent of students in Australia at the high level of the ASRMI index, 62 per cent internationally and 43 per cent of Australian students at the medium level, and 10 per cent internationally and two per cent in Australia at the low level.

In Australia, average mathematics achievement was highest among Year 8 students at the high level of the ASRMI index (514 score points), followed by the medium level (476 score points), with too few students at the low level in Australia to estimate achievement accurately.

Table 7.20 displays the percentage of students at the high, medium, and low levels of the ASRSI index for TIMSS participants, at both Year 4 and Year 8 levels, together with average science achievement.

**Table 7.20** Index of Availability of School Resources for Science Instruction (ASRSI) – Percentage of students and average science achievement, at Year 4 and Year 8

Science	High ASRSI		Medium ASRSI		Low ASRSI	
	Percentage of students	Average achievement	Percentage of students	Average achievement	Percentage of students	Average achievement
<b>Year 4</b>						
Australia	39 (4.1)	534 (4.7)	61 (4.2)	522 (5.4)	0 (0.4)	-
International avg.	31 (0.6)	483 (2.1)	59 (0.7)	477 (1.3)	10 (0.4)	442 (3.4)
<b>Year 8</b>						
Australia	57 (3.4)	531 (6.1)	41 (3.4)	493 (5.5)	2 (0.8)	-
International avg.	27 (0.4)	479 (1.5)	62 (0.5)	463 (0.9)	11 (0.4)	447 (2.3)

At Year 4, 31 per cent of students internationally and 39 per cent of students in Australia were at the high level of the ASRSI index, where principals reported that resource shortages were essentially not a problem. A further 59 per cent internationally and 61 per cent of Australian students were at the medium level and just 10 per cent internationally and no Australian students were at the low index level. In Australia, average science achievement was highest among students at the high index level (534 score points) followed by those at the medium level (522 score points). At Year 8 the situation was similar, with 57 per cent of Australian students at the high level of the index, 41 per cent at the medium level, and two per cent at the low level. Students at the high level of the index had highest average science achievement (531 score points) and for students at the medium level, their science achievement average was 493 score points.

### What are the perceptions of school climate?

The TIMSS questionnaires asked both school principals and teachers to characterise the climate of their school as an environment supportive of learning. The Index of Principals' Perception of School Climate (PPSC) was based on school principals' ratings of the following on a scale from very high to very low:

- teachers' job satisfaction;
- teachers' understanding of the school's curricular goals;
- teachers' degree of success in implementing the school's curriculum;
- teachers' expectations for student achievement;
- parental support for student achievement;
- parental involvement in school activities;
- students' regard for school property;
- students' desire to do well in school.

Students were assigned to the high level of the index if they attended schools where the principal averaged *high* or *very high* on these aspects of school climate, and to the low level where the principal averaged *low* or *very low*. Students at the medium level had principals with other response combinations.

Table 7.21 presents the percentage of students at each level of the PPSC index for Australia and internationally, together with average mathematics and science achievement.

**Table 7.21** Index of Principals' Perception of School Climate (PPSC) – Percentage of students and average mathematics and science achievement, at Year 4 and Year 8

	High PPSC			Medium PPSC			Low PPSC		
	Percentage of students	Average achievement		Percentage of students	Average achievement		Percentage of students	Average achievement	
		Mathematics	Science		Mathematics	Science		Mathematics	Science
<b>Year 4</b>									
Australia	50 (4.2)	536 (4.6)	545 (4.6)	47 (3.8)	499 (4.8)	512 (4.4)	2 (1.2)	-	-
International avg.	22 (0.5)	487 (1.8)	491 (2.3)	68 (0.6)	471 (0.7)	474 (0.8)	10 (0.4)	441 (2.4)	444 (2.6)
<b>Year 8</b>									
Australia	33 (3.5)	541 (8.5)	557 (8.1)	58 (4.5)	481 (4.1)	501 (3.8)	9 (2.4)	447 (9.4)	465 (10.3)
International avg.	16 (0.4)	473 (1.6)	484 (1.6)	68 (0.5)	450 (0.7)	465 (0.6)	16 (0.4)	428 (1.6)	445 (1.6)

At Year 4 and Year 8, on average internationally, 22 per cent and 16 per cent of students, respectively, were at the high level of the PPSC index. The majority of students (68% at both year levels) were at the medium index level and just 10 per cent and 16 per cent respectively at the low level.

In Australia, a majority of students attended schools where (50% at Year 4 and 33% at Year 8) principals' reported a high positive school climate. Around 50–60 per cent of students attended schools in which principals rated the school climate at a medium level, and very few were at the low level. At Year 4, achievement scores for students in the high levels of the index were significantly higher than for those in schools at the medium level of the index for both mathematics and science. At Year 8, achievement scores for students in the high levels of the index were significantly higher than for those students in schools at the medium and low levels of the index. Students in schools in which principals rated the school climate positively had an advantage over students in schools in which the principal rated the school climate as medium.

Table 7.22 presents mathematics<sup>9</sup> teachers' perceptions of their school climate, based on teachers' ratings of the same eight attributes rated by the principals. The Index of Mathematics Teachers' Perception of School Climate (TPSC) was calculated in the same way as the principals' index, and shows generally similar results.

**Table 7.22** Index of Mathematics Teachers' Perception of School Climate (TPSC) – Percentage of students and average mathematics achievement, at Year 4 and Year 8

	High TPSC		Medium TPSC		Low TPSC	
	Percentage of students	Average achievement	Percentage of students	Average achievement	Percentage of students	Average achievement
<b>Year 4</b>						
Australia	35 (3.5)	537 (5.7)	56 (3.3)	508 (4.9)	9 (1.8)	491 (16.3)
International avg.	17 (0.5)	488 (2.1)	67 (0.6)	473 (0.8)	16 (0.5)	453 (1.8)
<b>Year 8</b>						
Australia	20 (3.2)	544 (10.2)	53 (3.9)	497 (5.8)	27 (2.5)	465 (5.3)
International avg.	11 (0.3)	478 (2.0)	60 (0.5)	455 (0.7)	29 (0.5)	433 (1.1)

On average, at Year 4, 17 per cent of students internationally and 35 per cent of Australian students were in schools where teachers had a positive view of the school climate and so were at the high level of the index. Two-thirds of students internationally and half of the students in Australia were at the medium level of the TPSC index. At the low level were 16 per cent of students internationally and nine per cent in Australia. At Year 4, teachers had a less positive outlook on school climate than principals. On average in Australia, 35 per cent of students were at the high level of the index (compared to 50% for principals), 56 per cent at the medium level (compared to 47% for principals), and nine per cent at the low level (compared to 2% for principals).

<sup>9</sup> At Year 4 in most countries, the mathematics and science teacher was the classroom teacher.

Similarly at Year 8, mathematics teachers had a less positive outlook on school climate than principals. On average in Australia, 20 per cent of students were at the high level of the index (compared to 33% for principals), 53 per cent at the medium level (compared to 58% for principals), and 27 per cent at the low level (compared to 16% for principals).

Table 7.23 similarly presents science teachers' perceptions of their school climate, based on teachers' ratings of the same eight attributes rated by the principals. The Index of Science Teachers' Perception of School Climate (TPSC) was calculated in the same way as the principals' index, and shows generally similar results.

**Table 7.23** Index of Science Teachers' Perception of School Climate (TPSC) – Percentage of students and average science achievement, at Year 4 and Year 8

	High TPSC		Medium TPSC		Low TPSC	
	Percentage of students	Average achievement	Percentage of students	Average achievement	Percentage of students	Average achievement
<b>Year 4</b>						
Australia	37 (3.6)	546 (5.5)	54 (3.3)	520 (4.8)	10 (1.8)	497 (12.4)
International avg.	17 (0.5)	494 (1.9)	66 (0.6)	477 (0.9)	17 (0.5)	454 (1.8)
<b>Year 8</b>						
Australia	14 (1.8)	547 (8.3)	56 (3.5)	526 (5.8)	30 (3.4)	487 (5.8)
International avg.	11 (0.3)	489 (1.7)	58 (0.5)	469 (0.7)	31 (0.4)	449 (1.0)

At Year 4, 17 per cent of students internationally and 37 per cent of students in Australia, on average, were in schools where science teachers had a positive view of the school climate and so were at the high level of the TPSC index. Two-thirds of students internationally and 54 per cent of Australian students were at the medium level of the index. Seventeen per cent internationally and 10 per cent in Australia were at the low level. At Year 8, science teachers again had a somewhat less positive outlook on school climate than principals. In Australia, 14 per cent of students were at the high level of the index (compared to 33% for principals), 56 per cent at the medium level (compared to 58% for principals), and 30 per cent were at the low level (compared to 9% for principals).

### How safe and orderly are schools?

Since a supportive school environment for learning is one in which teachers and students feel safe and secure, TIMSS asked teachers and students about their perceptions of safety in their schools. The Index of 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. As shown in Table 7.24, Year 4 mathematics 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 TPSS index.

**Table 7.24** Index of Mathematics Teachers' Perception of Safety in School (TPSS) – Percentage of students and average mathematics achievement, at Year 4 and Year 8

	High TPSS		Medium TPSS		Low TPSS	
	Percentage of students	Average mathematics achievement	Percentage of students	Average mathematics achievement	Percentage of students	Average mathematics achievement
<b>Year 4</b>						
Australia	86 (2.4)	521 (4.3)	14 (2.3)	483 (10.2)	1 (0.4)	-
International avg.	80(0.5)	476 (0.7)	15 (0.5)	461 (1.8)	5 (0.3)	410 (4.5)
<b>Year 8</b>						
Australia	89 (2.0)	504 (3.8)	10 (1.8)	448 (11.9)	1 (0.8)	-
International avg.	77 (0.5)	454 (0.6)	18 (0.4)	440 (1.5)	5 (0.2)	435 (2.8)

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

**Table 7.25** Index of Students' Perception of Being Safe in School (SPBSS) – Percentage of students and average mathematics achievement, at Year 4 and Year 8

	High SPBSS		Medium SPBSS		Low SPBSS	
	Percentage of students	Average mathematics achievement	Percentage of students	Average mathematics achievement	Percentage of students	Average mathematics achievement
<b>Year 4</b>						
Australia	30 (1.2)	534 (3.9)	44 (1.3)	518 (3.5)	26 (1.4)	497 (5.4)
International avg.	42 (0.2)	485 (0.7)	40 (0.2)	471 (0.7)	18 (0.2)	452 (1.0)
<b>Year 8</b>						
Australia	46 (1.2)	503 (4.5)	38 (1.0)	494 (4.2)	15 (0.7)	487 (5.7)
International avg.	51 (0.2)	460 (0.6)	37 (0.1)	448 (0.6)	12 (0.1)	427 (1.0)

As shown in Table 7.25, 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 SPBSS 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.

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

## Summary

This chapter has examined a wide range of contextual factors that may have an impact, either directly or indirectly, on the mathematics and science learning of TIMSS students. This information was primarily obtained from the teacher and school questionnaires as it pertains directly to the classroom or school environment, with some information obtained from the student questionnaire.

The chapter profiled the science and mathematics teachers of TIMSS students: their age, qualifications, training and experience, preparedness to teach, and use of professional development. Across Australia, a majority of Year 4 teachers were female and about one half of Year 8 students were taught mathematics by female teachers. Internationally, more Year 8 students are taught by females than males. Nationally, in Year 8 science classes, there were equal proportions of male and female teachers. Internationally, however, Year 8 students were taught science more often by females than males.

The Australian workforce is well-educated in terms of completion of university and a postgraduate university degree with the majority of Year 4 and Year 8 science and mathematics students having teachers with a university or postgraduate university degree.

Internationally, about one-quarter of Year 4 students are taught by teachers with a qualification in primary or elementary education and a specialisation in either mathematics or science (or both). However, in Australia most students have teachers with a specialisation in primary/elementary education without a major or specialisation in science or mathematics. In Australia at Year 8, about one half of students had teachers with a mathematics education qualification or mathematics qualification. At Year 8, on average internationally and in Australia, over two-thirds of students had science teachers that had studied biology, physics, chemistry or Earth science.

The TIMSS 2007 questionnaire asked 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 framework. At Year 4 and Year 8, across all mathematics topics, Australian students generally had teachers who reported feeling 'very well' prepared to teach all topics, while for Year 4 science teachers reported feeling 'very well' prepared to a lesser extent. At Year 8, more students had science teachers who reported to a higher extent feeling 'very well' prepared than was the case for Year 4 science; however, more Year 8 mathematics students had teachers who reported feeling 'very well' prepared to a higher extent than was the case for Year 8 science.

For Year 4 mathematics, the percentage of students with teachers who reported feeling 'very well' prepared for *geometric shapes and measures* was lowest both internationally and in Australia. For Year 4 science, *physical science* was the weakest area both in Australia and internationally. For Year 8 mathematics, *data and chance* was highest and *geometry* and *algebra* were the weakest areas in Australia. For Year 8 science, the percentage of students whose teachers reported feeling 'very well' prepared for *chemistry* was highest and *physics* and *Earth science* were the weakest areas in Australia.

The chapter also reviewed teachers' and principals' views about classroom characteristics that were hypothesised to impact on learning. These included factors limiting instruction in science and mathematics (students with differing abilities, students with special needs, uninterested students, low morale and disruptive students), time on instruction, use of problem solving activities, use of scientific inquiry, teachers' beliefs about science (or mathematics) and teaching science (or mathematics), instructional strategies, computer use, and the use of homework and assessment.

The mathematics textbook and science textbook is the foundation of mathematics and science instruction at both Year 4 and Year 8 in most countries in the TIMSS study, although less so for science at Year 4. Australia stands out amongst the countries surveyed at Year 4 as having a quarter of classes not using a textbook for mathematics. Australia and New Zealand at Year 4 reported a large proportion of classes not using a textbook for science. At Year 8, Australian mathematics teachers use a textbook in a similar manner to teachers in most other countries, but for science, Australian teachers use a science textbook as a primary basis to a lesser extent than other countries.

Included in this chapter was an examination of the school contexts for mathematics and science learning, including schools' socioeconomic composition, perceptions of school climate, availability of resources for instruction, and students' perceptions of schools safety. About one-third of Australian students attend schools in which there are fewer than 10 per cent of students who come from economically disadvantaged homes. This is the same as the international average for Year 4 students and substantially greater than the international average for Year 8 students. At the other end of the scale, a lower proportion of Year 4 and Year 8 students attend schools in which the principal believes that more than half of the students are from economically disadvantaged homes. At both year levels, but particularly at Year 8 level, this is much lower than the international averages.

At Year 4, about one half of students in Australia attended schools rated by their principal as being at the high level of the Index of Availability of School Resources for Mathematics/Science Instruction (i.e. resource shortages essentially were not a problem for mathematics or science classes) and very few Australian students were rated at the low level of the index. Average mathematics and science achievement was highest among students in Australia at the high level of the index. The situation was similar at Year 8.

In summary, this chapter has shown that there are a great many factors at the class and school-level that can affect student learning in mathematics and science, with some factors being more influential than others.

## Summary and policy considerations

Developing the knowledge and skills of young people in the key areas of mathematics and science is important to a society in terms of future prosperity and well-being. Education systems play a vital role not only in developing students' knowledge and skills, but also in strengthening students' disposition towards learning at school and beyond. For those reasons an increasing number of education systems around the world monitor student performance at key points of schooling to provide information about how well young people are being prepared for life.

National tests in literacy and numeracy were carried out in 2008 in Australia for Years 3, 5, 7 and 9 to provide some of this monitoring information. Comparative international studies such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) can provide a context within which to interpret national results. TIMSS has a more explicit curriculum focus than PISA, and provides data against a framework in which most areas of the curriculum examined are covered in most countries. The goal of TIMSS is to provide comparative information about educational achievement across countries in order to improve teaching and learning in mathematics and science. To achieve this goal, TIMSS measures achievement at Year 4 and Year 8, and as it has collected data every four years since 1995, is able to monitor trends in achievement and provision of resources, as well as monitoring curricular implementation.

This report details results from Australia's participation in the international TIMSS 2007 study (for which Australia collected data in late 2006); reporting achievement internationally, nationally for the states and territories, for males and females, and for designated equity groups, as agreed by Education Ministers to enable reporting against the National Goals for Schooling. The samples of schools and students were large and nationally representative. Smaller states were oversampled (and the data weighted) so that accurate estimates can be provided for these jurisdictions.

Response rates were higher than they have ever been in previous studies. The overall response rate for Australia, which is a function of both school and student participation rates, has increased at Year 4 from 66 per cent in TIMSS 1995 to 85 per cent in TIMSS 2003 to 95 per cent in TIMSS 2007. Similarly, at Year 8 it has increased from 70 per cent in TIMSS 1995 to 83 per cent in TIMSS 2003 to 93 per cent in TIMSS 2007. These high participation rates reflect the growing understanding of the role of international tests in the National Assessment Program. However, the increased participation rates do have some implications for the interpretation of results. Previous experience from other surveys suggests that non-participation is not random, and there is a greater probability that it is lower achieving students that will not participate. The higher participation rate in 2007 could possibly reflect a somewhat higher proportion of lower achieving students in TIMSS 2007 compared to either TIMSS 2003 or 1995. Yet it is not possible to establish how much of the decrease in results (i.e. in achievement) could be explained by this trend.

## TIMSS in Australia

In Australia, 229 primary schools and 228 secondary schools, with approximately 4 000 students at each year level, participated in TIMSS 2007. The Australian students undertook the assessment in late 2006, while their northern hemisphere counterparts completed it in early 2007. This ensured that students in all countries were assessed at around the same stage of their school year. Students in the smaller states and Indigenous students were oversampled so that reliable estimates could be drawn for each of the individual states and for Indigenous students nationally, however, these data are not included in this report.

## International performance in mathematics and science

### Mathematics

In TIMSS 2007, Australian Year 4 students' average performance in mathematics was significantly higher than the TIMSS scale average. The score was significantly higher than that achieved in TIMSS 2003 and TIMSS 1995. Australia's score was lower than that of a large group of countries, including Hong Kong, Singapore, Chinese Taipei, Japan, the Russian Federation, Kazakhstan, Latvia and Lithuania, England, the Netherlands, Germany and the United States. This is much the same as in 2003; however, Australia scored the same as the TIMSS scale average in mathematics in that assessment. Within Australia, New South Wales, Victoria, Western Australia and Tasmania had improved scores from previous TIMSS cycles in mathematics at Year 4.

The Year 4 students that participated in TIMSS 2003 were from the same cohort as the Year 8 students tested in TIMSS 2007. The mathematics score for Australian Year 8 students was not significantly different to the TIMSS scale average. Students in the Asian countries Chinese Taipei, Korea, Singapore, Hong Kong and Japan, the Russian Federation, Hungary, England and the United States outperformed Australian Year 8 students. In TIMSS 2003 the scores for the Russian Federation, Lithuania, England and the United States were all the same as for Australia. In essence, Australia's score has declined at both assessments since TIMSS 1995, and the decline since TIMSS 1995 is significant. This decline in Australia's scores has come at the same time as increases in the scores for some other countries, England in particular. Within Australia, South Australia and Western Australia showed a significant decline in scores from TIMSS 1995. There were no other significant changes with the states.

### Science

Australian students' scores in TIMSS 2007 were significantly higher than the TIMSS scale average for science at both Year 4 and Year 8. At Year 4, the score did not change significantly from TIMSS 1995 or TIMSS 2003, whereas the scores of some other countries, notably Singapore, Hong Kong, Latvia, the Russian Federation and Slovenia, have increased substantially. Australian students were outperformed by students in Singapore, Chinese Taipei, Hong Kong, Japan, the Russian Federation, Latvia, England and the United States. Of this group, all except the Russian Federation outperformed Australia in Year 4 science in TIMSS 2003. While Australia performed at an equivalent level to the Russian Federation in TIMSS 2003, the increase in scores by the Russian Federation resulted in their better performance in TIMSS 2007. Among the Australian states the only significant change was a decline in scores in the Australian Capital Territory from the TIMSS 1995 assessment.

In Year 8 science, Australia's average score was also significantly higher than the TIMSS scale average. However, this score was significantly lower than the Australian Year 8 score in TIMSS 2003. Australian students were outperformed by those in the Asian countries, Singapore, Chinese Taipei, Japan, Korea and Hong Kong, by the Russian Federation, Czech Republic, Hungary, Slovenia and England. This is very similar to the position in TIMSS 2003 other than the improvement of the Russian Federation and Slovenia. Among the Australian States and

Territories, the only statistically significant decline in scores was in Western Australia from the TIMSS 1995 assessment.

The trend in results illustrates how TIMSS data can be used to monitor the impact of structural and curricular changes in education systems. The improvement in the scores of the Russian Federation and Slovenia is worthy of mention since these two countries have been undergoing structural changes in their primary school system that involved adding one more year of schooling at the primary level, as well as associated curricular and instructional reforms.

### International benchmarks

Achievement is not only measured in terms of mean scores, but in terms of benchmarks; put simply, what students can and cannot do in terms of the curriculum. An examination of the international data shows that countries with similar mean scores might have different profiles of performance and both the profiles and the overall mean score are important for considering policy directions. International benchmarks were developed by the International Study Centre to describe performance at four levels. These were the advanced, high, intermediate and low benchmarks. Thus, in addition to having students grouped by their mean scores, it is also possible to obtain a picture of the skills and knowledge that students at each level typically possess. At the advanced level, students are able to understand complex or abstract ideas and to interpret and apply these ideas. At the other end of the continuum are students at the low international benchmark, who have basic knowledge and skills and are limited in their ability to apply this knowledge or skills. The report highlights the proportions of students who do not achieve this low benchmark as these students may be at risk educationally. While having a large proportion of students achieving at the highest level is optional, it is also important that a country has as few students as possible below the low benchmark.

In mathematics at Year 4, nine per cent of Australian students achieved the advanced international benchmark, a significant increase from previous assessments. Conversely, the proportion of Australian students achieving better than the low international benchmark was also significantly higher than in previous assessments.

In mathematics at Year 8 there was a slightly different story. The proportion of Australian students at the highest and lowest benchmarks remained about the same as in previous assessments; about six per cent achieved the advanced international benchmark and 90 per cent of students achieved at least the low international benchmarks. However, a smaller proportion of students achieved the high international benchmark and correspondingly larger proportion of students achieved just the low international benchmark.

In science at Year 4, ten per cent of students achieved the advanced international benchmark, which was the same as in previous cycles. Only seven per cent of students failed to achieve the low benchmark, which is an improvement on the 11 per cent in TIMSS 1995.

In science at Year 8, the picture is slightly less clear. The same proportion of students achieved the advanced benchmark, fewer students reached the high and intermediate benchmarks, and more students reached the low benchmark, meaning overall that there were more students achieving the low international benchmark and no higher.

### Gender differences

In TIMSS 2003 there were no significant gender differences in either mathematics or science at Year 4 in Australia, or in Year 8 mathematics. In science at Year 8 however, there was a significant gender difference in favour of males. In TIMSS 2007 there were again no gender differences in either mathematics or science at Year 4. On the other hand, at Year 8 the differences of 15 score points in mathematics and 18 score points in science, both in favour of boys, were significant. Compared to previous cycles, the proportion of countries in which there are significant gender differences has declined, however, it is of some interest that the countries in which females achieved at

significantly higher levels than males in both mathematics and science are predominantly Arab countries.

## Performance within Australia

The major purpose of this report is to study achievement in mathematics and science within an international framework. This enables us to compare Australian students' achievement against that of students in other countries using a standard instrument and standard procedures. In addition to this, the report examines results for each of the states and territories of Australia.

### Mathematics

In mathematics at Year 4, students in New South Wales, Victoria, the Australian Capital Territory and Tasmania all had mean scores higher than the TIMSS scale average. For students in Western Australia, South Australia and the Northern Territory scores were not significantly different to the TIMSS scale average while those of Queensland students were significantly lower than the scale average. Achievement levels in mathematics at Year 4 of students in New South Wales and Victoria have increased significantly from both 1995 and 2003. In New South Wales this has been a steady rise while in Victoria the increase has been primarily since 2003. Western Australia also increased its average score in mathematics at Year 4 from 2003 to 2007, while Tasmania had a significant increase from 1995 to 2003, indicating a slower but steady increase from the previous assessment. In all of the other states there were minor changes but none reaching statistical significance.

At Year 4, the international median proportion of students reaching the advanced benchmark was five per cent. New South Wales achieved 14 per cent of its students at this highest benchmark, Victoria 10 per cent, the Australian Capital Territory and Tasmania both seven per cent. At the same time, the international median for the proportion of students not reaching the low benchmark was 10 per cent, and New South Wales, Victoria and the Australian Capital Territory all achieved better results than this (i.e. fewer students below the low benchmark) with eight per cent of students in the Australian Capital Territory and five per cent of students in the other two states achieving this level. As a comparison, in Hong Kong 40 per cent of students achieved the advanced international benchmark and less than one per cent of students failed to achieve the low benchmark.

At Year 8 in mathematics, all of the states scored at a similar level to the TIMSS scale average – only Tasmanian students' scores were significantly lower than this. There were also no significant differences between the scores for any of the states (due in part to the large standard errors of some states). There was a significant decline in the Year 8 mathematics scores of students in South Australia and Western Australia between 1995 and 2007. In South Australia this decline was spread fairly evenly over the 12-year period from 1995 to 2007, while in Western Australia it seems to have occurred primarily prior to 2003.

### Science

In Year 4 science, students in five states: Victoria, New South Wales, Tasmania, the Australian Capital Territory and Western Australia, all achieved average scores significantly higher than the TIMSS scale average. The average score for students in the other three states was not significantly different to the scale average. Students in Victoria and New South Wales performed at the same level as those in the Australian Capital Territory and Tasmania, and significantly outperformed students in Western Australia, South Australia, the Northern Territory and Queensland.

Examining the benchmarks in science at Year 4, Tasmania, New South Wales and Victoria all achieved a substantial proportion of students at the advanced level, and a proportion not achieving the low level that was not significantly different to the international average.

Within Australia, only the Australian Capital Territory had a significant decline in scores for Year 4 science, and this appears to have been a decline over the period since the 2003 TIMSS assessment.

In Year 8 science, Western Australia was the only state in which there was a significant change: a decline in scores from 1995 to 2007. As with Year 8 mathematics, there were no significant differences in scores between the states. In science at Year 8, all states scores were not significantly different to the TIMSS scale average.

### Indigenous students

Once again the results of an international study highlight that little has changed in regard to educational outcomes for Indigenous students. At Year 4, the average score for Indigenous students in both mathematics and science was around 90 score points lower than that of their non-Indigenous counterparts. This gap has actually increased over time, for example in mathematics at Year 4 it has increased from 69 score points in TIMSS 1995 to 91 score points in TIMSS 2007. In addition, while the average score of non-Indigenous students in Year 4 mathematics increased, that of Indigenous students remained the same, and is not statistically different to the average score in 1995. At Year 8, the difference in scores for both mathematics and science was 70 score points, unchanged since TIMSS 1995, indicating that the gap between the achievement of Indigenous and non-Indigenous students has not closed.

In terms of benchmarks, which represent what students can and cannot do, it is notable that between 31 per cent and 38 per cent of Indigenous students at each year level, in both subject areas, did not reach the low international benchmark. These students were not able to reach the level where they demonstrated some basic mathematical or scientific knowledge.

In summary, there has been no closing of the gap in achievement between Indigenous and non-Indigenous students in either mathematics or science at either year level.

### Parental education

Parental education is strongly related to student performance for a variety of reasons. This report has found that there is a large gap in the level of achievement in both mathematics and science of Year 8 students with at least one parent with a university degree and those whose parents did not achieve this. Even between these students and those with parents who had completed some form of post-secondary education but not university, there was a 43 point score gap in mathematics and a 45 point score gap in science.

The differences are also very apparent when looking at the benchmarks. In mathematics, 15 per cent of students with a tertiary-educated parent achieved the advanced benchmark, compared to five per cent of students whose parents had a post-secondary education but had not completed university, and compared to two per cent of students whose parents did not complete Year 12. At the other end of the scale, just four per cent of students whose parents held university degrees did not achieve the low benchmark, compared to 15 per cent of students whose parents did not complete secondary school. In science, 22 per cent of students who had at least one parent with a university degree reached the advanced international benchmark compared to seven per cent or less for all other parental education groups. At the same time, just one per cent of students with a tertiary-educated parent failed to achieve the low benchmark compared to 13 per cent of those whose parents did not complete secondary school.

### Student attitudes

Developing positive attitudes toward mathematics and science are important goals of the curriculum. Students may be more attracted to these subjects and more motivated to learn if they consider proficiency in mathematics and science to be advantageous to their future education and the world of work. Within Australia, at both year levels, students with higher achievement in mathematics and science had more positive attitudes toward these subjects, reported a higher level of self-confidence in learning mathematics and science, and placed a higher value on them as important to future success.

### **School environments fostering learning**

There is a body of literature that argues that successful schools have ambitious but reasonable goals and work toward implementing them (Teddle & Reynolds, 2000). A supportive school climate helps to build better morale among teachers and students, leading to higher student achievement. The results from TIMSS suggest that, at both Year 4 and Year 8, mathematics and science achievement was highest where principals and teachers had a positive view of the school climate, including high levels of teacher job satisfaction, expectations for student achievement, and parental support.

For students to have the opportunity to learn, they need to attend school regularly. As well, student learning can be more difficult in schools where students are frequently absent or late for class. Internationally, achievement was highest among students attending schools with few attendance problems. Problems with students arriving late, absenteeism, and missing class were more serious at Year 8.

### **Resources to support mathematics and science learning**

Access to facilities, equipment, and materials can enhance curriculum implementation and instruction. At both year levels, achievement was highest in schools where principals reported that resource shortages were not a problem. Teachers can be considered the most important resource of all and the supply of qualified teachers is problematic in some areas, such as remote schools and schools in poorer socioeconomic areas. At both Year 4 and Year 8, relatively few students were taught by younger teachers. The majority of students were taught by teachers aged between 30 and 50 years of age.

At Year 8, most teachers had studied mathematics or science and about three-quarters of them reported feeling very well prepared to teach the topics in the TIMSS assessment. In contrast, teachers at Year 4 reported less specific training or specialised education, especially in science. Less than half the Year 4 students had teachers who reported feeling very well prepared to teach the TIMSS science topics.

## Policy considerations

The only area in which Australian achievement has shown improvement over the cycles of TIMSS since 1995 has been in mathematics at Year 4. This has resulted in Australia moving from a position equal to the TIMSS scale average for Year 4 mathematics in 2003 to significantly above it in 2007. However, in Year 8 mathematics and Year 4 science there has been no change to Australia's scores and in Year 8 science scores have declined significantly. Other countries have improved on their already high scores and for some improvements (as with the Russian Federation and Slovenia) this appears to have been associated with systemic and curricular reform.

The TIMSS results suggest that greater attention be given to curriculum and teaching in junior secondary science. Participation in science studies in the post-compulsory years of secondary school and in post-school education depends on developing a sense of competence and interest in the junior secondary years. A failure to give sufficient attention to science in the junior secondary years is likely to have consequences for building the basis for education in the science-based occupations and for building a scientifically literate community. In addition, there are curriculum issues, particularly in the areas of *physics* and *chemistry*, which are highlighted by the poor average performance of Australian students in these areas.

Although the TIMSS results for Year 8 mathematics suggest maintenance of performance over time, this is in a context where comparable countries have improved. Attention to the teaching of mathematics in the junior secondary years also deserves attention and reflection on what has been done in those countries with similar contexts to Australia that have shown improvement over the TIMSS studies might provide insight regarding possible actions. In particular, Australian students performed poorly in *algebra* and *geometry*.

The static nature of achievement in Year 4 science, in a context of improvements in comparable countries, suggests that there is a case for finding ways to increase science expertise in schools, for increasing the small amount of time given to the teaching of science in primary schools, and for implementing curricula that highlight the science of the phenomena that students encounter in their lives.

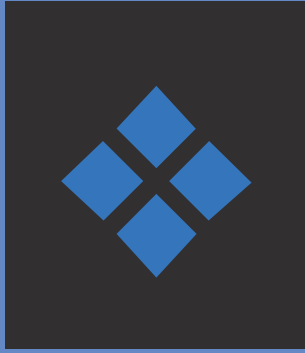
One of the areas that this TIMSS study has highlighted is that of teacher preparedness to teach maths and science. While most Year 8 teachers believe they are well-prepared to teach all of the mathematics topics covered in TIMSS, and around three-quarters of Year 8 science teachers feel they are well-prepared to teach science, this is only the case for half of the Year 4 teachers surveyed. Further analysis needs to be conducted on this issue. There also seem to be some areas where teachers have misplaced confidence – where teachers believe they are well-prepared to teach the subject matter but where the achievement of their students is not correspondingly high, and a number of areas in which professional development might well be needed.

The gender differences in favour of males in both mathematics and science at Year 8 are of concern, particularly after a number of years in which there were no such differences and in an international setting in which the number of countries with gender differences is declining.

The disparity in achievement, as has been noted before, between those from a high socioeconomic background and those from a low socioeconomic background, as measured in TIMSS by parental background, is large. This remains an issue of equity which needs to be addressed.

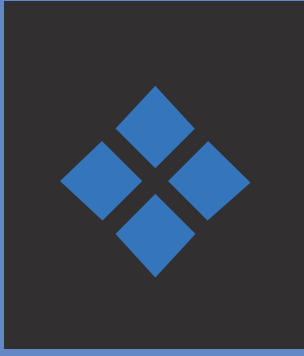
Finally, the education of Indigenous students remains an issue. Very little has changed over the period of TIMSS assessments. If the ideals of COAG and Education Ministers are to be realised it is imperative that action is taken that will improve these outcomes.





## References

- Martin, M. O., Mullis, I. V. S., & Foy, P. (2008). *TIMSS 2007 International Mathematics Report*. Chestnut Hill, MA: Boston College.
- Martin, M. O., Mullis, I. V. S., Gonzalez, E. J., Gregory, K. D., Smith, T. A., Chrostowski, S. J., Garden, R. A., & O'Connor, K. M. (2000). *TIMSS 1999 International Science Report*. Chestnut Hill, MA: Boston College.
- MCEETYA. (1999). *The Adelaide declaration on national goals for schooling in the twenty-first century*. Available at [http://www.curriculum.edu.au/mceetya/adelaide\\_declaration,11576.html](http://www.curriculum.edu.au/mceetya/adelaide_declaration,11576.html)
- MCEETYA. (2006). *Statements of learning for mathematics*. Available at [http://www.mceetya.edu.au/mceetya/statements\\_of\\_learning,22835.html](http://www.mceetya.edu.au/mceetya/statements_of_learning,22835.html)
- MCEETYA. (2006). *Statements of learning for science*. Available at [http://www.mceetya.edu.au/mceetya/statements\\_of\\_learning,22835.html](http://www.mceetya.edu.au/mceetya/statements_of_learning,22835.html)
- McKinnon, K. R. (1975). *Girls, schools and society*. Report by a Study Group to the Schools Commission, Canberra.
- Miland, M. (1984). *Girls and tomorrow: The challenge for schools*. The Report of the Commonwealth Schools Commission's Working Party on the Education of Girls, Canberra
- Mullis, I. V. S., Martin, M. O., & Foy, P. (2008). *TIMSS 2007 International Science Report*. Chestnut Hill, MA: Boston College.
- Mullis, I. V. S., Martin, M. O., Ruddock, G. J., O'Sullivan, C. Y., Arora, A., & Erberber, E. (2005). *TIMSS 2007 Assessment Frameworks*. Chestnut Hill, MA: Boston College.
- Lyons, T., Cooksey, R., Pannizzon, D., Parnell, A., & Pegg, J. (2006). *Science, ICT, and mathematics education in rural and regional Australia: The SiMERR national survey*. Available [simerr.une.edu.au/national\\_survey/Report/Fullreport\\_Full.pdf](http://simerr.une.edu.au/national_survey/Report/Fullreport_Full.pdf)
- Squires, D. (2003). Responding to isolation and educational disadvantage. *Education in Rural Australia*, 13(1), 24-40.
- Teddle, C., & Reynolds, D. (Eds.). (2000). *The International Handbook of School Effectiveness Research*. London: Falmer Press.



## Appendix 1: Sampling

The TIMSS 2007 assessment was administered to carefully-drawn random samples of students from the target population in each country. Because the accuracy of the TIMSS results depends on the quality of the national samples, TIMSS worked with participating countries on all phases of sampling to ensure efficient sampling design and implementation.

National coordinators were trained in how to select the school and student samples, and in how to use the *WinW3S* sampling software provided by the IEA Data Processing Center. Staff from Statistics Canada reviewed the national sampling plans, sampling data, sampling frames, and sample selections. The sampling documentation was used by the TIMSS & PIRLS International Study Center (in consultation with Statistics Canada and the sampling referee) to evaluate the quality of the samples.

In a few situations where it was not possible to test the entire international target population (i.e., all students enrolled in Year 4 or Year 8), countries were permitted to define a target population that excluded part of the international target population. Table A1.1 shows any differences in coverage between the international and national target populations. Almost all participants achieved 100% coverage, the exceptions at Year 4 being Georgia (tested only students taught in Georgian), Kazakhstan (students taught in Kazakh or Russian), Latvia (students taught in Latvian), and Lithuania (students taught in Lithuanian), and, at Year 8, Georgia (tested only students taught in Georgian), Lithuania (students taught in Lithuanian), and Serbia (did not include Kosovo).

Within the target population, countries could define a population that excluded a small percentage (no more than 5%) of certain kinds of schools or students that would be very difficult or resource intensive to test (e.g., schools for students with special needs or schools that were very small or located in remote rural areas). Almost all countries kept their excluded students below the five per cent limit. The only exception at Year 4 was the United States, which excluded more than five but less than 10 per cent of their Year 4 population. Exceptions at Year 8 included Serbia and the United States, which excluded more than 5 but less than 10 per cent of their Year 8 population, and Israel, which excluded more than 20 per cent of its Year 8 student population.

The basic design of the sample used in TIMSS 2007 was a two-stage stratified cluster design. The first stage consisted of a sampling of schools, and the second stage of a sampling of intact classrooms from the target year level in the sampled schools. Schools were selected with probability proportional to size, and classrooms with equal probabilities. Most countries sampled 150 schools and one or two intact classrooms from each school. This approach was designed to yield a representative sample of at least 4 500 students in each country.

**Table A1.1A** Coverage of TIMSS 2007 Target Population, Year 4

Country	International Target Population		Exclusions from National Target Population		
	Coverage	Notes on Coverage	School-level Exclusions	Within-sample Exclusions	Overall Exclusions
Algeria	100%		2.1%	0.0%	2.1%
Armenia	100%		2.7%	0.7%	3.4%
Australia	100%		1.3%	2.7%	4.0%
Austria	100%		1.3%	3.7%	5.0%
Chinese Taipei	100%		0.2%	2.5%	2.8%
Colombia	100%		1.3%	0.8%	2.1%
Czech Republic	100%		4.4%	0.5%	4.9%
Denmark	100%		2.0%	2.1%	4.1%
El Salvador	100%		1.4%	0.9%	2.3%
England	100%		1.6%	0.5%	2.1%
Georgia	85%	Students taught in Georgian	2.3%	2.5%	4.8%
Germany	100%		1.2%	0.2%	1.3%
Hong Kong SAR	100%		4.9%	0.5%	5.4%
Hungary	100%		2.6%	1.7%	4.4%
Iran, Islamic Rep. of	100%		2.9%	0.0%	3.0%
Italy	100%		0.1%	5.3%	5.3%
Japan	100%		0.4%	0.6%	1.1%
Kazakhstan	94%	Students taught in Kazakh or Russian	2.2%	3.1%	5.3%
Kuwait	100%		0.0%	0.0%	0.0%
Latvia	72%	Students taught in Latvian	4.2%	0.4%	4.6%
Lithuania	93%	Students taught in Lithuanian	2.2%	3.1%	5.4%
Morocco	100%		1.4%	0.0%	1.4%
Netherlands	100%		3.7%	1.0%	4.8%
New Zealand	100%		2.8%	2.6%	5.4%
Norway	100%		1.9%	3.3%	5.1%
Qatar	100%		1.5%	0.2%	1.8%
Russian Federation	100%		2.2%	1.5%	3.6%
Scotland	100%		2.6%	1.9%	4.5%
Singapore	100%		1.5%	0.0%	1.5%
Slovak Republic	100%		1.4%	1.9%	3.3%
Slovenia	100%		0.8%	1.3%	2.1%
Sweden	100%		2.0%	1.1%	3.1%
Tunisia	100%		2.7%	0.2%	2.9%
Ukraine	100%		0.6%	0.0%	0.6%
United States	100%		0.0%	9.2%	9.2%
Yemen	100%		1.9%	0.1%	2.0%

**Table A1.1B** Coverage of TIMSS 2007 Target Population, Year 8

Country	International Target Population		Exclusions from National Target Population		
	Coverage	Notes on Coverage	School-level Exclusions	Within-sample Exclusions	Overall Exclusions
Algeria	100%		0.1%	0.0%	0.1%
Armenia	100%		2.7%	0.5%	3.3%
Australia	100%		0.6%	1.2%	1.9%
Bahrain	100%		1.4%	0.1%	1.5%
Bosnia and Herzegovina	100%		0.4%	1.1%	1.5%
Botswana	100%		0.0%	0.1%	0.1%
Bulgaria	100%		2.2%	1.3%	3.4%
Chinese Taipei	100%		0.1%	3.3%	3.3%
Colombia	100%		1.5%	0.1%	1.6%
Cyprus	100%		0.0%	2.5%	2.5%
Czech Republic	100%		4.3%	0.3%	4.6%
Egypt	100%		0.1%	0.4%	0.5%
El Salvador	100%		1.2%	1.6%	2.8%
England	100%		2.0%	0.3%	2.3%
Georgia	85%	Students taught in Georgian	2.3%	1.6%	3.9%
Ghana	100%		0.9%	0.0%	0.9%
Hong Kong SAR	100%		3.7%	0.1%	3.8%
Hungary	100%		2.6%	1.4%	3.9%
Indonesia	100%		3.4%	0.0%	3.4%
Iran, Islamic Rep. of	100%		0.5%	0.0%	0.5%
Israel	100%		14.5%	8.3%	22.8%
Italy	100%		0.0%	4.9%	5.0%
Japan	100%		0.6%	2.9%	3.5%
Jordan	100%		0.2%	1.8%	2.0%
Korea, Rep. of	100%		1.2%	0.5%	1.6%
Kuwait	100%		0.0%	0.3%	0.3%
Lebanon	100%		1.4%	0.0%	1.4%
Lithuania	92%	Students taught in Lithuanian	1.4%	2.7%	4.2%
Malaysia	100%		3.3%	0.0%	3.3%
Malta	100%		0.8%	2.1%	2.9%
Morocco	100%		0.1%	0.0%	0.1%
Norway	100%		0.9%	1.7%	2.6%
Oman	100%		0.3%	0.9%	1.2%
Palestinian Nat'l Auth.	100%		0.1%	0.9%	1.0%
Qatar	100%		0.6%	0.2%	0.8%
Romania	100%		1.5%	0.3%	1.8%
Russian Federation	100%		1.1%	1.2%	2.3%
Saudi Arabia	100%		0.4%	0.1%	0.5%
Scotland	100%		1.3%	0.4%	1.7%
Serbia	80%	Serbia without Kosovo	2.9%	3.9%	6.8%
Singapore	100%		1.8%	0.0%	1.8%
Slovenia	100%		0.9%	1.0%	1.9%
Sweden	100%		2.1%	1.6%	3.6%
Syrian Arab Republic	100%		0.6%	0.0%	0.6%
Thailand	100%		3.4%	0.0%	3.4%
Tunisia	100%		0.0%	0.0%	0.0%
Turkey	100%		2.1%	0.5%	2.6%
Ukraine	100%		0.2%	0.0%	0.2%
United States	100%		0.0%	7.9%	7.9%

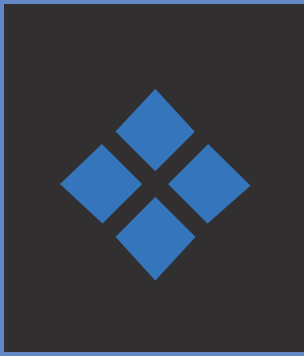
Table A1.2 shows the participation rates for schools, students, and overall – both with and without the use of replacement schools. Most countries achieved the minimum acceptable participation rates – 85 per cent of both the schools and students, or a combined rate (the product of school and student participation) of 75 per cent – although, at Year 4, Scotland and the United States did so only after including replacement schools and have been annotated in the tables and figures in this report. Although the Netherlands had an overall participation rate of 91 per cent, including replacement schools, its participation rate among schools before replacement (48%) was just below the required minimum of 50 per cent, and so the Netherlands has been annotated accordingly. At Year 4, all participants except Morocco achieved the minimum acceptable participation rate, although England, Hong Kong, Scotland, and the United States did so only after including replacement schools and were annotated in tables and figures in this report. Morocco, with an overall participation rate of 55 per cent, was also annotated in tables and figures.

**Table A1.2A** Participation Rates (Weighted) – Year 4

Country	School Participation		Class Participation	Student Participation	Overall Participation	
	Before replacement	After replacement			Before Replacement	After Replacement
Algeria	99%	99%	100%	97%	97%	97%
Armenia	93%	100%	100%	96%	90%	96%
Australia	99%	100%	100%	95%	94%	95%
Austria	98%	99%	99%	98%	96%	97%
Chinese Taipei	100%	100%	100%	100%	100%	100%
Colombia	93%	99%	100%	98%	91%	97%
Czech Republic	89%	98%	100%	94%	83%	92%
Denmark	71%	91%	99%	94%	66%	85%
El Salvador	99%	100%	100%	98%	97%	98%
England	83%	90%	100%	93%	77%	84%
Georgia	92%	100%	100%	98%	90%	98%
Germany	96%	100%	100%	97%	93%	96%
Hong Kong SAR	81%	84%	100%	96%	78%	81%
Hungary	93%	99%	100%	97%	90%	96%
Iran, Islamic Rep. of	100%	100%	100%	99%	99%	99%
Italy	91%	100%	100%	97%	88%	97%
Japan	97%	99%	100%	97%	94%	95%
Kazakhstan	99%	100%	100%	100%	99%	100%
Kuwait	100%	100%	100%	85%	85%	85%
Latvia	93%	97%	100%	95%	89%	92%
Lithuania	99%	100%	100%	94%	93%	94%
Morocco	81%	81%	100%	96%	77%	77%
Netherlands	48%	95%	98%	97%	46%	91%
New Zealand	97%	100%	100%	96%	93%	96%
Norway	88%	97%	100%	95%	83%	92%
Qatar	100%	100%	100%	97%	97%	97%
Russian Federation	100%	100%	100%	98%	98%	98%
Scotland	77%	94%	100%	94%	72%	88%
Singapore	100%	100%	100%	96%	96%	96%
Slovak Republic	98%	100%	100%	97%	95%	97%
Slovenia	92%	99%	100%	95%	87%	93%
Sweden	98%	100%	100%	97%	94%	97%
Tunisia	100%	100%	100%	99%	99%	99%
Ukraine	96%	96%	100%	97%	93%	93%
United States	70%	89%	100%	95%	66%	84%
Yemen	99%	100%	100%	98%	97%	98%

**Table A1.2B** Participation Rates (Weighted) – Year 8

Country	School Participation		Class Participation	Student Participation	Overall Participation	
	Before Replacement	After Replacement			Before Replacement	After Replacement
Algeria	99%	99%	100%	96%	95%	95%
Armenia	94%	100%	100%	96%	90%	96%
Australia	100%	100%	100%	93%	93%	93%
Bahrain	100%	100%	100%	97%	97%	97%
Bosnia and Herzegovina	100%	100%	100%	98%	98%	98%
Botswana	100%	100%	100%	99%	99%	99%
Bulgaria	94%	98%	100%	96%	90%	94%
Chinese Taipei	100%	100%	100%	99%	99%	99%
Colombia	96%	100%	100%	98%	94%	98%
Cyprus	100%	100%	100%	96%	96%	96%
Czech Republic	92%	100%	100%	95%	87%	95%
Egypt	99%	100%	100%	98%	97%	98%
El Salvador	99%	100%	100%	98%	97%	98%
England	78%	86%	100%	88%	69%	75%
Georgia	97%	100%	100%	97%	95%	97%
Ghana	100%	100%	100%	98%	98%	98%
Hong Kong SAR	73%	79%	100%	96%	70%	75%
Hungary	92%	99%	100%	97%	89%	96%
Indonesia	100%	100%	100%	97%	97%	97%
Iran, Islamic Rep. of	100%	100%	100%	98%	98%	98%
Israel	94%	97%	100%	94%	88%	91%
Italy	93%	100%	100%	96%	89%	96%
Japan	96%	97%	100%	93%	90%	91%
Jordan	100%	100%	100%	96%	96%	96%
Korea, Rep. of	100%	100%	100%	99%	99%	99%
Kuwait	97%	97%	100%	87%	84%	84%
Lebanon	81%	92%	100%	93%	76%	85%
Lithuania	98%	99%	100%	91%	89%	90%
Malaysia	100%	100%	100%	98%	98%	98%
Malta	100%	100%	100%	95%	94%	94%
Morocco	65%	65%	100%	85%	55%	55%
Norway	88%	93%	100%	93%	82%	86%
Oman	100%	100%	100%	99%	99%	99%
Palestinian Nat'l Auth.	100%	100%	100%	98%	98%	98%
Qatar	100%	100%	100%	97%	97%	97%
Romania	99%	99%	100%	97%	97%	97%
Russian Federation	100%	100%	100%	97%	97%	97%
Saudi Arabia	99%	99%	100%	95%	94%	94%
Scotland	74%	86%	100%	90%	66%	77%
Serbia	100%	100%	100%	98%	98%	98%
Singapore	100%	100%	99%	95%	95%	95%
Slovenia	92%	99%	100%	93%	85%	92%
Sweden	100%	100%	100%	94%	93%	94%
Syrian Arab Republic	100%	100%	100%	96%	96%	96%
Thailand	90%	100%	100%	99%	88%	99%
Tunisia	100%	100%	100%	98%	98%	98%
Turkey	100%	100%	100%	98%	98%	98%
Ukraine	98%	98%	100%	97%	95%	95%
United States	68%	83%	99%	93%	63%	77%



# Appendix 2: International Multiple Comparison Tables

**Table A2.1A** TIMSS 2007 Multiple Comparisons of Average Mathematics Achievement - Year 4

Instructions: Read across the row for a country to compare performance with the countries listed along the top of the chart. The symbols indicate whether the average achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the average achievement of the two countries.

Year 4 Mathematics	Average Score (SE)	Comparison Countries																																						
		Hong Kong SAR	Singapore	Chinese Taipei	Japan	Kazakhstan	Russian Federation	England	Latvia	Netherlands	Lithuania	United States	Germany	Denmark	Australia	Hungary	Italy	Austria	Sweden	Slovenia	Armenia	Slovak Republic	Scotland	New Zealand	Czech Republic	Norway	Ukraine	Georgia	Iran, Islamic Rep. of	Algeria	Colombia	Morocco	El Salvador	Tunisia	Kuwait	Qatar	Yemen			
Hong Kong SAR	607 (3.6)	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Singapore	599 (3.7)	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Chinese Taipei	576 (1.7)	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Japan	568 (2.1)	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Kazakhstan	549 (7.1)	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Russian Federation	544 (4.9)	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
England	541 (2.9)	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Latvia	537 (2.3)	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Netherlands	535 (2.1)	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Lithuania	530 (2.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
United States	529 (2.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Germany	525 (2.3)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	523 (2.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Australia	516 (3.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	510 (3.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Italy	507 (3.1)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	505 (2.0)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	503 (2.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	502 (1.8)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Armenia	500 (4.3)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	496 (4.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	494 (2.2)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	492 (2.3)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Czech Republic	486 (2.8)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Norway	473 (2.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Ukraine	469 (2.9)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Georgia	438 (4.2)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Iran, Islamic Rep. of	402 (4.1)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Algeria	378 (5.2)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Colombia	355 (5.0)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Morocco	341 (4.7)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
El Salvador	330 (4.1)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Tunisia	327 (4.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Kuwait	316 (3.6)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Qatar	296 (1.0)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Yemen	224 (6.0)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼

Note: 5% of these comparisons would be statistically significant by chance alone.

- ▲ Average achievement significantly higher than comparison country
- Average achievement not significantly different to comparison country
- ▼ Average achievement significantly lower than comparison country
- ◻ Statistically significantly above the TIMSS scale average
- ◻ Not statistically different to the TIMSS scale average
- ◻ Statistically significantly below the TIMSS scale average



**Table A2.2A** TIMSS 2007 Multiple Comparisons of Average Science Achievement - Year 4

Instructions: Read across the row for a country to compare performance with the countries listed along the top of the chart. The symbols indicate whether the average achievement of the country in the row is significantly lower than that of the comparison country, significantly higher than that of the comparison country, or if there is no statistically significant difference between the average achievement of the two countries.

Year 4 Science	Average Scale Score (SE)	Comparison Countries																																							
		Singapore	Chinese Taipei	Hong Kong SAR	Japan	Russian Federation	Latvia	England	United States	Hungary	Italy	Kazakhstan	Germany	Australia	Slovak Republic	Austria	Sweden	Netherlands	Slovenia	Denmark	Czech Republic	Lithuania	New Zealand	Scotland	Armenia	Norway	Ukraine	Iran, Islamic Rep. of	Georgia	Colombia	El Salvador	Algeria	Kuwait	Tunisia	Morocco	Qatar	Yemen				
Singapore	587 (4.1)	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Chinese Taipei	557 (2.0)	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Hong Kong SAR	554 (3.5)	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Japan	548 (2.1)	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Russian Federation	546 (4.8)	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Latvia	542 (2.3)	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
England	542 (2.9)	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
United States	539 (2.7)	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Hungary	536 (3.3)	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Italy	535 (3.2)	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Kazakhstan	533 (5.6)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Germany	528 (2.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Australia	527 (3.3)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	526 (4.8)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Austria	526 (2.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	525 (2.9)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Netherlands	523 (2.6)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovenia	518 (1.9)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Denmark	517 (2.9)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	515 (3.1)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Lithuania	514 (2.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
New Zealand	504 (2.6)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Scotland	500 (2.3)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Armenia	484 (5.7)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Norway	477 (3.5)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Ukraine	474 (3.1)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Iran, Islamic Rep. of	436 (4.3)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Georgia	418 (4.6)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Colombia	400 (5.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
El Salvador	390 (3.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Algeria	354 (6.0)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Kuwait	348 (4.4)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Tunisia	318 (5.9)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Morocco	297 (5.9)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Qatar	294 (2.6)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
Yemen	197 (7.2)	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼

Note: 5% of these comparisons would be statistically significant by chance alone.

- ▲ Average achievement significantly higher than comparison country
- Average achievement not significantly different to comparison country
- ▼ Average achievement significantly lower than comparison country
- ◻ Statistically significantly above the TIMSS scale average
- ◻ Not statistically different to the TIMSS scale average
- ◻ Statistically significantly below the TIMSS scale average



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