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Monitoring Australian Year 8 student achievement internationally : TIMSS 2011

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TIMSS • Trends in International Mathematics and Science Study

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Executive Summary

The Trends in International Mathematics and Science Study (TIMSS 2011) is an international study directed by the International Association for the Evaluation of Educational Achievement (IEA). In Australia, TIMSS was managed by the Australian Council for Educational Research (ACER), and funded by the Australian and state and territory governments.

The goal of TIMSS is to provide comparative information about educational achievement across countries to improve teaching and learning in mathematics and science. It also provides comparative perspectives on trends in achievement in the context of different educational systems, school organisational approaches and instructional practices and to enable this, TIMSS collects a rich array of background information.

This report analyses and interprets the Australian Year 8 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. A companion report details the achievement of Year 4 students in mathematics and science in TIMSS and in reading in PIRLS.

Who is assessed?

Across the world, Year 8 students in 45 countries and 14 benchmarking participants took part in TIMSS 2011. In Australia, over 7,500 students in 275 schools participated in the Year 8 sample of TIMSS 2011. In addition, an extra sample of Indigenous students in all participating schools was collected in order to provide a more detailed examination of the achievements of Australia's Indigenous students.

TIMSS 2011 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 class (or in the case of the Australian Capital Territory and the Northern Territory, two classes) of Year 8 students was randomly selected to take part in the study.

What is assessed?

Two organising dimensions: a content dimension and a cognitive dimension, framed the mathematics and science assessment for TIMSS 2011, 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. At Year 8 there are four content domains in mathematics – *number, algebra, geometry;* and *data and chance* and four in science – *chemistry, biology, Earth science and physics.* In addition there are three cognitive domains in each curriculum area: *knowing; applying;* and *reasoning.*

What did TIMSS 2011 participants do?

As TIMSS focuses on international curricula in mathematics and science, a large number of test items were required to cover the range of topics and abilities. These items were grouped into blocks, which were then distributed across a number of assessment booklets. There were 14 TIMSS booklets, each containing multiple-choice and constructed-response items. Participating students completed one of these booklets, which were evenly distributed within classes. This meant that only two or three students in each class completed each particular TIMSS booklet. After the assessment booklets were completed, students completed a questionnaire which provides rich background and attitudinal data.

Teachers, principals and curriculum experts also completed questionnaires to find out about what is intended to be taught and about how it is actually taught in classrooms.

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.

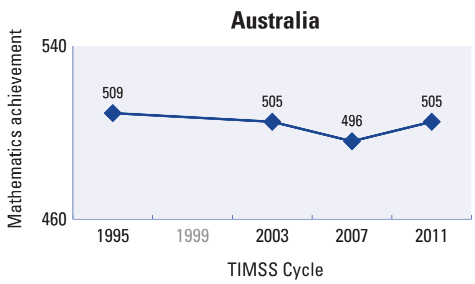
Australia's performance in TIMSS at Year 8

This section provides a summary of the findings to be found in more detail in this report.

Internationally

In mathematics:

- With an average mathematics score of 505, Australian students performed at a significantly lower level than students in six countries: Korea, Singapore, Chinese Taipei, Hong Kong, Japan, and the Russian Federation. This is relatively better than in 2007, when the United States, England and Hungary also outperformed Australia – in 2011 their scores are not significantly different to those of Australia.
- The average performance of Australian Year 8 students has not changed since TIMSS 1995.



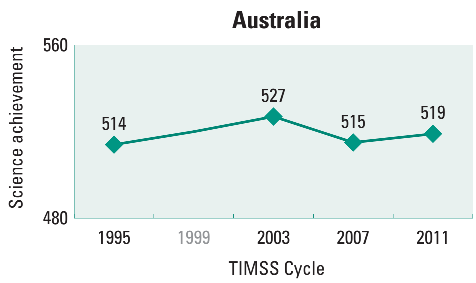
- Nine per cent of Australian students achieved at the Advanced international benchmark, with a further 20 per cent achieving the High international benchmark. Thirty-seven per cent of

Australian students did not achieve the Intermediate international benchmark, which is the minimum proficient standard expected.

- The proportion of Australian students achieving at each benchmark has not changed since TIMSS 1995.
- The movement of the Year 4 cohort in TIMSS 2007 to Year 8 in 2011 has seen a weakening of our overall score – from above the scale centrepoint in 2007 to equal to it in TIMSS 2011.
- Year 8 Australian students are weakest in *algebra* and strongest in *data and chance*, while cognitively, young Australian students are stronger in *applying*.

In Science:

- Australia's average score of 519 points in science was significantly lower than that of nine other countries: Singapore, Chinese Taipei, Korea, Japan, Finland, Slovenia, the Russian Federation, Hong Kong and England. With the exception of Finland, who did not participate in TIMSS 2007, these countries also outperformed Australia in 2007. Australia's performance was not significantly different to that of the United States, Hungary, Israel, Lithuania, New Zealand, and Sweden.
- Australia's average scale score was not significantly different to the score in TIMSS 1995.



- Eleven per cent of Australian students achieved at the Advanced international benchmark and 25 per cent achieved at the High international benchmark. Thirty per cent of students in Australian did not reach the Intermediate international benchmark.
- The only change in the proportion of Australian students at the benchmarks since TIMSS 1995 is that a higher proportion of students (92% compared to 89%) reached the Low benchmark.
- In terms of the content domains, Australian students are strongest in *Earth science* and *biology* and weakest in *chemistry* and *physics*. In the cognitive domains, *knowing*, *applying* and *reasoning*, the performance of Australian Year 8 students was similar to their overall science achievement score.

Results for the Australian states and territories

In mathematics:

- The performance of students in the Australian Capital Territory was significantly higher than that of students in all states except New South Wales. Students in New South Wales significantly outperformed students in South Australia, Tasmania and the Northern Territory, and students in Victoria and Queensland also significantly outperformed students in Tasmania and the Northern Territory.
- The only significant changes over time were declines in South Australia and Western Australia from the TIMSS 1995 score to the TIMSS 2011 score.
- Fourteen per cent of students in the Australian Capital Territory achieved the Advanced benchmark. Almost half of the students (43%) reached the High international benchmark, while 26 per cent failed to achieve the Intermediate benchmark. The next best achieving state

was New South Wales with 13 per cent of students achieving at the Advanced international benchmark, and 34 per cent of students failing to achieve the Intermediate benchmark.

- In each of the other states, fewer than ten per cent of students achieved at the Advanced benchmark and more than 35 per cent of the students did not achieve the Intermediate international benchmark. In Tasmania and the Northern Territory, more than 50 per cent of students failed to achieve the Intermediate benchmark.

In science:

- The score for students in the Australian Capital Territory was not significantly different to that of students in New South Wales, but was significantly higher than that of students in all other states. Students in New South Wales significantly outperformed students in South Australia, Tasmania and the Northern Territory, and students in Queensland also significantly outperformed students in Tasmania and the Northern Territory.
- There have been no significant changes in scores since TIMSS 1995 in any states.
- The Australian Capital Territory was the highest performing state, with 19 per cent of students reaching the Advanced international benchmark, just over half (53%) reaching the High international benchmark and 82 per cent achieving at least the Intermediate benchmark. The next best achieving state was New South Wales, in which 16 per cent of students achieved the Advanced international benchmark, while 28 per cent of students in New South Wales did not achieve the Intermediate international benchmark.
- In each of the other states, fewer than ten per cent of students achieved at the Advanced international benchmark. In the Northern Territory, 44 per cent of students and in Tasmania 40 per cent of students did not achieve the Intermediate benchmark.

Results for females and males

In mathematics:

- Internationally 22 countries, including Australia, had no significant gender difference in mathematics achievement at Year 8. Of the remaining countries, 13 had differences favouring female students, with four relatively larger differences (Palestine, Jordan, Bahrain and Oman). Seven countries had differences favouring males.
- Within Australia, there were no significant gender differences in state.
- A slightly higher proportion of male than female students achieved at the Advanced benchmark in New South Wales, Victoria, Queensland, Western Australia and Tasmania. The Australian Capital Territory, New South Wales and Victoria had more than ten per cent of male students achieving at the Advanced international benchmark. Only the Australia Capital Territory and New South Wales had more than ten per cent of female students reaching this level.
- In South Australia, a slightly greater proportion of female than male students (4% compared to 2%) achieved the Advanced benchmark, while a further 20 per cent of female students and 16 per cent of male students achieved the High benchmark.
- In New South Wales, Tasmania and the Northern Territory a larger proportion of female students than male students did not achieve the Intermediate benchmark.

In science:

- On average internationally, there was a significant gender difference in science in favour of females. Females achieved significantly higher average scores than males in 15 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 seven score points in Indonesia to 78 score points in Oman. Males achieved significantly higher average scores than females in ten countries, including Australia. Across the participating countries, the significant differences in favour of males ranged in size from seven score points in the Russian Federation to 30 score points in Ghana. In 17 countries there was no significant difference between females and males.

- In Australia, males outperformed females by 16 score points, a substantial, as well as significant, difference. There has been a significant gender difference in favour of males in Australia at Year 8 in each cycle of TIMSS.
- Around eight per cent of female students and 13 per cent of male students in Australia achieved the Advanced benchmark, and there was a greater proportion of female students (32%) than male students (27%) not achieving the Intermediate benchmark.
- Tasmania was the only state in which the gender difference in favour of males was significant.
- In terms of benchmarks, there was substantial variation between states. In the Australian Capital Territory, 21 per cent of males and 19 per cent of females achieved the Advanced benchmark, while in New South Wales 20 per cent of males but only 13 per cent of females achieved this level. The only other state to have double digits was Queensland, where 13 per cent of males but just six per cent of females achieved the Intermediate benchmark.
- In the other states fewer than 10 per cent of students achieved the Advanced benchmark.
- In New South Wales, Tasmania and the Northern Territory, substantial proportions of female students did not achieve the intermediate benchmark (31%, 45% and 47% respectively), and this was larger in each case than the proportion of males not achieving this benchmark.

Socioeconomic background

TIMSS collects data about two aspects of students' socioeconomic background at Year 8 level. Students are asked about the number of books in their home, and the highest level of education attained by their parents or guardians. Books in the home has traditionally acted as a proxy in large scale international studies for a family's educational and social background.

Generally, there is a strong correlation between books in the home and parental education and income and a moderate to strong positive correlation between books in the home and achievement, particularly in reading. Research suggests that the number of books in the home can be an indicator of a home environment that values literacy, the acquisition of knowledge and general academic support.

Across almost all of the participating countries, higher parental education is associated with higher average mathematics achievement. However, in Australia, there was a very high level of "Do not know" responses – 52 per cent of Australian Year 8 students did not provide a response to this question. As such, the results in this section should be treated with some caution, although they are strongly in agreement with international findings in other countries, and with findings from other Australian studies such as PISA in which there is not as much missing data.

Results by number of books in the home

This section provides some evidence about the achievement of students according to the number of books they report in their homes. For the purposes of this report, this variable has been grouped to represent *a few books* – 25 or fewer books (22% of students), *average number of books* – between 26 and 200 books (51% of students) and *many books* – more than 200 books (27% of students).

In mathematics:

- Students who reported having the most books in the home were found to have the highest levels of mathematics achievement, scoring, on average, 38 points higher than students with an *average number of books* in the home, and 90 score points higher than those with a *few books* in the home.

- Of those students who reported having many books in the home, 19 per cent achieved the Advanced benchmark. The proportion of students achieving this highest benchmark fell to eight per cent for students in the average number of books category and just two per cent of those with a *few books* in the home attaining this level of achievement.
- At the other end of the achievement scale, a total of 19 per cent of students in the group who reported having *many books* in the home did not achieve the Intermediate benchmark. However the performance of these students is still substantially better than that of students with access to fewer resources. Of those students in the *average number of books* in the home category, a total of 32 per cent of students did not achieve the Intermediate benchmark, while 59 per cent of the students who reported having *few books* in the home did not achieve the Intermediate benchmark.

In science:

- Students who reported the most books in the home also have the highest levels of achievement in science, scoring 45 points, on average, higher than students with an *average number of books* in the home, and 101 score points higher than those with *a few books* in the home.
- Of those students who reported having *many books* in the home, 25 per cent achieved the Advanced benchmark. The proportion at this highest benchmark falls away quickly though, with nine per cent of students in the average number of books category and just two per cent of those with *few books* in the home attaining this level of achievement.
- Around 12 per cent of students in the group who reported having *many books* in the home did not achieve the Intermediate benchmark. However the influence of books in the home is clear, as this group of students still performs better than other students. Twenty-four per cent of students with an average number of books did not achieve the Intermediate benchmark, and 52 per cent of those with *few books* in the home did not achieve even this basic level.

Results by level of parental education

Of the students who responded to this question, 33 per cent reported that the highest level of education attained by either parent was a university degree. A further 36 per cent said that this highest level was the completion of post-secondary (i.e. TAFE) but not university, 25 per cent upper secondary (ie Year 10 or 11 but not Year 12), and six per cent said that their parents were not educated past mid-secondary school level.

In mathematics:

- The mean score increases as the level of parental education increases, with students with at least one parent with a university degree having an average mathematics score a substantial 132 points higher than that of students whose parents did not complete secondary school, 89 score points higher than the average score for students for whom the highest level of parental education was completing secondary school and 70 score points higher than that of students whose parents completed a TAFE qualification.
- More than one-quarter (27%) of students who had at least one parent complete a university degree reached the Advanced benchmark compared to five per cent or fewer for all other groups. In comparison, almost three-quarters (71%) of students whose parents did not complete secondary school did not reach the Intermediate benchmark, compared to 14 per cent of students with parents holding university degrees.

In science:

- The average score for students who reported at least one parent with a university degree was a substantial 134 points higher than that of students whose parents did not complete secondary school, 85 score points higher than the average score for students for whom the highest level of parental education was completing secondary school and 59 score points higher than that of students whose parents completed a TAFE qualification.
- More than one-quarter (29%) of students who had at least one parent complete a university degree reached the Advanced benchmark compared to eight per cent of students who had a parent who undertook some other form of post-secondary education and less than five per cent for the two other groups. In comparison, two-thirds (66%) of students whose parents did not complete secondary school did not reach the Intermediate benchmark, compared to 10 per cent of students with at least one parent holding university degrees.

Results for Indigenous students

In mathematics:

- Indigenous students attained an average score of 438 score points in mathematics, which was 71 score points lower than the average score for non-Indigenous students of 509.
- Nine per cent of non-Indigenous students reached the Advanced benchmark, compared to one per cent of Indigenous students. More than two-thirds (68%) of Indigenous students compared to one-third (34%) of non-Indigenous students did not achieve the Intermediate international benchmark, with 32 per cent of Indigenous students not reaching the Low benchmark.
- As with students from a non-Indigenous background, there was no change in mathematics achievement for students with an Indigenous background between 1995 and 2011.
- The gap in scores between Indigenous and non-Indigenous students is around the same as that reported in TIMSS 1995.

In science:

- Indigenous students attained an average score in science of 459 score points, more than half a standard deviation lower than the average score for non-Indigenous Australian students of 524 score points.
- Eleven per cent of non-Indigenous students reached the Advanced benchmark compared to two per cent of Indigenous students, while the proportion of Indigenous students who did not achieve the Intermediate international benchmark was twice that of non-Indigenous students, 58 per cent compared to 28 per cent.
- None of the differences between years are significant, that is, the 2011 score for Indigenous students, as for non-Indigenous students, is not significantly different to the score in any of the other years of testing. The difference between the two groups is significant, as it has been in each year of testing, and has not decreased in size.

Results for language background

Students were categorised according to their own reports about the language spoken at home: those who 'always' spoke English, and those who indicated that they 'sometimes' or 'never' spoke English, who were considered to have a language background other than English (LBOTE). Seven per cent of students in the Year 8 sample indicated that they did not speak English at home.

In mathematics:

- There was no significant difference in the scores in mathematics for the two groups of students, however, the gap from the 5th to 95th percentile is much higher for those students with a language background other than English. At the 5th percentile the scores for the two groups were similar, however at the 95th percentile, students with a language background other than English were scoring about half a standard deviation higher than their English speaking counterparts.
- A much higher proportion of students from a language background other than English achieved the Advanced benchmark (21% compared to 8% of English-speaking students. While more students who spoke a language other than English at home did not reach the low benchmark (15%), compared to ten per cent of English-speaking students, more English speaking students (26% compared to 22%) achieved at the Low benchmark, resulting in a similar total of 37 per cent of LBOTE and 36 per cent of English-speaking students not achieving the Intermediate benchmark..

In science:

- At the Year 8 level, there was no significant difference between the scores of students who 'always' spoke English at home and those with a language background other than English. As with mathematics though there was a much larger range of scores. At the 95th percentile of achievement, the scores of LBOTE students were as high or higher than those of English-speaking students, however at the 5th percentile, LBOTE students were scoring, on average, about half a standard deviation lower than English-speaking students. Clearly this makes it difficult to generalise non-English speakers as either high or low achievers.
- Eleven per cent of English-background students and 13 per cent of students from a language background other than English reached the Advanced benchmark. At the lower levels of achievement, 42 per cent of students from a LBOTE background compared to 29 per cent from an English-speaking background did not achieve the Intermediate benchmark.

Results for geographic location

The proportion of Australia's population living in rural and remote areas continues to decline. According to ABS estimates from 2010, about nine per cent of the population live in outer regional areas and about two per cent in remote and very remote areas.

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. In the TIMSS sample, 72 per cent of students attended schools in metropolitan areas, 27 per cent in provincial areas and just one per cent in remote areas.

In mathematics:

- Students attending schools in metropolitan areas scored, on average, 25 score points higher than students attending schools in provincial areas, and 64 score points, on average, higher than students in remote schools. Students attending schools in provincial areas scored, on average, 39 score points higher than students attending schools in remote areas.
- Ten per cent of students from metropolitan schools, five per cent of students from provincial schools and two per cent of students in remote schools achieved at the Advanced benchmark. The proportion of students from remote schools who did not attain the Intermediate international benchmarks was 60 per cent, compared to 45 and 34 per cent of students from provincial and metropolitan schools, respectively.

In science:

- Students attending schools in metropolitan areas scored at a similar level on average to students attending schools in provincial areas, but 57 score points, on average, higher than students in remote schools. Students attending schools in provincial areas scored, on average, 45 score points higher than students attending schools in remote areas.
- Twelve per cent of students in metropolitan schools achieved the Advanced international benchmark, while 28 per cent did not achieve the Intermediate benchmark. In contrast, just four per cent of students attending schools in remote areas achieved the Advanced international benchmark, 51 per cent did not achieve the Intermediate benchmark.

Student attitudes

- Students who indicated that they like mathematics or science scored higher on average in the assessments than did other students.
- Among Australian students, male students liked mathematics and science, valued mathematics and were confident with mathematics and science to a greater degree than their female peers. Almost half of the female students surveyed said they did not like mathematics, which has possible implications for the uptake of further mathematics by female students at senior secondary level and beyond. There were no differences in levels at which male and female students valued science, however.
- There were no differences in the average scale scores of Indigenous and non-Indigenous students on the Students Like Learning Mathematics, Students Like Learning Science, Students Value Mathematics or Students Value Science scales. There were, however, significant differences on the Student Confidence with Mathematics and Student Confidence with Science scale, with Indigenous students' scores reflecting lower levels of confidence than their non-Indigenous peers in these subjects.
- Compared to the international average, the results for Australian students on the Home Educational Resources scale are very positive, and as expected, Australia was one of the countries with the highest proportions of students with *many resources.*
- Non-Indigenous students had a higher average Home Educational Resources scale score, and thus greater educational resources at home, than Indigenous students.
- Students who anticipated going on to university study (either undergraduate or postgraduate) scored higher in mathematics and science than students who anticipated going on to some other form of post-secondary study, or who thought that they would end their education with secondary school. This pattern was found internationally, for Australian students (on average), females and males and non-Indigenous students.
- Among Indigenous students, those who aspired to any form of post-secondary study recorded higher scores in mathematics and science than those who anticipated ending their education with secondary school.

Teachers and schools

- The majority of Year 8 students in Australia are taught mathematics and science by teachers aged between 30 and 50.
- While the distribution of male and female teachers of Year 8 mathematics and science is fairly even across Australia as a whole, there is some variation between the states. A greater proportion of students are taught mathematics by female teachers in South Australia (76% of students) than Tasmania (39%) for example, while a greater proportion of students are taught science by female teachers in the Northern Territory (79%) than in Western Australia (46%).
- The proportion of Year 8 students in Australia who have mathematics or science teachers with post-graduate qualifications is far greater than the average across countries participating

in TIMSS. However the proportion of students being taught by teachers who have no formal qualifications to teach mathematics was much greater than the international average.

- Far greater proportions of Australian Year 8 students had access to computers to use in their mathematics and science classes than was the case internationally, but this had no direct impact on their performance.
- Students in schools in urban locations tended to score higher on the mathematics and science assessments than students in schools in suburban or rural locations.
- The economic makeup of schools had an impact on the performance of students, with students in schools with more affluent than disadvantaged students scoring higher in mathematics and science than students in schools with more disadvantaged than affluent students.
- The proportion of a school's student population who spoke English as their first language did not appear to have an influence on average student achievement in mathematics or science.
- Resource shortages in the areas of mathematics and science were relatively rare among Australian schools, but did show a relationship with student achievement in mathematics – schools that were not affected by resource shortages in mathematics had average student scores that were higher than schools that were somewhat affected by shortages.
- Difficulties in filling science teacher vacancies were associated with lower average scores in science, whereas difficulties in filling mathematics teacher vacancies had no relationship with average mathematics scores.

The school climate

- Achievement in mathematics and science was higher on average among students who liked school and felt like they belong, were engaged during mathematics lessons, felt that they were safe and were almost never bullied.
- Achievement in mathematics and science was higher on average in schools in which principals and teachers report a high emphasis on academic success, teachers thought were safe and orderly, in which principals reported hardly any problems with discipline or attendance and where student factors such as a lack of prerequisite knowledge, nutrition and sleep deprivation and disruptive or uninterested students did not impact on student learning.
- Almost one third of Australian students reported not being engaged in their mathematics and science lessons.
- Among Australian students, teachers' reports of their working conditions had no relationship with student achievement in mathematics or science.

Policy considerations

The results of TIMSS 2011 show that Australia's scores in mathematics and science have largely stagnated over the past 16 years. Over this same time, a number of other countries have either dramatically improved their results (Chinese Taipei, for example), or slowly but surely improved (Korea, for example). More countries outperform Australia in mathematics and science in TIMSS 2011 than did in TIMSS 1995, while a number of countries whose performance was lower than Australia's are now achieving at roughly the same level.

It is clear that in both mathematics and science, Australia has a substantial 'tail' of underperformance. For such a highly developed country, this level of underperformance is not acceptable and its minimisation should become a priority, particularly if the aim for Australian education is to be one of the top five education systems in the world. Examining policy in the high performing Asian countries could provide some pointers. If the 11 per cent of students in mathematics and eight per cent of students in science in Australia currently not even achieving the Low international benchmark were to do so, it would lift Australia's overall average score substantially.

In addition, more attention needs to be paid to extending students at the highest levels of achievement. In comparison to higher achieving countries, the proportion of Australian students at the High and Advanced benchmarks is modest.

The issue of 'teaching out of field' in mathematics needs to be addressed. Around one-third of students are being taught by teachers with no content or pedagogical training in mathematics. Perhaps a reflection of this lack of training is that more than 20 per cent of students were taught mathematics by teachers who were only *somewhat confident* in teaching mathematics. The situation is not as critical in science, however a similar proportion of students were taught by teachers who were only *somewhat confident* about teaching science, and one-quarter of students were taught by science teachers who did not feel very well prepared to teach all topics in science, particularly Earth science and physics. Without strong pedagogical and content knowledge, teachers will be more likely to teach to the middle, failing to provide adequate extension for high-achieving students and unable to provide alternative structure for students who are having difficulties. It is essential that these issues are addressed in the early years of secondary school with good teaching, otherwise the decline in engagement continues and students do not pursue further studies in these areas.

It is evident that student motivation and self-confidence are also important factors within Australia. Similarly, teachers' job satisfaction is important, as is the provision of a supportive, ambitious school climate. It is important that Australia continues to develop systems that build accountability and support capacity building for teachers and school management in order to address attitudinal barriers towards teaching and learning, particularly in specific subject areas such as mathematics and science.

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Acknowledgements

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In Australia, TIMSS is managed by a team from the Australian Council for Educational Research and guided by the International Assessments Joint National Advisory Committee (IAJNAC). ACER wishes to thank the IAJNAC members, who are listed in a separate section of the report, for their continued interest and commitment throughout every phase of the project. Their involvement included assisting with the implementation of TIMSS in schools in their jurisdiction, reviewing the report and providing valuable information to ensure the continued success of TIMSS in Australia.

The team would also like to acknowledge the contribution of Rudra Sahoo to the data analysis for this report.

The undertaking of TIMSS 2011 was a collaborative effort. A national survey such as TIMSS could not be successful without the cooperation of the school systems, principals, teachers, parents and of course, the students. For high quality data a high participation rate of the randomly selected schools and students is essential. Australia was able to satisfy the internationally set response criteria completely for TIMSS 2011. ACER gratefully recognises the assistance of education system officials Australia-wide, and the principals, teachers and students in the participating schools who gave generously of their time and support to the project.

Parts of this report are modified, with permission, from the TIMSS 2011 International Results in Mathematics report (Mullis, Martin, Foy & Arora, 2012), the TIMSS 2011 International Results in Science report (Martin, Mullis, Foy & Stanco, 2012) and the TIMSS 2011 Assessment Frameworks (Mullis, Martin, Ruddock, O'Sullivan & Preuschoff, 2009).

Membership of the International Assessments Joint National Advisory Committee

Names in italics denote previous members of the National Advisory Committee.

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Reader's Guide

Sample surveys

TIMSS is conducted as a sample survey in most participating countries. In surveys such as this, 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 burdensome for 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.

Scores in TIMSS

TIMSS used item response theory (IRT) methods (please refer to the International Technical report for more information about item response theory) to summarise the achievement for Year 8 students on a scale with a mean of 500 and a standard deviation of 100. It should be noted that the results for mathematics and science should not be compared. While the scales are expressed in the same numerical units, they are not directly comparable in terms of being able to say how much learning in mathematics equals how much learning in science. Nor is it possible to compare the learning of Year 4 students (presented in a companion report) with those of Year 8 students. That is, achievement on the TIMSS scales cannot be described in absolute terms (like all such scales developed using IRT technology). Comparisons can only be made in terms of relative performance (higher or lower), for example, among countries and population groups as well as between assessments.

The TIMSS mathematics and science scales for 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 centrepoint*, the *international average* and the *international median*.

The *TIMSS scale centrepoint* is the mean of the scales (for each of Year 8 mathematics and science) established in the first cycle of the study, calibrated to be 500, with a standard deviation of 100 score points.

The *international average* is the mean score or percentage of all countries participating in TIMSS 2011 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.

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 assessments. 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 participated in 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.

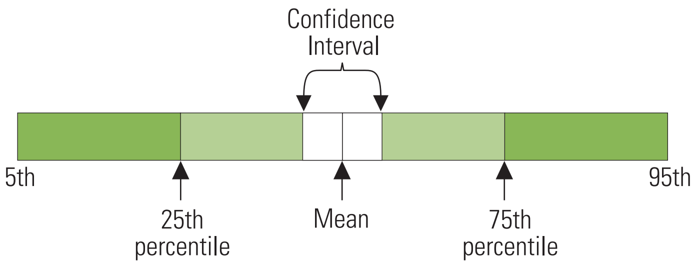
In this report, means are presented with an associated standard error. The standard error is an estimate of the error in the estimate of the population mean from the sample and is based on the standard deviation of sampling distribution of the mean. The size of the sample, as well as the variance in the scores within the sample, can affect the size of the standard error. Smaller samples, or samples with a greater 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. A larger standard error results in a larger confidence interval, and a greater likelihood that the confidence intervals of two means will overlap and, therefore, reduce any difference to non-significance (see the next section on statistical significance).

Rounding of figures

Due to rounding to eliminate decimals, some percentages in tables and figures 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.

Reading the achievement graphs



Each country's results are represented in horizontal bars with various colours. On the left end of the bar is the 5th percentile – this is the score below which five per cent of the students have scored. The next line indicates the 25th percentile. The white band is the confidence interval for the mean – that is, 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 75th and 95th percentiles.

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 affect 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.

Naming of countries

A number of countries have longer official names than they are usually referred to in conversation. In order to facilitate the reading of these reports, these countries are referred to by their shortened form (e.g. Hong Kong, Korea, Syria) in the text but are referred to by their official name (e.g. Hong Kong SAR; Korea, Rep of; Syrian Arab Republic) in the figure displaying participating countries in Chapter 1.

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 background:

Indigenous background 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 of Year 8 students 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)?

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.

Chapter

1 Introduction

The Trends in International Mathematics and Science Study (TIMSS) is an international study directed by the IEA (International Association for the Evaluation of Educational Achievement), 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, TIMSS is implemented by the Australian Council for Educational Research (ACER), which is Australia's representative to the IEA.

TIMSS has a primary goal of providing comparative information about educational achievement across countries to improve teaching and learning (in mathematics and science). TIMSS also provides comparative perspectives on trends in achievement in the context of different educational systems, school organisational approaches and instructional practices, and to enable this, TIMSS collects a rich array of background information.

Conducted on a regular four-year cycle, TIMSS has assessed mathematics and science in 1995, 1999, 2003, 2007 and now in 2011. 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 while the Year 4 students of 2007 became the Year 8 students of 2011).

Towards the end of 2010, just over 7500 Australian students in Year 8 participated in TIMSS.[1] 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 44 other countries and 14 regions or benchmarking participants[2], students, teachers and principals completed the same tests and questionnaires.

Why TIMSS?

The main goal of TIMSS is to assist countries to monitor and evaluate their mathematics and science teaching across time and across year levels.[3] 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 2010. The remaining countries tested at the end of the northern hemisphere school year: May to June 2011.

2 A benchmarking participant is a province or region 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 2011 Assessment Frameworks (Mullis, Martin, Ruddock, O'Sullivan & Preuschoff, 2009)

- 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 of mathematics and science 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 Year 8 achievement in mathematics and science in TIMSS, examining the issues presented above and issues particular to the Australian context, such as:

- How do Australian students score in each subject domain?
- 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 are also collected at the teacher and school level, so that such data can be used to highlight characteristics of teaching and learning of mathematics and science in Australia.

In 2011, the cycles for TIMSS and PIRLS (the Progress in International Reading Literacy Study, also conducted by the IEA) coincided for the first time, and participating countries were offered an unprecedented opportunity to conduct both TIMSS and PIRLS with their Year 4 students. Some countries elected to participate in both studies but to use separate samples of students for each assessment. Australia was one of a group of countries who elected to have the same sample of Year 4 students participate in TIMSS and PIRLS, thus receiving results for students in reading, mathematics and science. A companion report provides results pertaining to the achievement of Australian Year 4 students in reading, mathematics and science as measured in TIMSS and PIRLS 2011.

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.

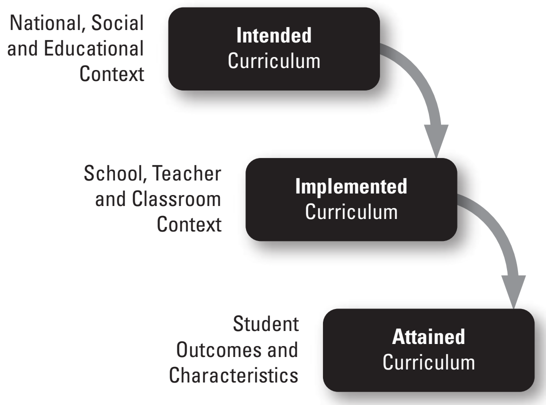


Figure 1.1 Three levels of curriculum developed in IEA research models

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 students' 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 2011.

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

Two organising dimensions – a content dimension and a cognitive dimension, framed the mathematics and science assessment for TIMSS 2011 – 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

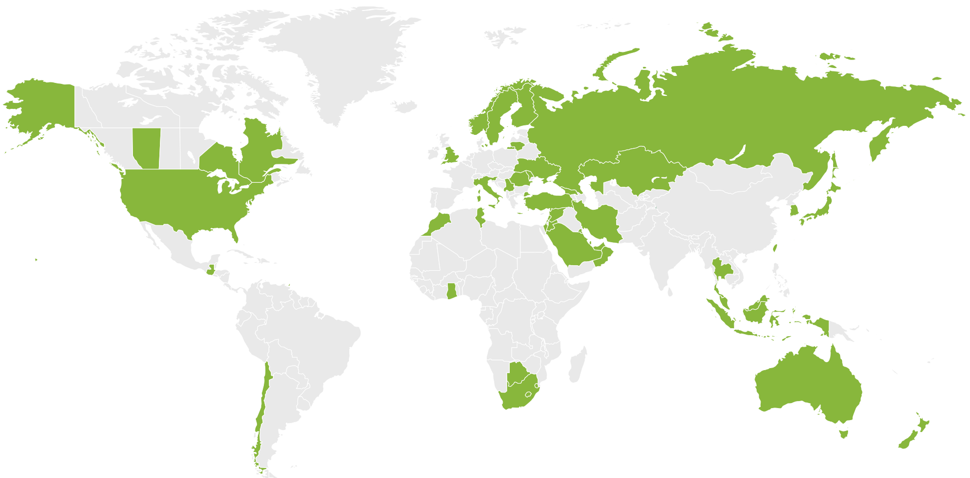
4 these content areas are not generally included in the curriculum. Similarly in science in Year 8, physics and chemistry are assessed as separate content domains, and receive more emphasis than in Year 4, where they are assessed as one content domain, physical science. Nevertheless the cognitive framework 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.

Further details about the content and cognitive domains on which the Year 8 TIMSS students were assessed are provided in Appendix 2.

Who participated?

Countries

A total of 45 countries (including 3 countries who tested older students and are thus not included in the calculation of the international mean or presented in this report) and 14 benchmarking participants administered the Year 8 TIMSS assessment. The participating countries are shown in Figure 1.2.



Participating Countries

Armenia
Australia
Bahrain
Botswana*
Chile
Chinese Taipei
England
Finland
Georgia
Ghana
Honduras*
Hong Kong SAR
Hungary
Indonesia
Iran, Islamic Rep. of
Israel
Italy
Japan
Jordan
Kazakhstan
Korea, Rep. of
Lebanon
Lithuania
Macedonia, Rep. of
Malaysia
Morocco
New Zealand
Norway
Oman
Palestinian Nat'l Auth.
Qatar
Romania
Russian Federation
Saudi Arabia
Singapore
Slovenia
South Africa*
Sweden
Syrian Arab Republic
Thailand
Tunisia
Turkey
Ukraine
United Arab Emirates
United States

Benchmarking Participants

Abu Dhabi, UAE
Alabama, US
Alberta, Canada
California, US
Colorado, US
Conneticut, US
Dubai, UAE
Florida, US
Indiana, US
Massachusetts, US
Minnesota, US
North Carolina, US
Ontario, Canada
Quebec, Canada

* Tested students in other year levels (Year 9)

Figure 1.2 Countries participating in TIMSS 2011 at Year 8.

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,[4] sector and by geographic location. This ensures that the sample drawn is representative of

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

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

The weighted[5] numbers for Australia for Year 8, along with the number of schools and actual number of students participating, are shown in Table 1.1.

Table 1.1 Australian designed and achieved school sample, Year 8

	Designed school sample	N schools	N students	Weighted N students	Weighted per cent students
ACT	30	30	1302	4961	2.0
NSW	45	42	1134	84570	33.6
VIC	45	43	958	65361	25.8
QLD	45	43	1198	52199	20.7
SA	40	39	888	18792	7.5
WA	40	38	872	17114	6.8
TAS	30	30	752	6691	2.7
NT	15	10	452	2297	0.9
TOTAL	290	275	7556	251985	100.0

Due to differences in school starting ages between the states, the age of students in Year 8 varies across states, with the youngest students around 13 years 6 months in Queensland and the oldest around 14 years 5 months in Tasmania. In the achievement tables for reading and mathematics (Figure 2.1 and Figure 3.1 respectively), the average age of students in each country is also provided, for comparison.

Table 1.2 Average age for Year 8 students, Australia and by state

State/Territory	Average age	SE
ACT	14.1	0.02
NSW	14.1	0.01
VIC	14.2	0.02
QLD	13.5	0.02
SA	14.0	0.01
WA	13.7	0.01
TAS	14.4	0.01
NT	14.0	0.02
Australia	14.0	0.01

5 Sample numbers are weighted to represent the proportion of students in each state within the Australian population of Year 8 students.

What did participants do?

Procedures for administering the test were determined by the TIMSS 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.

As TIMSS focuses on international curricula in mathematics and science, a large number of test items were required to cover the range of topics and abilities. Due to the total number of items being too much for an individual student to complete in a reasonable length of time, mathematics and science items were grouped into clusters, which were then rotated through 14 booklets, with each cluster found in more than one booklet. 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. Further information on the TIMSS assessment booklets and the types of items students attempted to complete is presented in Appendix 2, or available in the TIMSS 2011 Assessment Frameworks (Mullis et al., 2009).

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. In addition to the assessment booklet, students were also asked to complete a questionnaire.

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. 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 internationally standard Student Questionnaire sought information on students and their family background, and students' attitudes towards mathematics and science.

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.

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 scales by providing a profile of what students have achieved in terms of 'benchmarks'. Students at a particular benchmark typically demonstrate not only 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 Appendix 2.

It should be noted that the results for Year 4 and Year 8 are not directly comparable, nor are the results for reading, mathematics and science. While the scales for the two year levels and the three subject areas 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 or in one subject equals how much achievement or learning at the other year level or subject. That is, achievement on the TIMSS and PIRLS 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.

Organisation of report

Chapter 2 describes the international and national results for mathematics achievement overall, in the content and cognitive domains and for the international benchmarks, as well as for sub-groups of interest (such as gender and Indigenous background). Chapter 3 mirrors this for science. Chapter 4 reports on student attitudes and early home experiences in relation to achievement, Chapter 5 focuses on teachers and schools, Chapter 6 examines the school climate from multiple perspectives and Chapter 7, the final chapter, presents a summary and policy considerations arising from the TIMSS results.

Chapter

2 Mathematics

Key findings

- Korea, Singapore, Chinese Taipei, Hong Kong and Japan were the top-performing countries in TIMSS 2011. The scores for these countries were not significantly different to each other but were significantly higher than all other countries.
- With an average mathematics score of 505, Australia scored significantly higher than 27 countries in TIMSS, including New Zealand, but on par with England and the United States. Six countries outperformed Australia: the high performing Asian countries and the Russian Federation.
- Compared to the 2007 TIMSS cycle, Australia has improved its relative international position in Year 8 mathematics achievement slightly.
- Australia's average score for Year 8 TIMSS is not significantly different to the achieved score in TIMSS 1995.
- Over one-third of Australian Year 8 students failed to reach the Intermediate international benchmark, which is the minimum proficient standard.
- Trends in mathematics achievement scores by gender show that the gender difference that was evident in 2007 has been largely eliminated in 2011, due to an increase in the average performance of female students.
- The Australian Capital Territory was the highest performing state, in terms of both average mathematics score and performance at international benchmarks.
- Students from homes with greater educational resources (as indicated by number of books in the home and parental education) have higher achievement, on average, in mathematics than students from less well resourced homes.
- Indigenous students scored significantly lower that non-Indigenous students on average, and this gap in average mathematics achievement has remained fairly constant since 1995.
- Students from metropolitan schools performed better than students from provincial schools who in turn performed better than students from remote schools.
- In terms of mathematics content and cognitive domains, Australian Year 8 students seem to be weakest in *algebra* and *geometry*, and strongest in *data and chance* and *number*, while there was little difference in performance across the cognitive domains of *knowing, reasoning* and *applying*.

How is mathematics assessed in TIMSS?

The mathematics assessment framework is organised around two dimensions – a content dimension, which specifies the domains or subject matter to be assessed within mathematics (for example, number, algebra, etc) and the cognitive dimension, which specifies the thinking processes and sets of behaviours expected of students as they engage with the mathematics content. Items are developed that probe students' understandings on each dimension.

Mathematics content domains

In the TIMSS mathematics framework for Year 8 students, four content domains are defined:

- *Number;*
- *Algebra;*
- *Geometry; and*
- *Data and chance.*

Each of these content domains has several topic areas, for example the domain *number* includes whole numbers, fractions and decimals, integers and ratio, proportion and per cent. These are shown in Table 2.1.

For a detailed description of each of the content domains in mathematics, refer to the TIMSS 2011 Assessment Frameworks (Mullis et al., 2009).

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

Content domains	Topic areas	Target % of TIMSS assessment
Number	Whole numbers	30
	Fractions and decimals	
	Integers	
	Ratio, proportion and per cent	
Algebra	Patterns	30
	Algebraic expressions	
	Equations/formulas and functions	
Geometry	Geometric shapes	20
	Location and movement	
Data and chance	Data organisation and presentation	20
	Data interpretation	
	Chance	

Mathematics cognitive domains

To respond correctly to TIMSS test items, students need to be familiar with the mathematics content of the items. Just as importantly, however, 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 in Year 8. The student behaviours used to define the mathematics framework at 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 4 and Year 8, but the balance of testing time differs, reflecting the difference in age and experience of students in the two year levels. 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.

Table 2.2 TIMSS mathematics cognitive domains and proportion of assessment for each domain

Cognitive Domain	Target % of TIMSS assessment
Knowing	35
Applying	40
Reasoning	25

The TIMSS benchmarks

The TIMSS mathematics achievement scale summarises Year 8 students' performance when interacting with a variety of mathematical tasks and questions. Students' achievement is based on their responses to test questions designed to assess a range of content areas. When comparing groups of students across and within countries, summary statistics such as the average, or mean, scale score are often used. This score, however, does not provide detailed information as to what types of mathematical tasks the students were able to undertake successfully. Instead, to provide descriptions of achievement on the scale in relation to performance on the questions asked, TIMSS uses points on the scale as international benchmarks.

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.

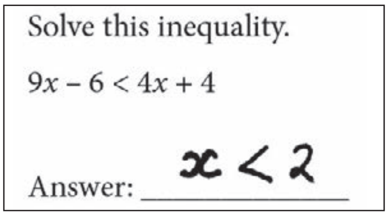
The descriptions of the levels are cumulative, so that a student who reached the High benchmark can typically demonstrate the knowledge and skills for levels for both the Intermediate and the Low benchmarks. Box 2.1 provides a summary of the TIMSS Year 8 mathematics benchmarks.

Box 2.1 The TIMSS 2011 international mathematics benchmarks, Year 8

625	**Advanced International Benchmark** *Students can reason with information, draw conclusions, make generalisations, and solve linear equations.* Students can solve a variety of fraction, proportion, and percent problems and justify their conclusions. Students can express generalizations algebraically and model situations. They can solve a variety of problems involving equations, formulas, and functions. Students can reason with geometric figures to solve problems. Students can reason with data from several sources or unfamiliar representations to solve multi-step problems.
550	**High International Benchmark** *Students can apply their understanding and knowledge in a variety of relatively complex situations.* Students can use information from several sources to solve problems involving different types of numbers and operations. Students can relate fractions, decimals, and percents to each other. Students at this level show basic procedural knowledge related to algebraic expressions. They can use properties of lines, angles, triangles, rectangles, and rectangular prisms to solve problems. They can analyse data in a variety of graphs.
475	**Intermediate International Benchmark** *Students can apply basic mathematical knowledge in a variety of situations* Students can solve problems involving decimals, fractions, proportions, and percentages. They understand simple algebraic relationships. Students can relate a two-dimensional drawing to a three-dimensional object. They can read, interpret, and construct graphs and tables. They recognise basic notions of likelihood.
400	**Low International Benchmark** *Students have some knowledge of whole numbers and decimals, operations, and basic graphs.* They have an elementary understanding of whole numbers and decimals and can do basic computations. They can match tables to bar graphs and pictographs and read a simple line graph.

At Year 8, students at the Low benchmark demonstrated some knowledge of whole numbers and decimals, operations and basic graphs. In the example shown in Box 2.2, from the content domain *number*, students are asked to show their understanding of basic operations with decimals, and add a two-place and a three-place decimal.

Box 2.2 Low international benchmark – Example item

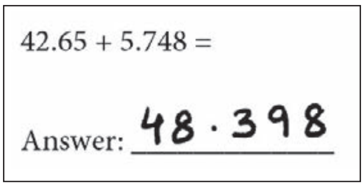

Solve this inequality.

$9x - 6 < 4x + 4$

Answer: $x < 2$

In contrast, students at the Advanced benchmark organised and drew conclusions from information, made generalisations and solved non-routine problems involving numeric, algebraic and geometric concepts and relationships. In the example shown in Box 2.3, students are asked to show their understanding of algebra by solving an inequality.

Box 2.3 Advanced international benchmark – Example item


$42.65 + 5.748 =$

Answer: 48·398

Further information about the types of mathematics skills and strategies demonstrated by students who performed at each of the international benchmarks, along with examples of the types of responses provided by students at each of the benchmarks, is provided in Appendix 2.

International student achievement in mathematics

This section reports the TIMSS 2011 mathematics results as average scores and distributions at Year 8 level on the TIMSS scales. The TIMSS mathematics achievement scales were established in TIMSS 1995 to have a mean of 500 and a standard deviation of 100 at each year level, and were designed to remain constant from assessment to assessment.

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. In this report, this will be reported by examining the difference between the 5th and 95th percentiles.

Figure 2.1 provides a summary of the overall performance of students in Year 8 across different countries on the combined mathematics scale, in terms of the mean scores achieved by students in each country, the standard error of this mean, the average age of students in that country, and the range of scores achieved between the 5th and 95th percentiles

Countries are shown in decreasing order of achievement; however this should not be interpreted as a simple ranking. The multiple comparisons table in Appendix 3 provides information about whether or not differences between countries are statistically significant. The shading on the table indicates whether the score for the particular country is significantly different to that of Australia.

The results in Figure 2.1 show that Korea, Singapore, Chinese Taipei, Hong Kong and Japan, which are also the countries with the highest average mathematics achievement at Year 4, have the highest achievement at Year 8, with average achievement above the High international benchmark of 550 in each case. The scores for Korea, Singapore and Chinese Taipei were not significantly different to each other, and were significantly higher than those of the following group of countries.

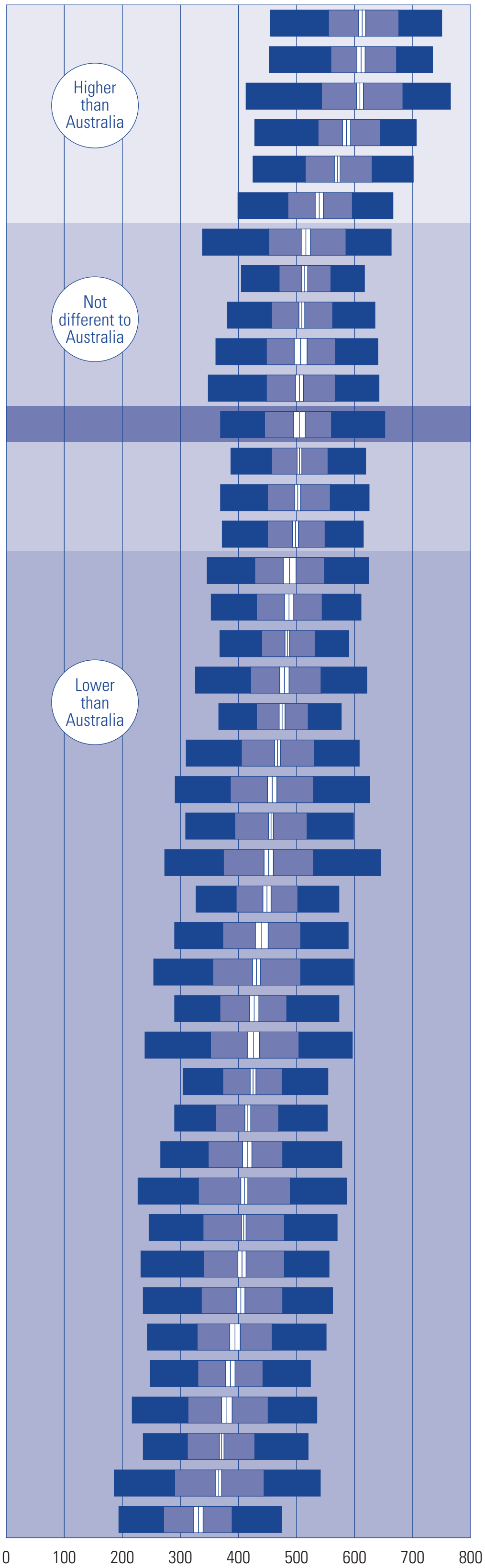
In TIMSS 2011 mathematics, Australian students attained an average score of 505 points, which places Australia on average at the Intermediate benchmark. Australia was significantly outperformed by Korea, Singapore, Chinese Taipei, Hong Kong, Japan and the Russian Federation. These countries also outperformed Australia in 2007. The United States and England also outperformed Australia in 2007, however small but non-significant changes over time have led to their scores being not significantly different to those of Australia in 2011. Australia significantly outperformed 27 other countries, including New Zealand, Sweden and Norway.

As might be expected, the results reveal substantial differences in mathematics achievement between the highest- and lowest-performing countries (613 in Korea, 611 in Singapore and 609 in Chinese Taipei to 331 in Ghana at Year 8). Of the 27 countries with an average score lower than that of Australia, six had average achievement scores below the Low benchmark, and a further 16 had average achievement scores at the Low benchmark.

While the gap between the 5th and 95th percentiles was about midrange for Korea and Singapore, Chinese Taipei had one of the largest achievement gaps, of 352 score points, between highest and lowest achievers. The Scandinavian countries of Norway, Finland and Sweden had the smallest gap between high and low achievers, while in addition to Chinese Taipei, Oman, Macedonia, Qatar and Turkey had the largest gaps. Australia's gap was also about midrange at 283 score points.

As a point of comparison, Figure 2.1 also provides the average age at time of testing. The average ages of students in Year 8 varied by two full years between countries – from under 14 years in Norway and Italy to almost 16 years in Ghana. The average age across all countries was 14.3 years, which was a little higher than the Australian average of 14.0 years. The average age of students in the United States, England, and New Zealand were all quite similar to the average age of Australian students.

	Mean	SE	Average age at time of testing	Gap 95th – 5th percentiles
Korea	613	2.9	14.3	295
Singapore	611	3.8	14.4	281
Chinese Taipei	609	3.2	14.2	352
Hong Kong	586	3.8	14.2	278
Japan	570	2.6	14.5	276
Russian Federation	539	3.6	14.7	267
Israel	516	4.1	14.0	325
Finland	514	2.5	14.8	212
United States	509	2.6	14.2	254
England	507	5.5	14.2	279
Hungary	505	3.5	14.7	232
Australia	505	5.1	14.0	283
Slovenia	505	2.2	13.9	294
Lithuania	502	2.5	14.7	256
Italy	498	2.4	13.8	243
New Zealand	488	5.5	14.1	278
Kazakhstan	487	4.0	14.6	258
Sweden	484	1.9	14.8	222
Ukraine	479	3.9	14.2	295
Norway	475	2.4	13.7	211
Armenia	467	2.7	14.6	298
Romania	458	4.0	14.9	335
United Arab Emirates	456	2.1	13.9	289
Turkey	452	3.9	14.0	372
Lebanon	449	3.7	14.3	246
Malaysia	440	5.4	14.4	299
Georgia	431	3.8	14.2	344
Thailand	427	4.3	14.3	283
Macedonia	426	5.2	14.7	357
Tunisia	425	2.8	14.3	249
Chile	416	2.6	14.2	263
Iran	415	4.3	14.3	312
Qatar	410	3.1	14.0	359
Bahrain	409	2.0	14.4	324
Jordan	406	3.7	13.9	324
Palestinian Nat'l Auth.	404	3.5	13.9	326
Saudi Arabia	394	4.6	14.1	308
Indonesia	386	4.3	14.3	276
Syrian Arab Republic	380	4.5	13.9	318
Morocco	371	2.0	14.7	284
Oman	366	2.8	14.1	355
Ghana	331	4.3	15.8	280



Note: See Reader's Guide for interpretation of graph.

Figure 2.1 Distribution of mathematics achievement, by country

Performance at the international benchmarks

In addition to the mean scores it is useful to use the international benchmarks described previously to gain further insight into student achievement. Figure 2.2 shows the proportion of students in each country at each of the international benchmarks.

The countries are ordered by the proportion of students reaching the minimum proficient standard. The Intermediate benchmark is the minimum proficient standard set for TIMSS in mathematics and science in Australia.

As was the case in 2007, the East Asian countries, and in particular Korea, Singapore and Chinese Taipei, showed their international dominance in mathematics. In these three countries, almost half of the students assessed (47–49%) reached the Advanced benchmark. In Hong Kong around one third (33%) and in Japan around one quarter (27%) of students reached this level. The Russian Federation (14%) and Israel (12%) were the next best at reaching the Advanced benchmark, but for all other countries the proportion of students reaching this level was less than 10 per cent.

In Australia, nine per cent of students reached the Advanced benchmark, with a further 20 per cent reaching the High benchmark. This compares to the international median of three per cent of students attaining the Advanced and a further 14 per cent achieving the High benchmark.

Figure 2.2 also provides useful information about the distribution of achievement in the TIMSS countries. For example some countries such as Turkey are doing reasonably well at the high end of achievement, with seven per cent of students attaining the Advanced benchmark, but not so well at the low end, with 67 per cent of students only reaching the Low benchmark. In comparison, Slovenia, Italy and Finland only had 3–4 per cent of students achieving at the Advanced benchmark, but nearly all students (at least 90%) achieving the Low benchmark. In Australia, 89 per cent of students achieved the Low benchmark; however 37 per cent failed to achieve the Intermediate benchmark and thus the proficient standard expected.

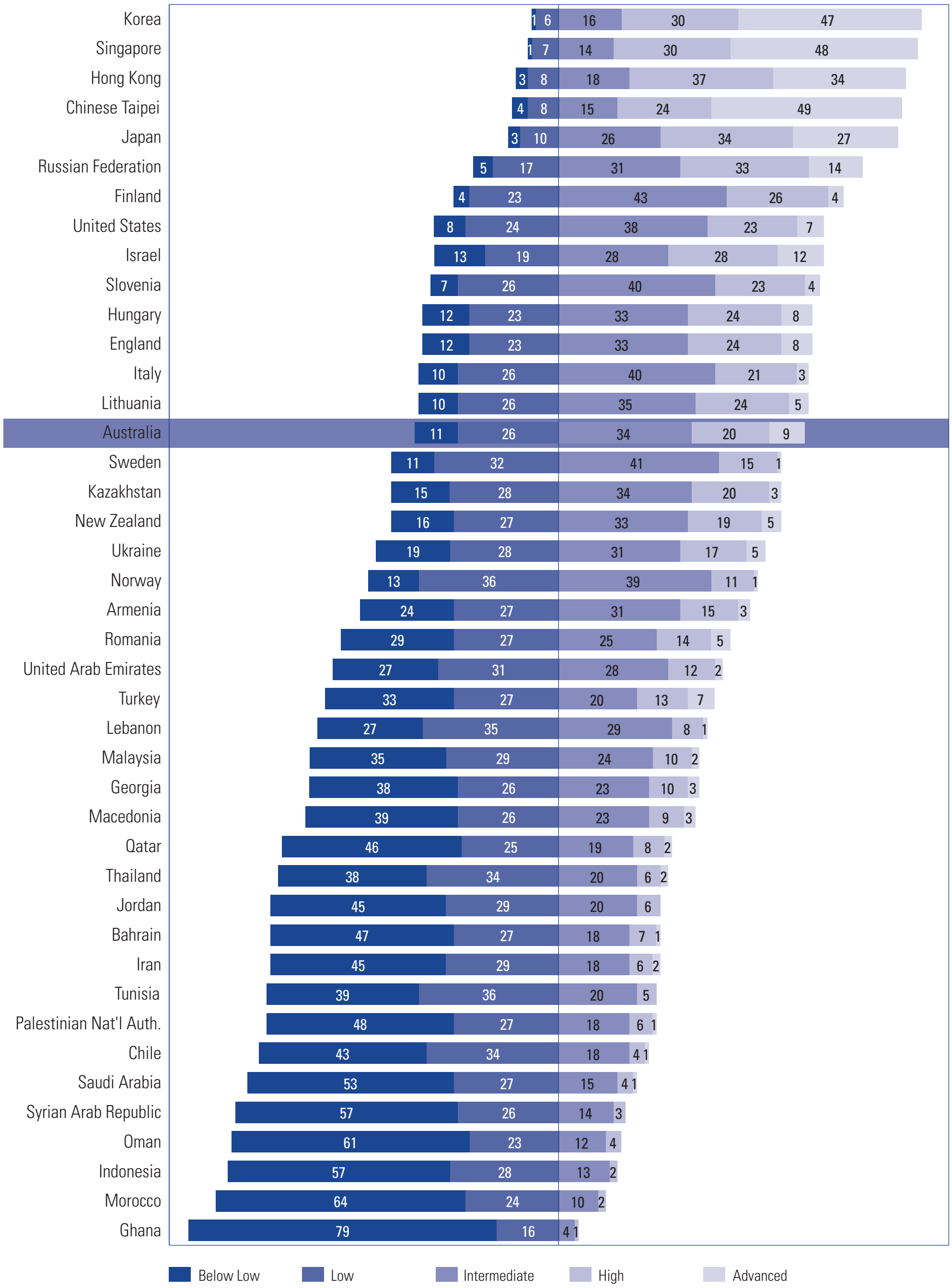


Figure 2.2 Percentages of students at the international benchmarks for mathematics, by country

Trends in international mathematics achievement

Figure 2.3 shows the trends in mathematics achievement at Year 8 for a selection of countries. Australia's score at Year 8 in 2007 had declined significantly from that measured in TIMSS 1995, however in 2011 the score has increased slightly (although not significantly), causing an overall non-significant difference from the score in 1995. However, over sixteen years the average score in mathematics at Year 8 in Australia has not changed significantly. A similar situation can be seen for New Zealand and the United States, where the score is largely unchanged since 1999, and England, which dropped back slightly after a significant increase in scores in 2007.

In comparison, scores for students in Korea and Chinese Taipei have increased significantly in each cycle, from already high scores to even higher scores.

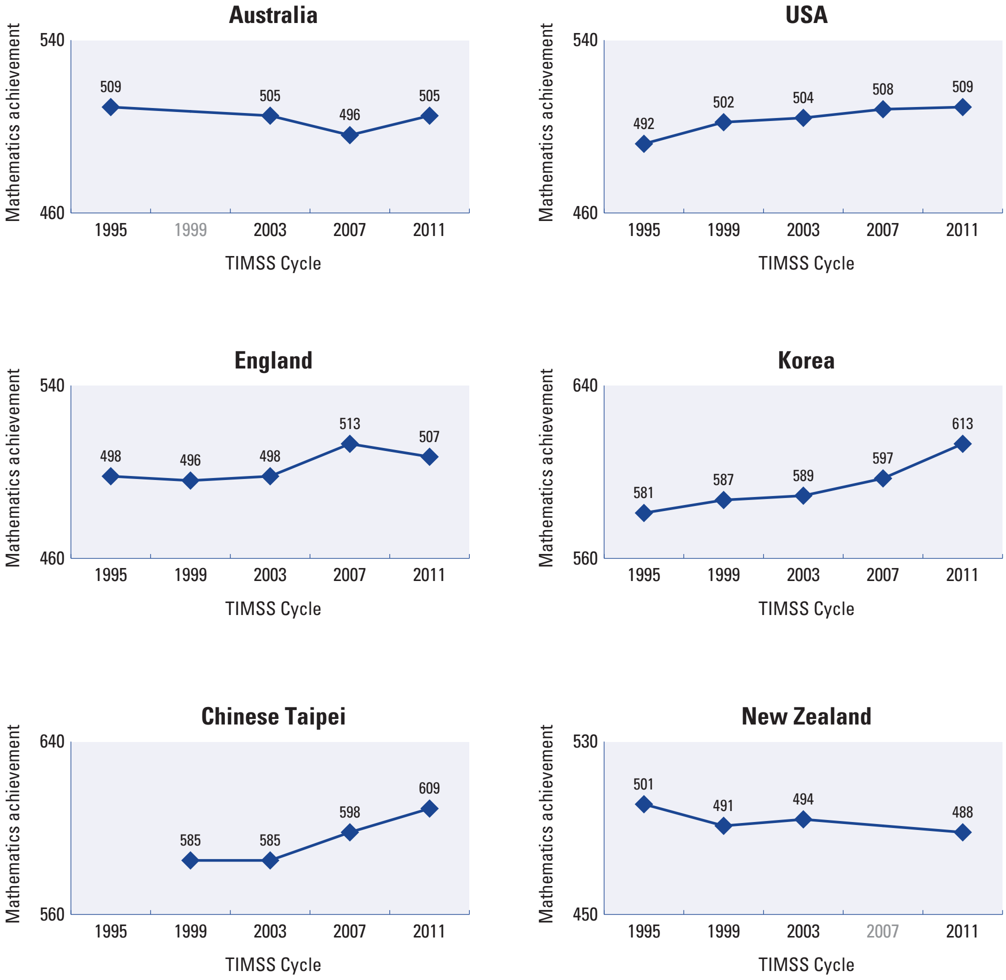


Figure 2.3 Trends in mathematics achievement scores, 1995-2011, selected countries

Similarly, the proportion of Australian students at each benchmark has not changed since TIMSS 1995.

Table 2.3 shows the relative position of Australia in 2011 in mathematics, and its relative position with the same countries in 2007, 2003 and 1995. The United States, England and Hungary were higher than Australia in 2007 but equal in 2011, Italy and Israel were lower in 2007 and equal in 2011 and Sweden was lower than Australia in 2011 but was on an equivalent ranking beforehand.

Table 2.3 Relative trends in mathematics achievement, by country

	Position relative to Australia 2011	Position relative to Australia 2007	Position relative to Australia 2003	Position relative to Australia 1995
Korea	↑	↑	↑	↑
Singapore	↑	↑	↑	↑
Chinese Taipei	↑	↑	↑	–
Hong Kong	↑	↑	↑	↑
Japan	↑	↑	↑	↑
Russian Federation	↑	↑	●	●
Israel	●	↓	●	●
Finland	●	–	–	–
United States	●	↑	●	↓
England	●	↑	●	↓
Slovenia	●	●	↓	●
Australia				
Hungary	●	↑	↑	●
Lithuania	●	●	●	↓
Italy	●	↓	↓	–
New Zealand	↓	–	●	↓
Kazakhstan	↓	–	–	–
Sweden	↓	●	●	●
Ukraine	↓	↓	–	–
Norway	↓	↓	↓	↓
Armenia	↓	●	↓	–
Romania	↓	↓	↓	↓
United Arab Emirates	↓	–	–	–
Turkey	↓	↓	–	–
Lebanon	↓	↓	↓	–
Malaysia	↓	↓	●	–
Georgia	↓	↓	↓	–
Thailand	↓	↓	–	–
Macedonia	↓	–	↓	–
Tunisia	↓	↓	↓	–
Chile	↓	–	↓	–
Iran	↓	↓	↓	↓
Qatar	↓	–	–	–
Bahrain	↓	↓	↓	–
Jordan	↓	↓	↓	–
Palestinian Nat'l Auth.	↓	↓	↓	–
Saudi Arabia	↓	↓	↓	–
Indonesia	↓	↓	↓	↓
Syrian Arab Republic	↓	↓	–	–
Morocco	↓	↓	↓	–

Oman	↓	↓	–	–
Ghana	↓	↓	↓	–

↑ Score significantly higher than Australia

↓ Score significantly lower than Australia

● Score not significantly different to that of Australia

- Did not participate in this cycle

Trends across year levels: Year 4 to Year 8 cohort analysis

One of the benefits of TIMSS being conducted on a four-year cycle is that is allows for an examination of changes over time within a cohort of students; the cohort of students that was assessed in Year 4 in 2007 was assessed as the Year 8 cohort in 2011. The results are presented in Table 2.4, which shows the average mathematics achievement as a difference from the TIMSS scale centrepoint (500) for the Year 4 students in 2007 on the left and the Year 8 students in 2011 on the right. Six countries – Hong Kong, Singapore, Chinese Taipei, Japan, the Russian Federation and the United States – performed above the scale centrepoint in Year 4 in 2007 and again above the scale centrepoint in Year 8 in 2011 (although not in the same order of average achievement). Norway, Georgia, Iran and Tunisia also retained the same relative positions, performing below the scale centrepoint at both Year 4 and Year 8.

Six countries had a relative decline in achievement from Year 4 to Year 8, with England, Lithuania, Australia, Hungary and Italy moving from above the centrepoint in Year 4 in 2007 to close to the centrepoint in Year 8 in 2011, and Sweden moving from near the centrepoint in 2007 to below the centrepoint in 2011. Slovenia was the only country to show a relative improvement in achievement, moving from about the centrepoint in 2007 to just above it in 2011.

Table 2.4 Relative achievement in mathematics of 2007 Year 4 students and 2011 Year 8 students, by country

	Year 4 2007		
Country	Achievement difference from TIMSS scale centrepoint	SE	
Hong Kong	107	3.6	▲
Singapore	99	3.7	▲
Chinese Taipei	76	1.7	▲
Japan	68	2.1	▲
Russian Federation	44	4.9	▲
England	41	2.9	▲
Lithuania	30	2.4	▲
United States	29	2.4	▲
Australia	16	3.5	▲
Hungary	10	3.5	▲
Italy	7	3.1	▲
Sweden	3	2.5	
Slovenia	2	1.8	
Norway	– 27	2.5	▼
Georgia	– 62	4.2	▼
Iran	– 98	4.1	▼
Tunisia	– 173	4.5	▼

	Year 8 2011		
Country	Achievement difference from TIMSS scale centrepoint	SE	
Singapore	111	3.8	▲
Chinese Taipei	109	3.2	▲
Hong Kong	86	3.8	▲
Japan	70	2.6	▲
Russian Federation	39	3.6	▲
United States	9	2.6	▲
England	7	5.5	
Hungary	5	3.5	
Australia	5	5.1	
Slovenia	5	2.2	▲
Lithuania	2	2.5	
Italy	– 2	2.4	
Sweden	– 16	1.9	▼
Norway	– 25	2.4	▼
Georgia	– 69	3.8	▼
Tunisia	– 75	2.8	▼
Iran	– 85	4.3	▼

▲ Country mean is significantly higher than the TIMSS scale centrepoint
▼ Country mean is significantly lower than the TIMSS scale centrepoint

Mathematics achievement by gender

Figure 2.4 presents achievement by gender in the TIMSS 2011 Year 8 assessment. It shows the average score for females and males, and the size of the difference between the average scores. Averaging achievement across countries, it is evident that there is a small gender difference in favour of females (469 score points vs 465 for males). There were no gender differences in 22 of the 42 countries that tested at Year 8, including Australia. Interestingly, however, as much of the literature points to males outperforming females in mathematics, there were more countries in which the gender difference favoured females, and the largest differences are in favour of females in TIMSS.

In Korea, Italy, Lebanon, Chile, Tunisia, New Zealand and Ghana, males scored significantly higher (between 6 and 23 score points) than females. However, in Singapore, Turkey, Lithuania, Armenia, Romania, Indonesia, the United Arab Emirates, Thailand, Malaysia, the Palestinian National Authority, Jordan, Bahrain and Oman, the difference was significantly in favour of females, with the differences ranging from 9 score points in Singapore to a massive 63 score points in Oman.

	Females				Males				Difference (absolute value)	SE
	% of students	SE of %	mean	SE	% of students	SE of %	mean	SE		
Morocco	47	0.8	371	2.3	53	0.8	371	2.7	0	3.2
Russian Federation	49	0.9	539	3.8	51	0.9	539	3.9	1	2.9
Kazakhstan	49	0.8	486	4.1	51	0.8	488	4.5	2	3.3
Norway	49	0.7	476	2.9	51	0.7	473	2.9	3	3.1
England	48	2	508	5.7	52	2	505	6.6	3	5.6
Georgia	47	0.9	430	4.1	53	0.9	432	4.4	3	4
Ukraine	50	1	478	4	50	1	481	4.9	3	4.4
United States	51	0.6	508	2.9	49	0.6	511	2.8	4	2.2
Sweden	48	0.9	486	2.1	52	0.9	482	2.4	4	2.4
Finland	48	1.1	516	2.7	52	1.1	512	2.7	4	2.3
International average	50	0.2	469	0.6	50	0.2	465	0.7	**4**	
Slovenia	49	0.9	502	2.4	51	0.9	507	2.8	5	2.8
Hungary	49	1.1	502	3.9	51	1.1	508	3.9	6	3.5
Hong Kong	49	1.6	588	5	51	1.6	583	4.3	6	5.5
Chinese Taipei	48	1	613	3.7	52	1	606	3.8	6	4.1
Korea	52	2.5	610	3.5	48	2.5	616	3.1	**6**	3.1
Iran	46	2.3	411	5.9	54	2.3	418	5.9	7	8.1
Macedonia	49	0.9	430	5.8	51	0.9	423	5.6	7	4.7
Japan	49	1.1	566	3.1	51	1.1	574	3.5	8	4.1
Israel	50	1.6	520	3.9	50	1.6	512	5.2	8	4.4
Singapore	49	0.7	615	3.7	51	0.7	607	4.5	**9**	3.5
Turkey	49	0.7	457	3.8	51	0.7	448	4.7	**9**	3.5
Australia	50	1.6	500	4.7	50	1.6	509	7.3	9	6.9
Lithuania	49	0.7	507	2.6	51	0.7	498	3.2	**9**	3
Armenia	49	0.8	472	3.1	51	0.8	462	3.2	**10**	3.1
Syrian Arab Republic	50	1.7	375	5.3	50	1.7	385	5.3	11	5.7
Italy	49	0.9	493	2.9	51	0.9	504	2.8	**11**	2.9
Romania	48	0.9	464	4.6	52	0.9	453	4.2	**11**	3.6
Qatar	50	3.3	415	5.8	50	3.3	404	5.5	11	9.5
Lebanon	55	1.9	444	4.2	45	1.9	456	4.7	**12**	4.7
Indonesia	50	1.2	392	4.9	50	1.2	379	4.5	**13**	4
Chile	53	1.5	409	3.2	47	1.5	424	3	**14**	3.6
Saudi Arabia	48	1.2	401	4.1	52	1.2	387	8	15	8.9
Tunisia	52	0.7	417	3.1	48	0.7	433	3.1	**17**	2.5
United Arab Emirates	50	1.7	464	2.7	50	1.7	447	3.1	**17**	4.2
Thailand	55	1.6	435	4.2	45	1.6	417	5.3	**18**	4.4
New Zealand	47	2	478	5.5	53	2	496	6.2	**18**	4.7
Malaysia	51	1.2	449	5.2	49	1.2	430	6.2	**19**	4.4
Palestinian Nat'l Auth.	52	1.7	415	4.2	48	1.7	392	5.6	**23**	7
Ghana	47	0.8	318	4.8	53	0.8	342	4.3	**23**	2.9
Jordan	49	1.7	420	4.3	51	1.7	392	5.9	**28**	7.4
Bahrain	50	0.8	431	2.5	50	0.8	388	3.1	**43**	4
Oman	51	2.1	397	3.1	49	2.1	334	3.8	**63**	4.6

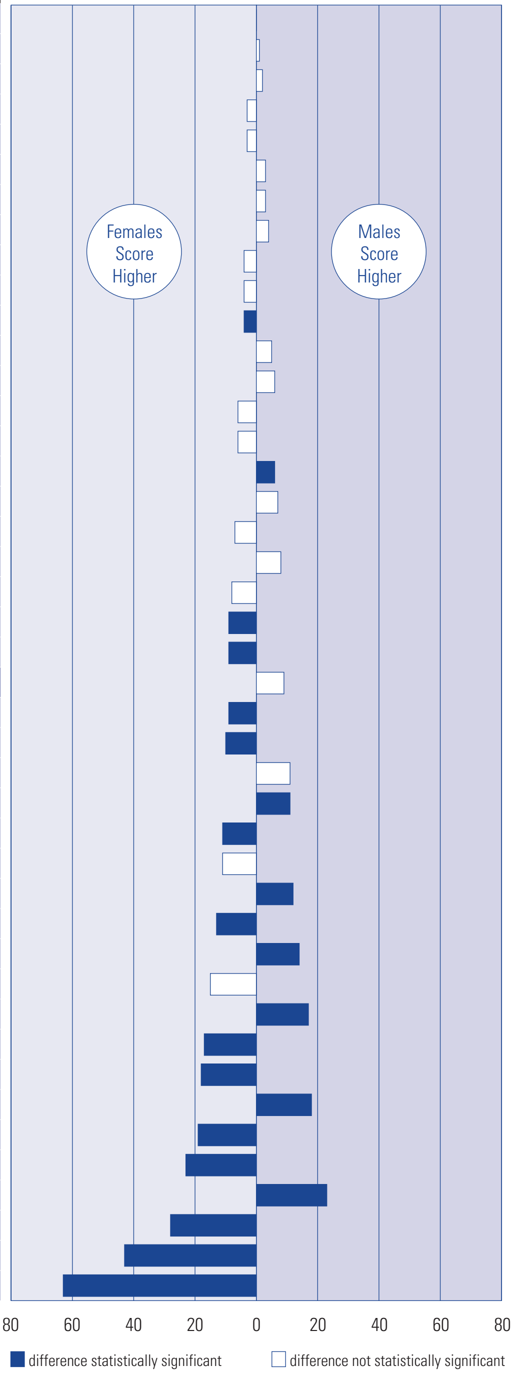


Figure 2.4 Gender differences in mathematics achievement, by country

Performance at the international benchmarks by gender

In Australia, 10 per cent of Australian Year 8 males achieved the Advanced benchmark in mathematics, compared to seven per cent of females. The same proportion of females and males (20%) achieved the High benchmark, putting almost one-third of both male and female students at a level at or above the High benchmark. However more than one-third of females (38%) and males (35%) did not achieve the minimum standard of the Intermediate benchmark. A similar proportion of males and females (10% and 11% respectively) were at the very lowest level of achievement, not achieving the Low benchmark (Figure 2.5).

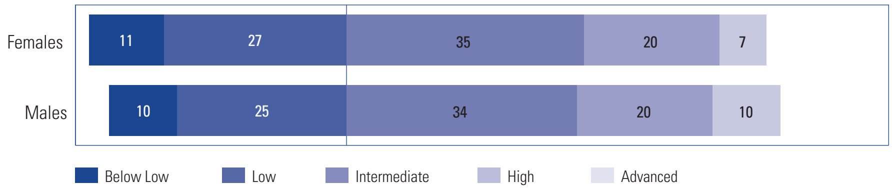


Figure 2.5 Percentages of Australian students at the international benchmarks for mathematics, by gender

Trends in mathematics achievement by gender

Figure 2.6 shows trends in mathematics achievement for male and female Australian students. It is evident that the average score for males has changed little over time, however the 23 score point decline in the average score for females between 1995 and 2007 has been partially recovered, leaving a non-significant gender gap of nine score points. Despite apparent differences, the only significant gender differences were in 2007.

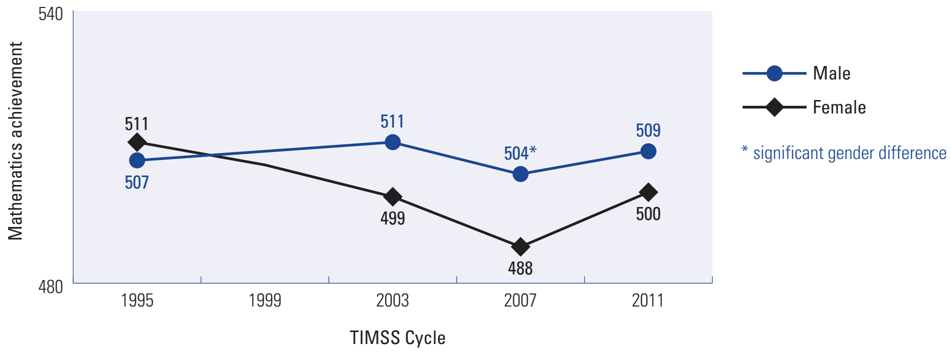


Figure 2.6 Trends in mathematics achievement within Australia, 1995-2011, by gender

Mathematics achievement by state

Figure 2.7 presents the distribution of mathematics performance for each of the Australian states for Year 8 in a similar way to that of the international results in Figure 2.1. To place the state results in perspective, the means and distributions for Australia as a whole, and for Korea, the highest achieving country at Year 8 in mathematics, are also included in this figure. The states are shown in order from highest to lowest mean scores.

Figure 2.7 should be read in conjunction with Table 2.5, which presents the multiple comparisons of average performance between the states.

For TIMSS 2011, the Australian Capital Territory had the highest average achievement in mathematics (532 score points). The Australian Capital Territory, along with New South Wales, also displayed the widest distribution of responses, with a range of 292 and 309 score points respectively between the 5th and 95th percentiles. South Australia had the narrowest range, with 243 score points separating the 5th and 95th percentiles.

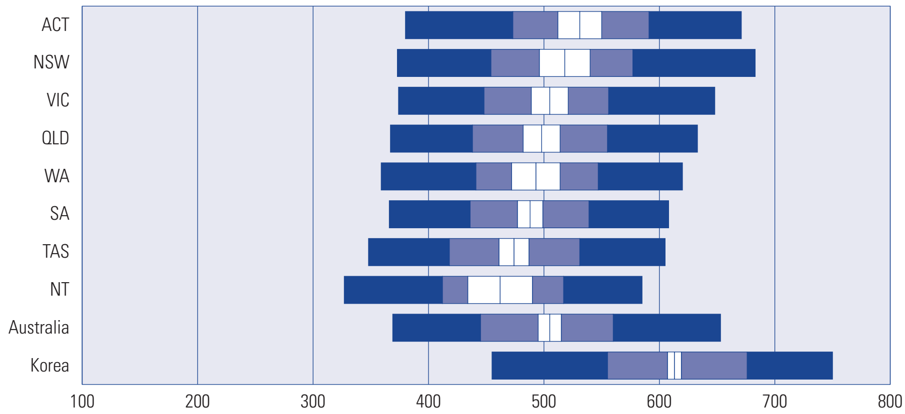


Figure 2.7 Distribution of mathematics achievement, by state

Figure 2.7 and Table 2.5 together show that variation across the states in average mathematics achievement at Year 8 was quite large (an overall range of 70 score points, from 462 for the Northern Territory to 532 for the Australian Capital Territory). The score for students in the Australian Capital Territory was not significantly different to that of students in New South Wales, but was significantly higher than that of students in all other states. Students in New South Wales significantly outperformed students in South Australia, Tasmania and the Northern Territory, and students in Victoria and Queensland also significantly outperformed students in Tasmania and the Northern Territory.

Table 2.5 Multiple comparisons of average mathematics achievement, by state

STATE	Mean	SE	ACT	NSW	VIC	QLD	WA	SA	TAS	NT
ACT	532	9.9		●	▲	▲	▲	▲	▲	▲
NSW	518	11.1	●		●	●	●	▲	▲	▲
VIC	504	8.0	▼	●		●	●	●	▲	▲
QLD	497	8.0	▼	●	●		●	●	▲	▲
WA	493	10.6	▼	●	●	●		●	●	●
SA	489	5.8	▼	▼	●	●	●		●	●
TAS	475	6.9	▼	▼	▼	▼	●	●		●
NT	462	14.4	▼	▼	▼	▼	●	●	●	

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 difference in mathematics achievement by state

Figure 2.8 shows the gender differences at Year 8 in each of the states. Given that there is no gender difference in mathematics for Australia as a whole, it would be expected that this would be reflected in the scores for the states. This appears to be the case, as none of the differences that appear in the figure are statistically significant.

	Female		Male		
	Mean	SE	Mean	SE	Difference
SA	495	5.9	483	7.3	–12
ACT	535	10.7	531	11.0	–5
VIC	500	7.3	509	10.2	9
QLD	491	7.4	503	10.7	12
WA	488	12.2	500	11.0	12
NSW	512	10.6	524	17.3	12
NT	458	12.2	470	14.7	13
TAS	467	8.7	483	7.8	16

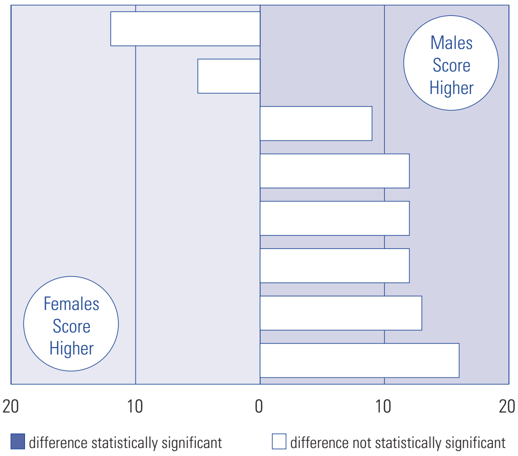


Figure 2.8 Gender differences in mathematics achievement, by state

Performance at the international benchmarks by state

Figure 2.9 presents the proportion of students in each state at each of the international benchmarks for Year 8 in mathematics, along with the corresponding proportions for Australia as a whole, and the highest scoring country at that year level, Korea, for comparison.

This figure shows that 14 per cent of Year 8 students in the Australian Capital Territory and 13 per cent of students in New South Wales reached the Advanced benchmark, but in all other states the proportion at this level was less than 10 per cent. This is well short of the 47 per cent of students in Korea that performed at this level. The other end of the achievement distribution, however, shows that a worrying 56 per cent of students in the Northern Territory and 51 per cent of students in Tasmania did not reach the Intermediate benchmark. In the other states this proportion ranged from between 39 and 42 per cent in Western Australia, South Australia and Queensland through to 26 per cent in the Australian Capital Territory.

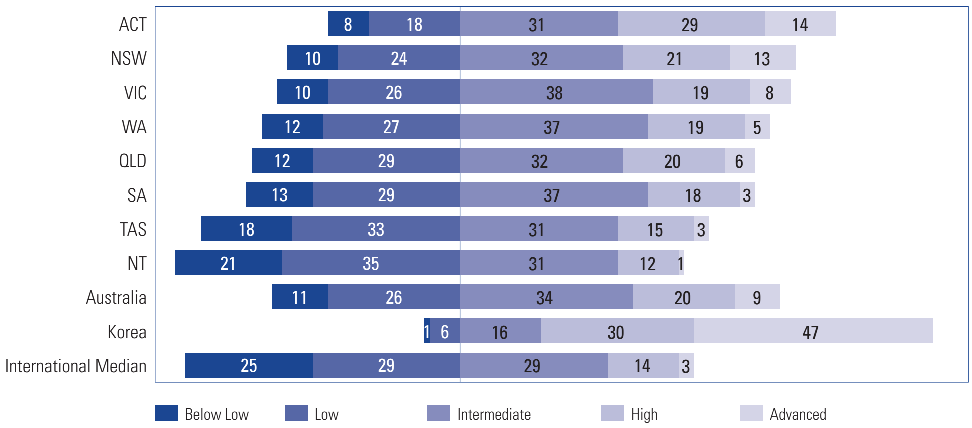


Figure 2.9 Percentages of students at the international benchmarks for mathematics, by state

Gender difference at the international benchmarks by state

Figure 2.10 shows the proportion of Year 8 students by gender at each of the international benchmarks in mathematics in each state. In the Australian Capital Territory the gender difference in achievement at the highest level was found to be in favour of females – 46 per cent of female students compared to 41 per cent of males achieved at least the High benchmark. In New South

Wales, however, the gender difference was found to be in favour of males, with 38 per cent of males and 31 per cent of females achieving at least the High benchmark.

In Victoria, Queensland and Western Australia the proportion of males at the Advanced benchmark was slightly higher than the proportion of females, but there was no difference at the High benchmark. South Australia showed small differences in favour of females, with 18 per cent of males and 24 per cent of females achieving at least the High benchmark. Of some concern, however, is that only one per cent of female students in Tasmania and the Northern Territory and one per cent of male students in the Northern Territory managed to attain the advanced level at Year 8.

Gender differences at the lower levels of achievement were negligible in the Australian Capital Territory (where 24% of females and 26% of males failed to achieve the Intermediate benchmark), Victoria (where 36% of females and 35% of males failed to achieve the Intermediate benchmark) and Queensland (where 42% of females and 40% of males failed to achieve the Intermediate benchmark). Of concern is the 55 per cent of females in Tasmania and 58 per cent of females and 52 per cent of males in the Northern Territory that did not achieve the Intermediate benchmark.

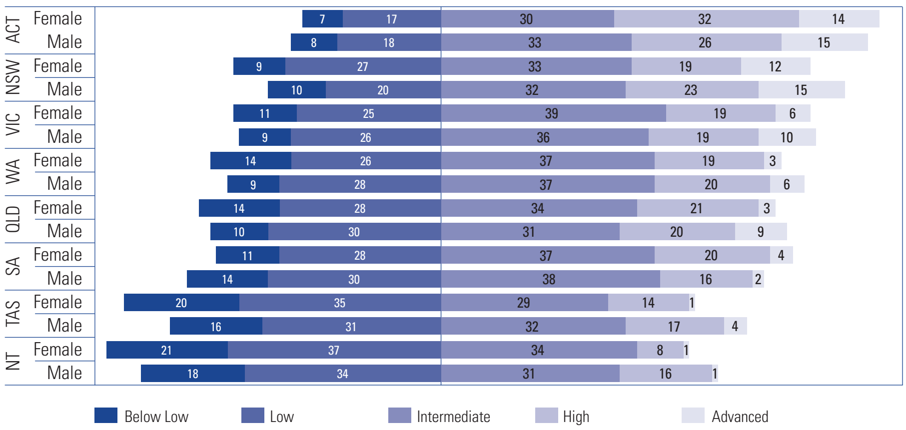


Figure 2.10 Percentages of students at the international benchmarks for mathematics, by gender within state

Trends in mathematics achievement by state

Table 2.6 presents the trends in mathematics achievement for each of the states for each cycle of TIMSS. The only significant changes over time were declines in South Australia and Western Australia from the TIMSS 1995 score to the TIMSS 2011 score.

Table 2.6 Trends in mathematics achievement, by state

	TIMSS 2011		TIMSS 2007		2011 - 2007 difference	TIMSS 2003		2011 - 2003 difference	TIMSS 1995		2011 - 1995 difference
State	Mean	SE	Mean	SE		Mean	SE		Mean	SE	
ACT	532	9.9	518	22.4	–	507	9.6	–	528	11.4	–
NSW	518	11.1	500	10.0	–	530	12.0	–	512	8.6	–
VIC	504	8.0	503	8.5	–	495	6.4	–	500	6.4	–
QLD	497	8.0	491	4.9	–	490	6.1	–	506	8.5	–
SA	489	5.8	490	6.7	–	501	11.3	–	513	5.6	↓
WA	493	10.6	485	8.3	–	487	7.6	–	527	6.7	↓
TAS	475	6.9	485	6.8	–	477	12.3	–	496	11.5	–
NT	462	14.4	483	13.9	–	449	14.2	–	470	19.9	–

– No statistically significant difference from comparison year.

↓ Average performance statistically significantly lower than in comparison year

Table 2.7 presents the cohort comparisons for the Australian states. Year 4 students in New South Wales and Victoria scored significantly higher than the TIMSS scale centrepoint in 2007, but not significantly different to it in TIMSS 2011. Students in the Australian Capital Territory and Queensland improved over the two cycles, with students in the Australian Capital Territory moving from achievement at a level equal to the scale centrepoint in 2007 to a level significantly higher than the centrepoint in 2011, and those in Queensland moving from significantly below the scale centrepoint in Year 4 to not significantly different to the scale centrepoint in Year 8. Students in Western Australia and South Australia achieved at a similar level to the scale centrepoint at both year levels, and the scores for students in Tasmania and the Northern Territory declined to below the scale centrepoint in 2011.

Table 2.7 Relative achievement in mathematics of Australian 2007 Year 4 students and 2011 Year 8 students

Year 4 2007				→	Year 8 2011			
State	Achievement difference from TIMSS scale centrepoint	SE				Achievement difference from TIMSS scale centrepoint	SE	
NSW	34	6.4	▲		ACT	32	9.9	▲
VIC	32	8.2	▲		NSW	18	11.1	
ACT	13	7.7			VIC	4	8.0	
TAS	10	6.0			QLD	–3	8.0	
WA	–7	5.4			WA	–7	10.6	
SA	–7	8.5			SA	–11	5.8	
QLD	–15	6.7	▼		TAS	–25	6.9	▼
NT	–16	9.6			NT	-38	14.4	▼

▲ State mean is significantly higher than the TIMSS scale centrepoint

▼ State mean is significantly lower than the TIMSS scale centrepoint

Mathematics achievement by books in the home

Throughout a child's development, the time devoted to literacy-related activities remains essential to the acquisition of reading literacy skills and the effects can be long-lasting. The amount of time which is able to be spent on such activities is predicated to some extent on the availability of resources. A recent study of the effects of books and schooling in 27 countries concluded that:

Regardless of how many books the family already has, each addition to a home library helps the children get a little farther in school. But the gains are not equally great across the entire range; instead they are larger at the bottom, far below elite level, in getting children from modest families a little further along in the first few years of school. Moreover, having books in the home has a greater impact on children from the least educated families, not on children of the university educated elite (Evans, Kelly, Sikora & Trieman, p. 17)

This section looks at the performance of Year 8 students in TIMSS according to their self-reports of the number of books in their homes. Internationally, 65 per cent of Korean students report having more than 100 books in the home, however after this, a larger proportion of Australian students than any other country report having more than 100 books in their homes. Forty-one per cent of Australian students reported this, with the next highest Sweden with 39 per cent and Finland with 38 per cent of students reporting having this moderately large number of books in their home. However, the data also make it evident that while having a home with many books (or by implication a home environment that values literacy, the acquisition of knowledge, and general academic support), the relationship is not definitive. For the purposes of this report, this variable has been grouped to represent *a few books* – 25 or fewer books, *average number of books* – between 26 and 200 books and *many books* – more than 200 books.

Table 2.8 provides the percentage of students in each category, and the average achievement score for students in each group. At this year level, the 22 per cent of students who report large numbers of books in the home gain a substantial advantage, scoring on average 38 points higher than the next category of students and almost one full standard deviation, 90 score points, higher than students with *a few books* in the home. Even having an average number, between 25 and 200 books in the home, has a substantial relationship with achievement, with these students scoring, on average, half a standard deviation, 52 score points, higher than the students with just *a few books* in the home.

Table 2.8 Mean mathematics achievement within Australia, by number of books in the home

Number of Books at Home	% of Students	Mean	SE	Gap 95th – 5th percentiles
Many books	22	549	8.7	289
Average number of books	51	511	4.5	259
A few books	27	459	4.8	254

Figure 2.11 shows the substantial spread of scores in mathematics for students by their reports of books in the home. The highest achieving students in the group who report having *many books* in the home achieved at a level similar to that of students in any of the top scoring countries, and equivalent to the High international benchmark, and the gap between the 5th and 95th percentiles is wider than for the other two groups at 289 score points. In contrast, for students with a *few books* in the home the average score was a little lower than the Intermediate benchmark.

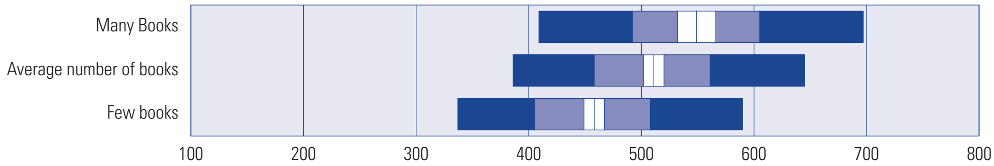


Figure 2.11 Distribution of mathematics achievement within Australia, by number of books in the home

Figure 2.12 shows the proportion of students at each of the benchmarks. Of those students who reported having *many books* in the home, a very commendable 19 per cent achieved the Advanced benchmark. The proportion in this highest benchmark falls away quickly though, with eight per cent of students in the average number of books category and just two per cent of those with a *few books* in the home attaining this level of achievement.

As has been pointed out, the relationship between books in the home and achievement is not definitive – there is a great deal of variation in the scores of students in each category. However, around 19 per cent of students in the group who reported having many books in the home did not achieve the Intermediate benchmark, with 15 per cent achieving the Low benchmark and four per cent of students not even achieving this very basic level. Of those students in the middle category, those with between 26 and 200 books in the home, around 25 per cent of students achieved the Low benchmark, and around seven per cent of students failed to achieve this level. However 37 per cent of the students who reported having a *few books* in the home just achieved the Low benchmark, and a further 22 per cent of students did not achieve this basic level.

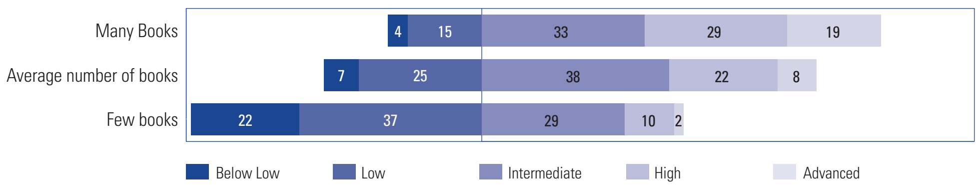


Figure 2.12 Percentages of Australian students at the international benchmarks for mathematics, by number of books in the home

Mathematics achievement by level of parental education

Parental education has also been found to be strongly related to student achievement. Year 8 students who participated in TIMSS 2011 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 is associated with higher average mathematics achievement. However, in Australia, there was a very high level of "Do not know" responses – 52 per cent of Australian Year 8 students did not provide a response to this question. As such, the results in this section should be treated with some caution, although they are strongly in agreement with international findings in other countries, and with findings from other Australian studies such as PISA in which there is not as much missing data.

Table 2.9 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 this table, 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 a substantial 132 points higher than that of students whose parents did not complete secondary school, 89 score points higher than the average score for students for whom the highest level of parental education was completing secondary school and 70 score points higher than that of students whose parents completed a TAFE qualification. All differences are statistically significant.

Table 2.9 Mean mathematics achievement within Australia, by parental education

	% of students	Mean	SE	Gap 95th – 5th percentiles
Completed university degree	33	569	9.9	277
Completed post-secondary but not university	36	499	4.9	248
Completed upper secondary education	25	480	7.0	246
Did not complete upper secondary education	6	437	9.6	262

Figure 2.13 shows the spread of scores in mathematics achievement for Year 8 students for the different parental education groups. Scores for students whose parents completed a university degree were, on average, around the High benchmark, while the average for students whose parents had completed secondary education only were around the Intermediate benchmark.

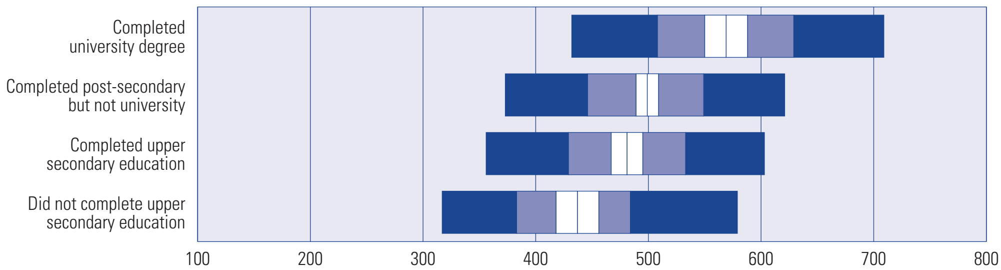


Figure 2.13 Distribution of mathematics achievement within Australia, by parental education

Figure 2.14 shows the proportion of students at each of the benchmarks. More than one-quarter (27%) of students who had at least one parent complete a university degree reached the Advanced benchmark compared to five per cent or fewer for all other groups. In comparison, almost three-quarters (71%) of students whose parents did not complete secondary school did not reach the Intermediate benchmark, compared to 14 per cent of students with parents holding university degrees.

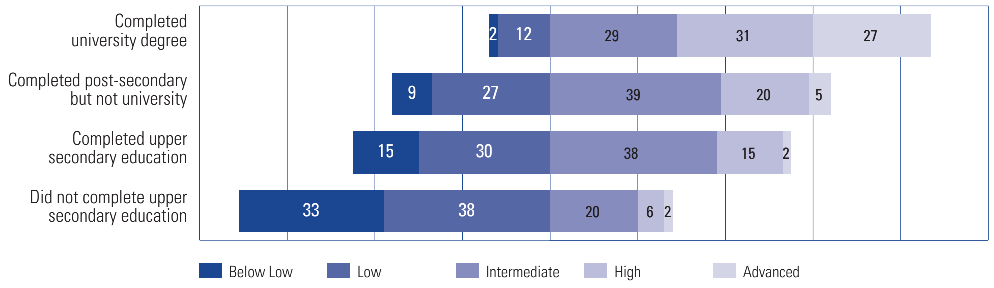


Figure 2.14 Percentages of Australian students at the mathematics benchmarks for mathematics, by parental education

Mathematics achievement by Indigenous background

The educational attainment of Australia's Indigenous students in core subject areas such as mathematics is an important 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 Table 2.10, 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 8 are also shown in Table 2.10. 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 438, 71 score points less than the average score of non-Indigenous students of 509 score points (a statistically significant difference). Year 8 Australian Indigenous students' average mathematics score was also significantly lower than the international scale average.

Table 2.10 Mean mathematics achievement within Australia, by Indigenous background

Indigenous Background	% of Students	Mean	SE	Gap 95th –5th percentiles
Non- Indigenous	95	509	5.3	281
Indigenous	5	438	4.8	253

Figure 2.15 also shows that the average mathematics achievement of Year 8 Indigenous students is significantly below that of their non-Indigenous counterparts.

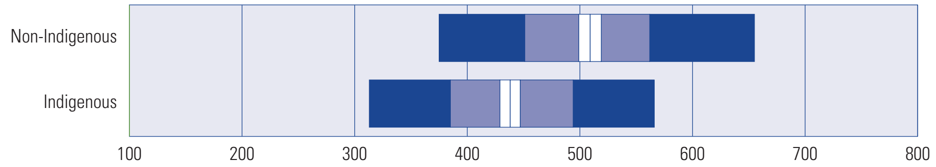


Figure 2.15 Distribution of mathematics achievement within Australia, by Indigenous background

Figure 2.16 adds to the picture of performance by presenting the proportion of Indigenous and non-Indigenous students in Year 8 at each of the international benchmarks for mathematics.

One per cent of Indigenous students achieved the Advanced benchmark, compared to nine per cent of non-Indigenous students. At the other end of the achievement spectrum, thirty-two per cent of Year 8 Indigenous students did not reach the Low benchmark, compared to nine per cent of the non-Indigenous students, and a total of 68 per cent of Indigenous students and 34 per cent of non-Indigenous students did not achieve the Intermediate benchmark.

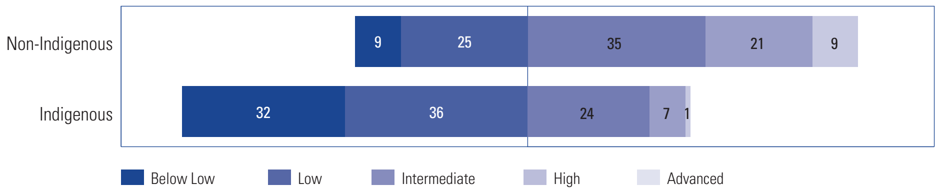


Figure 2.16 Percentages of Australian students at the international benchmarks for mathematics, by Indigenous background

Figure 2.17 shows trends in achievement for Indigenous and non-Indigenous students over the period from 1995 to 2011. None of the differences between years are significant, that is, the 2011 score for Indigenous students, as for non-Indigenous students, is not significantly different to the score in any of the other years of testing. The difference between Indigenous and non-Indigenous students is significant, as it has been in each year of testing, and has not decreased in size.

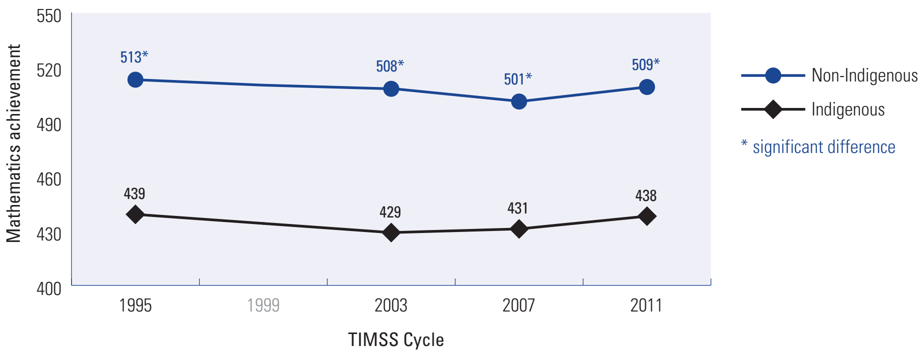


Figure 2.17 Trends in mathematics achievement within Australia, 1995-2011, by Indigenous background

Mathematics achievement 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 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.

Table 2.11 shows that while the majority of students tested in Year 8 spoke English 'always' or 'almost always' at home, there were around seven per cent of students for whom this was not true. While there was no significant difference between the means for the two groups in science, the gap from the 5th to 95th percentile is much higher for those students with a language background other than English (LBOTE).

Table 2.11 Mean mathematics achievement within Australia, by language background

Language Background	% of Students	Mean	SE	Gap 95th – 5th percentiles
English	93	504	5.0	271
LBOTE	7	521	10.3	316

This is also evident from Figure 2.18. The range of scores was 316 score points for students from a language background other than English, and 271 score points for those with an English-speaking background. At the 5th percentile the scores for the two groups were similar, however at the 95th percentile, students with a language background other than English were scoring about half a standard deviation higher than their English speaking counterparts. Clearly this makes it difficult to generalise non-English speakers as either high or low achievers.

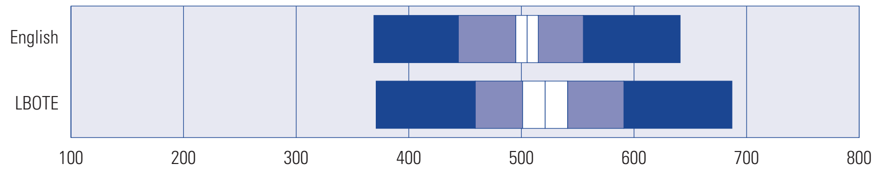


Figure 2.18 Distribution of mathematics achievement within Australia, by language background

Figure 2.19 further exemplifies this, showing that while a higher proportion of students from a language background other than English achieved the Advanced benchmark (21% compared to 8% of English-speaking students), larger proportions of English-speaking students performed at the Intermediate benchmark. While more students who spoke a language other than English at home did not reach the low benchmark (15%), compared to ten per cent of English-speaking students, more English speaking students (26% compared to 22%) achieved at the Low benchmark, resulting in a similar total of 37 per cent of LBOTE and 36 per cent of English-speaking students not achieving the Intermediate benchmark.

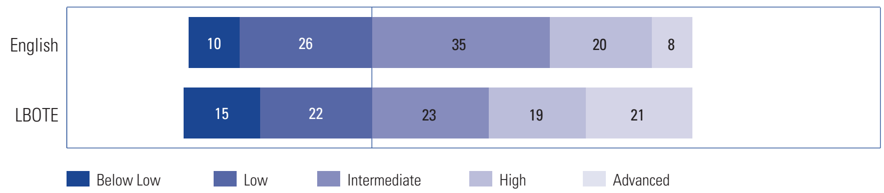


Figure 2.19 Percentages of Australian students at the international benchmarks for mathematics, by language background

Mathematics achievement by geographic location of the school

Over the last ten years, there has been a further drift from rural and regional areas into metropolitan areas. Often, 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). A decline in the quality of schools in remote areas contributes to the drift of families into provincial and metropolitan areas, further exacerbating the problems of remote schools.

To undertake the analyses in this section of the report, school addresses were coded using the MCEETYA Schools Geographic Location Classification (see 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 Table 2.12. It should be noted that the students in remote schools make up a small proportion of the Year 8 student sample (around one per cent) and therefore the level of uncertainty estimate of the mean will be very large, resulting in very large standard errors and reducing the likelihood that significant differences between groups will be found (see the Reader's Guide). It also means that the spread of scores for students in remote areas is very large, with the highest achieving students scoring almost 600 score points and the lowest just over 300 score points. The spread of scores is also large for students attending schools in metropolitan areas, with students at the 5th percentile achieving at about the same level as students at the 5th percentile at provincial schools. However, at each of the other percentiles the scores of students in metropolitan schools are higher than the equivalent scores for students in provincial schools.

Students in metropolitan schools significantly outperformed those in provincial schools and those in remote schools. The differences between the scores of Year 8 students in remote schools and those in metropolitan areas are particularly large – 64 score points separate students attending schools in remote areas and those attending metropolitan schools.

Table 2.12 Mean mathematics achievement within Australia, by geographic location

Geographic location	% of Students	Mean	SE	Gap 95th – 5th percentiles
Metropolitan	72	512	5.8	288
Provincial	27	487	9.1	258
Remote	1	448	27.4	290

As can be seen in Table 2.12 and Figure 2.20, the spread of achievement of students in remote schools is particularly wide, as is the spread of scores of students in metropolitan schools. For students in remote schools, however, at the lowest levels the score is similar to that of students in developing countries.

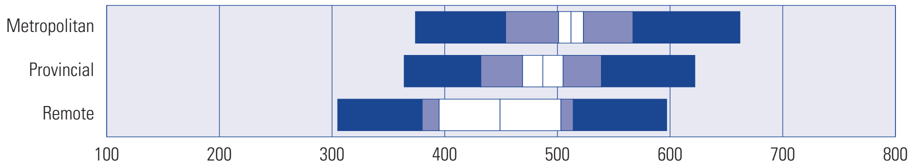


Figure 2.20 Distribution of mathematics achievement within Australia, by geographic location

Figure 2.21 presents the proportion of students in each geographic location at each of the benchmarks. More than one-third of students in metropolitan areas, almost half (45%) of students in provincial areas and almost two-thirds (60%) of students in remote areas did not achieve the Intermediate benchmark. Ten per cent of students in metropolitan areas achieved the advanced benchmark, compared to just five per cent of students in provincial areas and two per cent of students in remote areas.

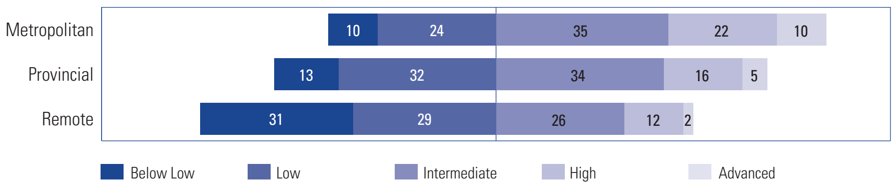


Figure 2.21 Percentages of Australian students at the international benchmarks for mathematics, by geographic location

This chapter so far has reported on the mathematics content achievement measured by TIMSS, examining achievement in terms of state, gender, number of books in the home, Indigenous background, language background, and geographic location. The next section of this chapter examines achievement in the mathematics content and cognitive domains.

Achievement in the mathematics content and cognitive domains

As outlined earlier in the chapter, 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 8, *number, algebra, geometry* and *data and chance.* The cognitive dimension details the thinking processes that students will need to use. The cognitive domains are *knowing, applying* and *reasoning*. Each item of the assessment 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 provide a way for participants to examine relative performance in the content domains, IRT scaling was used to place achievement in each of the four content domains and each of the three cognitive domains on the overall mathematics scale for Year 8. Tables 2.13 and 2.14 present the average achievement in each of the content and cognitive domains for Year 8 students in mathematics in each state, for males and females and for Indigenous and non-Indigenous students.

Mathematics content domains

Across Australia, Year 8 students' performance was clearly better in *data and chance* and *number* than in *algebra* and *geometry.* Of these, *data and chance* is the area in which Australian students clearly excel, with the overall average score for Australia and the score of most states substantially higher than overall average for mathematics.

There were no gender differences in any of the content domains, and the difference between non-Indigenous and Indigenous students remained the same in each.

Table 2.13 Relative mean achievement in mathematics content domains, for Australia, the states and by gender and Indigenous background

	Mathematics overall		Algebra		Absolute difference from overall mathematics score	Data and Chance		Absolute difference from overall mathematics score	Number		Absolute difference from overall mathematics score	Geometry		Absolute difference from overall mathematics score
	Mean	SE	Mean	SE		Mean	SE		Mean	SE		Mean	SE	
Australia	505	5.1	489	5.3	16	534	5.9	29	513	5.4	8	499	5.4	6
ACT	532	9.9	514	10.3	18	566	11.0	34	541	10.0	9	528	10.1	4
NSW	518	11.1	502	11.5	16	548	12.9	30	527	11.8	9	511	11.2	7
VIC	504	8.0	490	8.2	14	535	8.9	31	513	8.3	9	499	8.5	5
QLD	497	8.0	480	8.5	17	528	8.9	31	504	8.8	7	491	8.9	6
SA	489	5.8	473	6.5	16	514	7.3	25	495	6.6	6	483	6.1	6
WA	493	10.6	476	10.6	17	519	11.4	26	498	10.8	5	486	10.7	7
TAS	475	6.9	458	7.8	17	504	8.1	29	482	8.1	7	475	7.4	0
NT	462	14.4	445	13.9	17	482	16.9	20	466	15.5	4	459	14.2	3
Female	501	4.7	490	5.1	11	529	5.3	28	505	4.9	4	493	5.0	8
Male	510	7.4	489	7.6	21	541	8.8	31	521	7.9	11	506	7.6	4
Non-Indigenous	509	5.3	494	5.4	16	540	6.1	31	518	5.6	8	503	5.5	6
Indigenous	438	4.8	420	4.9	18	457	6.2	19	443	5.5	4	434	5.7	4

Note: No statistical differences are calculated between the mean of the overall scale score and the cognitive domains or the content domains. This is because the data in the content domains underpin or contribute to the data in the overall mathematics score.

Mathematics cognitive domains

Australian Year 8 students performed at a level that was statistically similar to the TIMSS scale average in all three cognitive domains – *knowing, applying* and *reasoning.*

Table 2.14 shows that, for Year 8 students, there was little variation from the overall mathematics score across the states and territories in achievement in the cognitive domains. There were no gender differences and the difference in scores between Indigenous and non-Indigenous students remained the same as for mathematics overall.

Table 2.14 Relative mean achievement in mathematics cognitive domains, for Australia, the states and by gender and Indigenous background

	Mathematics overall		Knowing		Absolute difference from overall mathematics score	Applying		Absolute difference from overall mathematics score	Reasoning		Absolute difference from overall mathematics score
	Mean	SE	Mean	SE		Mean	SE		Mean	SE	
Australia	505	5.1	504	5.1	1	506	4.8	1	506	4.9	1
ACT	532	9.9	531	10.4	1	532	9.9	0	532	10.1	0
NSW	518	11.1	518	11.2	0	519	10.6	1	518	10.9	0
VIC	504	8.0	504	7.9	0	506	7.5	2	505	7.8	1
QLD	497	8.0	495	8.4	2	497	8.1	0	499	8.0	2
SA	489	5.8	488	6.1	1	490	5.5	1	492	5.5	3
WA	493	10.6	490	10.0	3	494	9.5	1	496	9.8	3
TAS	475	6.9	473	7.4	2	479	7.3	4	475	7.1	0
NT	462	14.4	459	13.6	3	463	12.9	1	462	12.0	0
Male	510	7.4	507	7.4	3	513	7.0	3	511	7.2	1
Female	501	4.7	502	5.0	1	500	4.5	1	501	4.8	0
Non-Indigenous	509	5.3	509	5.3	1	510	5.0	1	510	5.1	1
Indigenous	438	4.8	436	5.4	2	444	5.1	5	440	4.9	1

Note: No statistical differences are calculated between the mean of the overall scale score and the cognitive domains or the content domains. This is because the data in the cognitive domains underpin or contribute to the data in the overall mathematics score.

In the next chapter of this report, the performance of Australian Year 8 students in science is examined in detail.

Chapter

3 Science

Key findings

- Australia's average score in science achievement (519 points) was significantly lower than that of nine other countries, including England as well as the participating Asian countries, Hong Kong, Singapore and Chinese Taipei. The average scores of the United States and New Zealand were not different to Australia's. This is a similar position to that achieved in TIMSS 2007.
- Thirty per cent of students in Australian did not reach the Intermediate international benchmark in science, the minimum proficient standard.
- The significant gender difference (in favour of males) in average science achievement found in earlier cycles of TIMSS has continued in 2011.
- The Australian Capital Territory was the highest performing state in Year 8 science, with an average score significantly higher than those for all states apart from New South Wales.
- Students from homes with greater educational resources (as indicated by number of books in the home and parental education) have higher achievement, on average, in science than students from less well resourced homes.
- Students who identified themselves as Indigenous performed at a significantly lower level in science than non-Indigenous students, and this gap in average science achievement has remained fairly constant since 1995.
- In terms of the content domains, Australian Year 8 students' performance was clearly better in *Earth science* and *biology* than in *chemistry* and *physics*. For the cognitive domains, *knowing*, *applying* and *reasoning*, the performance of Australian Year 8 students was statistically similar to their overall science score.

How is science assessed in TIMSS?

The TIMSS scientific assessment framework contends that for young people in today's world, some level of understanding of science is imperative to enable them to make decisions about themselves (e.g. nutrition, medication, hygiene) and the world in which they live (e.g. climate change, food production, natural resources). In TIMSS, students' scientific understanding is assessed by having participating students read selected questions and stimulus materials and respond to a variety of questions.

The scientific assessment framework is organised around two dimensions – a content dimension, which specifies the domains or subject matter to be assessed within science (for example, physics and chemistry) and the cognitive dimension, which specifies the thinking processes and sets of behaviours expected of students as they engage with the science content. In addition, the concept of scientific inquiry is treated as an overarching assessment strand that overlaps with all of the scientific fields 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.

Science content domains

In the TIMSS framework for Year 8 students, four content domains are defined:

- *Chemistry;*
- *Earth science;*
- *Biology; and*
- *Physics.*

Each of these content domains has several topic areas, for example the domain chemistry includes physical states and changes in matter, energy transformations, heat and temperature, light, sound, electricity and magnetism and forces and motion. These are shown in Table 3.1.

For a detailed description of each of the content domains in science, refer to the TIMSS 2011 Assessment Frameworks (Mullis et al., 2009).

Table 3.1 TIMSS science content domains and proportion of assessment for each domain

Content domains	Topic areas	Target % of TIMSS assessment
Biology	Characteristics, classification and life processes of organisms	35
	Cells and their functions	
	Life cycles, reproduction and heredity	
	Diversity, adaptation and natural selection	
	Ecosystems	
	Human health	
Physics	Classification and composition of matter	20
	Properties of matter	
	Chemical change	
Chemistry	Physical states and changes in matter	25
	Energy transformations, heat and temperature	
	Light	
	Sound	
	Electricity and magnetism	
	Forces and motion	
Earth science	Earth's structure and physical features	20
	Earth's processes, cycles and history	
	Earth's resources, their use and conservation	
	Earth in the solar system and the universe	

Science cognitive domains

To respond correctly to TIMSS test items, students need to be familiar with the science content of the items. Just as important, however, 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 in Year 8. The student behaviours used to define the science framework at 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 4 and Year 8, but the balance of testing time differs, reflecting the difference in age and experience of students in the two year levels. Each content domain included items developed to address each of the three cognitive domains, for example, the *chemistry* domain included *knowing, applying,* and *reasoning* items, as did the other content domains.

Table 3.2 TIMSS science cognitive domains and proportion of assessment for each domain

Cognitive Domain	Target % of TIMSS assessment
Knowing	35%
Applying	35%
Reasoning	30%

The TIMSS benchmarks

The TIMSS scientific achievement scale summarises Year 8 students' performance when interacting with a variety of scientific tasks and questions. Students' achievement is based on their responses to test questions designed to assess a range of content areas. When comparing groups of students, across and within countries, summary statistics such as the average, or mean, scale score are often used. This score, however, does not provide detailed information as to what types of mathematical tasks the students were able to undertake successfully. Instead, to provide descriptions of achievement on the scale in relation to performance on the questions asked, TIMSS uses four points on the scale as international benchmarks. The benchmarks represent the range of performance shown by students internationally.

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.

The descriptions of the levels are cumulative, so that a student who reached the High benchmark can typically demonstrate the knowledge and skills for levels for both the Intermediate and the Low benchmarks. Box 3.1 provides a summary of the TIMSS Year 4 science benchmarks.

Box 3.1 The TIMSS 2011 international science benchmarks, Year 8

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

At Year 8, students at the Low benchmark would be expected to interpret simple pictorial diagrams, complete simple tables and apply basic knowledge to practical situations. In the example shown in Box 3.2, students' basic understanding of biology is probed in a multiple choice item in which they should recognise that genetic material is inherited from both parents.

Box 3.2 Low international benchmark – Example item

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

Which statement is correct about their genetic makeup?

Ⓐ The boy and girl inherit genetic material from the father only.

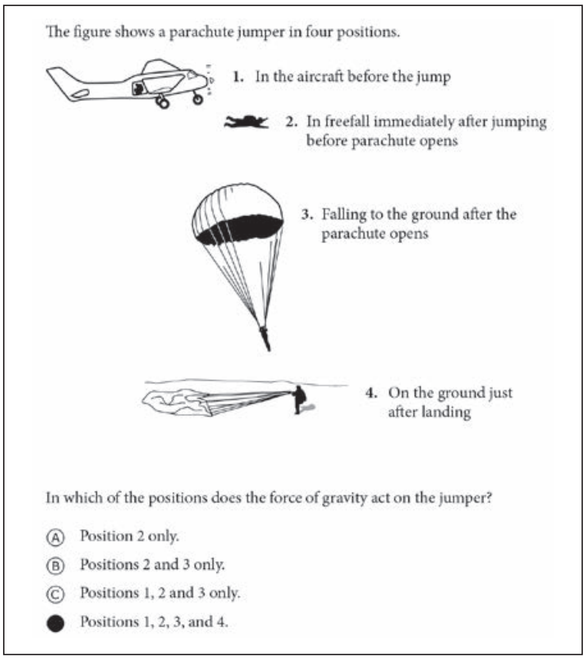
Ⓑ The boy and girl inherit genetic material from the mother only.

● The boy and girl inherit genetic material from both parents.

Ⓓ The boy inherits genetic material from the father only and the girl inherits it from the mother only.

In contrast, students at the Advanced benchmark are asked to apply their knowledge to what may be unfamiliar situations. For the example shown in Box 3.3, students would have to understand that gravity acts on a person regardless of position and movement in order to get the question correct.

Box 3.3 Advanced international benchmark – Example item



Further information about the types of scientific skills and strategies demonstrated by students who performed at each of the international benchmarks, along with examples of the types of responses provided by students at each of the benchmarks, is provided in Appendix 2.

International student achievement in science

This section reports the TIMSS 2011 science results as average scores and distributions at Year 8 level on the TIMSS scales. The TIMSS science achievement scales were established in TIMSS 1995 to have a mean of 500 and a standard deviation of 100 at each year level, and were designed to remain constant from assessment to assessment.

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. In this report, this will be reported by examining the difference between the 5th and 95th percentiles.

Figure 3.1 provides a summary of the overall performance of students in Year 8 across different countries on the combined science scale, in terms of the mean scores achieved by students in each country, the standard error of this mean, the average age of students in that country and the range of scores achieved between the 5th and 95th percentiles.

Countries are shown in decreasing order of achievement; however this should not be interpreted as a simple ranking. The multiple comparisons tables in Appendix 3 provide information about whether or not differences between countries are statistically significant. The shading on the table indicates whether the score for the particular country is significantly different to that of Australia.

The results in Figure 3.1 show that Singapore had the highest average achievement across participating countries, with a score about halfway between the High and Advanced benchmarks. The next highest-performing countries – Chinese Taipei, Korea and Japan – had higher levels of achievement than all countries other than Singapore, with average scores just higher than the High benchmark.

In TIMSS 2011 science, Australian students attained an average of 519 score points, which places them about halfway between the Intermediate and High benchmarks. Australia was significantly outperformed by Singapore, Chinese Taipei, Korea, Japan, the Russian Federation, Hong Kong and England. These countries also outperformed Australia in 2007. Australia's performance was not significantly different to that of the United States, Hungary, Israel, Lithuania, New Zealand, and Sweden. Achievement for all of these countries was at about the level of the Intermediate benchmark.

The results reveal substantial differences in science achievement between the highest- and lowest performing countries (590 in Singapore to 306 in Ghana at Year 8). The gap between the 5th and 95th percentiles was about midrange for Singapore, but substantially lower than this for Chinese Taipei and Korea. Finland had the lowest gap between high and low achievers (212 score points), while Qatar had the highest, with a difference of 394 score points.

As a point of comparison, Figure 3.1 also provides the average age of students at the time of testing. The average ages of students in Year 8 varied by two full years between countries – from under 14 years in Norway and Italy to almost 16 years in Ghana. The average age across all countries was 14.3 years, which was a little higher than the Australian average of 14.0 years. The average age of students in the United States, England and New Zealand were all quite similar to the average age of Australian students.

	Mean Score	SE	Average age at time of testing	Gap 95th – 5th percentiles
Singapore	590	4.3	14.4	321
Chinese Taipei	564	2.3	14.2	274
Korea	560	2.0	14.3	256
Japan	558	2.4	14.5	252
Finland	552	2.5	14.8	212
Slovenia	543	2.7	13.9	249
Russian Federation	542	3.2	14.7	251
Hong Kong	535	3.4	14.2	245
England	533	4.9	14.2	279
United States	525	2.6	14.2	267
Hungary	522	3.1	14.7	269
Australia	519	4.8	14.0	277
Israel	516	4.0	14.0	309
Lithuania	514	2.6	14.7	249
New Zealand	512	4.6	14.1	282
Sweden	509	2.5	14.8	265
Italy	501	2.5	13.8	249
Ukraine	501	3.4	14.2	274
Norway	494	2.6	13.7	241
Kazakhstan	490	4.3	14.6	258
Turkey	483	3.4	14.0	336
Iran	474	4.0	14.3	296
Romania	465	3.5	14.9	285
United Arab Emirates	465	2.4	13.9	320
Chile	461	2.5	14.2	242
Bahrain	452	2.0	14.4	335
Thailand	451	3.9	14.3	264
Jordan	449	4.0	13.9	337
Tunisia	439	2.5	14.3	221
Armenia	437	3.1	14.6	312
Saudi Arabia	436	3.9	14.1	272
Malaysia	426	6.3	14.4	334
Syrian Arab Republic	426	3.9	13.9	276
Georgia	420	3.0	14.2	297
Oman	420	3.2	14.1	361
Palestinian Nat'l Auth.	420	3.2	13.9	343
Qatar	419	3.4	14.0	394
Macedonia	407	5.4	14.7	372
Indonesia	406	4.5	14.3	258
Lebanon	406	4.9	14.3	319
Morocco	376	2.2	14.7	283
Ghana	306	5.2	15.8	367

Note: See Reader's Guide for interpretation of graph.

Figure 3.1 Distribution of science achievement, by country

Performance at the international benchmarks

In addition to the mean scores it is useful to use the international benchmarks described previously to gain further insight into student achievement. Figure 3.2 shows the proportion of students in each country at each of the international benchmarks.

The countries are ordered by the proportion of students reaching the minimum proficient standard. The Intermediate benchmark is the minimum proficient standard set for TIMSS in mathematics and science in Australia.

The four Asian countries, Japan, Chinese Taipei, Korea and particularly Singapore, showed their international dominance in science. In Singapore, 40 per cent of students reached the Advanced benchmark. In the other three countries, between 18 and 24 per cent of students achieved at this very high level. In a range of other countries, including Australia (11%), the United States (10%) and England (14%), more than 10 per cent of students achieved the Advanced benchmark. The international median was just four per cent.

The figure also shows the distribution of achievement internationally, and provides some interesting findings. Ideally, it is advantageous for a country to have both a solid proportion of students achieving at high levels, and all or almost all students achieving at least a basic level. Finland places on top of Figure 3.2 because although they did not achieve the highest proportion of students achieving the Advanced benchmark, almost all (99%) of their students achieved the Low benchmark.

Australia achieved a further 25 per cent of students at the High benchmark, compared to an international median of 17 per cent. At the lower ends of achievement, eight per cent of students did not achieve the Low benchmark, and a further 22 per cent of students did not attain the Intermediate benchmark. While this compares favourably with the proportion of students internationally who did not achieve this level (48%), it leaves a great deal of room for improvement.

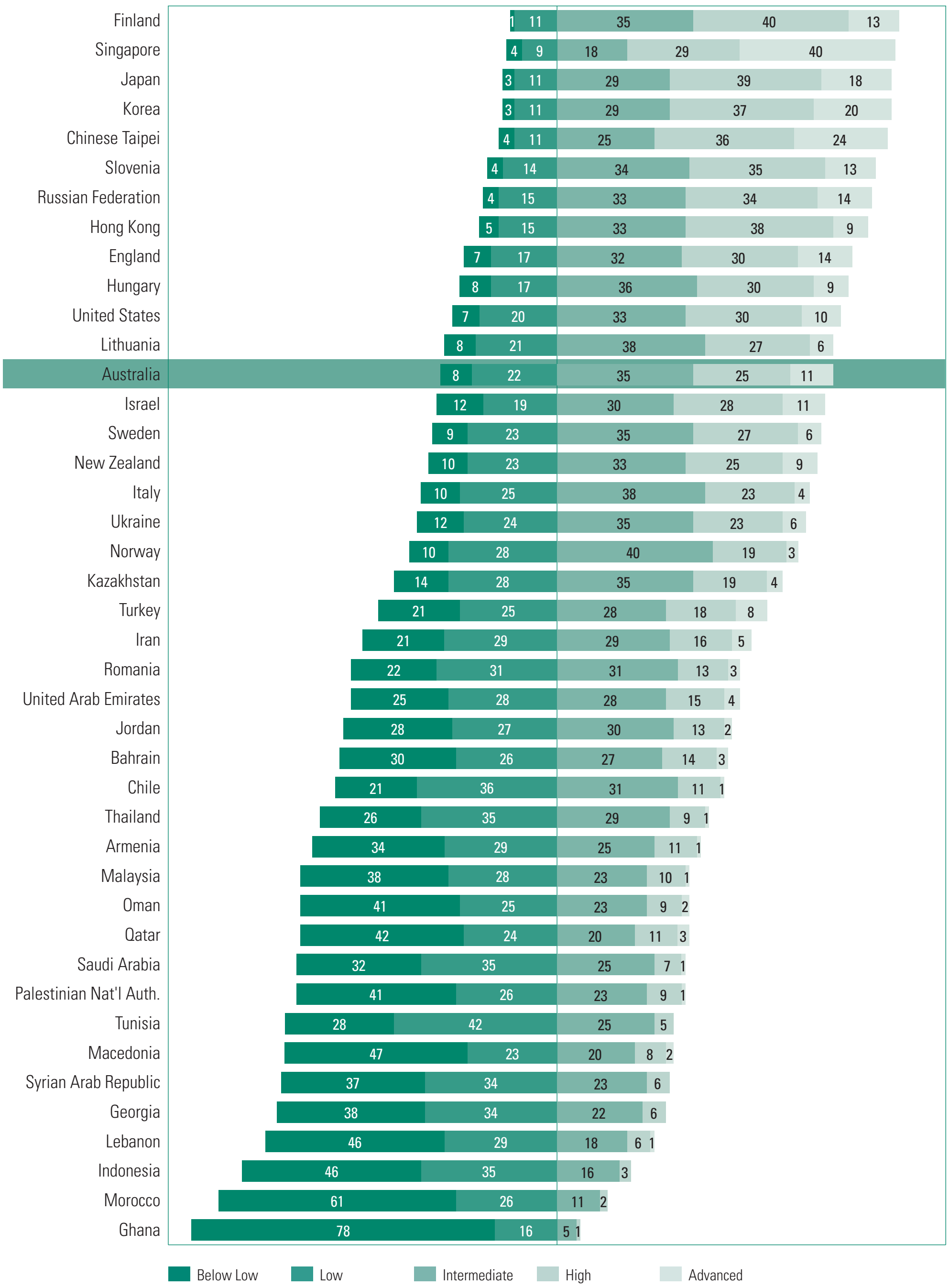


Figure 3.2 Percentages of students at the international benchmarks for science, by country

Trends in international science achievement

Figure 3.3 shows the trends in science achievement at Year 8 for a selection of countries. Australia's score at Year 8 in 2007 had declined significantly from that measured in TIMSS 2003, which had shown a significant increase from 1995. However, in 2011 the score increased slightly (although not significantly), causing an overall non-significant difference to the score in 1995. In sixteen years the average score in science at Year 8 has not changed significantly. A similar situation can be seen for New Zealand and England where the score is largely unchanged since 1995.

In contrast, the United States has shown an overall increase from 1995, maintaining the increase made in 2003. Likewise, scores for students in Slovenia have increased, with great gains made between each cycle, with students in Slovenia showing a 29 score point increase from 1995 to

2011, on top of a 24 score point increase from 2003 to 2007. Impressively, scores for students in Korea have also increased significantly since 1995, from already high scores to even higher scores.

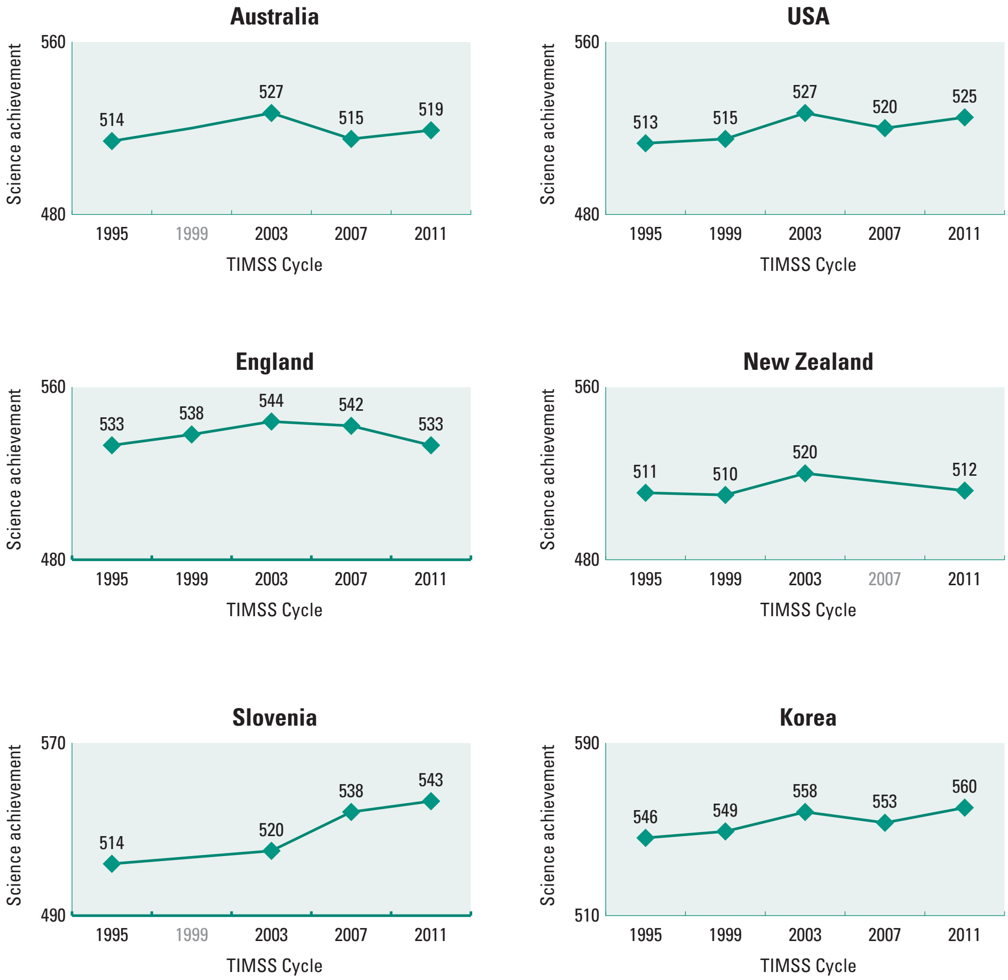


Figure 3.3 Trends in science achievement scores, 1995-2011, selected countries

Similarly, in terms of the benchmarks, the only change over the sixteen years since TIMSS 1995 is that a significantly higher proportion of students (92% compared to 89%) reached the Low benchmark in 2011.

Table 3.3 shows the relative position of Australia in 2011 in science, and its relative position with the same countries in 2007, 2003 and 1995. Hungary (higher in 2007 and equal in 2011) and Israel (lower in 2007 and equal in 2011) were the only countries that showed any change in rankings relative to Australia.

Table 3.3 Relative trends in science achievement, by country

	Position relative to Australia 2011	Position relative to Australia 2007	Position relative to Australia 2003	Position relative to Australia 1995
Singapore	↑	↑	↑	↑
Chinese Taipei	↑	↑	↑	–
Korea	↑	↑	↑	↑
Japan	↑	↑	↑	↑
Finland	↑	–	–	–
Slovenia	↑	↑	●	●
Russian Federation	↑	↑	↓	●
Hong Kong	↑	↑	↑	↓
England	↑	↑	↑	●
United States	●	●	●	●
Hungary	●	↑	↑	●
Australia				
Israel	●	↓	↓	–
Lithuania	●	●	●	↓
New Zealand	●	–	●	↓
Sweden	●	●	●	●
Italy	↓	↓	↓	–
Ukraine	↓	↓	–	–
Norway	↓	↓	↓	↓
Kazakhstan	↓	–	–	–
Turkey	↓	↓	↓	↓
Iran	↓	↓	↓	↓
Romania	↓	↓	↓	↓
United Arab Emirates	↓	–	–	–
Chile	↓	–	↓	–
Bahrain	↓	↓	↓	–
Thailand	↓	↓	–	–
Jordan	↓	↓	↓	–
Tunisia	↓	↓	↓	–
Armenia	↓	↓	↓	–
Saudi Arabia	↓	↓	–	–
Malaysia	↓	↓	↓	–
Syrian Arab Republic	↓	↓	–	–
Georgia	↓	↓	–	–
Oman	↓	↓	–	–
Palestinian Nat'l Auth.	↓	↓	↓	–
Qatar	↓	↓	–	–
Macedonia	↓	↓	–	–
Indonesia	↓	↓	↓	–
Lebanon	↓	↓	↓	–
Morocco	↓	↓	↓	–
Ghana	↓	↓	↓	–

↑ Score significantly higher than Australia

↓ Score significantly lower than Australia

● Score not significantly different to that of Australia

- Did not participate in this cycle

Trends across year levels: Year 4 to Year 8 cohort analysis

Because TIMSS is conducted on a four-year cycle, the cohort of students that was assessed in Year 4 in 2007 was assessed as the Year 8 cohort in 2011. The results are presented in Table 3.4, which shows the average science achievement as a difference from the TIMSS scale centrepoint (500) for the Year 4 students in 2007 on the left and the Year 8 students in 2011 on the right. Twelve countries, Singapore, Chinese Taipei, Hong Kong, Japan, the Russian Federation, England, the United States, Hungary, Australia, Sweden, Slovenia and Lithuania, performed above the scale centrepoint in Year 4 in 2007 and again above the scale centrepoint in Year 8 in 2011 (although not in the same order of average achievement). Slovenia showed a particularly notable increase, with performance moving from 18 points above the scale centrepoint in 2007 to 43 score points above it in 2011. Norway, Iran, Georgia and Tunisia also retained the same relative positions, performing below the scale centrepoint at both Year 4 and Year 8.

Only Italy had a relative decline in achievement from Year 4 to Year 8, moving from above the centrepoint in Year 4 in 2007 to the centrepoint in Year 8 in 2011.

Table 3.4 Relative achievement in science of 2007 Year 4 students and 2011 Year 8 students, by country

	Year 4 2007		
Country	Achievement difference from TIMSS scale centrepoint	SE	
Singapore	87	4.1	▲
Chinese Taipei	57	2.0	▲
Hong Kong	54	3.5	▲
Japan	48	2.1	▲
Russian Federation	46	4.8	▲
England	42	2.9	▲
United States	39	2.7	▲
Hungary	36	3.3	▲
Italy	35	3.2	▲
Australia	27	3.3	▲
Sweden	25	2.9	▲
Slovenia	18	1.9	▲
Lithuania	14	2.4	▲
Norway	–23	3.5	▼
Iran	–64	4.3	▼
Georgia	–82	4.6	▼
Tunisia	–182	5.9	▼

	Year 8 2011		
Country	Achievement difference from TIMSS scale centrepoint	SE	
Singapore	90	4.3	▲
Chinese Taipei	64	2.3	▲
Japan	58	2.4	▲
Slovenia	43	2.7	▲
Russian Federation	42	3.2	▲
Hong Kong	35	3.4	▲
England	33	4.9	▲
United States	25	2.6	▲
Hungary	22	3.1	▲
Australia	19	4.8	▲
Lithuania	14	2.6	▲
Sweden	9	2.5	▲
Italy	1	2.5	▼
Norway	–6	2.6	▼
Iran	–26	4.0	▼
Tunisia	–61	2.5	▼
Georgia	–80	3.0	▼

▲ State mean is significantly higher than the TIMSS scale centrepoint
▼ State mean is significantly lower than the TIMSS scale centrepoint

Science achievement by gender

Figure 3.4 shows the performance of male and female Year 8 students in science achievement across the countries participating in TIMSS 2011. This figure presents 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 presented in the figures in increasing order of the absolute difference between females and males in average achievement.

	Females				Males				Difference (absolute value)
	% of students	SE of %	Mean	SE	% of students	SE of %	Mean	SE	
Chinese Taipei	48	1.0	564	2.7	52	1.0	564	3.0	0
Norway	49	0.7	495	3.2	51	0.7	494	3.4	1
Singapore	49	0.7	589	4.2	51	0.7	591	4.1	1
Hong Kong	49	1.6	536	4.5	51	1.6	534	4.6	2
Romania	48	0.9	466	3.8	52	0.9	464	3.4	2
England	48	2.0	534	5.0	52	2.0	532	5.6	2
Sweden	48	0.9	511	2.7	52	0.9	508	3.0	3
Morocco	47	0.8	378	2.6	53	0.8	374	3.0	4
Kazakhstan	49	0.8	492	4.6	51	0.8	488	3.6	4
Lebanon	55	1.9	404	5.4	45	1.9	408	6.7	4
Slovenia	49	0.9	541	3.0	51	0.9	545	3.4	4
Ukraine	50	1.0	499	3.7	50	1.0	503	4.1	4
Korea	52	2.5	558	2.6	48	2.5	563	3.1	5
Finland	48	1.1	555	2.4	52	1.1	550	2.7	5
Iran	46	2.3	477	5.3	54	2.3	472	7.0	5
Syria	50	1.7	424	4.4	50	1.7	429	5.2	6
International Average	50	0.2	480	0.6	50	0.2	474		**6**
Russian Federation	49	0.9	539	3.6	51	0.9	546	2.9	**7**
Israel	50	1.6	519	3.7	50	1.6	512	4.2	7
Indonesia	50	1.2	409	5.1	50	1.2	402	3.6	**7**
Japan	49	1.1	554	2.9	51	1.1	562	3.3	**8**
Lithuania	49	0.7	518	3.0	51	0.7	510	3.3	**8**
Georgia	47	0.9	425	3.3	53	0.9	415	3.4	**10**
United States	51	0.6	519	2.8	49	0.6	530	2.4	**11**
Malaysia	51	1.2	434	6.3	49	1.2	419	5.5	**15**
Thailand	55	1.6	458	3.9	45	1.6	443	4.9	**15**
Italy	49	0.9	493	3.1	51	0.9	508	2.8	**15**
Chile	53	1.5	454	3.2	47	1.5	470	3.6	**16**
Turkey	49	0.7	491	3.2	51	0.7	475	3.2	**16**
Australia	50	1.6	511	4.5	50	1.6	527	5.9	**16**
Tunisia	52	0.7	431	2.6	48	0.7	447	2.6	**17**
Macedonia	49	0.9	417	5.6	51	0.9	399	4.7	**18**
Hungary	49	1.1	513	3.5	51	1.1	531	3.7	**18**
Armenia	49	0.8	446	3.5	51	0.8	428	3.4	**18**
New Zealand	47	2.0	501	4.6	53	2.0	522	3.9	**20**
United Arab Emirates	50	1.7	477	2.9	50	1.7	452	4.2	**25**
Qatar	50	3.3	432	7.0	50	3.3	406	10.7	**26**
Saudi Arabia	48	1.2	450	3.5	52	1.2	424	7.2	**26**
Palestinian Nat'l Auth.	52	1.7	434	3.8	48	1.7	406	6.8	**27**
Ghana	47	0.8	290	5.7	53	0.8	320	4.0	**30**
Jordan	49	1.7	471	4.3	51	1.7	428	7.6	**43**
Bahrain	50	0.8	482	2.2	50	0.8	423	4.4	**59**
Oman	51	2.1	458	2.9	49	2.1	380	4.9	**78**

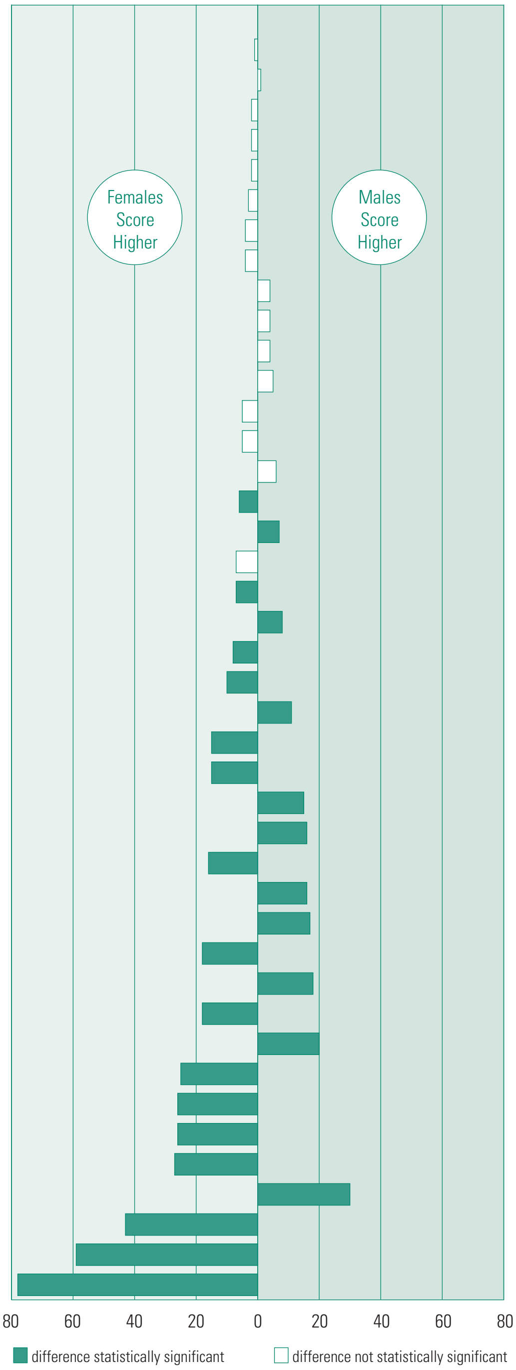


Figure 3.4 Gender differences in science achievement, by country

Figure 3.4 shows that on average across the TIMSS 2011 countries, there was a significant gender difference in science in favour of females. Females achieved significantly higher average scores than males in 15 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 seven score points in Indonesia to 78 score points in Oman. Males achieved significantly higher average scores than females in ten countries, including Australia. Across the participating countries, the significant differences in favour of males ranged in size from seven score points in the Russian Federation to 30 score points in Ghana. In Australia, males outperformed females by 16 score points, a substantial, as well as significant, difference. In 17 countries there was no significant difference between females and males.

Performance at the international benchmarks by gender

In Australia, 13 per cent of Australian Year 8 males achieved the Advanced benchmark, compared to eight per cent of females. A similar proportion of females and males (23% compared to 26%) achieved the High benchmark. However around one-third of females (32%) compared to one-quarter of males (27%) did not achieve the minimum standard of the Intermediate benchmark. A similar proportion of males and females (7% and 8% respectively) were at the very lowest level of achievement, not achieving the Low benchmark (Figure 3.5).

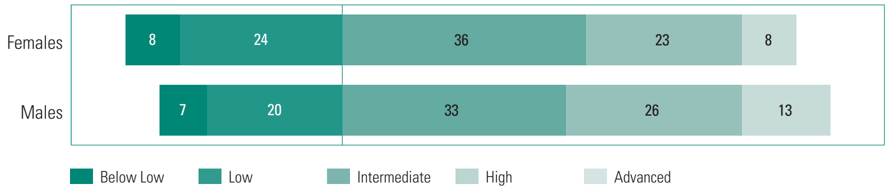


Figure 3.5 Percentages of Australian students at the international benchmarks for science, by gender

Trends in science achievement by gender

Figure 3.6 shows trends in science achievement for male and female Australian students. In each cycle of TIMSS, despite a lack of significant gender difference at Year 4 level, there have been significant gender differences in favour of males at Year 8 level, and the 2011 cycle is no different.

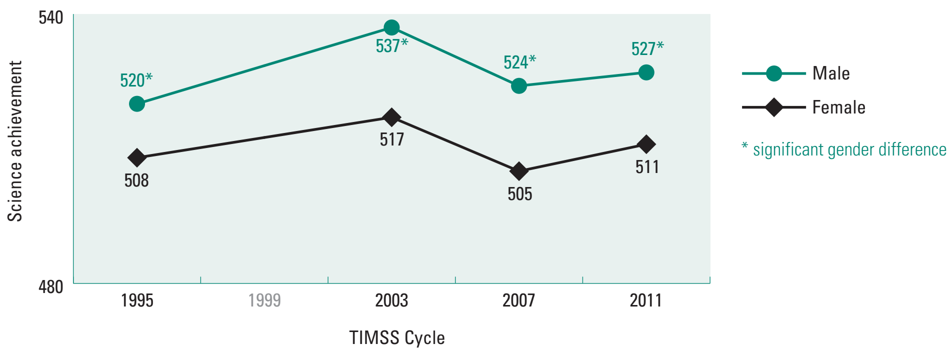


Figure 3.6 Trends in science achievement within Australia, 1995-2011, by gender

Science achievement by state

Figure 3.7 presents the distribution of science performance for each of the Australian states for Year 8 in a similar way to that of the international results in Figure 3.1. To place the state results in perspective, the means and distributions for Australia as a whole, and for Singapore, the highest achieving country at Year 8 in science, are also included in this figure. The states are shown in order from highest to lowest mean scores.

Figure 3.7 should be read in conjunction with Table 3.5, which presents the multiple comparisons of average performance between the states.

For TIMSS 2011, the Australian Capital Territory had the highest average achievement (551 score points). The Australian Capital Territory, along with New South Wales, also displayed the widest distribution of responses, with a range of 286 and 294 score points respectively between the 5th and 95th percentiles. South Australia had the narrowest range, with only 244 score points separating the 5th and 95th percentiles.

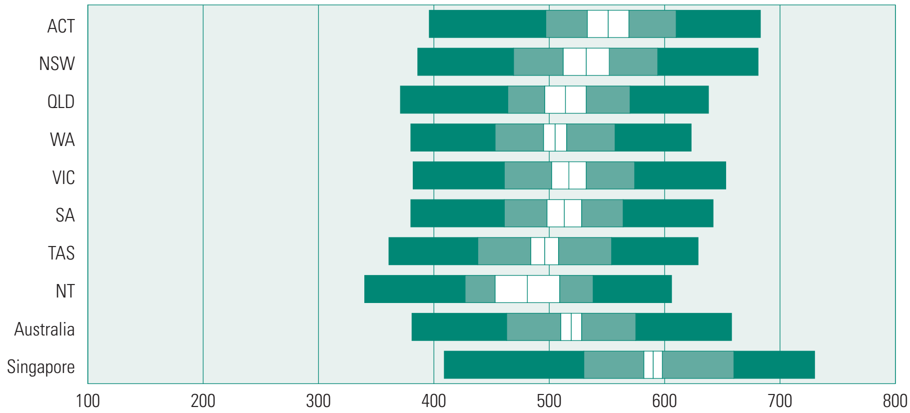


Figure 3.7 Distribution of science achievement, by state

Figure 3.7 and Table 3.5 together show that variation across the states in average science achievement at Year 8 was quite large (an overall range of 70 score points, from 481 for the Northern Territory to 551 for the Australian Capital Territory). The score for students in the Australian Capital Territory was not significantly different to that of students in New South Wales, but was significantly higher than that of students in all other states. Students in New South Wales significantly outperformed students in South Australia, Tasmania and the Northern Territory, and students in Queensland also significantly outperformed students in Tasmania and the Northern Territory.

Table 3.5 Multiple comparisons of average science achievement, by state

STATE	Mean	SE	ACT	NSW	QLD	WA	VIC	SA	TAS	NT
ACT	551	9.2		●	▲	▲	▲	▲	▲	▲
NSW	532	10.1	●		●	●	●	▲	▲	▲
QLD	516	7.5	▼	●		●	●	●	▲	▲
WA	514	9.2	▼	●	●		●	●	●	●
VIC	513	7.5	▼	●	●	●		●	●	●
SA	506	5.0	▼	▼	●	●	●		●	●
TAS	496	6.4	▼	▼	▼	●	●	●		●
NT	481	14.4	▼	▼	▼	●	●	●	●	

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 difference in science achievement by state

Figure 3.8 shows the gender differences at Year 8 in each of the states. Given that there is a 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. However, due to large standard errors, only the difference in Tasmania was found to be statistically significant. In all states other than South Australia and the Australian Capital Territory, however, there was a tendency towards higher scores for males.

	Female		Male		
	Mean	SE	Mean	SE	Difference
SA	508	5.0	505	7.1	4
ACT	552	10.3	552	10.0	0
WA	509	10.9	521	9.3	11
VIC	507	7.3	520	9.1	13
NT	476	13.6	491	13.6	15
QLD	506	6.7	524	10.1	18
TAS	484	8.8	508	7.3	24
NSW	520	9.4	544	14.9	25

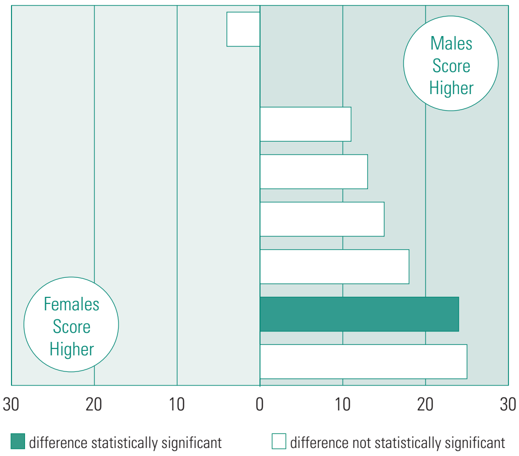


Figure 3.8 Gender differences in science achievement, by state

Performance at the international benchmarks by state

Figure 3.9 presents the proportion of students in each state at each of the international benchmarks for Year 8, along with the corresponding proportions for Australia as a whole, and Singapore, the country with the greatest proportion of their students achieving the Low benchmark in science at Year 8, for comparison.

This figure shows that 19 per cent of Year 8 students in the Australian Capital Territory and 16 per cent of students in New South Wales reached the Advanced benchmark, but in all other states the proportion at this level was less than 10 per cent. This is well short of the 40 per cent of students in Singapore that performed at this level, but the proportion of students achieving at this highest level was similar to the proportion in Korea and Japan. The other end of the achievement distribution, however, shows that a worrying 44 per cent of students in the Northern Territory and 40 per cent of students in Tasmania did not reach the Intermediate benchmark. In the other states this proportion ranged from around 32 per cent in South Australia, Queensland and Victoria, through to 18 per cent in the Australian Capital Territory.

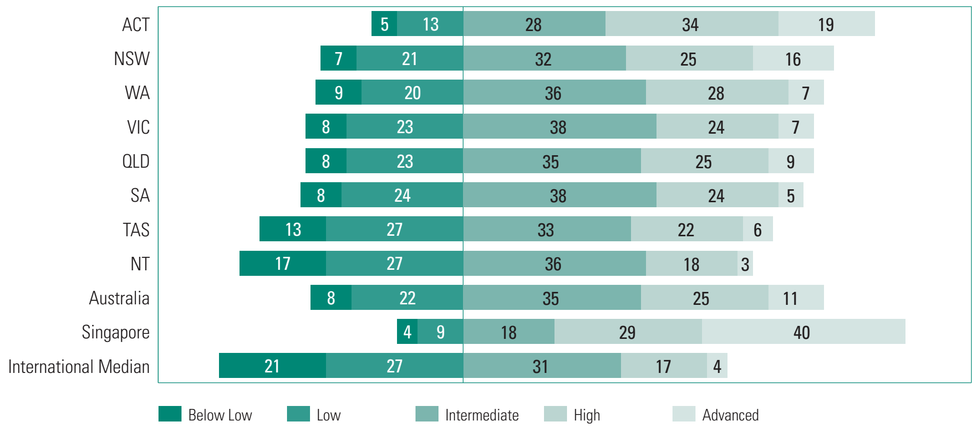


Figure 3.9 Percentages of students at the international benchmarks for science, by state

Gender difference at the international benchmarks by state

Figure 3.10 highlights the considerable variation in performance for male and females Year 8 students in some states. In New South Wales, there were considerable differences in the percentage of females and males achieving the advanced benchmark, with 20 per cent of males and 13 per cent of females achieving this benchmark. In the Australian Capital Territory both males and females performed well in science, with 21 per cent of males and 19 per cent of females achieving the Advanced benchmark. Of concern is the small proportion (3%) of female students in Tasmania and the Northern Territory who managed to attain the Advanced benchmark at Year 8.

At the lower benchmarks there were also some substantial gender differences. In New South Wales, Tasmania and the Northern Territory, a much larger proportion of females than males did not reach the Intermediate benchmark. Only in South Australia was there a slightly higher proportion of males than females not achieving the Intermediate benchmark.

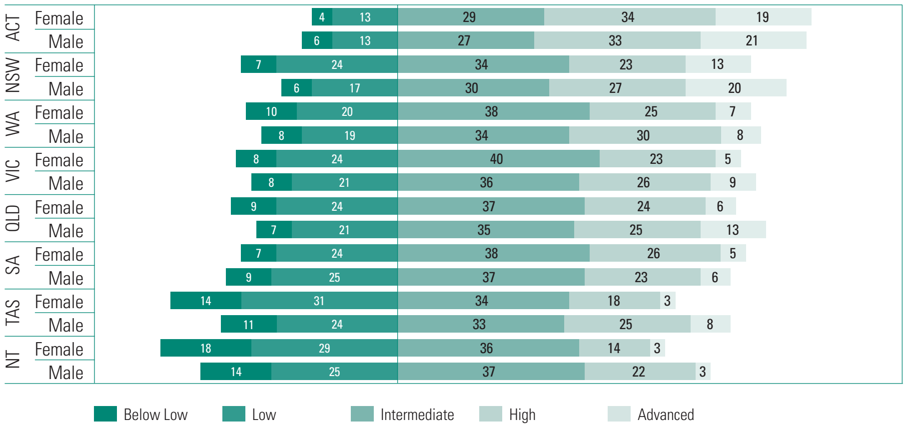


Figure 3.10 Percentages of students at the international benchmarks for science, by gender within state

Trends in science achievement by state

Table 3.6 presents the trends in science achievement for each of the states for each cycle of TIMSS. As in Australia as a whole, there were no significant improvements or declines in any of the states.

Table 3.6 Trends in science achievement, by state

	TIMSS 2011		TIMSS 2007		2011 – 2007 difference	TIMSS 2003		2011 – 2003 difference	TIMSS 1995		2011 – 1995 difference
State	Mean	SE	Mean	SE		Mean	SE		Mean	SE	
ACT	551	9.2	538	20.1	-	538	9.2	-	529	12.7	-
NSW	532	10.1	521	9.4	-	547	9.6	-	517	8.2	-
VIC	513	7.5	513	7.9	-	516	5.3	-	497	6.2	-
QLD	516	7.5	513	4.3	-	516	6.0	-	510	8.4	-
SA	506	5.0	512	6.1	-	524	10.9	-	510	5.9	-
WA	514	9.2	506	7.8	-	520	6.9	-	531	6.7	-
TAS	496	6.4	507	7.1	-	504	11.7	-	496	10.7	-
NT	481	14.4	502	11.2	-	482	13.7	-	466	16.8	-

Table 3.7 presents the cohort comparisons for the Australian states. Year 4 students in Victoria, New South Wales, Tasmania, the Australian Capital Territory, and Western Australia, all achieved at a level higher than the TIMSS scale centrepoint in 2007. Students in the Australian Capital Territory and New South Wales achieved this again in Year 8 in TIMSS 2011. Students in

Queensland went from equivalent to the TIMSS scale centrepoint in 2007 to significantly higher than the scale centrepoint in 2011. Students in Victoria, Western Australia and Tasmania went from higher than the scale centrepoint in 2007 to equivalent to the scale centrepoint in 2011.

Table 3.7 Relative achievement in science of Australian 2007 Year 4 students and 2011 Year 8 students, by state

Year 4 2007				→	Year 8 2011			
State	Achievement difference from TIMSS scale centrepoint	SE			State	Achievement difference from TIMSS scale centrepoint	SE	
VIC	44	8.3	▲		ACT	51	9.2	▲
NSW	38	6.1	▲		NSW	32	10.1	▲
TAS	33	6.0	▲		QLD	16	7.5	▲
ACT	27	8.6	▲		WA	14	9.2	
SA	12	10.5			VIC	13	7.5	
WA	12	4.9	▲		SA	6	5.0	
NT	3	9.9			TAS	–4	6.4	
QLD	1	6.0			NT	–19	14.4	

▲ State mean is significantly higher than the TIMSS scale centrepoint
▼ State mean is significantly lower than the TIMSS scale centrepoint

Science achievement by number of books in the home

As described in Chapter 2, the number of books in the home is an important indicator of a family's background. This section of the report examines science achievement by the number of books in students' homes (self-reported). For the purposes of this report, this variable has been grouped to represent *a few books* – 25 or fewer books, *average number of books* – between 26 and 200 books and *many books* – more than 200 books. As can be seen in Table 3.8, in Australia, the relationship is strong. The average score for Australian students who reported *many books* in the home, some 22 per cent of students, was 570 score points, well up there with some of the highest performing countries in the world. The bulk of students (51%) reported somewhere between 25 and 200 books in their home, and the score for these students (525 score points) was significantly lower (45 score points) than that of students with *many books* in the home. Students in the lowest category, those with *a few books* in the home, had the lowest overall score of all, just 469 score points on average, significantly and substantially lower than the scores for students in other categories.

Table 3.8 Mean science achievement within Australia, by number of books in the home

Books	% of students	Mean	SE	Gap 95th – 5th percentiles
Many books	22	570	7.6	266
Average number of books	51	525	4.1	245
A few books	27	469	4.7	243

Figure 3.11 shows these differences graphically. The spread from the 5th to 95th percentiles is greater for students in the *many books* category than in either of the other two categories, as is the confidence interval around the mean.

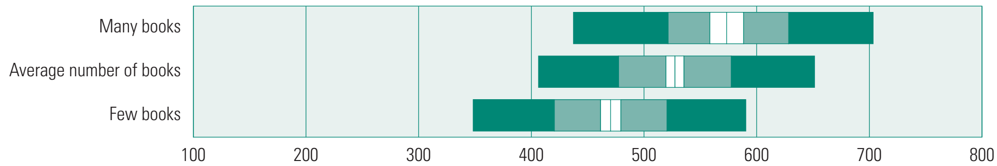


Figure 3.11 Distribution of science achievement within Australia, by number of books in the home

Figure 3.12 presents the proportion of students in each of the three books in the home categories at each of the TIMSS benchmarks. The differences are stark. Twenty-five per cent of the students who reported having *many books* in the home achieved at the Advanced benchmark, compared to nine per cent of those who reported having an average number of books, and just two per cent of students who reported only having a *few books* at home.

At the lower end of the achievement spectrum, while 12 per cent of students with *many books* did not achieve the Intermediate benchmark, with just two per cent not achieving the Low benchmark, 52 per cent of students who reported a *few books* in the home did not achieve the basic standard, with 18 per cent not achieving the Low benchmark.

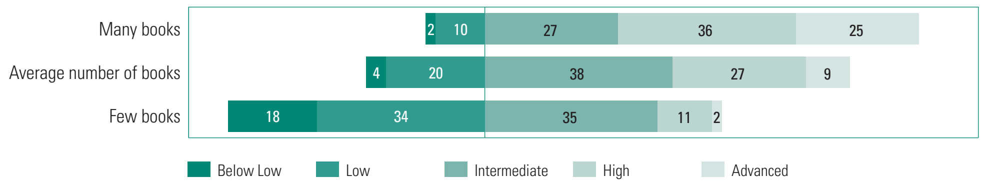


Figure 3.12 Percentages of Australian students at the international benchmarks for science, by number of books in the home

Science achievement by level of parental education

Parental education has been found to be strongly related to student achievement. Year 8 students who participated in TIMSS 2011 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 is associated with higher average science achievement. However, in Australia, there was a very high level of "Do not know" responses – 52 per cent of Australian Year 8 students did not provide a response to this question. As such, the results in this section should be treated with some caution, although they are strongly in agreement with international findings in other countries, and with findings from other Australian studies such as PISA in which there is not as much missing data.

Table 3.9 shows the mean scores and associated standard errors in science for Year 8 Australian students according the highest level of education attained by either parent. As can be seen in this table, 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 a substantial 134 points higher than that of students whose parents did not complete secondary school, 85 score points higher than the average score for students for whom the highest level of parental education was completing secondary school and 59 score points higher than that of students whose parents completed a TAFE qualification. All differences are statistically significant.

Table 3.9 Mean science achievement within Australia, by parental education

	% of students	Mean	SE	Gap 95th – 5th percentiles
Completed university degree	33	580	8.3	261
Completed post-secondary but not university	36	521	4.9	244
Completed upper secondary education	25	495	6.2	251
Did not complete upper secondary education	6	446	10.8	255

Figure 3.13 shows the spread of scores in science achievement at Year 8 for the different parental education groups. Scores for students whose parents completed a university degree were, on average, around the High benchmark, while the average for students whose parents had completed secondary education only were around the Intermediate benchmark.

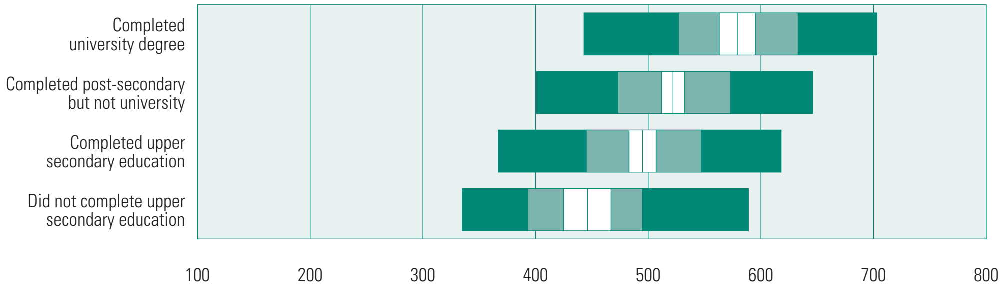


Figure 3.13 Distribution of science achievement within Australia, by parental education

Figure 3.14 shows the proportion of students at each of the benchmarks. More than one-quarter (29%) of students who had at least one parent complete a university degree reached the Advanced benchmark compared to eight per cent of students who had a parent who undertook some other form of post-secondary education and less than five per cent for the two other groups. In comparison, two-thirds (66%) of students whose parents did not complete secondary school did not reach the Intermediate benchmark, compared to 10 per cent of students with at least one parent holding university degrees.

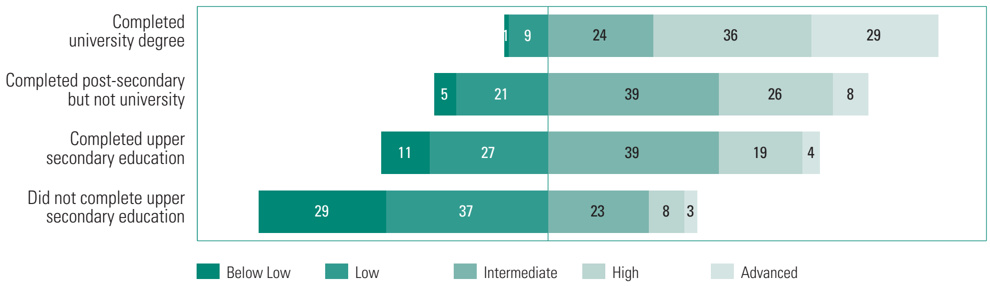


Figure 3.14 Percentages of Australian students at the science benchmarks for science, by parental education

Science Achievement by Indigenous background

The educational attainment of Australia's Indigenous students in core subject areas such as science is an important issue. Indigenous status in TIMSS is based on students' self-reports. As reported previously and as shown in Table 3.10, about five per cent of the TIMSS sample identified as Indigenous.

Table 3.10 Mean science achievement within Australia, by Indigenous background

	% of students	Mean	SE	Gap 95th – 5th percentiles
Non-Indigenous	95	524	5.0	273
Indigenous	5	459	4.5	263

The means in Table 3.10 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 459, 65 score points less than the average score of non-Indigenous students of 524 score points (a statistically significant difference). Year 8 Australian Indigenous students' average science score was also significantly lower than the TIMSS scale average.

Figure 3.15 shows the spread of scores for Indigenous and non-Indigenous students in science achievement at Year 8 (between the 5th and 95th percentile) was substantial, but similar for non-Indigenous and Indigenous students (273 and 263 score points respectively).

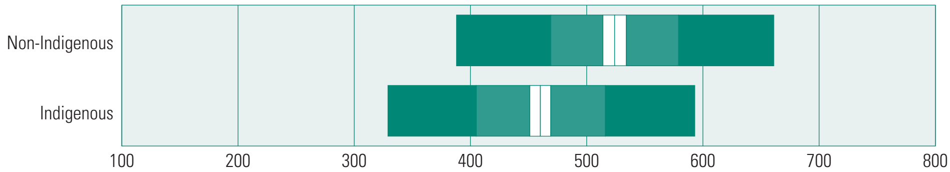


Figure 3.15 Distribution of science achievement within Australia, by Indigenous background

Figure 3.16 adds to the picture of science performance by showing the proportion of Indigenous students and non-Indigenous students in Year 8 in each of the international benchmarks for science.

Eleven per cent of non-Indigenous students, compared to two per cent of Indigenous students, achieved the Advanced benchmark in science. Almost one-quarter (23%) of Indigenous students and seven per cent of non-Indigenous students failed to achieve even the Low benchmark, while 58 per cent of Indigenous students and 28 per cent of non-Indigenous students did not reach the Intermediate benchmark.

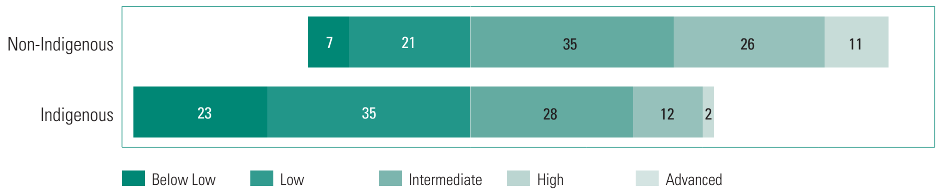


Figure 3.16 Percentages of Australian students at the international benchmarks for science, by Indigenous background

Figure 3.17 shows trends in achievement for Indigenous and non-Indigenous students over the period from 1995 to 2011. None of the differences between years are significant, that is, the 2011 score for Indigenous students, as for non-Indigenous students, is not significantly different to the score in any of the other years of testing. The difference between the two groups is significant, as it has been in each year of testing, and has not decreased in size.

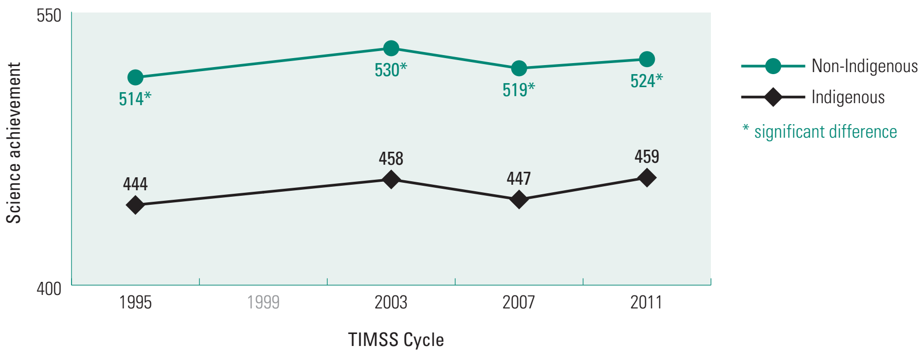


Figure 3.17 Trends in science achievement within Australia, 1995-2011, by Indigenous background

Science achievement by language background

Table 3.11 shows that while the majority of students tested in Year 8 spoke English 'always' or 'almost always' at home, there were around seven per cent of students for whom this was not true. Figure 3.18 shows that there was no significant difference between the means for the two groups in science, the gap from the 5th to 95th percentile is much higher for those students with a language background other than English. The range of scores was 330 score points for students from a language background other than English, and 270 score points for those with an English-speaking background.

This provides some interesting information about students with a language background other than English. At the 95th percentile of achievement, the scores of LBOTE students were as high or higher than those of English-speaking students, however at the 5th percentile, LBOTE students were scoring, on average, about half a standard deviation lower than English-speaking students. Clearly this makes it difficult to generalise non-English speakers as either high or low achievers and further information could be valuable in determining whether there are particular characteristics of this group of students that would allow us to identify some of the problems faced by non-English speaking students in our schools.

Table 3.11 Mean science achievement within Australia, by language background

Language background	% of students	Mean	SE	Gap 95th – 5th percentiles
English	93	521	4.8	270
LBOTE	7	500	9.2	330

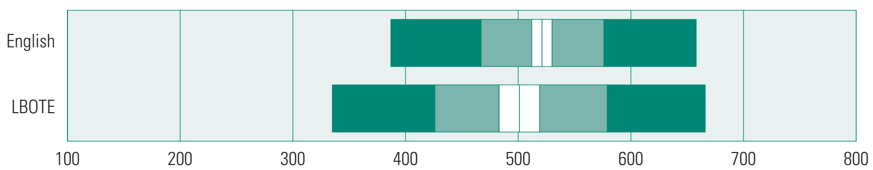


Figure 3.18 Distribution of science achievement within Australia, by language background

Figure 3.19 further exemplifies this, showing that while a slightly higher proportion of students from a language background other than English than English-speaking students achieved the Advanced benchmark (13% and 11%, respectively), larger proportions of English-speaking students performed at each of the High and Intermediate benchmarks. Strikingly, 18 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, with a further 22 per cent of

English speaking students and 24 per cent of other language background students achieving the Low benchmark, a total of 42 per cent of LBOTE and 29 per cent of English-speaking students not achieving the Intermediate benchmark.

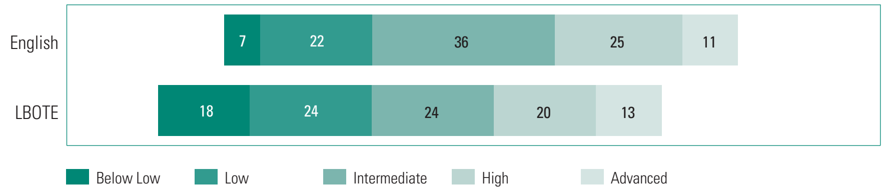


Figure 3.19 Percentages of Australian students at the international benchmarks for science, by language background

Science achievement by geographic location of the school

To undertake the analyses in this section of the report, schools' addresses were coded using the MCEETYA Schools Geographic Location Classification (see 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 Table 3.12. It should be noted that the percentage of students in remote schools is very small (only around one per cent of students) and therefore the level of uncertainty estimate of the mean will be very large, which is reflected in very large standard errors and reducing the likelihood that significant differences between groups will be found (see the Reader's Guide).

Table 3.12 Mean science achievement within Australia, by geographic location

	% of students	Mean	SE	Gap 95th – 5th percentiles
Metropolitan	72	523	5.3	280
Provincial	27	511	8.6	263
Remote	1	466	32.5	298

The difference in scores between metropolitan and provincial schools was not found to be significant – and it can be seen in Figure 3.20, for example, that scores for these two groups are similar at the 5th and 25th percentile

As can be seen in Table 3.12 and Figure 3.20, the spread of achievement of students in remote schools is particularly wide, as is the spread of scores of students in metropolitan schools. For students in remote schools, however, at the lowest levels the score is similar to that of students in developing countries.

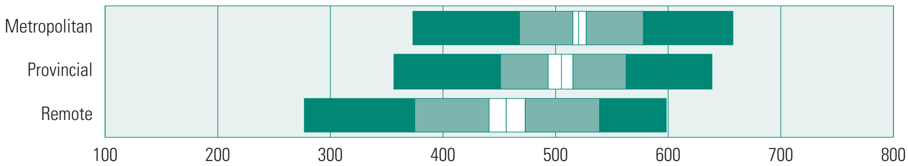


Figure 3.20 Distribution of science achievement within Australia, by geographic location

Figure 3.21 shows the proportion of Year 8 students at each of the international science benchmarks by geographic location. A little over one quarter of students in remote schools were doing very poorly, with 27 per cent not achieving the Low benchmark and a further 24 per cent performing at the Low benchmark. There were also 28 per cent of students in metropolitan schools and 33 per cent in provincial schools who did not achieve the Intermediate benchmark.

The differences in achievement are also evident at the high end of the achievement spectrum. Only four per cent of students from remote schools achieved at the international advanced benchmark, compared with eight per cent of students from provincial schools and 12 per cent of students attending metropolitan schools.

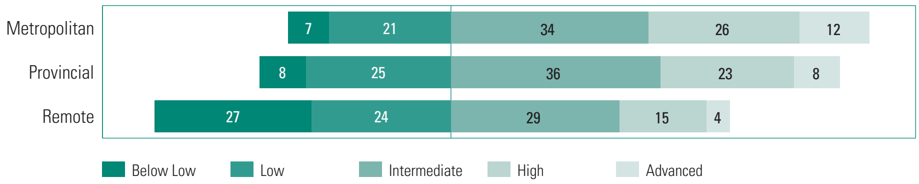


Figure 3.21 Percentages of Australian students at the international benchmarks for science, by geographic location

Achievement in the science content and cognitive domains

As outlined earlier in the chapter, the TIMSS science assessment can be described in terms of content and cognitive domains. The content domain outlines the subject matter to be assessed – at Year 8, *biology, chemistry, physics* and *Earth science.* The cognitive dimension details the thinking processes that students will need to use. The cognitive domains are *knowing*, *applying* and *reasoning*. Each item of the assessment 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 provide a way for participants to examine relative performance in the content domains, IRT scaling was used to place achievement in each of the four content domains and each of the three cognitive domains on the overall science scale for Year 8. Table 3.13 shows the average achievement for each of the states, males and females and Indigenous and non-Indigenous students in each of the Year 8 science content domains, and Table 3.14 provides the average scores for the cognitive domains.

Across Australia, Year 8 students' performance was clearly better in *Earth science* and *biology* than in *chemistry* and *physics*.

The overall gender differences in favour of males in science was reflected in significantly higher scores for males in Earth science and physics, but the difference between non-Indigenous and Indigenous students remained the same in each.

Table 3.13 Relative mean achievement in the science content domains, for Australia, the states and by gender and Indigenous background

	Science overall		Chemistry		Absolute difference from overall science score	Earth Science		Absolute difference from overall science score	Biology		Absolute difference from overall science score	Physics		Absolute difference from overall science score
	Mean	SE	Mean	SE		Mean	SE		Mean	SE		Mean	SE	
Australia	519	4.8	501	5.1	18	533	5.4	14	527	4.7	8	511	5.1	8
ACT	551	9.2	535	9.4	15	569	9.1	19	559	8.5	9	544	8.3	7
NSW	532	10.1	513	11.1	18	545	11.5	14	540	10.3	8	521	10.8	10
VIC	513	7.5	497	7.3	16	525	8.1	12	519	6.7	6	504	7.1	9
QLD	516	7.5	495	8.3	20	532	8.3	16	523	7.1	7	509	7.5	6
SA	506	5.0	489	6.3	17	520	6.9	14	516	5.7	9	499	6.1	7
WA	514	9.2	495	11.2	20	529	11.2	14	524	9.8	10	507	9.9	7
TAS	496	6.4	477	7.7	19	509	7.9	12	506	6.8	9	492	7.5	4
NT	481	14.4	463	14.9	18	492	15.5	11	490	14.5	9	477	13.7	4
Male	528	6.6	506	7.1	21	547	7.3	19	530	6.7	2	523	7.0	5
Female	512	4.5	497	4.7	15	521	5.5	9	525	4.6	14	500	4.8	11
Non-Indigenous	524	5.0	505	5.3	18	538	5.7	15	531	4.9	8	515	5.3	8
Indigenous	459	4.5	439	6.0	21	465	6.5	5	468	5.9	8	453	5.8	6

Note: No statistical differences are calculated between the mean of the overall scale score and the cognitive domains or the content domains. This is because the data in the content domains underpin or contribute to the data in the overall science score.

In terms of the cognitive domains, Australian Year 8 students performed at a level that was significantly higher than the TIMSS scale average in all three cognitive domains *knowing and applying,* and *reasoning*.

Table 3.14 shows that, for Year 8 students, there was little variation from the overall science score for Australia across the states and territories in achievement in the cognitive domains. For each of the cognitive domains, similar patterns emerge. Scores for students in the Australian Capital Territory and New South Wales were significantly higher than the TIMSS scale average, while scores for students in the other states were generally similar to the scale average.

There was a significant gender difference in favour of males in knowing, however the difference in scores between Indigenous and non-Indigenous students remained similar as for science overall.

Table 3.14 Relative mean achievement in the science cognitive domains, for Australia, the states and by gender and Indigenous background

	Science overall		Knowing		Absolute difference from overall science score	Applying		Absolute difference from overall science score	Reasoning		Absolute difference from overall science score
	Mean	SE	Mean	SE		Mean	SE		Mean	SE	
Australia	519	4.8	514	5.4	5	517	4.8	2	526	5.2	7
ACT	551	9.2	552	9.1	2	548	8.3	3	557	9.3	6
NSW	532	10.1	528	11.8	4	528	10.9	3	538	11.3	7
VIC	513	7.5	505	8.2	8	510	6.5	3	520	7.0	8
QLD	516	7.5	511	8.3	5	514	7.5	2	521	8.3	6
SA	506	5.0	501	5.7	5	506	5.5	1	514	5.8	8
WA	514	9.2	510	10.4	4	514	9.9	0	521	10.3	7
TAS	496	6.4	491	7.2	5	496	6.3	1	502	7.3	6
NT	481	14.4	474	15.7	7	482	13.6	2	484	15.2	4
Male	528	6.6	525	7.7	2	525	7.0	3	531	7.5	4
Female	512	4.5	504	4.8	8	510	4.4	2	522	4.5	10
Non-Indigenous	524	5.0	519	5.6	5	521	5.0	2	531	5.4	7
Indigenous	459	4.5	450	6.6	10	461	5.4	2	464	5.7	4

Note: No statistical differences are calculated between the mean of the overall scale score and the cognitive domains or the content domains. This is because the data in the cognitive domains underpin or contribute to the data in the overall science score.

The next chapter focuses on the attitudes and home background of the TIMSS 2011 Year 8 students.

Chapter

4

Student Attitudes

Key findings:

- Students who indicated that they like mathematics or science scored higher on average in the assessments than did other students.
- Among Australian students, male students liked mathematics and science, valued mathematics and were confident with mathematics and science to a greater degree than their female peers. Almost half of the female students surveyed said they did not like mathematics, which has possible implications for the uptake of further mathematics by female students at senior secondary level and beyond. There were no differences in levels at which male and female students valued science, however.
- There were no differences in the average scale scores of Indigenous and non-Indigenous students on the Students Like Learning Mathematics, Students Like Learning Science, Students Value Mathematics or Students Value Science scales. There were, however, significant differences on the Student Confidence with Mathematics and Student Confidence with Science scale, with Indigenous students' scores reflecting lower levels of confidence than their non-Indigenous peers in these subjects. Compared to the international average, the results for Australian students on the Home Educational Resources scale are very positive, and as expected, Australia was one of the countries with the highest proportions of students with *many resources*.
- Non-Indigenous students had a higher average Home Educational Resources scale score, and thus greater educational resources at home, than Indigenous students.
- Students who anticipated going on to university study (either undergraduate or postgraduate) scored higher in mathematics and science than students who anticipated going to on some other form of post-secondary study, or who thought that they would end their education with secondary school. This pattern was found internationally, for Australian students (on average), females and males and non-Indigenous students. Among Indigenous students, those who aspired to any form of post-secondary study recorded higher scores in mathematics and science than those who anticipated ending their education with secondary school.

This chapter looks at student-level factors, such as home background and student attitudes that are potentially related to student achievement. In particular, this chapter presents detailed information about students' attitudes towards mathematics and science, the value they place on mathematics and science, their self-confidence with mathematics and science, their resources for learning at home and their educational aspirations.

Students' attitudes towards mathematics and science

Developing positive attitudes towards mathematics and science is an important goal of the curriculum in many countries. To summarise information about progress towards these goals, TIMSS examined students' general attitudes towards mathematics and science, the value they place on mathematics and science as a way of improving their lives and their self-confidence with mathematics and science.

Students' positive affect towards mathematics and science

Students like learning mathematics

To investigate how students feel about mathematics, TIMSS created a Students Like Learning Mathematics scale, based on students' responses to five statements about mathematics:

- I enjoy learning mathematics
- I wish I did not have to study mathematics (reverse scored)
- Mathematics is boring (reverse scored)
- I learn many interesting things in mathematics
- I like mathematics.

Students were asked to indicate their level of agreement with each statement and their responses were combined to create the Students Like Learning Mathematics scale.

Students who *like learning mathematics* had a score on the scale of at least 11.3, which corresponds to them 'agreeing a lot' with three of the items and 'agreeing a little' to the other two, on average. Students who *do not like learning mathematics* had a score that was no higher than 9.0, corresponding to them 'disagreeing a little' with three of the five statements and 'agreeing a little' to the remaining two. All other students were classified as *somewhat like learning mathematics*.

Table 4.1 shows the percentage of students at each level of the scale, and the average mathematics achievement of students at each level, for both Australian students and the international average.

Table 4.1 The Students Like Learning Mathematics scale and student achievement in mathematics, Australia and the international average

	Like learning mathematics				Somewhat like learning mathematics				Do not like learning mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	16	0.9	553	7.5	40	0.9	520	5.6	45	1.4	476	4.4	9.3	0.1
International average	26	0.3	504	0.8	42	0.1	467	0.6	31	0.2	443	0.7		

In Australia, 16 per cent of Year 8 students *like learning mathematics*, which was lower than the international average of 26 per cent of students. Around 40 per cent of students *somewhat like learning mathematics*, both in Australia and among participating countries on average, while 45 per cent of Australian students *do not like learning mathematics*, compared to 31 per cent across participating countries.

Morocco was the country with the highest proportion of students in the *like learning mathematics* category at 48%, although the average achievement of students in this category was well below the TIMSS scale mean, at 398 points. Interestingly, some of the highest performing countries, like Japan and Korea, were among the countries with the lowest proportions of students who *like learning mathematics*, at nine and eight per cent respectively.

As shown in Table 4.1, average mathematics achievement across countries was highest among students who *like learning mathematics* (504 points), next highest among those at the medium level (467 points), and lowest among those who *do not like learning mathematics* (443 points). Among Australian Year 8 students, a similar pattern was found and all performance differences between the groups were significant.

Gender

Table 4.2 shows the percentage of female and male Australian students at each level of the scale, and the average mathematics achievement of students at each level.

The proportion of male students who *like learning mathematics* was greater than the proportion of female students who do so (18% vs 14%). Conversely, the proportion of female students in the *do not like mathematics* category (48%) was significantly higher than the proportion of male students in this category (41%). This is of particular concern given the decline in the number of both male and female students enrolling in further mathematics in the latter years of secondary school and beyond, and for the participation of females in STEM careers.

Table 4.2 The Students Like Learning Mathematics scale and student achievement in mathematics, by gender

	Like learning mathematics				Somewhat like learning mathematics				Do not like learning mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Females	14	1.0	546	6.1	38	1.0	517	6.5	48	1.7	476	4.5	9.2	0.1
Males	18	1.3	559	10.9	41	1.4	522	7.4	41	1.9	477	5.8	9.5	0.1

The pattern of higher average mathematics achievement scores among students who *like learning mathematics*, followed next by those who *somewhat like learning mathematics,* with the lowest average scores among those who *do not like learning mathematics,* was found among male and female students. The average mathematics scores of male and female students in each category (*like learning mathematics, somewhat like learning mathematics* and *do not like learning mathematics*) were not statistically significantly different from one another. There was, however, a difference found in the average scale scores of male and female students, with male students recording higher values on the Students Like Learning Mathematics scale than female students, on average.

Indigenous background

The results for Indigenous and non-Indigenous students on the Students Like Learning Mathematics scale, and their TIMSS mathematics achievement scores, are presented in Table 4.3. There was no significant difference in the average scale scores of Indigenous and non-Indigenous students, indicating that, on average, liking or not liking mathematics was independent of Indigenous background.

The proportion of non-Indigenous students who *like learning mathematics* (16%) was significantly higher than the proportion of Indigenous students who were in this category (10%). Unfortunately, the proportion of Indigenous and non-Indigenous students who *do not like learning mathematics* was the same – 44%.

Table 4.3 The Students Like Learning Mathematics scale and student achievement in mathematics, by Indigenous background

	Like learning mathematics				Somewhat like learning mathematics				Do not like learning mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Non-Indigenous	16	1.0	556	7.6	40	0.9	525	5.7	44	1.5	479	4.6	9.3	0.1
Indigenous	10	1.5	484	15.6	46	2.1	439	6.1	44	2.4	431	6.5	9.1	0.1

Among non-Indigenous students, the same pattern as was found for Australian students as a whole, and male and female students (see Table 4.2) was found, with those who *like learning mathematics* performing better in the TIMSS mathematics assessment, on average, than students who only *somewhat like learning mathematics* or who *do not like learning mathematics*. Among Indigenous students, however, those who *like learning mathematics* scored higher than those who *somewhat like learning mathematics* but there was no significant difference in the average scores of those who *do not like learning mathematics* and those who *somewhat like learning mathematics*.

In each category of the Students Like Learning Mathematics scale, non-Indigenous students recorded higher average mathematics scores than their Indigenous peers.

Students like learning science

As for mathematics, a Students Like Learning Science scale was created, based on students' responses to five statements about science:

- I enjoy learning science
- I wish I did not have to study science (reverse scored
- Science is boring (reverse scored)
- I learn many interesting things in science
- I like science.

Table 4.4 shows the percentage of students at each level of the scale, and the average science achievement of students at each level, for both Australian students and the international average (of countries in which science was taught as an integrated subject, rather than as separate subject areas, such as biology, chemistry, etc).

Table 4.4 The Students Like Learning Science scale and student achievement in science, Australia and the international average

	Like learning science				Somewhat like learning science				Do not like learning science				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	25	1.3	559	6.1	42	1.0	521	4.8	33	1.3	490	4.9	9.3	0.1
International average	35	0.2	515	0.8	44	0.2	472	0.8	21	0.2	450	1.1		

At Year 8, on average across countries where science was taught as a single subject, 35 per cent of students *like learning science*, compared with 44 per cent at the medium level and 21 per cent who *do not like learning science*. In Australia, 25 per cent of Year 8 students *like learning science*, 42 per cent *somewhat like learning science* and 33 per cent *do not like learning science.*

Among the other countries who teach science as an integrated or general subject at Year 8, Tunisia recorded the highest proportion (56%) of students who *like learning science*, while two of the top performing countries, Japan and Korea, recorded the lowest proportions of students who *like learning science*, at 15 per and 11 per cent respectively.

As shown in Table 4.4, on average among countries who taught science as a general or integrated subject, science achievement was higher among students at the high level of the scale (those who *like learning science*) than among those who only *somewhat like learning science* or who *do not like learning science*. Results for Australian students showed the same pattern, with students who *like learning science* scoring 559 points on the TIMSS Science assessment on average, while those who only *somewhat like learning science* or who *do not like learning science* scoring 521 and 490, respectively.

Gender

The proportions of female and male students in each of the Students Like Learning Science categories, along with their average science scores, are presented in Table 4.5.

A greater proportion of male students, compared to female students, were in the *like learning science category* (29% compared to 21%), while a greater proportion of female students (37%) were in the *do not like learning science* category, compared to their male peers (30%).

This difference in the proportions in the scale categories was reflected in the average Students Like Learning Science scale scores recorded by female students and male students, with male students recording a significantly higher score than females.

Table 4.5 The Students Like Learning Science scale and student achievement in science, by gender

	Like learning science				Somewhat like learning science				Do not like learning science				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Females	21	1.4	545	5.0	42	1.3	516	4.8	37	1.8	488	5.9	9.1	0.1
Males	29	1.8	568	8.5	41	1.2	526	6.2	30	1.6	492	6.3	9.5	0.1

Comparing the average sciences scores of female and male students in each of the Students Like Learning Science categories, there was a significant difference in the proportion of female and male students who *like learning science*. Among these students who actually liked science, who performed better on average than their peers who *somewhat like science* or *do not like science*, male students recorded higher scores, on average, than female students. There were no differences in the average science scores of female and male students in the other categories.

Indigenous background

As shown in Table 4.6, the proportions of Indigenous and non-Indigenous students who *like learning science*, *somewhat like learning science* or *do not like learning science* were similar, with around one-quarter liking learning science and one-third not liking learning science. The average Students Like Learning Science scale scores of Indigenous and non-Indigenous students were also similar, indicating that Indigenous and non-Indigenous students report similar levels of liking learning science.

Table 4.6 The Students Like Learning Science scale and student achievement in science, by Indigenous background

	Like learning science				Somewhat like learning science				Do not like learning science				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Non-Indigenous	25	1.4	562	6.2	41	1.0	526	4.8	33	1.4	492	5.1	9.3	0.1
Indigenous	22	3.1	493	8.8	46	2.8	456	6.3	32	2.8	445	7.3	9.1	0.1

In each category of the Students Like Learning Science scale, non-Indigenous students recorded higher average science scores than their Indigenous peers.

Among non-Indigenous students, the same pattern as was found for Australian students as a whole, and male and female students (see Table 4.5) was found, with those who *like learning science* recording higher science scores, on average, than students who only *somewhat like learning science,* who in turn recorded higher scores than those who *do not like learning science*. Among Indigenous students, however, those who *like learning science* scored higher than those who *somewhat like learning science* but those who *do not like learning science* and those who *somewhat like learning science* recorded statistically similar scores in the science assessment.

Students' valuing of mathematics and science

In addition to having a positive attitude towards 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.

Students value mathematics

The TIMSS Students Value Mathematics scale is based on Year 8 students' responses to six 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;
- I need to do well in mathematics to get the job I want;
- I would like a job that involves using mathematics; and
- It is important to do well in mathematics.

Students were asked their level of agreement with each statement, and were scored on the scale based on their levels of agreement. Their scores were then used to allocate them to the categories shown in Table 4.3.

Students who *value mathematics* had a score on the scale of at least 10.3, which corresponds to them 'agreeing a lot' with three of the six statements and 'agreeing a little' to the other three. Students who *do not value mathematics*, in contrast, had a score no higher than 7.9, which would correspond with them 'disagreeing a little' with three of the statements and 'agreeing a little' with the other three, on average. All other students were assigned to the *somewhat value mathematics* group.

Table 4.7 shows that just under half of Australian Year 8 students placed a high value on mathematics, with a further 40 per cent who *somewhat value mathematics* and only 14 per cent who *do not value mathematics*. These proportions were very similar to the international average.

Ghana was the participating country with the highest proportion of students who *value mathematics*, with more than three-quarters (78%) of its students in this category. This contrasted sharply with the situation in Korea, Chinese Taipei and Japan, all of whom were among the top performers in mathematics but who had less than 15 per cent (14%, 13% and 13% respectively) of their students in the *value mathematics* category. In developing countries such as Ghana, perceptions of students about the value of mathematics may be strongly influenced by it being seen as a key to self-improvement, whereas in highly developed countries there are many more options.

Table 4.7 The Students Value Mathematics scale and student achievement in mathematics, Australia and the international average

	Value mathematics				Somewhat value mathematics				Do not value mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	46	0.9	521	5.6	40	0.8	499	4.8	14	0.7	475	6.1	10	0.0
International average	46	0.2	482	0.7	39	0.1	463	0.6	15	0.1	439	0.9		

Across the participating countries, on average, and among Australian students, those Year 8 students who *value mathematics* had significantly higher average mathematics achievement than students who *somewhat value mathematics* or who *do not value mathematics*.

Gender

Table 4.8 presents the proportions of female and male students in each category of the Students Value Mathematics scale, and their average mathematics scores.

Just over 50 per cent of male students were in the *value mathematics* category, which was significantly higher than the 40 per cent of female students in this category. The proportion of female students in the *somewhat value mathematics* category was higher than the proportion of male students in this group.

The average Students Value Mathematics scale scores of male students (10.1) was higher than the average score of female students (9.8), indicating that, on average, Year 8 males value mathematics to a greater degree than do Year 8 females.

Table 4.8 The Students Value Mathematics scale and student achievement in mathematics, by gender

	Value mathematics				Somewhat value mathematics				Do not value mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Females	41	1.2	514	5.5	43	1.1	498	4.9	16	1.1	476	6.9	9.8	0.0
Males	51	1.5	526	7.4	36	1.0	500	7.4	13	1.0	474	7.7	10.1	0.1

Among male and female students, those who *value mathematics* had significantly higher average mathematics achievement than students who *somewhat value mathematics* or who *do not value mathematics*. There were no significant differences between the average scores of male and female students in each of the Students Value Mathematics scale categories.

Indigenous background

As shown in Table 4.9, there were no significant differences in the proportion of Indigenous and non-Indigenous students in each of the Students Value Mathematics categories. Nor was there a difference in the average Students Value Mathematics scale scores for these two groups of students.

Table 4.9 The Students Value Mathematics scale and student achievement in mathematics, by Indigenous background

	Value mathematics				Somewhat value mathematics				Do not value mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Non-Indigenous	46	1.0	525	5.7	40	0.8	503	4.9	14	0.8	479	6.7	10.0	0.0
Indigenous	43	3.1	449	5.8	40	2.5	436	8.7	17	2.4	423	13.7	9.8	0.2

While the same relationship between valuing mathematics and mathematics scores that was found for Australian Year 8 students overall and among males and females was found for non-Indigenous students (with those who *value mathematics* scoring higher on average than those who *somewhat value mathematics* or *do not value mathematics*), there was no such relationship found among Indigenous students – there were no significant differences in the mathematics scores of Indigenous students in each of the three categories.

Students value science

As for mathematics, the Students Value Science scale was based on Year 8 students' responses to six 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 choic
- I need to do well in science to get the job I want
- I would like a job that involves using science
- It is important to do well in science.

Students were asked to indicate if they 'agreed a lot', 'agreed a little', 'disagreed a little' or 'disagreed a lot' with each statement.

The Students Value Science scale was then created based on these responses. For general or integrated science (as is taught in Australia), students who *value science* have a score on the scale of at least 10.5, which corresponds to them 'agreeing a lot' with three of the six statements and 'agreeing a little' with the remaining three, on average. Students who *do not value science* had a score no higher than 8.6, corresponding to them 'disagreeing a little' with three of the six statements and 'agreeing a little' with the other three. All other students were assigned to the *somewhat value science* category.

Table 4.10 shows the percentage of students, and their average science achievement, at each level of the Students Value Science scale for Australia and the international average for countries who taught a general or integrated science subject.

Table 4.10 The Students Value Science scale and student achievement in science, Australia and the international average

	Value science				Somewhat value science				Do not value science				Average Scale Score	SE
	%of students	SE of %	Average science achievement	SE	%of students	SE of %	Average science achievement	SE	%of students	SE of %	Average science achievement	SE		
Australia	25	1.3	557	6.4	31	0.8	525	5.5	44	1.3	496	3.8	9.1	0.1
International average	41	0.2	502	0.8	33	0.2	477	0.8	26	0.2	457	1.1		

Around 25 per cent of Australian Year 8 students *value science*, 31 per cent *somewhat value science* and 44 per cent *do not value science*. On average across the countries that taught science as an integrated subject, 41 per cent *value science* and 26 per cent *do not value science* – the opposite pattern, in fact, as was found amongst Australian students.

Among the other participating countries in which science was taught as an integrated subject at Year 8, Ghana had the highest proportion of students in the *value science* category, at 80%. Chinese Taipei and Japan, two of the higher performing countries in TIMSS science, were again those who recorded the lowest proportions of students who *value science*, with 12 and 10 per cent, respectively.

In Australia, as internationally, Year 8 students who *value science* had higher average science achievement (557 score points on average for Australian students) than students who *somewhat value science* (525 for Australian students, 477 on average internationally) or who *do not value science* (496 for Australian students and 457 internationally). All differences were statistically significant.

Gender

Similar proportions of female and male students were in each of the Students Value Science categories, as shown in Table 4.11. There was no significant difference in the average scale scores of male and female students either, indicating that among Australian Year 8 students, male and females value science at similar levels.

Table 4.11 The Students Value Science scale and student achievement in science, by gender

	Value science				Somewhat value science				Do not value science				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Females	24	1.3	545	5.4	30	0.9	517	5.5	46	1.4	492	4.8	9.0	0.1
Males	27	1.8	567	8.9	32	1.3	533	7.3	41	2.1	500	4.6	9.2	0.1

While a similar relationship between valuing of science and science scores was found for female and male students, with higher scores recorded by those who *value science,* followed by those who *somewhat value science* and the lowest average scores recorded by those who *do not value science,* there was also a gender difference in achievement found among those students who value science. In this category, male students recorded higher science scores (567 points), on average, than did female students (545 points).

Indigenous background

Table 4.12 presents the proportions of Indigenous and non-Indigenous students in each of the three Students Value Science categories, along with their average science scores and the average Students Value Science scale score.

There were no differences in the proportions of Indigenous and non-Indigenous students who were in each category of Students Value Science, nor was there any difference between their average scores on the Students Value Science scale (9.1 for both Indigenous and non-Indigenous students).

Table 4.12 The Students Value Science scale and student achievement in science, by Indigenous background

	Value science				Somewhat value science				Do not value science				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Non-Indigenous	26	1.4	560	6.4	31	0.9	531	5.6	44	1.5	498	4.0	9.1	0.1
Indigenous	21	2.2	481	8.1	34	2.8	450	9.0	45	3.5	459	7.6	9.1	0.1

In each category of the Students Value Science scale, non-Indigenous students recorded higher science scores, on average, compared to their non-Indigenous peers.

Among Indigenous students, those who *value science* recorded significantly higher science scores than those who *somewhat value science*, but there was no difference in the average science scores of those who *somewhat value science* (450 points) and those who *do not value science* (459 points).

The pattern of science performance across the Students Value Science categories among non-Indigenous students was the same as that found among Australian Year 8 students in general (Table 4.10) with those who value science recording the highest average scores, followed next by those who somewhat value science and lastly by those who do not value science.

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 and experiences in and out of the classroom.

Student confidence with mathematics

To investigate students' beliefs about their abilities in mathematics, TIMSS created a scale called Student Confidence with Mathematics, based on students' responses to nine statements about their mathematics ability:

- I usually do well in mathematics
- Mathematics is more difficult for me than for many of my classmates (reverse scored)
- Mathematics is not one of my strengths (reverse scored)
- I learn things quickly in mathematics
- Mathematics makes me confused and nervous (reverse scored)
- I am good at working out difficult mathematics problems
- My teacher thinks I can do well in mathematics classes with difficult materials
- My teacher tells me I am good at mathematics
- Mathematics is harder for me than any other subject.

Students were asked to indicate their level of agreement with each statement. Their levels of agreement were then used to create the scale. Students who were *confident with mathematics* had a scale score of at least 12.0, which corresponds to them 'agreeing a lot' with five of the nine statements and 'agreeing a little' with the other four. Students who were *not confident with mathematics* scored no higher than 9.4 on the scale, which corresponds with them 'disagreeing a little' with five of the nine statements and 'agreeing a little' with the other four statements, on average. All of other students were classified as s*omewhat confident with mathematics*.

Table 4.13 shows the percentage of students in each category of the Student Confidence with Mathematics scale, and the average mathematics achievement of students at each level, for both Australian students and the international average.

Table 4.13 The Student Confidence with Mathematics scale and student achievement in mathematics, Australia and the international average

	Confident with mathematics				Somewhat confident with mathematics				Not confident with mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	17	1.1	581	6.8	46	0.8	516	4.8	37	1.4	456	3.8	10.2	0.1
International average	14	0.1	539	0.9	45	0.1	478	0.6	41	0.2	435	0.6		

The proportions of Australian Year 8 students in each category of the Student Confidence with Mathematics scale were quite similar to the international proportions. In Australia, 17 per cent of Year 8 students were classified as *confident with mathematics*, with another 46 per cent *somewhat confident with mathematics* and 37 per cent *not confident with mathematics*.

Over one third of students from Israel were *confident with mathematics*, the highest proportion among participating countries. Japan and Thailand had the lowest proportions of students who were *confident with mathematics*, at only two per cent (an interesting finding given Japan's relatively high performance in TIMSS mathematics).

Among Australian students, and across participating countries on average, there was a positive association at Year 8 between mathematics performance and self-confidence. Australian Year 8 students who were *confident with mathematics* had the highest average mathematics performance score (581 points), followed by students who were *somewhat confident with mathematics* (516 points) and students who were *not confident with mathematics* had the lowest average score (456 points).

Gender

In Australia (see Table 4.14), 21 per cent of Year 8 male students compared to 14 per cent of female students were confident with mathematics, whereas 43 per cent of female students were not confident with mathematics compared to 31 per cent of male students.

These differences in the proportions of male and female students in each of the Student Confidence with Mathematics categories is reflected in the average scale scores, with males scoring higher on average (10.5) on the Confident with Mathematics scale than females (9.9).

Table 4.14 The Student Confidence with Mathematics scale and student achievement in mathematics, by gender

	Confident with mathematics				Somewhat confident with mathematics				Not confident with mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Females	14	0.9	574	7.2	43	1.1	520	5.3	43	1.5	458	4.3	9.9	0.1
Males	21	1.8	586	9.1	48	1.2	513	6.4	31	2.0	454	4.5	10.5	0.1

There were no significant differences in the average mathematics scores of female and male students in each of the Confident with Mathematics categories. Those students, both male and female, who were *confident with mathematics* had higher mathematics scores on average than students who were *somewhat confident with mathematics* or who were *not confident with mathematics*.

Indigenous background

Table 4.15 presents the proportions of Indigenous and non-Indigenous students in each of the Confident with Mathematics categories, along with their average mathematics scores and average scores on the Confident with Mathematics scale.

The proportion of Indigenous students who were *confident with mathematics* was significantly lower than the proportion of non-Indigenous students in this category – 10 per cent compared to 18 per cent. The proportion of Indigenous students in the *not confident with mathematics* category, however, was significantly higher than the proportion of non-Indigenous students in this category. These differences were reflected in the average Confident with Mathematics scale scores, with non-Indigenous students recording higher scores on average than Indigenous students (10.2 compared to 9.8).

Table 4.15 The Student Confidence with Mathematics scale and student achievement in mathematics, by Indigenous background

	Confident with mathematics				Somewhat confident with mathematics				Not confident with mathematics				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Non-Indigenous	18	1.2	583	7.0	46	0.8	521	4.8	36	1.4	459	4.0	10.2	0.1
Indigenous	10	1.6	526	10.0	46	3.0	447	6.4	43	3.0	413	6.8	9.8	0.1

Among Indigenous and non-Indigenous students, those who were *confident with mathematics* scored higher on average in the TIMSS mathematics assessment than did students who were *somewhat confident with mathematics* or *not confident with mathematics.* In each category, the average mathematics score of non-Indigenous students was significantly higher than the average scores of Indigenous students.

Student confidence with Science

As for mathematics, TIMSS created a Student Confidence with Science scale, based on students' responses to nine statements about their science ability:

- I usually do well in science
- Science is more difficult for me than for many of my classmates (reverse scored)
- Science is not one of my strengths (reverse scored)
- I learn things quickly in science
- Science makes me confused and nervous (reverse scored)
- I am good at working out difficult science problems
- My teacher thinks I can do well in science lessons with difficult materials
- My teacher tells me I am good at science
- Science is harder for me than any other subject (reverse scored).

Students were asked to indicate their level of agreement with each statement. Their responses were then combined to create the Student Confidence with Science scale. Students who were *confident with science* had a scale score of at least 11.5, which corresponds to them 'agreeing a lot' with five of the statements above and 'agreeing a little' with the other four, on average. Students who were *not confident with science* had a score no higher than 9.0, which corresponds to them 'disagreeing a little' with five of the nine statements and 'agreeing a little' with the remaining four. All other students were assigned to the *somewhat confident with science* category.

Table 4.16 shows the percentage of students at each category of the scale, and the average science achievement of students at each level, for both Australian students and the international average.

Table 4.16 The Student Confidence with Science scale and student achievement in science, Australia and the international average

	Confident with science				Somewhat confident with science				Not confident with science				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	16	1.1	575	6.5	49	1.1	527	4.8	35	1.4	486	4.6	9.8	0.1
International average	20	0.2	536	1.0	49	0.2	482	0.8	31	0.2	450	0.9		

The proportions of Australian Year 8 students who were classified into the three groups based on their confidence levels in science were similar to those found across participating countries (who taught science as an integrated subject) on average, and were also quite similar to the proportions found for confidence in mathematics (see Table 4.15). Sixteen per cent of students were *confident with science*, 49 per cent were *somewhat confident with science* and 35 per cent were *not confident with science*.

Over one-third of students in Tunisia (37%) were *confident with science*, which was the highest proportion among all participating countries who taught science as an integrated subject (rather than as separate strands such as biology or chemistry) at Year 8. As was found for mathematics, Japan was once again the country with the lowest proportion of students who were *confident with science*, with only three per cent of its students in this category – far lower than the international average and Australia's 16 per cent.

As was found for mathematics, there was a positive relationship between self-confidence and performance in science, both internationally and within Australia. Australian students who were *confident with science* (575 points) scored significantly higher than those who were only *somewhat confident with science* (527 points) and those who were *not confident with science* (486 points).

Gender

Twenty-nine per cent of Year 8 males compared to 21 per cent of females recorded high levels of self-confidence in science, being placed in the *confident with science* category, while 37 per cent of females compared to 30 per cent of males were *not confident with science*. There was a significant difference in the average Student Confidence with Science scale scores of male and female students, with male students recording higher scores, on average, than their female peers (see Table 4.17).

Both male and female students who were *confident with science* scored higher on average in the TIMSS science assessment than students who were *somewhat confident with science*, who in turn scored higher than students who were *not confident with science*.

Table 4.17 The Student Confidence with Science scale and student achievement in science, by gender

	Confident with science				Somewhat confident with science				Not confident with science					
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	Average Scale Score	SE
Females	21	1.4	545	5.0	42	1.3	516	4.8	37	1.8	488	5.9	9.5	0.1
Males	29	1.8	568	8.5	41	1.2	526	6.2	30	1.6	492	6.3	10.0	0.1

Table 4.17 also indicates that, unlike the trend observed for mathematics, there was a significant difference in average science achievement between males and females within each category of the Students Confident with Science scale, with male students in each category scoring higher on the TIMSS science assessment than did female students in that category.

Indigenous background

Table 4.18 presents the proportions of Indigenous and non-Indigenous students in each of the categories of the Students Confident with Science scale, along with their overall scale score and their average scores on the science assessment.

Ten per cent of Indigenous students were confident with science, compared to 17 per cent of non-Indigenous students, but there was no significant difference in the proportions of Indigenous and non-Indigenous students who were *not confident with science.* There was, however, a significant difference in the average Student Confidence with Science scale scores of these two groups of students, with non-Indigenous students having higher scores, and thus being slightly more confident, than their Indigenous peers.

Table 4.18 The Student Confidence with Science scale and student achievement in science, by Indigenous background

	Confident with science				Somewhat confident with science				Not confident with science				Average Scale Score	
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		SE
Non-Indigenous	17	1.1	578	6.5	48	1.2	531	4.8	35	1.5	489	4.8	9.8	0.1
Indigenous	10	1.6	521	12.9	52	2.9	463	5.8	38	2.7	441	6.3	9.5	0.1

The same relationship between confidence with science and scores on the TIMSS science assessment was found for Indigenous and non-Indigenous students, with those who were *confident with science* scoring highest on the assessment, followed by those who were *somewhat confident with science* and then by those who were *not confident with science.* Within each category, non-Indigenous students recorded higher average achievement scores than did Indigenous students.

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. These resources may be physical, such as books or an internet connection, or in the form of more intangible attributes such as parental education or occupation. Past cycles of TIMSS have found a strong relationship between parental education and student achievement. Parental education is both an indicator of socio-economic status (SES) and also an indicator of educational capital in the form of positive attitudes towards learning and higher expectations of their children. The number of books in the home has also been found to be strongly related to mathematics and science achievement.

The Home Educational Resources scale was created using Year 8 students' responses to three items:

- Parents educational background
- Number of books in the home
- Home study supports – students having their own room, and an Internet connection at home.

Just under one third of Australian Year 8 students reported that at least one of their parents had finished university (although response rates to this particular item were quite low). Over 40 per cent had more than 100 books in the home and 86 per cent reported having their own room and an Internet connection at home.

Students with *many resources* had a score on the scale of at least 12.5, which corresponds to them reporting that they had more than 100 books in the home, both home study supports (own room and an Internet connection) and that at least one of their parents had finished university, on average. In contrast, students with few resources had a scale score no higher than 8.2, which corresponds to them reporting that they had 25 or fewer books in the home, neither their own room nor an Internet connection and that neither parents had gone beyond upper-secondary school. All other students were classified as having *some resources*.

Table 4.19 presents the proportions of students in each of the three groups formed for the Home Educational Resources scale, along with the average mathematics achievement for each group, for Australian students and for the average across participating countries.

Table 4.19 The Home Educational Resources scale and student achievement in mathematics and science, Australia and the international average

	% of students	SE of %	Average mathematics score	SE	Average science score	SE	Average Scale Score	SE
Many resources								
Australia	22	1.4	558	8.9	577	7.6	11.2	0.1
International average	12	0.1	530	1.2	540	1.1		
Some resources								
Australia	75	1.3	494	4.3	508	4.0		
International average	67	0.2	470	0.6	480	0.6		
Few resources								
Australia	4	0.4	430	7.9	433	7.7		
International average	21	0.2	415	1.0	424	1.0		

Just over one in five Australian students had *many resources* at home, while three in four had some resources. Only 4 per cent of Australian students had *few resources* at home. Compared to the international average, the conditions for Australian students are very favourable – just over 10 per cent of students on average across participating countries had *many resources,* around two-thirds had *some resources* and almost one in every five had *few resources*.

Compared to the international average, the results for Australian students are very positive, and as expected, Australia was one of the countries with the highest proportions of students with *many resources.* Korea and Norway were the countries with the highest proportion, 32 per cent, of their students in the many resources category. Ghana and Indonesia were the countries with the lowest proportions of students with many resources at home, with only one per cent of students in this category.

Unsurprisingly, there was a positive association between the level of Home Educational Resources and students' performance in mathematics and science, both internationally and within Australia. Students with many resources scored higher on average than students with some or few resources (see Table 4.19).

Gender

In Table 4.20, the proportions of female and male students in each of the categories created for the Home Educational Resources scale are presented, along with the average mathematics and science achievement scores.

Similar proportions of female and male students were in each of the categories of the Home Educational Resources scale, around 20 per cent with *many resources,* over 70 per cent with some *resources* and less than five per cent with *few resources.* There was no difference in the average Home Education Resources scale scores of female and male students, either.

For female and male students, those with *many resources* tended to score higher on average in the TIMSS mathematics and science assessments, followed by those who had *some resources* and those who had *few resources* recording the lowest achievement scores, on average.

Table 4.20 The Home Educational Resources scale and student achievement in mathematics and science, by gender

	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	Average Scale Score	SE
Many resources								
Females	21	1.3	549	7.2	562	5.7	11.2	0.1
Males	23	2.0	565	14.3	590	11.6	11.1	0.1
Some resources								
Females	76	1.2	491	4.3	502	4.0		
Males	73	1.9	497	5.4	514	5.0		
Few resources								
Females	3	0.6	425	9.9	429	11.0		
Males	4	0.6	434	8.8	436	8.5		

For mathematics achievement, there were no differences found between the average scores of female and male students in each of the Home Educational Resources categories, while for science achievement, there was a significant difference found in the *many resources* category, with male students in this category scoring higher on average than female students in the same category.

Indigenous background

Table 4.21 presents the proportions of Indigenous and non-Indigenous students in each of the Home Educational Resources categories, along with their average mathematics and science scores.

As can be seen from these results, there are vast differences in the resources that Indigenous and non-Indigenous report having available in their homes: while around one in five non-Indigenous students were in the *many resources* category, only one in every ten Indigenous students was so fortunate. Three times as many Indigenous students, compared to non-Indigenous students, were in the *few resources category*. As expected, given these differences, there was a significant difference in the average Home Educational Resources scale scores of these two groups of students, with non-Indigenous students recording higher scores on average, and thus greater educational resources at home, than Indigenous students.

Table 4.21 The Home Educational Resources scale and student achievement in mathematics and science, by Indigenous background

	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	Average Scale Score	SE
Many resources								
Non-Indigenous	22	1.4	560	8.7	579	7.5	11.2	0.1
Indigenous	9	1.5	479	14.5	514	12.7	10.2	0.1
Some resources								
Non-Indigenous	74	1.3	497	4.4	511	4.1		
Indigenous	79	1.9	441	5.3	462	5.0		
Few resources								
Non-Indigenous	3	0.4	439	9.2	439	9.5		
Indigenous	12	1.3	390	14.3	403	11.3		

Among Indigenous and non-Indigenous students alike, those with *many resources* scored higher on the TIMSS mathematics and science assessments than those with *some resources*, who in turn scored higher than students with *few resources*. Within each of these categories, non-Indigenous students recorded higher scores on average than Indigenous students.

Students' educational aspirations

Table 4.22 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.

Over one third of Year 8 students in Australia expect to attend university, with 20 per cent expecting to earn a post graduate qualification (including PhDs, Doctorates, Masters or some other postgraduate degree or diploma). Thirty per cent expected to complete some form of post-secondary qualification (such as an apprenticeship or traineeship or a TAFE qualification) but not to attend university. Around one in five expected to complete either Year 12 or lower before leaving school and 15 per cent of students did not know what level of education they might complete. Compared to the international average, fewer Australian students expected to attend university, while more expected to continue with some form of non-university post-secondary education (this may be due to the strength of the TAFE system in Australia).

Saudi Arabia recorded the highest proportion of student expecting to complete a postgraduate degree at university, with almost two-thirds (62%) of their students aspiring to this level of education. Interestingly, only two per cent of Japanese students expected to undertake a postgraduate degree (with 46% expecting to complete an undergraduate degree), despite their relatively strong performance in both mathematics and science, which may reflect a highly competitive entry system in that country.

Table 4.22 Students' educational aspirations and student achievement in mathematics and science, Australia and the international average

	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE
Postgraduate degree						
Australia	20	1.2	561	8.2	570	7.8
International average	29	0.2	504	0.8	513	0.8
University but not postgraduate degree						
Australia	14	0.7	543	6.7	552	6.3
International average	27	0.1	482	0.7	492	0.7
Post-secondary but not university						
Australia	30	1.0	487	4.0	508	4.2
International average	14	0.1	445	0.9	456	0.9
Upper-secondary education or less						
Australia	22	1.1	454	4.6	470	4.6
International average	15	0.1	402	0.9	412	1.0
Do not know						
Australia	15	0.7	524	6.7	534	6.7
International average	15	0.1	450	1.0	457	1.0

Internationally, and in Australia, there appeared to be a relationship between educational expectations and students' performance in mathematics and science.

Among Australian students, those who expected to attend university (whether to complete an undergraduate or postgraduate degree) scored higher on average than those who expected to complete some other form of post-secondary qualification but not at university. Those who expected to complete some post-secondary education scored higher than those who expected to leave education after completing Year 12 or a lower year level. Interestingly, those Australian students who were unsure of their educational plans actually scored higher on average in mathematics and science than did students who expected to complete some post-secondary qualification or upper-secondary only.

Internationally, the pattern was more straightforward, which each category of educational expectation scoring higher than the category below it – for example, those who expected to complete a postgraduate degree scored higher than those who expected to complete an undergraduate degree, who in turn scored higher than those who expected to complete a post-secondary qualification, and so on. Across participating countries, students who did not know what qualifications they might complete scored higher in mathematics and science than those who expected to complete some upper-secondary education only.

Gender

The educational expectations of female and male Year 8 students are presented in Table 4.23, along with their average mathematics and science achievement scores.

While the proportions of female and male students who aspired to a postgraduate degree were similar, a greater proportion of female students expected to go on to university but not undertake a postgraduate degree (17 per cent compared to 10 per cent of male students). In contrast, more male students than female students thought that they would either complete Year 12 or leave school beforehand (upper-secondary school or less).

Table 4.23 Students' educational aspirations and student achievement in mathematics and science, by gender

	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE
Postgraduate degree						
Females	20	1.0	549	7.4	554	6.2
Males	19	1.8	573	12.5	586	11.8
University but not postgraduate degree						
Females	17	1.2	535	7.6	541	7.2
Males	10	0.9	556	11.4	570	9.8
Post-secondary but not university						
Females	30	1.2	480	4.5	499	4.3
Males	30	1.6	493	5.1	518	5.4
Upper-secondary education or less						
Females	19	1.2	447	5.7	458	5.7
Males	25	1.6	459	5.2	479	5.1
Do not know						
Females	15	1.0	517	7.1	524	6.7
Males	15	0.9	531	10.0	544	9.6

The average mathematics scores of male and female students in each of the educational expectation categories were similar, whereas there were differences in the average science scores of males and females in each category, apart from those students who did not know how far they would go with their education. In every other category, male students scored higher on average in the science assessment than did female students.

Among female students, those who aspired to a university education (either a postgraduate or a undergraduate degree) scored higher in mathematics and science than did those students who expected to complete some other form of post-secondary qualification or those who expected to complete secondary school only, or leave without completing. A similar pattern was found among male students.

Those students who did not know how far they would go with their education were an interesting group. While it may be expected that these students would not perform well in the TIMSS assessments, in fact they tended to perform at similar levels to those students who expected to go on to university.

Indigenous background

Table 4.24 presents the educational expectations of Indigenous and non-Indigenous students along with the average mathematics and science achievement scores of those in each category.

The proportion of Indigenous students who aspired to a university education (18% for either an undergraduate or postgraduate degree) was significantly lower than the proportion of non-Indigenous students who aspired to go this far (34%). Over one third of Indigenous Year 8 students expected to either finish school or leave before completing, compared to one fifth of non-Indigenous students.

Table 4.24 Students' educational aspirations and student achievement in mathematics and science, by Indigenous background

	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE
Postgraduate degree						
Non-Indigenous	20	1.3	564	8.2	573	7.8
Indigenous	14	2.3	469	12.5	493	13.1
University but not postgraduate degree						
Non-Indigenous	14	0.8	544	6.8	553	6.4
Indigenous	4	1.1	471	12.2	497	15.8
Post-secondary but not university						
Non-Indigenous	30	1.0	490	4.1	511	4.2
Indigenous	34	3.1	447	5.9	475	7.7
Upper-secondary education or less						
Non-Indigenous	21	1.1	458	4.7	474	4.7
Indigenous	35	3.0	413	7.8	428	8.2
Do not know						
Non-Indigenous	15	0.7	528	6.7	537	6.8
Indigenous	13	1.8	457	14.8	472	12.5

Among Indigenous students, those who aspired to undertake some form of post-secondary education (be that university or non-university study) scored higher in mathematics and science than those who expected to complete secondary school or less. Those who did not know what they expected to do scored similarly to those who expected to continue their education beyond secondary school and higher than those who expected to stop with secondary school.

Among non-Indigenous students, the same pattern as was found for male and female students and for Australian students in general was found – those who expected to undertake university study scored higher than those who expected to undertake post-secondary (but not university) study, and those students in turn scored higher than those who expected to end their education in secondary school.

The next chapter focuses on the teachers and schools of the TIMSS 2011 students.

Chapter

5

Teachers and Schools

Key findings:

- The majority of Year 8 students in Australia are taught mathematics and science by teachers aged between 30 and 50.
- While the distribution of male and female teachers of Year 8 mathematics and science is fairly even across Australia as a whole, there is some variation between the states.
- The proportion of Year 8 students in Australia who have mathematics or science teachers with post-graduate qualifications is far greater than the average across countries participating in TIMSS. However the proportion of students being taught by teachers who have no formal qualifications to teach mathematics was much greater than the international average.
- Far greater proportions of Australian Year 8 students had access to computers to use in their mathematics and science classes than was the case internationally, but this had no impact on their performance.
- Students in schools in urban locations tended to score higher on the mathematics and science assessments than students in schools in suburban or rural locations.
- The economic makeup of schools had an impact on the performance of students, with students in schools with more affluent than disadvantaged students scoring higher in mathematics and science than students in schools with more disadvantaged than affluent students.
- The proportion of a school's student population who spoke English as their first language did not appear to have an influence on average student achievement in mathematics or science.
- Resource shortages in the areas of mathematics and science were relatively rare among Australian schools, but did show a relationship with student achievement in mathematics – schools that were not affected by resource shortages in mathematics had average student scores that were higher than schools that were somewhat affected by shortages.
- Difficulties in filling science teacher vacancies were associated with lower average scores in science, whereas difficulties in filling mathematics teacher vacancies had no relationship with average mathematics scores.

This chapter examines the context for TIMSS students' learning in Australia – the schools 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 2011 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 2011. 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. 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 2011.

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.

In Australia, responses were obtained from over 70 per cent of Year 8 mathematics teachers, 60 per cent of Year 8 science teachers and 98 per cent of the schools of the Year 8 students. As the responses are not those of a random sample of teachers though, the information in this chapter should be thought of as indicative, and is provided for the purposes of setting student achievement in context.

Teachers

This section presents information about the background characteristics of Year 8 mathematics and science teachers, including their age, gender, qualifications and years of experience.

Age and gender

Across Australia, 28 per cent of Year 8 students were taught mathematics by teachers between the ages of 30 and 39, while 30 per cent were taught science by teachers in this age group (see Table 5.1).

The proportions in this table suggest that the majority of Year 8 students are being taught mathematics and science by teachers in their thirties to fifties, with very few being taught by younger (and presumably less experienced) teachers. While this indicates that Year 8 students may well be benefiting from having more experienced teachers, it does raise questions about the replenishment of the teaching force.

There was some variation across the states and territories in terms of the ages of the teaching force – for example, no students in the Northern Territory were being taught science by a teacher under the age of 25, whereas one in ten students in Queensland and Western Australia had science teachers in this age group.

Table 5.1 Age of teachers of Year 8 students in Australia, by state

	UNDER 25		25-29		30-39		40-49		50-59		60 OR MORE	
	% of students with teachers this age	SE of %	% of students with teachers this age	SE of %	% of students with teachers this age	SE of %	% of students with teachers this age	SE of %	% of students with teachers this age	SE of %	% of students with teachers this age	SE of %
Mathematics												
ACT	5	4.4	13	6.5	19	5.3	31	6.5	32	7.7	1	0.9
NSW	3	2.9	16	4.9	24	7.8	20	7.5	38	7.9	0	0.0
VIC	5	3.2	11	5.5	37	7.7	14	6.0	24	6.5	9	6.4
QLD	6	4.2	20	6.8	27	9.0	35	8.3	7	4.3	5	3.5
SA	3	2.8	31	9.1	11	5.7	11	5.8	37	8.3	7	5.0
WA	3	3.0	7	4.1	22	7.5	43	9.3	19	6.2	6	4.5
TAS	6	4.4	16	5.4	28	10.2	20	9.8	23	8.9	7	5.7
NT	0	0.0	38	29.3	32	14.4	19	12.3	11	11.8	0	0.4
AUS	4	1.6	16	2.8	28	3.5	22	3.8	26	3.7	5	2.3
SCIENCE												
ACT	5	4.5	15	6.7	25	8.9	26	5.4	26	7.6	3	1.6
NSW	2	1.3	8	3.2	35	6.6	26	6.0	28	5.6	1	0.4
VIC	5	3.2	11	4.2	34	8.7	17	5.1	26	7.0	7	3.9
QLD	11	4.7	17	6.6	26	5.4	22	5.2	23	7.9	2	1.2
SA	1	1.1	35	8.3	19	7.8	8	5.1	30	10.0	6	3.4
WA	11	8.3	22	7.2	22	6.4	20	7.3	17	4.9	8	4.9
TAS	3	2.8	15	7.0	18	5.6	24	8.7	28	9.9	13	6.5
NT	0	0.0	37	38.7	52	39.5	1	0.6	10	8.8	0	0.0
AUS	5	1.5	14	2.2	30	3.5	21	2.9	26	3.3	4	1.5

Table 5.2 shows the proportion of Year 8 students taught mathematics and science by female or male teachers. On average across Australia, the distribution of male and female teachers in these subjects seems fairly even, with 55–56 per cent of students being taught by a female teacher and 44–45 per cent being taught by a male teacher.

There was some variation between the states and territories, however, with over three-quarters of South Australian students being taught mathematics by a female teacher, compared to 39 per cent of Tasmanian students, for example. In science, over half of the Western Australian students were being taught by a male teacher, while only 20 per cent students in the Northern Territory had a male teacher.

Table 5.2 Gender of teachers of Year 8 students in Australia, by state

	Students taught mathematics by a female teacher		Students taught mathematics by a male teacher		Students taught science by a female teacher		Students taught science by a male teacher	
	%	SE of %	%	SE of %	%	SE of %	%	SE of %
ACT	63	7.4	37	7.4	68	6.7	32	6.7
NSW	60	10.2	40	10.2	57	7.0	43	7.0
VIC	50	8.4	50	8.4	51	8.7	49	8.7
QLD	51	11.0	49	11.0	60	7.8	40	7.8
SA	76	7.1	24	7.1	55	10.5	45	10.5
WA	56	8.9	44	8.9	46	9.5	54	9.5
TAS	39	13.3	61	13.3	62	8.3	38	8.3
NT	58	14.2	42	14.2	79	10.6	21	10.6
AUS	56	4.9	44	4.9	55	4.2	45	4.2

Qualifications

The general qualifications of mathematics and science teachers in Australia, and the average across countries participating in TIMSS at Year 8, are presented in Table 5.3.

Table 5.3 Teachers' formal education, Australia and the international average

	Teachers' Educational Level							
	Completed postgraduate degree		Completed Bachelor's degree or equivalent but not a postgraduate degree		Completed post-secondary education but not a Bachelor's degree		No further than upper secondary education	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Mathematics teachers								
Australia	64	3.6	36	3.6	0	0.2	0	0
International average	24	0.4	63	0.5	11	0.3	3	0.1
Science teachers								
Australia	79	2.8	21	2.8	0	0.2	0	0
International average	27	0.4	63	0.4	8	0.2	2	0.1

Over sixty per cent of Year 8 students in Australia were being taught mathematics by a teacher with a postgraduate qualification, while close to 80 per cent had a science teacher with a postgraduate qualification. These proportions compared very favourably with the international average of around one quarter of students across participating countries having teachers in these subject areas with postgraduate qualifications.

Table 5.4 presents more details about the qualifications of mathematics teachers, regarding the major areas of study they followed in their teaching preparation.

Table 5.4 Year 8 teachers' mathematics qualifications and student achievement in mathematics, Australia and the international average

	Major in mathematics and mathematics education				Major in mathematics education but no major in mathematics				Major in mathematics but no major in mathematics education				All other majors			
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE
Australia	37	4.1	505	7.5	9	2.4	522	23.3	21	3.0	519	14.0	34	3.6	500	7.5
International average	33	0.5	471	1.2	12	0.3	465	2.8	42	0.5	468	1.1	12	0.4	461	2.4

Over one third of Australian Year 8 students were taught mathematics by a teacher with majors in both mathematics and mathematics education. Worthy of note, however, is that a similar proportion were taught by teachers with majors in neither. According to these data, Australia has a much higher proportion of teachers teaching 'out-of-field' in mathematics than is the average over all TIMSS countries. The report prepared for the Australian Council of Deans of Science (Harris & Jenz, 2006) argues that "teachers teaching 'out-of-field' are not well equipped to teach mathematics" (p. vi), and while the Australian data do not reflect this in the achievement scores (possibly because of the number of teacher responses), the international data do. The average performance of students with teachers with majors in both mathematics and mathematics education (471 points) tended to be higher than the average performance of students with teachers with majors in mathematics education but not mathematics (465 points) and those with majors in other fields (461 points).

The major areas of study of science teachers in Australia, and on average across participating countries, are presented in Table 5.5.

Table 5.5 Year 8 teachers' science qualifications and student achievement in science, Australia and the international average

	Major in science and science education				Major in science education but no major in science				Major in science but no major in science education				All other majors			
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE
Australia	55	4.0	530	7.8	6	1.3	525	17.5	25	3.4	526	10.5	14	2.6	507	8.1
International average	28	0.5	480	1.2	11	0.3	470	2.2	51	0.5	478	1.0	8	0.3	476	2.7

Interestingly, the issue of 'out-of-field' teaching appears not to be so much of a problem in science. The majority of Year 8 students in Australia had science teachers with majors in both science and science education, and these students tended to perform better on average in the TIMSS science assessment (530 points) than did students whose teachers had majors in 'other' areas (507 points).

Internationally, the majority of Year 8 students were taught by science teachers with majors in science, but not in science education, while just over one quarter had teachers with majors in both fields. Across the participating countries, on average, students whose teachers had majors both in science and science education tended to perform better than those students whose teachers had completed a major in science only.

Years of experience

In most cases, the years of experience teaching a teacher has will be related to their age (presented in Table 5.1), and given the information reported about teachers' ages, we would expect that many Australian students have teachers with a number of years of teaching experience. Tables 5.6 and 5.7 present the proportions of students whose mathematics and science teachers reported their years of experience, within Australia and across all participating countries on average.

Table 5.6 Year 8 mathematics teachers' years of experience and student achievement in mathematics, Australia and the international average

	20 years or more				10 to 20 years				5 to 10 years				Less than 5 years				Average years of experience	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	37	4.0	519	8.1	22	3.4	513	10.8	18	3.2	504	17.1	24	3.4	485	8.4	15	0.9
International average	36	0.5	474	1.3	28	0.5	470	1.2	19	0.4	463	1.7	18	0.4	458	1.8	16	0.1

While the majority of Year 8 students in Australia had mathematics teachers with more than 10 years teaching experience, almost one quarter had teachers with less than five years experience. Students with the least experienced teachers tended to perform less well on the TIMSS mathematics assessment on average (485 points) compared to students with more experienced teachers.

Across the participating countries, over one third of students had mathematics teachers with more than 20 years of experience, and a relationship between teachers' experience and student performance is evident – students with the most experienced teachers (with more than 20 years of teaching) scored 474 points on average, compared to 470 points for those with teachers who had 10 to 20 years experience, 463 points for students with teachers who had five to 10 years experience and 458 points for students whose teachers had less than five years experience.

Table 5.7 Year 8 science teachers' years of experience and student achievement in science, Australia and the international average

	20 years or more				10 to 20 years				5 to 10 years				Less than 5 years				Average years of experience	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	32	3.3	528	8.0	21	2.7	524	9.6	21	3.4	523	10.5	26	2.9	526	8.9	14	0.8
International average	33	0.4	480	1.3	29	0.5	480	1.2	19	0.4	475	1.3	20	0.4	471	1.3	15	0.1

As was the case for mathematics, over 50 per cent of Year 8 students in Australia were being taught science by teachers with more than 10 years experience (average years of experience was 14), and just over one quarter were being taught by relatively new teachers (with less than five years experience). There were no differences in the average science performance of students who were taught by teachers with varying years of experience.

Internationally, one third of students had science teachers with more than 20 years experience, with a further 29 per cent being taught by teachers with between 10 and 20 years experience. These students tended to perform better on average (scoring 480 points) than students with teachers with five to 10 years experience (475 points) or students whose teachers had less than five years experience (471 points).

Professional development

Beyond their initial qualifications, many education systems, including Australia's, require registered teachers to participate in ongoing professional development, to ensure that students receive up-to-date instruction methods and information.

Tables 5.8 and 5.9 present the proportions of students whose teachers reported participating in various forms of professional development in the past two years.

Table 5.8 Participation in professional development in mathematics in the past two years, Australia and the international average

	Students whose teachers had professional development in:											
	Mathematics content		Mathematics pedagogy/ instruction		Mathematics curriculum		Integrating Information Technology in mathematics		Improving students' critical thinking or problem solving skills		Mathematics assessment	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	52	4.5	65	3.7	55	4.6	69	3.7	48	5.2	39	4.3
International average	55	0.5	58	0.6	52	0.5	48	0.5	43	0.6	47	0.5

Over two-thirds of Year 8 students' mathematics teachers had participated in professional development focused on integrating Information Technology into mathematics classes or in mathematics pedagogy or instruction. In fact, more Australian students' teachers participated in professional development in integrating Information Technology into mathematics than on average across all participating countries.

Table 5.9 Participation in professional development in science in the past two years, Australia and the international average

	Students whose teacher's had professional development in:											
	Science content		Science pedagogy/ instruction		Science curriculum		Integrating Information Technology in science		Improving students' critical thinking or inquiry skills		Science assessment	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	53	3.4	48	4.1	61	3.4	64	3.5	53	3.4	40	3.9
International average	55	0.5	58	0.5	53	0.5	49	0.5	43	0.5	48	0.5

Over half of the Australia Year 8 students' science teachers had participated in some form of science-related professional development in the past two years. Most common were sessions that focused on integrating Information Technology into Science classes, and sessions that focused on Science curriculum. Over 60 per cent of students' teachers had participated in these types of professional development, which was significantly higher than was found across participating countries, on average (49% and 53%, respectively). In contrast, the proportions of Australian students whose teachers participated in professional development in Science assessment (40%) and Science Pedagogy or instruction (48%) were significantly lower than the international average.

General teaching attitudes and practices

The mathematics and science teachers of the Year 8 TIMSS participants were asked to complete a questionnaire that contained questions about their instructional attitudes and practices, as well as the background information presented in the sections above. Some of these items contributed to scales about teaching in general, while others focused more on the subject (mathematics or science).

Teachers collaborate to improve instruction

Teachers were asked how often ('daily or almost daily', 'one–three times per week', 'two–three times per month' or 'never or almost never') they had the following types of interactions with fellow teachers:

- Discuss how to teach a particular topic
- Collaborate in planning and preparing instructional materials
- Share what I have learned about my teaching experiences
- Visit another classroom to learn more about teaching
- Work together to try out new ideas.

Their responses to these items were combined to create the Collaborate to Improve Teaching scale, a measure of the extent of collaboration teachers experienced at their school. Students were then assigned to one of three groups based on their teacher's Collaborate to Improve Teaching scale score.

Students assigned to the *very collaborative* category had a teachers with a score of at least 11.4, which corresponds to having interactions with other teachers 'one to three times per week' in each of three of the five areas above and 'two or three times per month' in the other two areas, on average.

Students assigned to the *somewhat collaborative* category had teachers with a score no higher than 7.5 which is the scale point corresponding to their teachers having interactions with other teachers 'never or almost never' in three of the five areas and 'two or three times per month' in the other two, on average.

All other students were assigned to the *collaborative* category.

Table 5.10 presents the proportions of students in each of these categories, with mathematics and science teachers' results reported separately; along with the students' average achievement scores in the TIMSS assessments.

Table 5.10 The Collaborate to Improve Teaching scale and student achievement in mathematics and science, Australia and the international average

	Very collaborative				Collaborative				Somewhat Collaborative					
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	Average Scale Score	SE
Mathematics														
Australia	32	3.9	510	10.0	55	4.0	509	8.1	12	2.1	490	8.8	10	0.2
International average	28	0.5	467	1.2	57	0.6	468	0.8	15	0.4	465	1.9		
Science														
Australia	37	3.6	520	7.1	52	3.4	530	6.8	11	2.2	518	13.8	10.4	0.2
International average	29	0.5	476	1.1	58	0.5	479	0.8	13	0.4	472	2.1		

Around one–third (32%) of Year 8 students in Australia had mathematics teachers who they rated as *very collaborative,* while over one–third (37%) had science teachers who they rated as *very collaborative.* Around 11 to 12 per cent of students had science teachers who were only *somewhat collaborative.*

Both in Australia and internationally, there were no significant differences in mathematics or science performance for students whose teachers were *very collaborative, collaborative* or *sometimes collaborative.*

Instruction to engage students in learning

Another measure of the quality of teaching to which the TIMSS students were exposed focussed on the extent to which mathematics and science teachers made an effort to engage students in the classroom. Teachers were asked to indicate how regularly ('every or almost every lesson', 'about half the lessons', 'some lessons' or 'never') they did the following while teaching the TIMSS class(es):

- Summarise what students should have learned from the lesson
- Use questioning to elicit reasons and explanations
- Encourage all students to improve their performance
- Praise students for good effort.

The Engaging Students in Learning scale was then composed of the responses to these items, and students classified into three groups based on the scale score of their teachers.

Students whose teachers made efforts to engage them *most lessons* had a score of at least 8.7, which is the point on the scale corresponding to teachers reporting that they did two of the four activities 'every or almost every lesson' and the other two activities in 'about half the lessons', on average.

Students whose teachers made efforts to engage them in *some lessons* had a score no higher than 5.7, which is the scale point corresponding to teachers reporting that they used two of the four practices in 'some' lessons and the other two in 'about half the lessons', on average.

All other students had teachers who used engagement practices *about half the lessons*.

Table 5.11 The Engaging Students in Learning scale and student achievement in mathematics and science, Australia and the international average

	Most lessons				About half the lessons				Some lessons				Average Scale Score	SE
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE		
Mathematics														
Australia	75	4.0	508	6.7	22	3.7	505	10.0	3	1.4	533	34.8	9.5	0.2
International average	80	0.4	469	0.7	17	0.4	459	1.8	3	0.2	484	4.5		
Science														
Australia	81	2.7	527	6.9	18	2.7	524	7.9	1	0.3	~	~	9.8	0.1
International average	80	0.4	478	0.6	17	0.4	474	1.5	3	0.2	509	5.6		

On average, the majority of Year 8 students, both in Australia and internationally, had mathematics and science teachers who used engagement practices in *most lessons,* with very few having teachers who used these practices in only *some lessons* (see Table 5.11).

While for Australian students there was no significant relationship between the extent to which their mathematics or science teachers used engagement strategies and their performance on the TIMSS assessment, internationally those students whose mathematics and science teachers used such practices in *most lessons* tended to score higher on average than students whose teachers used engagement practices in *about half* the lessons.

Teaching mathematics

Time spent

Australian principals reported that over 1000 hours (1039) were devoted to teaching during Year 8, with teachers reporting spending around 143 hours on average teaching their students mathematics.

This was similar to the international average of 1,012 hours of instruction reported by principals and the average 137 hours teaching mathematics to Year 8 students reported by teachers.

Classroom activities

Table 5.12 presents the proportions of students whose mathematics teachers reported using a variety of classroom activities in every or almost every lesson.

Table 5.12 Activities during mathematics lessons, Australia and the international average

	Students doing the following activities every or almost every lesson											
	Work on problems (individually or with peers) with teacher guidance		Work on problems together in whole class with direct teacher guidance		Work on problems (individually or with peers) while teacher doing other tasks		Memorising rules, procedures and facts		Explain their answers		Apply facts, concepts and procedures	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	64	4.2	43	4.2	25	3.3	32	3.0	46	5.0	60	4.6
International average	55	0.6	48	0.6	14	0.4	45	0.5	60	0.5	49	0.6

Compared to the international average, greater proportions of Australian Year 8 students spent time in every or almost every lesson working on problems (on their own or with peers) with teacher guidance, working on problems (on their own or with peers) while their teacher was occupied with other tasks and applying facts, concepts and procedures. Fewer Australian Year 8 students, compared to the international average, memorised rules, procedures and facts or explained their answers in every or almost every mathematics lesson.

Computer activities in mathematics

Along with the more traditional sorts of classroom activities presented above, teachers were also asked about their use of computers while teaching mathematics to the TIMSS Year 8 students. Table 5.13 presents the proportions of students (for Australia and internationally) who had access to computers during mathematics classes and the different types of activities they were used for.

Table 5.13 Computer activities during mathematics lessons and student achievement in mathematics, Australia and the international average

	Computers available for mathematics lessons						Students whose teachers have them use computers at least monthly							
	Yes				No		To explore mathematics principles and concepts		To look up ideas and information		To process and analyse data		To practise skills and procedures	
	% of students	SE of %	Average maths achievement	SE	Average maths achievement	SE	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	64	4.5	510	7.3	506	7.3	49	4.0	34	4.1	40	3.8	53	4.1
International average	36	0.5	470	1.4	467	0.8	22	0.5	23	0.5	21	0.5	24	0.5

Close to two-thirds of Year 8 students in Australia have computers available for them to use during mathematics lessons, according to their teachers' reports, which is significantly higher than the one third of students on average across participating countries who reported access to these resources. Not surprisingly, given this difference in availability, greater proportions of Australian Year 8 students were required to do each of the listed activities at least monthly, compared to the international average. Over half the Australian Year 8 students are required to practise skills and procedures on computers at least monthly during their mathematics classes, and close to half also reported being required to use their computers to explore mathematical principles and concepts.

Resources used

While Australian teachers will eventually move to following the same national curriculum, there is a greater amount of leeway in the resources they may use to apply this curriculum than is the case in other countries that participate in TIMSS. As shown in Table 5.14, just over half of the Australian Year 8 students' teachers used textbooks as the basis for mathematics instruction, which was significantly lower than the international average of over three-quarters (77%).

Table 5.14 Resources used during mathematics lessons, Australia and the international average

	Students whose teachers use:															
	Textbooks				Workbooks or worksheets				Concrete objects or materials that help students understand quantities or procedures				Computer software for mathematics instruction			
	as basis for instruction		as a supplement		as basis for instruction		as a supplement		as basis for instruction		as a supplement		as basis for instruction		as a supplement	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	56	4.0	41	3.9	20	3.5	77	3.6	13	2.7	78	3.4	9	2.5	78	3.3
International average	77	0.4	21	0.4	34	0.5	62	0.5	23	0.5	71	0.5	7	0.3	55	0.5

Compared to the international average, fewer Australian Year 8 students had teachers who used workbooks or worksheets, or concrete objects or materials as the basis for mathematics instruction. However, more Australian students had teachers who used workbooks or worksheets (77%) or computer software (78%) as a supplement for mathematics instruction compared to the international average.

Confidence in teaching mathematics

This scale summarises mathematics teachers' responses to the statements below about their levels of confidence in five aspects of teaching their mathematics classes:

- Answer students' questions about mathematics
- Show students a variety of problem solving strategies
- Provide challenging tasks for capable students
- Adapt my teaching to engage students' interest
- Help students appreciate the value of learning mathematics.

Teachers were asked to indicate whether they felt 'very confident', 'somewhat confident' or 'not confident' with each of these aspects and their responses were combined to create the Confidence in Teaching Mathematics scale. Students were then assigned to one of two groups based on the Confidence in Teaching Mathematics scale score of their mathematics teachers.

Students assigned to the *very confident* category had a score of 9.2, which is the point on the scale corresponding to their teachers reporting that they are 'very confident' using three of the five strategies during mathematics lessons and 'somewhat confident' using the other two, on average.

All other students were assigned to the *somewhat confident* category.

Table 5.15 presents the proportions of students whose teachers were *very confident* or *somewhat confident* in teaching mathematics, and their average mathematics score on the TIMSS 2011 assessment.

Table 5.15 The Confidence in Teaching Mathematics scale and student achievement in mathematics, Australia and the international average

	Very confident				Somewhat confident				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	78	3.4	507	5.8	22	3.4	513	11.3	10.2	0.2
International average	76	0.5	470	0.7	24	0.5	456	1.7		

Over three-quarters of Year 8 students, both internationally on average and within Australia, had teachers who were *very confident* in their ability to teach mathematics. While there was no significant difference in the average mathematics scores of those Australian students whose teachers were *very confident* (507 points) compared to those whose teachers were only *somewhat confident* (513 points), there was a trend internationally for those students with more confident teachers to score higher than other students.

How prepared teachers feel they are to teach mathematics

TIMSS 2011 asked students' teachers of mathematics how prepared they felt to teach a subset of the mathematics and science topics included in the TIMSS 2011 frameworks.

At Year 8, teachers were asked about 19 topics in mathematics, including 5 topics in *number*, 5 topics in *algebra*, 6 topics in *geometry* and 3 topics in *data and chance*.

Table 5.16 Year 8 teachers feel well prepared to teach mathematics topics, Australia and the international average

	Students whose teachers feel 'very well prepared' to teach TIMSS mathematics topics									
	Overall mathematics (19 topics)		Number (5 topics)		Algebra (5 topics)		Geometry (6 topics)		Data and Chance (3 topics)	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	91	1.6	93	1.7	92	1.6	91	1.8	86	2.6
International average	84	0.3	92	0.3	87	0.3	85	0.3	62	0.4

At Year 8, an average of 84 per cent of teachers indicated that they were 'very well prepared' to teach *all mathematics* topics. In Australia, the average was 91 per cent (see Table 5.16). For Australia, the proportion for *number* was highest, followed by *algebra*, with 93 per cent and 92 per cent of students respectively in Australia having teachers who reported that they were 'very well prepared' to teach these topics. *Geometry* and *data and chance* were the areas with the lowest levels of preparedness in Australia. However, there were still more than 80 per cent of students that had teachers who felt 'very well prepared' to teach the topics in these content areas.

Time students spend on mathematics homework

Students in Year 8 were asked how often their teacher gives them mathematics homework and how much time they usually spend on it when it is given.

Table 5.17 presents the results of these questions (weekly time was estimated by multiplying the frequency of assignment by the amount of time spent) for Australia and the average across countries who participated in TIMSS 2011.

Table 5.17 Time spent on mathematics homework per week and student achievement in mathematics, Australia and the international average

	3 hours or more				More than 45 minutes but less than 3 hours				45 minutes or less			
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE
Australia	7	0.7	535	13.6	35	1.5	529	5.8	59	1.6	491	5.2
International average	15	0.1	464	1.1	38	0.2	478	0.6	48	0.2	460	0.7

Over one third of students, within Australia and internationally, spent between 45 minutes and three hours on mathematics homework every week. Fewer Australian students (7%) compared to the international average (15%) spent more than three hours doing mathematics homework, while more spent 45 minutes or less (59% compared to 48%).

The relationship between time spent on homework and student performance can be difficult to disentangle, because of different approaches and policies regarding assigning homework – in some cases, homework may be assigned to weaker students in order for them to gain needed practice, while in other cases more homework may be assigned to more able students as challenge or enrichment exercises. Among Australian students, those who did between 45 minutes and three or more hours scored higher on average than those students who performed less than 45 minutes of mathematics homework per week. Internationally, students who did between 45 minutes and three hours scored higher than students who did more than three hours, who in turn scored higher than students who did less than 45 minutes of mathematics homework per week.

Mathematics tests and examinations

The mathematics teachers of the Year 8 TIMSS students were asked how frequently they gave their classes tests or examinations, and what types of questions they regularly used in these assessments. Their responses to these questions are presented in Table 5.18.

Table 5.18 Frequency of mathematics tests and types of questions, Australia and the international average

	Students whose teachers give mathematics tests or examinations						Students whose teachers give test questions: involving application of mathematical procedures						Students whose teachers give test questions: involving searching for patterns and relationships						Students whose teachers give test questions: requiring explanations or justification					
	Every 2 weeks or more		About once a month		A few times a year or less		Always or almost always		Sometimes		Never or almost never		Always or almost always		Sometimes		Never or almost never		Always or almost always		Sometimes		Never or almost never	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	16	2.7	66	4.2	18	3.4	84	2.8	16	2.8	0	0.1	30	4.6	66	4.4	3	1.5	37	4.3	52	3.9	11	2.7
International average	45	0.5	40	0.5	15	0.3	77	0.5	23	0.5	0	0.1	31	0.5	64	0.6	5	0.2	37	0.5	56	0.6	8	0.3

Fewer Australian students, compared to the international average, had tests or examinations in mathematics every two weeks or more. Over two-thirds of Australian students had mathematics tests or examinations about once a month. In terms of the types of questions that were included in their tests, 84 per cent of Australian Year 8 students had mathematics tests that included application of mathematical procedures 'always or almost always', which was significantly higher than the international average of 77 per cent. Results for the other types of questions were very similar for Australian students and the international average.

Teaching science

Time spent

Australian principals reported that over 1000 hours (1038) were devoted to teaching during Year 8, with teachers reporting spending around 131 hours on average teaching their students science.

On average internationally, over 1000 hours of instruction were reported by principals (1012), with teachers spending 156 hours on average teaching science to their Year 8 students.

Emphasise science investigation

In previous cycles of TIMSS, the role of inquiry-based scientific learning has been explored by asking teachers to report the frequency with which they engaged in a range of inquiry-related activities in the science classroom. In TIMSS 2011, this approach was changed somewhat, and a new scale created. The Emphasise Science Investigation scale for Year 8 students is based on teacher reports of how often, in teaching science, teachers ask students to engage in the following seven activities:

- Observe natural phenomena and describe what they see
- Watch me (the teacher) demonstrate an experiment or investigation
- Design or plan experiments or investigations
- Conduct experiments or investigations
- Use scientific formulas and laws to solve routine problems
- Give explanations about something they are studying
- Relate what they are learning in science to their daily lives.

Students were scored according to their teachers' responses to how often they used each of seven instructional activities. Students with teachers who emphasised science investigation in *about half* *the lessons or more* had a score on the scale of at least 10.2, which corresponds to their teachers using all seven activities in "about half of the lessons", on average. All other students had teachers who emphasised science investigation in *less than half the lessons*.

The proportions of students in each of these categories (based on their science teachers' reports) and their average science scores in the TIMSS 2011 assessment are presented in Table 5.19.

Table 5.19 The Emphasise Science Investigation scale and student achievement in science, Australia and the international average

	About half the lessons or more				Less than half the lessons				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	34	3.2	523	10.6	66	3.2	528	6.0	9.2	0.1
International average	48	0.5	479	0.9	52	0.5	474	0.9		

According to their teachers' responses, around one in every three Australian Year 8 students had teachers who emphasised scientific investigations in half or more of their science lessons. This was less than the international average, which was closer to one in every two students.

While among Australian students there were no differences in the science assessment scores of those students whose teachers emphasised scientific investigations in *about half the lessons or more* and those who did so less often, a relationship was found across participating countries on average. Those students whose teachers emphasised scientific investigation in at least half of their lessons tended to outperform those students whose teachers emphasised this aspect less often.

Computer activities in science

Science teachers were also asked about the availability of computers for use during their classes, and the types of activities they used these computers for (Table 5.20).

As was found for mathematics, Australia had one of the highest proportions of Year 8 students who had access to computers to use during their science lesions, with over 70 per cent having a computer available for their use (compared to less than half of students on average, internationally). There was, however, no difference in the Australian students' performance in the TIMSS science assessment based on whether they had access to a computer or not, whereas internationally, on average, having access to a computer during science lessons was associated with a higher score on the TIMSS science assessment.

Table 5.20 Computer activities during science lessons and student achievement in science, Australia and the international average

	Computers available for science lessons						Students whose teachers have them do the following activities on computers at least monthly									
	Yes		Yes		No		To look up ideas and information		To do scientific procedures or experiments		To study natural phenomena through simulations		To process and analyse data		To practise skills and procedures	
	% of students	SE of %	Average science achievement	SE	Average science achievement	SE	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	71	2.8	522	6.2	536	9.2	66	3.6	40	4.5	44	3.8	49	3.9	47	4.5
International average	46	0.5	481	1.0	475	0.8	39	0.5	28	0.5	30	0.5	31	0.5	33	0.5

Given that more Australian students had computers available for use during their science lessons than on average across participating countries, it is not surprising that greater proportions of Australian students were regularly required to perform these tasks on computers.

Resources used

Interestingly, there was no one resource that emerged as being the most common basis for science instruction for Australian students. Compared to the international average, far fewer Australian Year 8 students had teachers who used textbooks as the basis for their teaching in science lessons (although close to two-thirds of students had teachers who used workbooks or worksheets as a supplement).

Table 5.21 Resources used during science lessons, Australia and the international average

	Students whose teachers use:															
	Textbooks				Workbooks or worksheets				Science equipment and materials				Computer software for science instruction			
	as basis for instruction		as a supplement		as basis for instruction		as a supplement		as basis for instruction		as a supplement		as basis for instruction		as a supplement	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	45	3.5	51	3.3	34	2.9	65	2.9	47	4.3	53	4.3	12	2.3	77	2.7
International average	74	0.4	24	0.4	35	0.5	60	0.5	43	0.5	54	0.5	16	0.4	61	0.5

Just under half of Australian Year 8 students' teachers used science equipment and materials as a basis for instruction, which was similar to the international average. More than three quarters of Australian Year 8 students used computer software as a supplement in their science classes.

Confidence in teaching science

Science teachers' confidence in their ability to instruct their classes in science was measured using a set of questions about different classroom strategies. Sciences teachers were asked how confident ('very confident', 'somewhat confident' or 'not confident') they felt doing the following in their science classes:

- Answer students' questions about science
- Explain science concepts or principles by doing science experiments
- Provide challenging tasks for capable students
- Adapt my teaching to engage students' interest
- Help students appreciate the value of learning science.

Their responses to these items were combined to create the Confidence in Teaching Science scale, and students were assigned to one of three groups based on the Confidence in Teaching Science scale score of their science teachers.

Students with *very confident* teachers had a score on the scale of at least 9.3, which corresponds to teachers reporting that they are 'very confident' using three of the five strategies during science lessons and 'somewhat confident' in using the other two, on average.

All other students had *somewhat confident* teachers.

Table 5.22 presents the proportions of students (for Australia and on average across participating countries) whose teachers were very confident or somewhat confident in teaching science, and their average science scores on the TIMSS 2011 assessment.

Table 5.22 The Confidence in Teaching Science scale and student achievement in science, Australia and the international average

	Very confident				Somewhat confident				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	77	3.7	529	7.3	23	3.7	518	8.6	10.3	0.2
International average	73	0.4	479	0.7	27	0.4	467	1.5		

Around three in every four Australian Year 8 students had a teacher who was *very confident* in teaching science, which was similar to the international average. While internationally there was a tendency for those students with very confident teachers to perform better on the TIMSS science assessment, scoring 479 points on average compared to 467 points for students whose teachers were only somewhat confident, there was, however, no relationship between the confidence levels of Year 8 science teachers as measured by this scale and Australian students' performance on the TIMSS science assessment.

How prepared teachers feel they are to teach science

TIMSS 2011 asked students' teachers of science how prepared they felt to teach a subset of the science topics included in the TIMSS 2011 frameworks.

At Year 8, teachers were asked about 20 topics in science, including 7 topics in *biology*, 4 topics in *chemistry*, 5 topics in *physics* and 4 topics in *Earth science*.

Table 5.23 presents the proportions of students whose teachers reported feeling 'very well prepared' to teach these science topics.

Table 5.23 Year 8 teachers feel well prepared to teach science topics, Australia and the international average

	Students whose teachers feel 'very well prepared' to teach the TIMSS science topics									
	Overall Science (20 topics)		Biology (7 topics)		Chemistry (4 topics)		Physics (5 topics)		Earth science (4 topics)	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	78	1.6	84	1.9	87	2.0	79	2.1	58	3.1
International average	72	0.3	77	0.4	82	0.4	78	0.4	47	0.5

On average internationally, across all science topics, an average of 72 per cent of students had teachers who reported feeling 'very well prepared' to teach. In Australia, 78 per cent of students had teachers who felt 'very well prepared' to teach these science topics, which was significantly higher than the international average. In *biology*, 84 per cent of students and in *chemistry* 87 per cent of students had teachers who felt 'very 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 terms of teachers' sense of preparedness in Australia, although at close to 60 per cent, the proportion of Australian students whose teachers felt 'very well prepared' to teach the *Earth science* topics was still significantly higher than the international average of just under 50 per cent.

Time students spend on science homework

Students in Year 8 were asked how often their teacher gives them science homework and how much time they usually spend on it when it is given. Table 5.24 presents the results of these questions (weekly time was estimated by multiplying the frequency of assignment by the amount of time spent) for Australia and the average across countries who participated in TIMSS 2011.

Table 5.24 Time spent on science homework per week and student achievement in science, Australia and the international average

	3 hours or more				More than 45 minutes but less than 3 hours				45 minutes or less			
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE
Australia	2	0.2	~	~	17	1.0	535	6.8	81	1.1	519	4.8
International average	5	0.1	448	1.9	29	0.2	487	0.9	67	0.2	482	0.8

Eight in every ten Australian Year 8 students reported spending less that 45 minutes per week on science homework, which was significantly greater than the proportion of students across participating countries who spent this amount of time on science homework. In contrast, the international average proportion of students who spent three or more hours on science homework (5%) was significantly higher than the proportion of Australian students who spent an extended period of time on science homework.

As discussed earlier in the mathematics section, the relationship between time spent on homework and student performance can be difficult to interpret. Among Australian students, the proportion who did three or more hours per week was too small to allow estimation of their average performance in science, and there was no significant difference in the science scores of those who spent between 45 minutes and three hours per week on homework and those who spent less than 45 minutes (the vast majority of Australian Year 8 students). Internationally, the highest science scores on average were recorded by students who did between 45 minutes and three hours, followed by those who did less than 45 minutes of science homework, and then by students who did more than three hours of mathematics homework per week.

Science tests and examinations

As for mathematics, science teachers were also asked how frequently they gave science tests or examinations to their Year 8 students, and the types of questions they included on these tests. Their responses are summarised in Table 5.25.

Table 5.25 Frequency of science tests and types of questions, Australia and the international average

	Students whose teachers give science tests or examinations						Students whose teachers give test questions:																	
							involving application of knowledge and understanding						involving developing hypotheses and designing scientific investigations						requiring explanations or justification					
	Every 2 weeks or more		About once a month		A few times a year or less		Always or almost always		Sometimes		Never or almost never		Always or almost always		Sometimes		Never or almost never		Always or almost always		Sometimes		Never or almost never	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	9	2.1	47	3.9	44	4.3	83	2.3	17	2.4	0	0.2	30	3.0	56	4.4	14	3.4	59	3.6	40	3.8	1	0.8
International average	35	0.4	41	0.5	24	0.4	78	0.4	22	0.4	1	0.1	21	0.4	62	0.5	17	0.4	54	0.5	42	0.5	3	0.2

Internationally, over one third of Year 8 students had science tests or examinations every two weeks or more, compared to only nine per cent of Australian students who had science tests this often. Close to half of the Australian Year 8 students had science tests once a month.

On the science tests and examinations they sat, the vast majority of Australian Year 8 students received questions involving the application of knowledge and understanding 'always or almost always' (83% compared to 78% internationally), while close to one third of students 'always or almost always' had science test questions that involved developing hypotheses and designing scientific investigations.

Teacher career satisfaction

Teachers' satisfaction with their careers may be an important element in the classroom and school environment and could well impact on students' own attitudes towards learning, the classroom and their achievement.

Teachers were asked to indicate their level of agreement ('agree a lot', 'agree a little', 'disagree a little' or 'disagree a lot') to the following six statements:

- I am content with my profession as a teacher
- I am satisfied with being a teacher at this school
- I had more enthusiasm when I began teaching than I have now (reverse coded)
- I do important work as a teacher
- I plan to continue as a teacher for as long as I can
- I am frustrated as a teacher (reverse coded).

Their responses were combined to create the Teacher Career Satisfaction scale.

Students whose teachers were *satisfied* had a score of at least 10.4, which is the point on the scale corresponding to their teachers 'agreeing a lot' with three of the six statements and 'agreeing a little' to the other three, on average.

Students whose teachers were *less than satisfied* had a score no higher than 7.0, corresponding to teachers 'disagreeing a little' with three of the six statements and 'agreeing a little' with the other three, on average.

All other students had *somewhat satisfied* teachers.

Internationally on average, close to half of the Year 8 students (47%) had teachers who were *satisfied with their careers,* while around 40 per cent of Australian students had mathematics teachers (42%) or science teachers (38%) who were satisfied with their teaching careers (Table 5.26). The average Teacher Career Satisfaction scale score for teachers of mathematics and science in Australia was just under 10, which was the centrepoint for the scale (and thus the international average).

Table 5.26 The Teacher Career Satisfaction scale and student achievement in mathematics and science, Australia and the international average

	Satisfied				Somewhat satisfied				Less than satisfied					
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	Average Scale Score	SE
Mathematics														
Australia	42	3.9	516	8.3	43	3.4	505	8.3	15	2.8	487	13.8	9.8	0.2
International average	47	0.6	473	0.9	45	0.6	464	1.0	7	0.3	462	2.4		
Science														
Australia	38	3.9	525	7.8	52	4.3	526	6.1	10	2.3	522	13.5	9.7	0.2
International average	47	0.5	481	0.8	45	0.5	474	0.8	8	0.3	473	2.3		

Among Australian Year 8 students, there were no significant differences in the mathematics or science performance of students whose teachers were *satisfied, somewhat satisfied* or *less than satisfied.* Internationally, however, students whose mathematics or science teachers were *satisfied* outperformed students whose teachers were *somewhat satisfied* or *less than satisfied.*

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 8 students was around 894 students. The smallest school had 45 students and the largest 2903 students.

Table 5.27 presents information about where these schools were located. In order that comparisons can be made internationally, the grouping used in this analysis is not the same as in other chapters, in which the MCEETYA coding is used. Therefore the means for achievement in this table are not comparable with those in other chapters.

Table 5.27 Location of schools and student achievement in mathematics and science, Australia and the international average

	Urban area						Suburban areas or medium sized city						Rural area or small town					
	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	%of students	SE of %	Average mathematics score	SE	Average science score	SE	% of students	SE of %	Average mathematics score	SE	Average science score	SE
Australia	29	3.6	542	12.0	545	11.4	57	4.2	500	5.4	517	5.3	14	2.4	468	6.6	493	6.5
International average	28	0.5	482	1.4	488	1.3	41	0.6	468	0.9	478	0.9	31	0.4	443	1.1	458	1.1

The majority of Australian Year 8 students were attending schools in suburban areas or medium sized cities (57%), with just under 30 per cent in urban schools and 14 per cent in schools in rural areas or small towns.

There was an association between the location of the school and the average performance of students in mathematics and science, both within Australia and internationally, on average. Students in urban schools tended to score higher in mathematics and science than students in suburban schools, who in turn scored higher on average than students in rural schools.

School socioeconomic composition

Acknowledging that the socioeconomic circumstances of students can impact on their readiness to learn, school principals in TIMSS were asked to report on the economic composition of their school, in particular by reporting 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%'. These categories were then collapsed further and schools assigned to one of three categories – *Schools with More Affluent than Disadvantaged students* (25% or fewer from economically disadvantaged home and more than 25% of students from affluent homes); *Schools with More Disadvantaged than Affluent students* (more than 25% of student from disadvantaged home and 25% or fewer from economically affluent homes); and *School with Neither More Affluent nor More Disadvantaged students* (all other response combinations).

Table 5.28 presents the proportions of students in each of these categories, along with their average mathematics and science scores.

Table 5.28 Socioeconomic composition of schools and student achievement in mathematics and science, Australia and the international average

	Schools with More Affluent than Disadvantaged students						Schools with Neither More Affluent nor More Disadvantaged students						Schools with More Disadvantaged than Affluent students					
	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE
Australia	32	3.4	543	11.2	553	9.7	39	3.7	507	6.1	521	5.5	29	3.1	476	7.5	493	7.9
International average	32	0.5	494	1.4	501	1.3	33	0.6	471	1.2	481	1.2	36	0.5	448	1.3	458	1.3

Just under one-third of Australian Year 8 students were attending schools that their principals described as having more students from affluent backgrounds than from disadvantaged backgrounds, while close to 40 per cent were in schools in which the ratios of students from affluent backgrounds and disadvantaged backgrounds were fairly even. Just under 30 per cent of Year 8 students in Australia attended schools in which disadvantaged students outnumbered affluent students. These proportions were quite similar to those found across participating countries, on average.

Among Australian students, there was a relationship between student performance on the TIMSS assessments of mathematics and science and the type of population of the schools they attended, with students at schools with more affluent than disadvantaged students scoring higher on average in mathematics and science than students in schools with even proportions of affluent and disadvantaged students and students in schools with more disadvantaged than affluent students. Students in schools with equal proportions of affluent and disadvantaged students also outperformed students in schools with more disadvantaged than affluent students in these subject areas. A similar pattern was found across other participating countries on average, although not all.

Language background of school populations

According to principals, close to two-thirds of Year 8 students in Australia were attending schools in which more than 90 per cent of the student population spoke English (the language of testing in Australia) as their first language, around one-quarter of students attended schools in which more than half but less than 90 per cent of the students spoke English and 10 per cent were in schools in which half or less of the student body spoke English as their first language (Table 5.29).

Table 5.29 Language background of schools' populations and student achievement in mathematics and science, Australia and the international average

	More than 90% of students						51% to 90% of students						50% of students or less					
	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE
Australia	65	3.6	502	6.3	520	6.1	25	3.2	519	10.0	527	9.3	10	2.2	525	11.3	522	10.7
International average	69	0.4	471	0.9	483	1.0	13	0.4	465	1.9	478	1.9	17	0.3	461	2.8	466	2.8

Internationally, a relationship between the language background of schools' student populations and student performance was found for mathematics and science, with the highest scores generally being found amongst students attending schools in which more than 90 per cent of students spoke the language of the test.

However, there was no significant relationship between the proportion of a school's student population speaking English as their first language and the performance of Australian Year 8 students in mathematics and science.

What school resources are available to support 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 scales 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.

Instruction affected by mathematics resource shortages

Principals were asked to comment on the extent to which their school's capacity to provide instruction was affected by a shortage (or inadequacy) of the following general instruction resources:

- Instructional materials (e.g. textbooks)
- Supplies (e.g. paper, pencils)
- School building and surrounds
- Heating/cooling and lighting systems
- Instructional space (e.g. classrooms)
- Technologically competent staff
- Computers for instruction.

Principals were also asked to comment on the extent to which shortages in mathematics resources impacted on instruction at their school. Principals were asked how much ('not at all', 'a little', 'some' or 'a lot') shortages in the following mathematics resources affected learning at their school:

- Teachers with a specialisation in mathematics
- Computer software for mathematics instruction
- Library materials relevant to mathematics instruction
- Audio-visual resources for mathematics instruction
- Calculators for mathematics instruction.

Principals' responses to these items were combined with their responses to items about shortages with general school resources to create the Mathematics Resource Shortages scale. Students were then assigned to groups based on their principal's scale score.

Students in schools where instruction is *not affected* by mathematics resource shortages had a score of at least 11.1, which is the point on the scale corresponding to their principals indicating that resource shortages affected instruction 'not at all' for six of the twelve resources and 'a little' for the other six, on average.

Students in schools where instruction was *affected a lot* had scores no higher than 7.3, which corresponds to principals reporting that shortages affected instruction 'a lot' for six of the twelve resources and 'some' for the remaining six, on average.

All other students were allocated to the middle category, where instruction in schools was *somewhat affected* by resource shortages.

Table 5.30 displays the percentage of Year 8 students in each of these three categories, together with their average mathematics achievement.

Table 5.30 The Mathematics Resource Shortages scale and student achievement in mathematics, Australia and the international average

	Not affected				Somewhat affected				Affected a lot				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	51	3.5	525	8.6	46	3.2	489	5.7	3	1.5	516	15.5	11.1	0.2
International average	25	0.5	488	2.2	69	0.5	464	0.7	6	0.3	453	2.9		

Just over 50 per cent of Year 8 students in Australia were attending a school in which instruction was *not affected* by shortages in mathematics resources, with a further 46 per cent of students attending schools in which instruction was *somewhat affected* by such shortages. Very few students, around three per cent, were in schools in which instruction was *affected a lot* by shortages in mathematics resources. These proportions compare quite favourably with those of other participating countries, on average.

Among Australian Year 8 students, those who attended schools *not affected* by mathematics resource shortages scored higher on average on the TIMSS mathematics assessment than students in schools that were *somewhat affected* by shortages in resources. A similar pattern was found across participating countries, on average.

Difficulties getting mathematics teachers

School principals were asked to comment on their experiences in recruiting qualified mathematics teachers (Table 5.31). While over one third of students were in schools in which vacancies for mathematics teachers were 'easy to fill', according to their principals, there were some indications that finding qualified mathematics teachers is more difficult in Australia than across participating countries on average, with higher proportions of students in schools that find it 'somewhat difficult' or 'very difficult' to fill vacancies, compared to the international average.

Table 5.31 Difficulties filling vacancies for mathematics teachers and student achievement in mathematics, Australia and the international average

	No vacancies				Vacancies are easy to fill				Vacancies are somewhat difficult to fill				Vacancies are very difficult to fill			
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE
Australia	25	2.7	509	10.2	34	4.0	517	10.1	31	3.5	500	9.1	10	2.5	498	16.8
International average	58	0.5	468	0.9	23	0.5	468	1.5	15	0.4	458	2.0	4	0.2	433	4.0

There were no significant differences in the average mathematics performance of Australian Year 8 students in schools with varying degrees of difficulty filling mathematics teacher vacancies, whereas internationally, there was a trend for students in schools that found it 'easy' to fill vacancies to score higher than students in schools in which it was 'somewhat difficult' or 'very difficult'.

Instruction affected by science resource shortages

Principals were asked to indicate to what extent ('not at all', a little', 'some' or 'a lot') their school's capacity to provide science instruction was affected by shortages of the following science resources:

- Teachers with a specialisation in science
- Computer software for science instruction
- Library materials relevant to science instruction
- Audio-visual resources for science instruction
- Science equipment and materials.

Their responses to these items were combined with their responses to the set of items about general resource shortages (listed under the section reporting on instruction affected by mathematics resource shortages) to create the Science Resource Shortage scale. Students were then assigned to groups based on their principal's scale score.

Students in schools where instruction was *not affected* had a score of at least 11.2, which is the point on the scale corresponding to their principals indicating that capacity to provide instruction is affected 'not at all' for six of the twelve science resources and 'a little' for the other six, on average.

Students in schools where instruction was *affected a lot* had scores of no higher than 7.3, which is the point corresponding to their principals indicating that capacity to provide instruction is affected 'a lot' for six of the twelve resources and 'some' for the other six, on average.

All other students were in schools that were *somewhat affected* by science resource shortages.

As shown in Table 5.32, 45 per cent of Year 8 students in Australia were attending a school that, according to their principal, was *not affected* by shortages in science resources, while just over 50 per cent of students were in schools that were *somewhat affected* by such shortages.

Table 5.32 The Science Resource Shortages scale and student achievement in science, Australia and the international average

	Not affected				Somewhat affected				Affected a lot				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	45	3.0	531	8.0	52	2.9	514	5.8	3	1.5	523	31.0	11.2	0.2
International average	22	0.4	494	1.9	71	0.5	474	0.7	7	0.3	464	3.3		

Internationally, a relationship between principals' reports of science resource shortages and the performance of students in the TIMSS science assessment was found, with students in schools *not affected* by shortages outperforming students in schools that were *somewhat affected,* who in turn scored higher than students in schools *affected a lot*. In Australia, there was no relationship between the extent to which schools were affected by science resource shortages and the average performance of students in the TIMSS science assessment.

Difficulties getting science teachers

One quarter of Australian Year 8 students were in schools in which there were no science teacher vacancies (according to principals' reports), which was substantially less than the international average of over half of students (Table 5.33). Given this difference in the existence of vacancies, it is not surprising that greater proportions of Australian students were in schools that find it 'somewhat difficult' or 'very difficult' to fill science teacher vacancies, compared to the international average.

Table 5.33 Difficulties filling vacancies for science teachers and student achievement in science, Australia and the international average

	No Vacancies				Vacancies are easy to fill				Vacancies are somewhat difficult to fill				Vacancies are very difficult to fill			
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE
Australia	25	2.7	520	8.1	37	3.2	535	8.0	32	3.3	507	7.0	7	2.1	526	28.4
International average	56	0.5	477	0.9	25	0.5	479	1.5	15	0.4	468	1.9	4	0.2	459	3.6

Internationally, there was a trend for students in schools that found it 'easy' to fill vacancies to score higher than students in schools in which it was 'somewhat difficult' to fill vacancies, who in turn scored higher than students in schools for whom finding science teachers was 'very difficult'. Among Australian students, those in schools who found it 'easy' to fill vacancies scored higher on average (535 points) than students in schools that found it 'somewhat difficult' to find science teachers.

Principals' activities

Another aspect of the school environment that may have an impact on students' performance is school leadership – how school principals spend their time and on what. Principals of schools that participated in TIMSS were asked to indicate how much time they spent on a variety of activities, and their responses are presented below (as proportions of students whose principals spend 'a lot of time' on each activity).

Table 5.34 Principals' activities, Australia and the international average

	Students whose principals spend 'a lot of time' on these activities																	
	Promoting the school's educational vision or goals		Developing the schools' curricular and education al goals		Monitoring teachers' implementation of the schools' educational goals in their teaching		Monitoring students' learning progress to ensure that the schools' educational goals are reached		Keeping an orderly atmosphere in the school		Addressing disruptive student behaviour		Advising teachers who have questions or problems with their teaching		Initiating educational projects or improvement		Participating in professional development activities specifically for school principals	
	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %	% of students	SE of %
Australia	64	3.3	63	4.1	34	3.5	53	3.9	55	3.5	35	3.8	19	3.0	52	4.1	30	3.9
International average	64	0.6	62	0.5	62	0.5	65	0.5	75	0.5	54	0.5	44	0.6	41	0.6	40	0.5

Almost two-thirds of students, both within Australia and on average across participating countries, were in schools in which the principal spent 'a lot of time' promoting the school's educational vision or goals, or developing the school's curricular and educational goals. Internationally, three-quarters of students were in schools in which a lot of the principal's time was taken up in keeping an orderly atmosphere at the school, compared to just over half of Australian Year 8 students. Just under 20 per cent of Australian Year 8 students were in schools in which the principal reported spending a lot of time advising struggling teachers or answering their questions, compared to over 40 per cent of students across the countries who participated in TIMSS at this year level.

The next chapter reports on the climate of schools of TIMSS students, using information provided by students, their teachers and school principals to build a well-rounded picture of the school environment.

Chapter

6

The School Climate – Multiple Perspectives

Key findings:

- Achievement in mathematics and science was higher on average –
  - Among students who: liked school and felt like they belong, were engaged during mathematics lessons, felt that they were safe and were almost never bullied.
  - In schools in which: principals and teachers report a high emphasis on academic success, teachers thought were safe and orderly, in which principals reported hardly any problems with discipline or attendance and where student factors such as a lack of prerequisite knowledge, nutrition and sleep deprivation and disruptive or uninterested students did not impact on student learning.
- Almost one third of Australian students reported not being engaged in their mathematics and science lessons.
- Among Australian students, teachers' reports of their working conditions had no relationship with student achievement in mathematics or science.

This chapter uses data from students, teachers and school principals to provide a picture of the climate in Australian schools in terms of engagement, emphasis on academic success, discipline and behavioural issues and working conditions.[1]

Engagement and academic emphasis

Students engaged in school

The TIMSS 2011 student questionnaire asked Year 8 students how much they agreed with the statements 'I like being at school' and 'I feel like I belong at this school'. While these single items do not contribute to a scale, they are a straightforward way of gaining some indication of how students feel about their day-to-day school experiences. The responses of Australian Year 8 students are presented in Table 6.1, along with their average mathematics achievement and in Table 6.2, with their science achievement.

1 As mentioned in Chapter 5, the teachers' responses to the questionnaire were not necessarily representative of those of all mathematics or science teachers, as these teachers were simply the teachers of a representative sample of students assessed as part of TIMSS 2011. The school principals' responses, however, should be representative of Australian schools as a whole due to the sampling procedures followed.

Table 6.1 Students like being at school and feel like they belong and student achievement in mathematics, Australia

	Agree a lot				Agree a little				Disagree a little				Disagree a lot			
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE
Like being at school	26	1.1	532	6.8	51	1.0	508	5.0	14	0.7	480	5.4	9	0.5	451	6.3
Feel like belong at this school	41	1.2	524	6.2	40	0.8	503	5.1	13	0.8	481	6.5	6	0.5	453	6.1

The majority of Year 8 students in Australia indicated that they either 'agree a lot' or 'agree a little' that they like school and feel like they belong. Higher proportions agreed a lot that they felt like they belonged at their school (41%) than agreed a lot that they liked school (26%), an interesting distinction (assuming that there is overlap in the proportions of students who agreed a lot to both items).

Students' levels of agreement to these statements were positively related to their performance on the mathematics assessment in TIMSS (Table 6.1), with those who agreed a lot scoring higher on average than those who agreed a little, who in turn scored higher than those who disagreed a little. The relatively small proportion of students who disagreed a lot recorded the lowest average mathematics score.

Table 6.2 Students like being at school and feel like they belong and student achievement in science, Australia

	Agree a lot				Agree a little				Disagree a little				Disagree a lot			
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE
Like being at school	26	1.1	541	6.7	51	1.0	522	4.6	14	0.7	501	5.2	9	0.5	476	7.1
Feel like belong at this school	41	1.2	536	5.7	40	0.8	518	5.0	13	0.8	495	5.9	6	0.5	482	6.3

The relationship between liking being at school and students' performance in the TIMSS science assessment was similar to that found for mathematics – those who agreed a lot scored higher on average than those who agreed a little, followed by those who disagreed a little and then those who disagreed a lot (Table 6.2). While those students who agreed a lot that they felt like they belonged at school scored higher than those who agreed a little, and those who agreed a little in turn scored higher than those who disagreed a little, there was no significant difference in the average science scores of those who disagreed a little or disagreed a lot to this statement.

Students engaged in mathematics lessons

The Engaged in Mathematics Lessons scale summarises students' responses to five questions about their levels of engagement in the mathematics classroom. Students indicated their level of agreement ('agree a lot', 'agree a little', 'disagree a little' or 'disagree a lot') to the following statements about their mathematics lessons:

- I know what my teacher expects me to do
- I think of things not related to the lesson (reverse coded)
- My teacher is easy to understand
- I am interested in what my teacher says
- My teacher gives me interesting things to do.

Their responses to these items were combined to create the Engaged in Mathematics Lessons scale, and students were assigned to one of three group based on their scale score.

Students who were *engaged* in mathematics lessons had a score of at least 11.4, which is the point on the scale corresponding to 'agreeing a lot' with three of the five statements and 'agreeing a little' with the remaining two, on average.

Students who were *not engaged* in mathematics lessons had a score no higher than 8.3, which corresponds to them 'disagreeing a little' with three of the five statements and 'agreeing a little' with the other two, on average.

All other students were assigned to the *somewhat engaged* category.

Table 6.3 presents the proportions of Australian Year 8 students, along with the international average in each of these three categories, and the average mathematics score.

Table 6.3 The Engaged in Mathematics Lessons scale and student achievement in mathematics, Australia and the international average

	Engaged				Somewhat engaged				Not engaged				Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE	% of students	SE of %	Average mathematics achievement	SE		
Australia	14	0.9	535	7.7	56	1.4	513	5.5	30	1.5	479	5.7	9.3	0.1
International average	25	0.2	484	0.8	54	0.2	468	0.6	21	0.2	449	0.9		

Over fifty per cent of Year 8 students in Australia and across participating countries on average, indicated that they were *somewhat engaged* in their mathematics lessons. In Australia, 14 per cent were engaged, compared to 25 per cent internationally. Almost one third of Australian students reported being *not engaged* in their mathematics lessons.

Engagement in mathematics lessons was positively related to performance in the TIMSS mathematics assessment, both among Australian students and across participating countries on average. Those students who were *engaged* tended to score higher than those who were *somewhat engaged*, who in turn scored higher than those students who were *not engaged* in their mathematics classes.

Students engaged in science lessons

Students' levels of engagement in the science classroom were gauged from their responses to the following set of five statements about their science lessons:

- I know what my teacher expects me to do
- I think of things not related to the lesson (reverse coded)
- My teacher is easy to understand
- I am interested in what my teacher says
- My teacher gives my interesting things to do.

Students indicated whether they 'agree a lot', 'agree a little', 'disagree a little' or 'disagree a lot' to these items and their responses were combined to create the Engaged in Science Lessons scale.

For countries such as Australia, in which science is taught as a general or integrated subject (rather than as separate subjects like Biology, Chemistry or Physics), students who were classified as *engaged* in science lessons had a score of at least 11.2, which is the point on the scale corresponding to 'agreeing a lot' to three of the statements above, and 'agreeing a little' to the other two, on average.

Students who were classified as *not engaged* in science lessons had a score no higher than 8.4, which is the scale point corresponding to 'disagreeing a little' with three of the five statements and 'agreeing a little' with the other two.

All other students were assigned to the *somewhat engaged* category.

Table 6.4 presents the proportions of students in each of the three categories along with the average science assessment score for each category, for Australian students and the international average.

Table 6.4 The Engaged in Science Lessons scale and student achievement in science, Australia and the international average

	Engaged				Somewhat engaged				Not engaged				Average Scale Score	SE
	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE	% of students	SE of %	Average science achievement	SE		
Australia	21	1.2	547	6.2	51	1.2	522	5.0	28	1.4	497	5.9	9.5	0.1
International average	29	0.2	508	0.9	51	0.2	479	0.8	21	0.2	457	1.3		

Around one in every five Australian Year 8 students was *engaged* in their science lessons, with a further 50 per cent being *somewhat engaged.* On average across participating countries (who also taught science as an integrated or general subject), close to 30 per cent of students were *engaged* and 50 per cent were *somewhat engaged.* The proportion of Australian students who were *not engaged*, at 28 per cent, was slightly above the international average of 21 per cent.

As was found for mathematics, those students whose responses to the above questions classified them as engaged in science scored significantly higher on average in the TIMSS science assessment than students who were either *somewhat engaged* or *not engaged,* and those who were *somewhat engaged* scored higher than those who were *not engaged.* This pattern was found for Australian students as well as across participating countries, on average.

School emphasis on academic success – principals

Principals' views of the academic climate of their schools, that is, the degree of support and encouragement of academic success, were collected using their ratings (of 'very high', 'high', 'medium', 'low' or 'very low') of the following fives aspects:

- 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
- Students' desire to do well in school.

The ratings of these aspects were combined to create the School Emphasis on Academic Success – Principal scale, and students' were categorised into three groups based on their principals' scale score.

Students in schools with *very high emphasis* for academic success had a score of at least 13.3, which is the point on the scale corresponding to their principals characterising three of the five aspects of the school climate as 'very high' and the other two as 'high', on average.

Students in schools with *medium emphasis* for academic success had a score no higher than 9.2 which is the scale point corresponding to their principals characterising three of the five aspects of the school climate as 'medium', and the remaining two as 'high' on average.

All other students were assigned to the *high emphasis* category.

The proportions of students in each of these three categories, along with the average scores in mathematics and science, are presented in Table 6.5.

Table 6.5 The Emphasis on Academic Success – Principals scale and student achievement in mathematics and science, Australia and the international average

	Very high emphasis						High emphasis						Medium emphasis							
	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	%of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	Average Scale Score	SE
Australia	20	2.7	558	15.8	567	12.6	48	3.8	509	5.9	522	5.6	32	3.1	476	7.4	495	8.0	10.8	0.2
International average	7	0.3	495	3.1	504	2.8	53	0.6	477	0.9	486	0.9	41	0.5	449	1.0	460	1.0		

One in five Australian Year 8 students attended a school that their principal described as having *very high emphasis* on academic success, compared to less than one in ten internationally, on average. Thirty two per cent of Australian students were in schools with only *medium emphasis* on academic success, compared to just over 40 per cent on average across participating countries.

Unsurprisingly, students in schools described as having a *very high emphasis* on academic success scored significantly higher, on average, in the TIMSS mathematics and science assessments than students in schools described as having a *high emphasis* or *medium emphasis*. Students in schools described by principals as having a *high emphasis* also scored higher than did students in schools with a *medium emphasis* on academic success. This pattern was evident among Australian students, as well as in the international average.

School emphasis on academic success – teachers

Teachers' were also asked for their view of the emphasis on academic success at their schools, using the same items as were presented to the principals.

Teachers' responses to those five items were combined to create the School Emphasis on Academic Success – Teacher scale.

As for the School Emphasis on Academic Success - Teacher scale, students in schools with *very high emphasis* for academic success had a score of at least 13.6, which is the point on the scale corresponding to their teachers characterising three of the five aspects of the school climate as 'very high' and the other two as 'high', on average.

Students in schools with *medium emphasis* for academic success had a score no higher than 9.5, which is the scale point corresponding to their teachers characterising three of the five aspects of the school climate as 'medium', and the remaining two as 'high' on average.

All other students were assigned to the *high emphasis* category.

Table 6.6 The Emphasis on Academic Success – Teachers scale and student achievement in mathematics and science, Australia and the international average

	Very high emphasis				High emphasis				Medium emphasis				Average Scale Score	SE
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE		
Mathematics														
Australia	13	2.4	569	15.2	50	3.7	515	7.7	37	3.9	475	7.5	10.4	0.2
International average	5	0.3	506	3.4	48	0.6	478	0.9	47	0.5	452	0.9		
Science														
Australia	10	2.2	570	11.1	51	3.5	535	8.7	39	3.6	501	6.9	10.4	0.2
International average	5	0.2	504	3.2	50	0.5	487	0.8	46	0.5	463	0.9		

Interestingly, according to teachers' reports, between 10 and 13 per cent of Australian Year 8 students attended schools with a *very high emphasis* on academic success, while according to principals' reports, this figure was one in five (see Table 6.5). Nevertheless, the reports of teachers put higher proportions of Australian students in *very high emphasis* schools than on average across participating countries, and smaller proportions in schools with only a *medium emphasis* on academic success (37% compared to 47% for mathematics, and 39% compared to 46% for science).

As was found for the principals' reports in Table 6.5, teachers' reports of the level of emphasis a school placed on academic success were positively related to students' average scores on the TIMSS mathematics and science assessments. Among Australian Year 8 students, and across participating countries on average, every decrease in emphasis on academic success (from very high to high, and from high to medium) was associated with a decrease in average mathematics and science scores.

Safety, discipline and other issues

Since a supportive school environment for learning is one in which teachers and students feel safe and secure, TIMSS students and their teachers were asked about their perceptions of safety in their schools.

This important aspect of school life was measured in two ways for students – firstly, through students' agreement to a single statement 'I feel safe when I am at school', and also through a scale constructed from their responses to a number of items about bullying or aggressive behaviours.

Students feel safe at school

Table 6.7 Students feel safe at school and student achievement in mathematics and science, Australia

	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE
Agree a lot	45	1.1	524	6.3	535	5.6
Agree a little	42	0.8	498	4.8	514	5.0
Disagree a little	10	0.6	474	6.2	495	6.0
Disagree a lot	3	0.3	443	8.5	463	8.7

As shown in Table 6.7, the majority of Australian Year 8 students agreed a lot or a little that they felt safe when at school. A feeling of security at school showed a positive relationship with students' performance in the TIMSS mathematics and science assessments, such that those students who agreed a lot that they felt safe scored higher on average in mathematics and science than students who agree a little, who in turn scored higher than students who disagreed a little. Students who disagreed a lot to this statement recorded the lowest scores in mathematics and science, on average.

Students bullied at school

Students' views of their personal safety at school were collected using items that focused on their experiences of bullying behaviours. Students were asked to indicate how often ('never', 'a few times a year', 'once or twice a month' or 'at least once a week') they had experienced the following:

- I was made fun of or called names
- I was left out of games or activities by other students
- Someone spread lies about me
- Something was stolen from me
- 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.

The Students Bullied at School scale was created by combining the responses to these items, and students were assigned into one of three groups based on their Students Bullied at School scale score.

Students who were bullied *almost never* had a score of at least 9.6, which is the point on the scale corresponding to them reporting that they 'never' experienced three of the six bullying behaviours and each of the other three behaviours 'a few times a year', on average.

Students who were bullied *about weekly* had a score no higher than 7.7, which is the scale point corresponding to them reporting that the three of the six bullying incidents happened to them 'once or twice a month' and the other three 'a few times a year', on average.

All other students were assigned to the *about monthly* group.

Table 6.8 presents the proportions of students in each of the groups, along with their average mathematics and science scores.

Table 6.8 The Students Bullied at School scale and student achievement in mathematics and science, Australia and the international average

	Almost never						About monthly						About weekly						Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE		
Australia	58	1.1	511	5.3	523	5.0	31	1.0	504	5.3	521	5.1	11	0.7	480	7.3	502	6.7	9.9	0.0
International average	59	0.2	473	0.6	483	0.6	29	0.1	467	0.7	478	0.7	12	0.1	441	1.0	452	1.1		

The majority of students, both in Australia and on average across participating countries, *almost never experienced* the bullying behaviours they were asked about, while around one in ten students were bullied *about weekly.*

Among Australian Year 8 students, those who were bullied almost *never* or *about monthly* scored higher on average in their mathematics and science assessments than those students who were bullied *about weekly*.

Internationally, students who were *almost never* bullied scored higher on average in mathematics and science than students who were bullied *about monthly*, and they in turn scored higher than students who were bullied *about weekly*.

Teachers views of school safety

Teachers' perspectives of the safety of the schools they worked in were also collected in TIMSS. Teachers were asked to indicate the extent of their agreement ('agree a lot', 'agree a little', 'disagree a little', 'disagree a lot') to the following five statements:

- This school is located in a safe neighbourhood
- I feel safe at this school
- This school's security policies and practices are sufficient
- The students behave in an orderly manner
- The students are respectful of the teachers.

Responses to these items were then combined to create the Safe and Orderly School scale.

Students assigned to the *safe and orderly* category had a score of 10.7, which is the point on the scale corresponding to their teachers 'agreeing a lot' to three of the five statements and 'agreeing a little' to the remaining two, on average.

Students assigned to the *not safe and orderly* category had a score no higher than 6.8, which is the scale point corresponding to their teachers 'disagreeing a little' with three of the five statements and 'agreeing a little' with the other two, on average.

All other students were assigned to the *somewhat safe and orderly* category.

Table 6.9 presents the proportions of Australian Year 8 students in each category, along with their average mathematics and science scores. Results for the international average are also presented for comparative purposes.

Table 6.9 The Safe and Orderly School scale and student achievement in mathematics and science, Australia and the international average

	Safe and orderly				Somewhat safe and orderly				Not safe and orderly				Average Scale Score	SE
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE		
	Mathematics													
Australia	55	4.2	530	8.3	36	3.9	482	7.0	9	2.3	465	17.0	10.5	0.2
International average	45	0.5	479	1.0	49	0.6	458	0.9	6	0.3	445	3.1		
	Science													
Australia	53	3.8	542	8.4	38	3.2	510	7.1	9	2.8	488	13.8	10.4	0.2
International average	45	0.5	488	0.9	50	0.5	470	0.8	6	0.3	457	2.3		

According to the reports of their teachers, over 50 per cent of Australian Year 8 students were in schools that were *safe and orderly*, while over 30 per cent were in schools that were *somewhat safe and orderly*. Fewer than one in every ten students were in schools that were *not safe and orderly*, according to the reports of their mathematics and science teachers.

Australian students who were in schools that were designated as *safe and orderly* scored higher on average in the mathematics and science assessments than students who were in schools that were *somewhat safe and orderly* or *not safe and orderly,* according to teachers' reports. Internationally, on average, students in *somewhat safe and orderly* schools also performed better than students in schools that were *not safe and orderly,* but there was no difference in the average scores of students in these two groups of schools for Australian Year 8 students.

Schools have discipline and safety problems

Principals' views of safety and disciplinary issues at their schools were collected using a different scale than was used for students and teachers. Principals were asked to indicate the extent of the following behaviours and issues in their school:

- Arriving late at school
- Absenteeism (i.e. unjustified absences)
- Classroom disturbance
- Cheating
- Profanity
- Vandalism
- Theft
- Intimidation or verbal abuse among students (including texting, emailing, etc.)
- Physical injury to other students
- Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.)
- Physical injury to teachers or staff.

Principals were asked to indicate whether each of these was 'not a problem', 'minor problem', 'moderate problem' or a 'serious problem'. These responses were combined to create the School Discipline and Safety scale, and students assigned to one of three groups based on their principal's scale score.

Students assigned to the *hardly any problems* category had a score of at least 10.7, which is the point on the scale corresponding to their principals reporting 'not a problem' for six of the eleven discipline and safety issues and 'minor problem' for the other five, on average.

Students assigned to the *moderate problems* category had scores no higher than 8.0 which is the scale point corresponding to their principals reporting 'moderate problems' with six of the eleven issues and 'minor' problems with the other five, on average.

All other students were assigned to the *minor problems* category.

Table 6.10 School Discipline and Safety scale and student achievement in mathematics and science, Australia and the international average

	Hardly any problems						Minor problems						Moderate problems						Average Scale Score	SE
	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE	% of students	SE of %	Average mathematics achievement	SE	Average science achievement	SE		
Australia	33	3.8	538	10.7	548	9.1	62	3.9	496	5.6	511	5.7	5	1.5	458	18.4	484	22.0	10.1	0.1
International average	38	0.5	478	1.0	488	1.0	49	0.6	463	0.9	473	0.9	13	0.4	434	2.2	446	2.2		

The vast majority of Australian Year 8 students were in schools that were largely unaffected by discipline and attendance problems, 33 per cent with *hardly any problems* and 62 per cent with *minor problems.* One in 20 students attended schools with *moderate problems* according to their principal's report. These results were quite similar to the international average, although the proportion of students across participating countries, on average, in schools with *moderate problems* was larger than the proportion of Australian students in similar schools – 13 per cent compared to five per cent.

In terms of the relationship between the disciplinary climate of the school and students' performance, Australian students in schools with *hardly any problems* scored higher on average in mathematics and science than students in schools with *minor* or *moderate problems*, but significant differences were found between the scores of students in these latter two groups of schools for mathematics only. Internationally, students in schools with *moderate problems* scored lower than students in schools with *minor problems,* who in turn scored lower than students in schools with *hardly any problems*. The implication is clear – students perform better in an environment in which behavioural and disciplinary issues are kept to a minimum.

Factors limiting instruction in mathematics and science

Student factors affecting learning-instruction limited by students not ready to learn

Teachers of the TIMSS classes were asked their opinion on the extent ('limited a lot', 'some' or 'not at all') to which instruction at their school was limited by students who were not ready to learn. Three types of 'unready' students were referred to:

- Students lacking prerequisite knowledge or skills
- Students suffering from lack of basic nutrition
- Students suffering from not enough sleep.

The proportions of students who teachers indicated that instruction was *limited a lot* or *some* or *not at all* for each of these categories are presented in Tables 6.11 and 6.12, along with the average mathematics and science performance of students in each of these two groups of schools.

Table 6.11 Factors impacting learning (lack prerequisite knowledge or skills) and student achievement in mathematics and science, Australia and the international average

	Not at all				Some				A lot			
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE
Mathematics												
Australia	19	3.0	567	12.1	62	4.0	507	6.5	19	2.9	452	8.7
International average	15	0.4	490	1.9	57	0.6	471	0.8	28	0.5	443	1.2
Science												
Australia	32	3.7	560	9.7	58	3.5	516	5.9	10	2.0	480	14.4
International average	20	0.4	497	2.0	61	0.5	478	0.7	19	0.4	455	1.5

According to their teachers' report, almost 20 per cent of Australian Year 8 students are in mathematics classes that are limited *a lot* by students lacking prerequisite knowledge or skills, while 10 per cent of students are in the same position in their science classes. While these proportions compare quite favourably with the international averages (28% and 19%, respectively), they are still not desirable and warrant further attention.

Not surprisingly, there was a significant relationship between students' performance and their teachers' reports of lack of knowledge and skills impacting on instruction – those students whose mathematics and science classes were affected *not at all* by this limiting factor scored higher on average in the assessment (both mathematics and science) than students in classes that were *affected somewhat*, who in turn scored higher than students in classes that were affected *a lot*. The same pattern was found for Australian students and across participating countries on average.

Table 6.12 Factors impacting learning (nutrition and sleep) and student achievement in mathematics and science, Australia and the international average

	Instruction is limited by students suffering from lack of basic nutrition								Instruction is limited by students suffering from not enough sleep							
	Not at all				Some or A lot				Not at all				Some or A lot			
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE
Mathematics																
Australia	75	2.7	524	6.6	25	2.7	461	5.1	38	3.6	533	8.5	62	3.6	493	7.5
International average	63	0.5	477	0.8	37	0.5	449	1.2	43	0.6	477	1.0	57	0.6	461	0.9
Science																
Australia	76	2.8	540	6.1	24	2.8	484	8.9	37	3.6	535	6.4	63	3.6	522	7.6
International average	64	0.5	485	0.8	36	0.5	461	1.2	42	0.5	484	1.0	58	0.5	473	0.8

Around 75 per cent of Australian Year 8 students were in mathematics and science classes in which instruction was *not at all affected* by students suffering from a lack of basic nutrition, while over 60 per cent were in classes that were *affected some* or *a lot* by students suffering from not enough sleep.

As might be expected, the average mathematics and science scores of Australian students in classes that were impacted on negatively by lack of basic nutrition were significantly lower than the average scores of students in classes that were *not affected* by this factor. While the average mathematics scores of Australian students in classes impacted on by students lacking sleep were significantly lower than the scores of students in classes *not at all affected* by this factor (493 points compared to 533, respectively), there was no significant difference in the average science scores of students in classes that were impacted on *some* or *a lot* by lack of sleep and classes that were unaffected by this factor.

Internationally, on average, students in mathematics and science classes that were *not affected* by students lacking either basic nutrition or sleep scored higher in the TIMSS assessments than did students in classes that *were affected some* or *a lot* by these factors.

Student factors affecting learning-instruction limited by disruptive students

Teachers of the TIMSS classes were also asked their opinion on the extent ('limited a lot', 'some' or 'not at all') to which instruction in their classrooms was limited by students who were disruptive, or students who were uninterested.

The proportions of students whose teachers indicated that instruction was *limited a lot* or *some* or *not at all* for each of these categories is presented in Table 6.13, along with the average performance of students in classrooms that were impacted on by these factors, and those who were in classrooms in which these factors had little impact on instruction.

Table 6.13 Factors impacting learning (disruptive and uninterested students) and student achievement in mathematics and science, Australia and the international average

	Instruction is limited by disruptive students								Instruction is limited by uninterested students							
	Some or Not at all				A lot				Some or Not at all				A lot			
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE
Mathematics																
Australia	82	2.5	520	6.2	18	2.5	457	10.6	87	2.4	518	6.1	13	2.4	441	9.8
International average	83	0.4	472	0.6	17	0.4	444	1.8	76	0.5	475	0.7	24	0.5	441	1.5
Science																
Australia	87	2.4	533	6.2	13	2.4	488	10.5	91	1.9	531	5.9	9	1.9	480	13.1
International average	83	0.4	481	0.6	17	0.4	462	1.8	79	0.4	482	0.6	21	0.4	456	1.7

The majority of students, both internationally and in Australia, were in mathematics and science classes in which instruction was limited minimally by disruptive or uninterested students. The average proportion of students across participating countries who were in classes affected *a lot* by uninterested students, according to their teachers' reports, was higher than the proportion of Australian students in these sorts of conditions, particularly for science classes.

Students in classes that their teachers reported were affected *a lot by* either disruptive or uninterested students tended to score lower on average in the TIMSS assessments of mathematics and science than students whose classes were affected *some* or *not at all* by peers being disruptive or uninterested. This pattern was found among Australian students as well as across participating countries, on average.

Teachers' report of working conditions

Teachers' views of the physical environment and working conditions at their school were collected using the following five statements:

- The school building needs significant repair
- Classrooms are overcrowded
- Teachers have too many teaching hours
- Teachers do not have adequate workspace (e.g. for preparation, collaboration or meeting with students)
- Teachers do not have adequate instructional materials and supplies.

Teachers were asked to indicate whether each of these issues was 'not a problem', 'minor problem', 'moderate problem' or a 'serious problem' at their school. These responses were combined to create the Teacher Working Conditions scale, and students assigned to one of three categories on this scale based on their teachers' responses.

Students assigned to the *hardly any problems* category had a score of 11.7, which is the point on the scale corresponding to their teachers reporting 'not a problem' for three of the five issues and 'minor problems' for the other two, on average.

Students assigned to the *moderate problems* category had scores no higher than 8.9, which is the scale point corresponding to their teachers reporting "moderate problems" with three of the five issues and 'minor problems' for the other two, on average.

All other students were assigned to the *minor problems* category.

Table 6.14 presents the proportions of students (within Australia and on average internationally) in each of these three categories, and their average achievement scores in mathematics and science.

Table 6.14 The Teacher Working Conditions scale and student achievement in mathematics and science, Australia and the international average

	Hardly any problems				Minor problems				Moderate problems				Average Scale Score	SE
	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE	% of students	SE of %	Average achievement	SE		
Mathematics														
Australia	32	4.0	510	7.7	51	3.7	511	8.2	16	3.1	489	12.7	10.9	0.2
International average	21	0.5	479	1.6	49	0.6	467	0.9	31	0.5	464	1.2		
Science														
Australia	27	3.4	527	10.0	54	3.0	522	6.0	18	2.7	533	9.9	10.6	0.2
International average	20	0.4	489	1.5	48	0.5	477	0.8	32	0.5	473	1.1		

Fewer than 20 per cent of Australian students attended schools in which their mathematics and science teachers reported *moderate problems* with their working conditions (16% according to their mathematics teachers and 18% according to their science teachers), which compares favourably with the international averages of just over 30 per cent.

Among Australian students, there was no significant direct relationship between teachers' reports of working conditions and students' scores on the TIMSS mathematics and science assessments. Internationally, there was a trend for students in schools in which mathematics and science teachers reported *hardly any problems* to score higher on average in their assessments than schools with *moderate problems* with working conditions (479 points compared to 464 for mathematics and 489 points compared to 473 for science).

The next, and final chapter of this report, presents a summary of the findings and considerations for policy-makers.

Chapter

7

Summary and Policy Considerations

Summary

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 carried out in Australia for Years 3, 5, 7 and 9 provide some of this monitoring information. Comparative international studies such as the Trends in International Mathematics and Science Study (TIMSS), the Progress in International Reading Literacy Study (PIRLS) and the Programme for International Student Assessment (PISA) can provide an international 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 in mathematics and science 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. Australia has participated in TIMSS in each cycle since 1995.

This report details results from the participation by Australian Year 8 students in the TIMSS 2011 study (for which Australia collected data in late 2010); reporting achievement internationally and 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.

TIMSS in Australia

In Australia, 275 secondary schools and more than 7500 Year 8 students participated in TIMSS 2011. The Australian students undertook the assessment in late 2010, while their northern hemisphere counterparts completed it in early 2011, ensuring 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.

International performance in mathematics and science

Mathematics

Australia's average score remains unchanged over the 16 years since TIMSS 1995 was conducted. Australian Year 8 students' average performance in mathematics in 2011 was not significantly different to the TIMSS scale average, but was significantly lower than that of six other countries: the high performing Asian countries – Korea, Singapore, Chinese Taipei, Hong Kong and Japan – and the Russian Federation. Italy and Israel, whose relative positions were significantly lower than Australia in 2007, have recently caught up and are now at the same level, while the United States, England and Hungary, which all out-performed Australia in 2007, performed at a similar level to Australia in 2011. In terms of trends since 1995, the Russian Federation scored significantly lower than Australia in 1995 but significantly higher than Australia in TIMSS 2011.

Science

Australian Year 8 students' scores in science also remain unchanged since TIMSS 1995. Australia was outperformed by students in nine other countries, including Finland, Slovenia, the Russian Federation and England, as well as the participating Asian countries Singapore, Chinese Taipei, Korea, Japan and Hong Kong. Hungary (higher in 2007 and equal in 2011) and Israel (lower in 2007 and equal in 2011) were the only countries that showed any change in rankings relative to Australia.

International benchmarks

Achievement is not only measured in terms of mean scores, but also in terms of benchmarks: put simply, what students can and cannot do regarding 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 Center to describe performance at four levels. These were the Advanced, High, Intermediate and Low benchmarks. In addition to having students grouped by their mean scores, it is also therefore possible to obtain a picture of the skills and knowledge that students at each level typically possess. At the Advanced level, students typically 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 also 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 clearly something to which to aspire, it is also important that a country has as few students as possible below the Low benchmark. The minimum standard set for TIMSS in mathematics and science is the performance at the Intermediate Benchmark.

In mathematics at Year 8, nine per cent of Australian students achieved the Advanced international benchmark. At the other end of the achievement scale, though, more than one-third (37%) of Year 8 students did not achieve the Intermediate benchmark.

Similarly in science at Year 8, 11 per cent of Australian students achieved the Advanced international benchmark, however 30 per cent of students did not achieve the Intermediate benchmark.

Gender differences

In Year 8 mathematics in TIMSS 2011, as in previous cycles other than TIMSS 2007, there were no significant gender differences in mathematics in Australia; however as in all previous cycles, there was a significant gender difference favouring males in science. In the majority of participating countries there were no gender differences in either mathematics or science; however there are a substantial number of countries in which the gender difference in favour of males is still significant, and a handful of countries in which the gender difference is slightly larger and in favour of females. The only significant gender difference at the jurisdictional level was found in Tasmania, where males significantly outperformed females in science.

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 8, students in the Australian Capital Territory outperformed students in all other states with the exception of New South Wales. Students in New South Wales significantly outperformed students in South Australia, Tasmania and the Northern Territory, and students in Victoria and Queensland also significantly outperformed students in Tasmania and the Northern Territory.

Within Australia, scores in South Australia and Western Australia have declined significantly since TIMSS 1995; however there have been no other statistically significant changes in Year 8 mathematics achievement across all the cycles of TIMSS assessment.

At Year 8, the international median proportion of students reaching the Advanced benchmark was three per cent. Several states had substantially higher proportions of students at this level – the Australian Capital Territory (14%) and New South Wales (13%) in particular, with Victoria also achieving eight per cent at this level. At the same time, the international median for the proportion of students not reaching the Intermediate benchmark was 54 per cent, and all states other than the Northern Territory achieved better results than this (i.e. fewer students were below the Intermediate benchmark). As a comparison, in Korea 47 per cent of students achieved the Advanced international benchmark and just seven per cent of students failed to achieve the Intermediate benchmark.

Science

In Year 8 science, students in the Australian Capital Territory outperformed students in all other states other than New South Wales. Students in New South Wales significantly outperformed students in South Australia, Tasmania and the Northern Territory, and students in Queensland also significantly outperformed students in Tasmania and the Northern Territory.

There were no significant changes in scores for any state between any of the TIMSS cycles.

The international median proportion of students reaching the Advanced benchmark in science at Year 8 was four per cent. Several states had substantially higher proportions of students at this level – the Australian Capital Territory (19%) and New South Wales (16%) in particular, with Queensland (9%), Western Australia (7%) and Victoria (7%) also acquitting themselves well. At the same time, the international median for the proportion of students not reaching the Intermediate benchmark was 48 per cent, and all states achieved better results than this (i.e. fewer students were below the Intermediate benchmark). As a comparison, in Singapore 40 per cent of students achieved the Advanced international benchmark and 13 per cent of students failed to achieve the Intermediate benchmark.

Books in the home

The number of books in the home has traditionally acted as a proxy in large scale international studies for a family's educational and social background. Generally, there is a strong correlation between books in the home and parental education and income, and a moderate to strong positive correlation between books in the home and achievement. Nevertheless this relationship does not always work between countries. For example on average, Australian students reported a greater number of books in the home than students in most other countries yet achievement levels for Australia overall were not substantially better than those of students in these other countries. However, within Australia, the relationship is strong. In each of the domains covered by TIMSS, the average score for students who reported having many (i.e. more than 200) books in the home was significantly and substantially higher than that of students who reported an average number (i.e. between 26 and 200) of books in the home, and this score was in turn, in each domain, higher than the score for students with few books in the home. This relationship was the same in all countries.

Parental education

Parental education has also been found to be strongly related to student achievement. Year 8 students who participated in TIMSS 2011 were asked to indicate the highest level of education attained by each of their parents or guardians. The relationship was found to be strong: in both mathematics and science, a student's mean score increases as the level of parental education increases, with students who have at least one parent with a university degree having average scores significantly higher than those of students whose parents did not achieve this level of education.

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. These resources may be physical, such as books or an internet connection, or in the form of more intangible attributes such as parental education or occupation. TIMSS 2011, as in past cycles, found that there was a positive association between the level of Home Educational Resources and students' performance in mathematics and science, both internationally and within Australia. Students with *many resources* scored higher on average than students with *some* or *few resources.*

Indigenous students

At Year 8 the average score for Indigenous students in mathematics and science was substantially lower than that of their non-Indigenous counterparts (71 score points for mathematics and 65 score points for science). This gap has not changed significantly over the past 16 years.

In terms of benchmarks, which represent what students can and cannot do, it is notable that in both mathematics and science, more than half of the Indigenous students tested did not reach the Intermediate benchmark.

Student attitudes

Positive attitudes towards mathematics and science are important goals of the curriculum, particularly as students get older and begin to consider life after school and future careers. Within Australia, students who expressed more positive attitudes and reported a higher level of self-confidence in mathematics and science scored higher in the cognitive assessments than those who expressed less positive attitudes. Unfortunately, almost one-third of Australian students reported not being engaged with their mathematics and science lessons.

Among Australian students, male students liked mathematics and science, valued mathematics and were confident with mathematics and science to a greater degree than their female peers. Almost half of the female students surveyed said they did not like mathematics, which has possible implications for the uptake of further mathematics by female students at senior secondary level and beyond. Students who anticipated going on to university study (either undergraduate or postgraduate) scored higher in mathematics and science than students who anticipated going on to some other form of post-secondary study, or who thought that they would end their education with secondary school. This pattern was found internationally, for Australian students (on average), females and males and non-Indigenous students. Among Indigenous students, those who aspired to any form of post-secondary study recorded higher scores in mathematics and science than those who anticipated ending their education with secondary school.

School environments fostering learning

The results from TIMSS suggest that mathematics and science achievement was highest in schools in which principals and teachers reported a high emphasis on academic success, that teachers thought were safe and orderly and where student factors such as a lack of prerequisite knowledge, nutrition and sleep deprivation and disruptive or uninterested students did not impact on student learning. A school environment in which students liked school and felt as though they belonged, were engaged during mathematics lessons, felt that they were safe and were almost never bullied was also found to encourage higher academic achievement.

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 and in Australia, achievement was highest among students attending schools with few attendance or disciplinary problems.

Resources to support mathematics and science learning

Access to facilities, equipment and materials can enhance curriculum implementation and instruction. Achievement was highest in schools where principals reported that resource shortages were not a problem. Relatively few students were taught by younger teachers; the majority of students were taught by teachers aged between 30 and 50 years of age.

Policy considerations

The results of TIMSS 2011 show that Australia's scores in mathematics and science have largely stagnated over the past 16 years. Over this same time, a number of other countries have either dramatically improved their results (Chinese Taipei, for example), or slowly but surely improved (Korea, for example). More countries outperform Australia in mathematics and science in TIMSS 2011 than in TIMSS 1995, while a number of countries whose performance was lower than Australia's are now achieving at roughly the same level.

It is clear that in both mathematics and science, Australia has a substantial 'tail' of underperformance. For such a highly developed country, this level of underperformance is not acceptable and its minimisation should become a priority. Examining policy in the high performing Asian countries could provide some pointers. If the 11 per cent of students in mathematics and eight per cent of students in science in Australia currently not even achieving the Low international benchmark were to do so, it would lift Australia's overall average score substantially.

In addition, more attention needs to be paid to extending students at the highest levels of achievement. In comparison to higher achieving countries, the proportion of Australian students at the High and Advanced benchmarks is modest.

The issue of 'teaching out of field' in mathematics needs to be addressed. Around one-third of students are being taught by teachers with no content or pedagogical training in mathematics.

Perhaps a reflection of this lack of training is that more than 20 per cent of students were taught mathematics by teachers who were only *somewhat confident* in teaching mathematics. The situation is not as critical in science, however a similar proportion of students were taught by teachers who were only *somewhat* confident about teaching science, and one-quarter of students were taught by science teachers who did not feel very well prepared to teach all topics in science, particularly Earth science and physics. Without strong pedagogical and content knowledge, teachers will be more likely to teach to the middle, failing to provide adequate extension for high-achieving students and unable to provide alternative structure for students who are having difficulties. It is essential that these issues are addressed in the early years of secondary school with good teaching, otherwise the decline in engagement continues and students do not pursue further studies in these areas.

It is evident that student motivation and self-confidence are also important factors within Australia. Similarly, teachers' job satisfaction is important, as is the provision of a supportive, ambitious school climate. It is important that Australia continues to develop systems that build accountability and support capacity building for teachers and school management in order to address attitudinal barriers towards teaching and learning, particularly in specific subject areas such as mathematics and science.

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Appendix 1 Sampling in TIMSS

The TIMSS 2011 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, the TIMSS study center 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 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 the national target populations. Almost all participants achieved 100% coverage, the exceptions at Year 8 being Georgia (tested only students taught in Georgian) and Lithuania (tested only students taught in Lithuanian).

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. Exceptions at Year 8 included the Russian Federation, Singapore 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 that 20 per cent of its Year 8 student population.

The basic design of the sample used in TIMSS 2011 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 4500 students in each country.

Table A1.1 Coverage of Year 8 target population

	International Target Population		Exclusions from National Target Population		
	Coverage	Notes on Coverage	School-level Exclusions	Within-sample Exclusions	Overall Exclusions
Armenia	100%		1.5%	0.0%	1.5%
Australia	100%		1.3%	1.9%	3.2%
Bahrain	100%		0.5%	1.1%	1.6%
Chile	100%		1.1%	1.7%	2.8%
Chinese Taipei	100%		0.1%	1.2%	1.3%
England	100%		2.2%	0.1%	2.2%
Finland	100%		2.6%	0.9%	3.4%
Georgia [1 a]	93%	Students taught in Georgian	0.9%	3.7%	4.5%
Ghana	100%		0.6%	0.0%	0.6%
Hong Kong SAR	100%		3.9%	1.3%	5.3%
Hungary	100%		2.3%	2.1%	4.4%
Indonesia	100%		3.2%	0.0%	3.2%
Iran, Islamic Rep. of	100%		2.2%	0.0%	2.2%
Israel	100%		16.4%	6.1%	22.6%
Italy	100%		0.0%	4.6%	4.7%
Japan	100%		1.8%	1.0%	2.8%
Jordan	100%		0.0%	0.4%	0.4%
Kazakhstan	100%		3.8%	1.3%	5.1%
Korea, Rep. of	100%		1.0%	0.9%	1.9%
Lebanon	100%		1.4%	0.0%	1.4%
Lithuania	93%	Students taught in Lithuanian	1.4%	3.4%	4.8%
Macedonia	100%		2.8%	0.6%	3.3%
Malaysia	100%		0.1%	0.0%	0.1%
Morocco	100%		0.1%	0.0%	0.1%
New Zealand	100%		2.0%	1.2%	3.2%
Norway	100%		0.5%	1.4%	1.9%
Oman	100%		0.9%	0.3%	1.2%
Palestinian Nat'l Auth.	100%		0.6%	0.9%	1.5%
Qatar	100%		4.0%	0.5%	4.5%
Romania	100%		0.0%	1.2%	1.3%
Russian Federation	100%		2.9%	3.1%	6.0%
Saudi Arabia	100%		1.2%	0.1%	1.2%
Singapore	100%		5.7%	0.4%	6.0%
Slovenia	100%		1.7%	0.6%	2.3%
Sweden	100%		2.2%	2.9%	5.1%
Syrian Arab Republic	100%		1.9%	0.0%	1.9%
Thailand	100%		1.4%	0.1%	1.5%
Tunisia	100%		0.3%	0.1%	0.3%
Turkey	100%		0.2%	1.2%	1.5%
Ukraine	100%		2.5%	0.4%	2.8%
United Arab Emirates	100%		1.5%	1.3%	2.8%
United States	100%		0.0%	7.2%	7.2%

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

[1] National Target Population does not include all of the International Target Population.

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

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

[a] Exclusion rates for Georgia are slightly underestimated as some conflict zones were not covered and no official statistics were available.

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 8, England did so only after including replacement schools and have been annotated in the tables and figures in this report.

Table A1.2 Participation rates (weighted) for Year 8 students

Country	School Participation		Class Participation	Student Participation	Overall Participation	
	Before Replacement	After Replacement			Before Replacement	After Replacement
Armenia	100%	100%	100%	97%	97%	97%
Australia	96%	98%	100%	90%	87%	88%
Bahrain	99%	99%	100%	98%	97%	97%
Chile	88%	99%	100%	95%	84%	95%
Chinese Taipei	100%	100%	100%	99%	99%	99%
England ‡	75%	79%	100%	89%	67%	70%
Finland	97%	98%	100%	95%	91%	93%
Georgia	97%	98%	100%	98%	96%	97%
Ghana	100%	100%	100%	97%	97%	97%
Hong Kong	77%	78%	100%	96%	74%	75%
Hungary	98%	99%	100%	96%	94%	95%
Indonesia	100%	100%	100%	96%	96%	96%
Iran	100%	100%	100%	99%	98%	99%
Israel	94%	100%	100%	92%	87%	92%
Italy	83%	97%	100%	96%	80%	93%
Japan	85%	92%	100%	94%	80%	87%
Jordan	100%	100%	100%	96%	96%	96%
Kazakhstan	99%	100%	100%	98%	98%	98%
Korea	100%	100%	100%	99%	99%	99%
Lebanon	90%	98%	100%	96%	87%	94%
Lithuania	92%	99%	100%	93%	85%	92%
Macedonia	100%	100%	100%	95%	95%	95%
Malaysia	100%	100%	100%	98%	98%	98%
Morocco	100%	100%	100%	94%	94%	94%
New Zealand	87%	98%	100%	90%	78%	88%
Norway	89%	89%	100%	94%	84%	84%
Oman	99%	99%	100%	98%	97%	97%
Palestinian Nat'l Auth.	100%	100%	100%	98%	98%	98%
Qatar	99%	99%	100%	99%	99%	99%
Romania	99%	100%	100%	99%	97%	99%
Russian Federation	100%	100%	100%	98%	98%	98%
Saudi Arabia	98%	100%	100%	98%	96%	98%
Singapore	100%	100%	100%	95%	95%	95%
Slovenia	96%	98%	100%	94%	91%	92%
Sweden	97%	98%	100%	94%	91%	92%
Syrian Arab Republic	99%	99%	100%	93%	92%	92%
Thailand	92%	100%	100%	99%	90%	99%
Tunisia	99%	99%	100%	97%	97%	97%
Turkey	99%	100%	100%	97%	96%	97%
Ukraine	98%	100%	100%	98%	97%	98%
United Arab Emirates	100%	100%	100%	97%	97%	97%
United States	87%	87%	100%	94%	81%	81%

TIMSS guidelines for sampling participation: The minimum acceptable participation rates were 85 per cent of both schools and students, or a combined rate (the product of school and student participation) of 75 per cent. Participants not meeting these guidelines were annotated as follows:

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

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

¶ Did not satisfy guidelines for sample participation rates.

Appendix

2

The TIMSS mathematics and science assessments

Two organising dimensions, a content dimension and a cognitive dimension, framed the mathematics and science assessment for TIMSS 2011, 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 8 are shown in Table A2.1. For a more detailed description of each of the content domains in both mathematics and science refer to the TIMSS 2011 Assessment Frameworks (Mullis et al., 2009).

For each of the content domains shown in Table A2.1, the mathematics framework identifies several topic areas to be included in the assessment. For example at Year 8, *number* is further categorised by whole numbers, fractions and decimals, integers and ratio, proportion and percentages.

Table A2.1 TIMSS mathematics content domains and proportion of assessment for each domain at Year 8

Content domains	Topic areas	Target % of TIMSS assessment
Number	Whole numbers	30
	Fractions and decimals	
	Integers	
	Ratio, proportion and per cent	
Algebra	Patterns	30
	Algebraic expressions	
	Equations/formulas and functions	
Geometry	Geometric shapes	20
	Location and movement	
Data and chance	Data organisation and presentation	20
	Data interpretation	
	Chance	

Similarly, the content domains for science for Year 8 are shown in Table A2.2. 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 8 *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 A2.2 TIMSS science content domains and proportion of assessment for each domain at Year 8

Content domains	Topic areas	Target % of TIMSS assessment
Biology	Characteristics, classification and life processes of organisms	35
	Cells and their functions	
	Life cycles, reproduction and heredity	
	Diversity, adaptation and natural selection	
	Ecosystems	
	Human health	
Physics	Classification and composition of matter	20
	Properties of matter	
	Chemical change	
Chemistry	Physical states and changes in matter	25
	Energy transformations, heat and temperature	
	Light	
	Sound	
	Electricity and magnetism	
	Forces and motion	
Earth science	Earth's structure and physical features	20
	Earth's processes, cycles and history	
	Earth's resources, their use and conservation	
	Earth in the solar system and the universe	

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 TIMSS 2011.

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 8. The student behaviours used to define both the mathematics and the science framework at 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 TIMSS 2011 assessment is shown in Table A2.3.

Table A2.3 TIMSS mathematics and science cognitive domains and proportion of assessment for each domain at Year 8

Cognitive Domain	Mathematics	Science
Knowing	35%	35%
Applying	40%	35%
Reasoning	25%	30%

The structure of the TIMSS assessment

TIMSS 2011 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 2011 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 12 to 18 items in each block. TIMSS 2011 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 2007 assessment, eight of the 14 mathematics blocks and eight of the 14 science blocks were secured for use in measuring trends in 2011. The remaining 12 blocks were released into the public domain for use in publications, research and teaching, to be replaced by newly developed items in the TIMSS 2011 assessment. Accordingly, the 28 blocks in the TIMSS 2011 assessment comprise 16 blocks of trend items (eight mathematics and eight science) and 12 blocks of new items developed for 2011.

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 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 4500 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 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 are also 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, 2003 and 2007. This allows countries to accurately compare their Year 8 achievement in 2011 with that of 1995, 1999, 2003 and 2007 (for the years in which the country participated).

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 2011. 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 2011 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 2011 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 the Low benchmarks. These are shown in Figures A2.1 through A2.20.

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.

Students who did not reach the Low international benchmark are referred to as Below Low. Benchmarks are only one way of examining student performance. The benchmarks discussed in this report are based solely on student performance in TIMSS 2011, 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, illustrative items and examples of the correct answers are provided. Alongside each example is a table providing the percentage of students in participating countries answering the item correctly, to gain an idea of how Australian students performed.

Year 8 mathematics – Descriptors of performance at the international benchmarks

Table A2.4 provides descriptors for each level of the benchmarks for Year 8 mathematics. As can be seen in Table A2.4, students at the advanced international benchmark can reason with information and make generalisations, and solve non-routine problems involving numeric, algebraic and geometric concepts and relationships. In comparison, those at the low international benchmark demonstrated some knowledge of whole numbers and decimals, operations and basic graphs.

At Year 8, 30 per cent of the assessment items were devoted to assessing the *number content domain*. According to the *TIMSS 2011 Mathematics Framework*, students should have developed computational fluency with fractions and decimals, understand how operations relate to one another and have 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 (also 30% of the assessment), 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 (20% of the assessment), the focus is on using geometric properties and their relationships to solve problems. Students should also be competent in geometric measurement, using measuring instruments accurately, estimating where appropriate and selecting and using formulas for perimeters, areas and volumes. This content domain 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 (20% of the assessment) 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.

Table A2.4 Descriptions of the TIMSS international benchmarks for mathematics

Low International Benchmark	Intermediate International Benchmark	High International Benchmark	Advanced International Benchmark
400	475	550	625
Students have some knowledge of whole numbers and decimals, operations and basic graphs.	Students can apply basic mathematical knowledge in a variety of situations. Students can solve problems involving decimals, fractions, proportions and percentages. They understand simple algebraic relationships. Students can relate a two-dimensional drawing to a three-dimensional object. They can read, interpret and construct graphs and tables. They recognise basic notions of likelihood.	Students can apply their understanding and knowledge in a variety of relatively complex situations. Students can use information from several sources to solve problems involving different types of numbers and operations. Students can relate fractions, decimals and percentages to each other. Students at this level show basic procedural knowledge related to algebraic expressions. They can use properties of lines, angles, triangles, rectangles and rectangular prisms to solve problems. They can analyse data in a variety of graphs.	Students can reason with information, draw conclusions, make generalisations and solve linear equations. Students can solve a variety of fraction, proportion and per cent problems and justify their conclusions. Students can express generalisations algebraically and model situations. They can solve a variety of problems involving equations, formulas and functions. Students can reason with geometric figures to solve problems. Students can reason with data from several sources or unfamiliar representations to solve multi-step problems.

Year 8 mathematics – Performance at the Advanced international benchmark

Year 8 students achieving at the Advanced international benchmark were adept at many of the framework topics. They demonstrated their ability to reason with different types of numbers, geometric figures and data from a variety of sources and to generalise algebraically, so as to solve a variety of problems. 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.

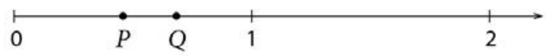
Figure A2.1 shows a numerical reasoning item (belonging to the content domain *number* and the cognitive domain *reasoning*) likely to be answered correctly by students who are performing at the Advanced benchmark.

Country	Percent Correct		
Chinese Taipei	53	(2.0)	↑
Hong Kong	47	(2.5)	↑
Singapore	45	(2.0)	↑
Korea	44	(2.0)	↑
Japan	43	(2.1)	↑
Russian Federation	31	(2.1)	↑
Sweden	30	(1.8)	↑
England	29	(3.0)	↑
Finland	29	(2.0)	↑
Palestinian Nat'l Auth.	28	(1.8)	↑
Israel	27	(2.0)	↑
Oman	26	(1.5)	↑
Syrian Arab Republic	25	(2.2)	
Saudi Arabia	25	(1.9)	
Jordan	24	(1.6)	
Australia	23	(2.1)	
Hungary	23	(1.6)	
International Avg.	**23**	**(0.3)**	
United States	22	(1.5)	
Qatar	22	(2.2)	
Slovenia	21	(1.9)	
Bahrain	21	(1.9)	
New Zealand	19	(2.3)	
Ukraine	19	(2.0)	↓
Lebanon	18	(2.0)	↓
Malaysia	18	(1.4)	↓
Lithuania	18	(1.8)	↓
Macedonia, Rep. Of	17	(2.4)	↓
Iran	16	(1.2)	↓
Morocco	16	(1.2)	↓
Italy	16	(1.6)	↓
Norway	15	(1.8)	↓
Armenia	15	(1.7)	↓
United Arab Emirates	15	(0.9)	↓
Turkey	15	(1.4)	↓
Tunisia	14	(1.4)	↓
Kazakhstan	14	(1.8)	↓
Chile	14	(1.3)	↓
Georgia	13	(1.7)	↓
Ghana	13	(1.1)	↓
Romania	12	(1.6)	↓
Thailand	12	(1.5)	↓
Indonesia	10	(1.7)	↓

Content Domain: Number

Cognitive Domain: Reasoning

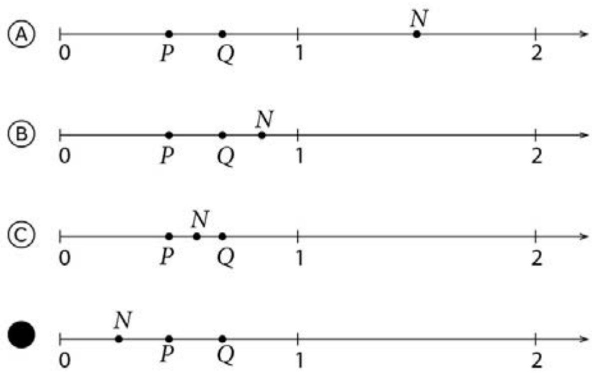
Description: Given two points on a number line representing unspecified fractions, identifies the point that represents their product



P and Q represent two fractions on the number line above.

$P \times Q = N$.

Which of these shows the location of N on the number line?



SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.1 Advanced international benchmark – mathematics example 1

On average across participating countries, 23 per cent of students answered this item correctly. Australia performed at this international average, with 23 per cent of students responding correctly. In the highest performing countries – Chinese Taipei, Hong Kong, Singapore, Korea and Japan – over 40 per cent of their Year 8 students provided the correct answer to this question.

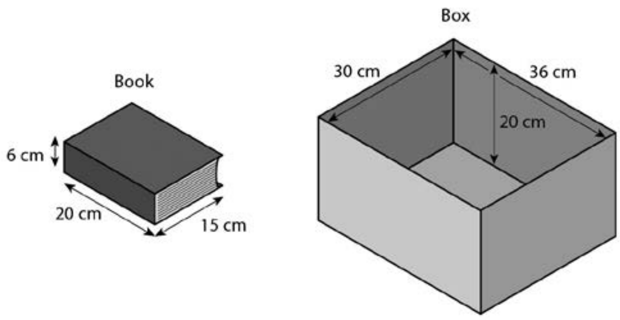
Figure A2.2 shows an item belonging to the content domain *geometry* and the cognitive domain *reasoning* that students who performed at the Advanced benchmark were likely to complete correctly.

Country	Percent Full Credit		
Chinese Taipei	66	(1.8)	↑
Hong Kong	65	(2.1)	↑
Korea	62	(2.0)	↑
Singapore	60	(1.9)	↑
Japan	58	(1.8)	↑
Russian Federation	36	(2.6)	↑
Israel	34	(2.4)	↑
Kazakhstan	33	(2.5)	↑
Lithuania	30	(2.0)	↑
Australia	29	(2.3)	↑
Finland	29	(2.3)	
Malaysia	28	(2.1)	
Slovenia	28	(2.6)	
New Zealand	27	(2.3)	
England	26	(2.3)	
United States	26	(1.5)	
Armenia	25	(2.1)	
International Avg.	**25**	**(0.3)**	
Ukraine	23	(2.7)	
Norway	22	(2.0)	
Italy	22	(2.1)	
Romania	22	(2.1)	
Hungary	21	(1.7)	↓
Sweden	20	(1.6)	↓
United Arab Emirates	20	(1.3)	↓
Turkey	20	(1.5)	↓
Thailand	16	(1.5)	↓
Chile	16	(1.5)	↓
Macedonia, Rep. Of	16	(2.0)	↓
Georgia	15	(1.7)	↓
Palestinian Nat'l Auth.	14	(1.7)	↓
Bahrain	14	(1.5)	↓
Iran	14	(1.6)	↓
Qatar	13	(1.5)	↓
Tunisia	12	(1.5)	↓
Saudi Arabia	12	(1.7)	↓
Indonesia	11	(1.5)	↓
Oman	11	(0.9)	↓
Lebanon	11	(1.8)	↓
Jordan	9	(0.9)	↓
Syrian Arab Republic	9	(1.5)	↓
Morocco	8	(1.0)	↓
Ghana	4	(1.0)	↓

Content Domain: Geometry
Cognitive Domain: Reasoning
Description: Solves a word problem involving filling a three-dimensional shape with rectangular solids

Ryan is packing books into a rectangular box.

All the books are the same size.



What is the largest number of books that will fit inside the box?

Answer: 12

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.2 Advanced international benchmark – mathematics example 2

On average across the participating countries, only one quarter of students were able to complete this word problem. Twenty-nine per cent of Australian Year 8 students successfully completed this item, which was significantly higher than the international average, but still well below the highest performing countries on this item, Chinese Taipei and Hong Kong (66% and 65%, respectively).

Figure A2.3 presents an item belonging to the content domain *algebra* and the cognitive domain *knowing* that students who performed at the Advanced benchmark were likely to complete correctly.

Country	Percent Full Credit		
Korea	60	(2.3)	↑
Chinese Taipei	52	(2.0)	↑
Armenia	47	(2.5)	↑
Russian Federation	46	(3.0)	↑
Singapore	44	(1.9)	↑
Israel	41	(2.5)	↑
Lebanon	40	(3.0)	↑
Hungary	38	(2.3)	↑
Kazakhstan	38	(2.6)	↑
Romania	34	(2.4)	↑
Macedonia	26	(2.9)	↑
Georgia	23	(2.1)	↑
Lithuania	23	(1.9)	↑
United States	21	(1.6)	↑
International Avg.	**17**	**(0.3)**	
Hong Kong	16	(2.0)	
Oman	15	(1.4)	
Bahrain	13	(1.1)	↓
Ghana	13	(1.6)	↓
Morocco	13	(1.2)	↓
Turkey	10	(1.3)	↓
Japan	9	(1.2)	↓
Jordan	9	(1.0)	↓
Finland	8	(1.4)	↓
Australia	8	(1.7)	↓
United Arab Emirates	7	(0.8)	↓
Syrian Arab Republic	7	(1.2)	↓
Qatar	6	(1.3)	↓
Ukraine	6	(1.7)	↓
England	5	(1.3)	↓
Italy	5	(0.9)	↓
Palestinian Nat'l Auth.	4	(0.9)	↓
Saudi Arabia	4	(1.0)	↓
Indonesia	3	(1.1)	↓
Malaysia	3	(0.8)	↓
New Zealand	2	(0.9)	↓
Thailand	2	(0.5)	↓
Slovenia	2	(0.8)	↓
Norway	1	(0.5)	↓
Tunisia	1	(0.6)	↓
Chile	1	(0.2)	↓
Iran	0	(0.2)	↓
Sweden	-	-	

Content Domain: Algebra
Cognitive Domain: Knowing
Description: Solves a linear inequality

Solve this inequality.

$9x - 6 < 4x + 4$

Answer: $x < 2$

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.
A dash (-) indicates comparable data not available.

Figure A2.3 Advanced international benchmark – mathematics example 3

The item in Figure A2.3 asks Year 8 students to solve a linear inequality. This was beyond many students in most countries, with only 17 per cent of students on average across the participating countries able to solve this problem. Most Australian students struggled with this question with only eight per cent successfully completing this item, which was significantly lower than the international average. Students in the highest scoring countries (Korea and Chinese Taipei) performed well above the international average (60% and 52%, respectively).

Year 8 mathematics – Performance at the High international benchmark

Year 8 students achieving at the High international benchmark could apply their mathematical knowledge and understanding in a variety of relatively complex situations. They could relate fractions, decimals and percentages to each other, and analyse data from charts to solve problems. Students performing at this level also showed procedural knowledge related to algebraic problems and could use the properties of lines, angles and triangles to solve problems.

Figure A2.4 presents an item belonging to the content domain *number* and the cognitive domain *knowing* that students who performed at the High benchmark were likely to complete correctly.

Country	Percent Full Credit		
Singapore	89	(1.2)	↑
Korea	76	(1.9)	↑
Hong Kong	76	(2.4)	↑
Chinese Taipei	69	(1.7)	↑
Japan	57	(2.2)	↑
Israel	57	(2.1)	↑
Russian Federation	55	(2.1)	↑
United States	54	(1.5)	↑
Australia	53	(2.6)	↑
Lithuania	53	(1.9)	↑
Sweden	51	(1.8)	↑
Finland	50	(2.4)	↑
Slovenia	49	(2.2)	↑
England	48	(3.0)	↑
New Zealand	46	(2.8)	↑
Hungary	46	(2.5)	↑
Italy	46	(2.3)	↑
Norway	42	(2.4)	
Malaysia	42	(2.3)	
International Avg.	**37**	**(0.3)**	
United Arab Emirates	37	(1.4)	
Kazakhstan	36	(2.5)	
Lebanon	35	(2.5)	
Armenia	34	(2.2)	
Turkey	33	(1.6)	↓
Ukraine	33	(2.7)	
Romania	26	(1.8)	↓
Chile	26	(1.5)	↓
Qatar	24	(1.4)	↓
Macedonia, Rep. Of	22	(2.0)	↓
Bahrain	22	(1.7)	↓
Iran	22	(2.0)	↓
Indonesia	20	(1.9)	↓
Georgia	20	(2.0)	↓
Tunisia	19	(1.7)	↓
Thailand	18	(2.1)	↓
Palestinian Nat'l Auth.	18	(1.8)	↓
Syrian Arab Republic	17	(1.9)	↓
Saudi Arabia	12	(1.6)	↓
Morocco	11	(0.8)	↓
Jordan	11	(1.2)	↓
Oman	10	(1.0)	↓
Ghana	8	(1.2)	↓

Content Domain: Number
Cognitive Domain: Knowing
Description: Given the part and the whole can express the part as a percentage and given the whole and the percentage can find the part

Peter, James, and Andrew each had 20 tries at throwing balls into a basket.

Complete the missing boxes below.

Name	Number of Successful Shots	Percentage of Successful Shots
Peter	10 out of 20	50 %
James	15 out of 20	[75] %
Andrew	[16] out of 20	80%

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.4 High international benchmark – mathematics example 1

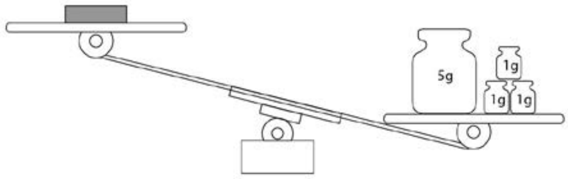
This constructed-response item was successfully completed by 37 per cent of Year students, on average, internationally. Students in Singapore were the clear top performers, with 89 per cent able to correctly complete the problem. More than half of Australian Year 8 students were successful on this item, a result that places Australia significantly higher than the international average.

Figure A2.5 presents an item belonging to the content domain *algebra* and the cognitive domain *reasoning* that students who performed at the High benchmark were likely to complete correctly.

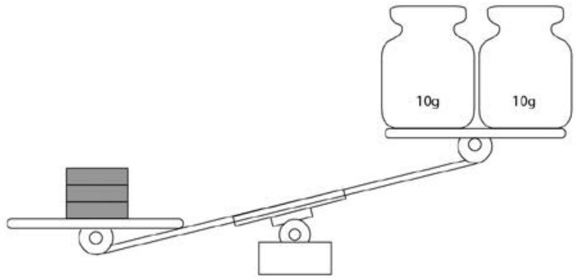
Country	Percent Correct		
Korea	79	(1.6)	↑
Japan	76	(2.0)	↑
Singapore	75	(1.7)	↑
Finland	74	(1.9)	↑
Chinese Taipei	74	(1.6)	↑
Hong Kong	68	(2.1)	↑
Russian Federation	67	(2.2)	↑
England	62	(2.8)	↑
Australia	62	(2.4)	↑
Sweden	62	(2.1)	↑
Lithuania	61	(2.4)	↑
Hungary	58	(2.3)	↑
Slovenia	58	(2.3)	↑
Israel	58	(2.4)	↑
United States	57	(1.5)	↑
New Zealand	57	(2.4)	↑
Norway	55	(2.5)	↑
Ukraine	54	(2.7)	↑
Italy	51	(2.2)	↑
Georgia	50	(2.6)	
Turkey	47	(1.7)	
International Avg.	**47**	**(0.3)**	
Thailand	46	(2.0)	
Chile	45	(1.7)	
Kazakhstan	43	(2.7)	
Romania	40	(2.3)	↓
Armenia	38	(2.4)	↓
United Arab Emirates	37	(1.4)	↓
Iran	37	(2.1)	↓
Malaysia	36	(2.4)	↓
Macedonia, Rep. of	35	(2.4)	↓
Lebanon	34	(2.4)	↓
Jordan	33	(1.9)	↓
Tunisia	32	(1.8)	↓
Qatar	32	(2.0)	↓
Bahrain	30	(2.1)	↓
Palestinian Nat'l Auth.	26	(2.0)	↓
Saudi Arabia	24	(2.1)	↓
Syrian Arab Republic	22	(2.1)	↓
Oman	22	(1.3)	↓
Morocco	18	(1.2)	↓
Indonesia	18	(1.6)	↓
Ghana	9	(0.9)	↓

Content Domain: Algebra
Cognitive Domain: Reasoning
Description: Identifies the quantity that satisfies two inequalities represented by balances in a problem situation

Jo has three metal blocks. The weight of each block is the same.
When she weighed one block against 8 grams, this is what happened.



When she weighed all three blocks against 20 grams, this is what happened.



Which of the following could be the weight of one metal block?

Ⓐ 5 g
Ⓑ 6 g
● 7 g
Ⓓ 8 g

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.5 High international benchmark – mathematics example 2

The performance of Australian Year 8 students on this algebraic problem was higher than the international average, with 62 per cent of Australian students (and 47% internationally) able to solve it successfully. However, over 75 per cent of students in Singapore, Japan and Korea were successful on this item.

Figure A2.6 presents an item belonging to the content domain *data and chance* and the cognitive domain *applying* that students who performed at the High benchmark were likely to complete correctly.

Country	Percent Full Credit		
Singapore	85	(1.5)	↑
Korea	85	(1.4)	↑
Chinese Taipei	80	(1.7)	↑
Hong Kong	76	(1.8)	↑
Japan	75	(1.7)	↑
Finland	70	(2.3)	↑
Slovenia	67	(2.5)	↑
Australia	67	(2.3)	↑
England	65	(3.0)	↑
Israel	63	(1.9)	↑
Russian Federation	63	(2.6)	↑
United States	62	(1.7)	↑
Lithuania	62	(2.5)	↑
Hungary	62	(2.1)	↑
Norway	61	(2.7)	↑
New Zealand	59	(2.5)	↑
Sweden	58	(1.9)	↑
Italy	54	(2.5)	↑
Malaysia	50	(2.2)	
Ukraine	48	(3.0)	
Turkey	48	(2.0)	
International Avg.	**47**	**(0.3)**	
Thailand	45	(2.3)	
Chile	44	(1.7)	
United Arab Emirates	41	(1.4)	↓
Kazakhstan	40	(2.8)	↓
Jordan	34	(2.1)	↓
Qatar	33	(2.2)	↓
Bahrain	33	(1.8)	↓
Oman	30	(1.5)	↓
Palestinian Nat'l Auth.	30	(1.8)	↓
Georgia	30	(2.1)	↓
Romania	29	(2.2)	↓
Indonesia	28	(2.2)	↓
Tunisia	27	(1.9)	↓
Armenia	25	(2.2)	↓
Macedonia, Rep. Of	24	(2.1)	↓
Iran	23	(1.8)	↓
Syrian Arab Republic	23	(2.4)	↓
Saudi Arabia	19	(1.9)	↓
Morocco	18	(1.1)	↓
Lebanon	17	(1.7)	↓
Ghana	11	(1.3)	↓

Content Domain: Data and Chance

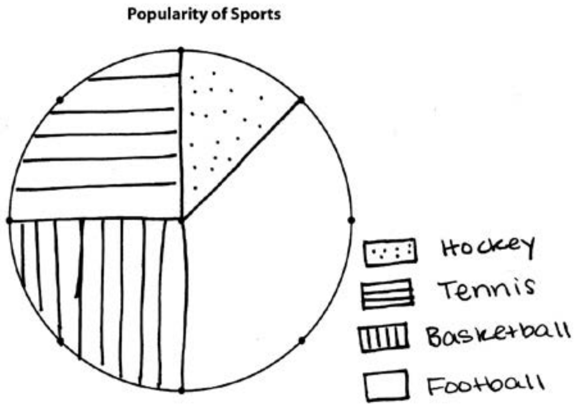
Cognitive Domain: Applying

Description: Constructs and labels a pie chart representing a given situation

480 students were asked to name their favorite sport. The results are shown in this table.

Sport	Number of Students
Hockey	60
Football	180
Tennis	120
Basketball	120

Use the information in the table to complete and label this pie chart.



SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 2 of 2 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.6 High international benchmark – mathematics example 3

Australian Year 8 students performed above the international average on this data display item. Two thirds of Australian students were able to successfully draw the pie chart from the data in the table, compared to 47 per cent internationally. However, 85 per cent of students in Singapore and Korea were also able to successfully complete this item.

Year 8 mathematics – Performance at the Intermediate international benchmark

Year 8 students achieving at the Intermediate international benchmark can solve problems involving decimals, fractions, proportions and percentages. They know the meaning of simple algebraic expressions and have some understanding of the likelihood of an event. Relating two-dimensional drawings to 3 dimensional objects, such as recognising a pyramid from its net, is also a skill students at this level display.

Figure A2.7 presents an item belonging to the content domain *algebra* and the cognitive domain *knowing* that students who performed at the Intermediate benchmark were likely to complete correctly.

Country	Percent Correct		
Hong Kong	94	(1.3)	↑
Korea	91	(1.3)	↑
Singapore	91	(1.1)	↑
Chinese Taipei	90	(1.3)	↑
Russian Federation	89	(1.2)	↑
Japan	87	(1.5)	↑
Ukraine	81	(2.1)	↑
United States	80	(1.2)	↑
Armenia	79	(1.9)	↑
Slovenia	76	(2.0)	↑
Lithuania	75	(2.3)	↑
Israel	74	(2.0)	↑
Kazakhstan	73	(1.9)	↑
Hungary	73	(1.9)	↑
Finland	72	(2.2)	↑
England	72	(2.8)	↑
Georgia	71	(1.8)	↑
Australia	71	(2.3)	↑
Jordan	69	(2.0)	
United Arab Emirates	66	(1.4)	
International Avg.	**65**	**(0.3)**	
Italy	65	(2.0)	
Romania	65	(2.3)	
Macedonia, Rep. Of	63	(2.5)	
Bahrain	62	(1.7)	
New Zealand	60	(2.3)	↓
Thailand	60	(2.5)	↓
Lebanon	59	(2.6)	↓
Turkey	58	(1.9)	↓
Chile	58	(2.4)	↓
Saudi Arabia	57	(2.2)	↓
Palestinian Nat'l Auth.	56	(2.0)	↓
Qatar	55	(2.3)	↓
Iran	55	(2.0)	↓
Sweden	53	(2.0)	↓
Tunisia	49	(1.8)	↓
Indonesia	48	(2.3)	↓
Syrian Arab Republic	48	(2.2)	↓
Oman	47	(1.7)	↓
Malaysia	43	(2.0)	↓
Morocco	41	(1.6)	↓
Ghana	36	(1.8)	↓
Norway	36	(2.6)	↓

Content Domain: Algebra

Cognitive Domain: Knowing

Description: Knows the meaning of a simple algebraic expression involving multiplication and addition

What does $xy + 1$ mean?

Ⓐ Add 1 to y, then multiply by x.

Ⓑ Multiply x and y by 1.

Ⓒ Add x to y, then add 1.

● Multiply x by y, then add 1.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average

↓ Percent significantly lower than international average

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.7 Intermediate international benchmark – mathematics example 1

On average internationally, 65 per cent of students were able to understand the symbolic representation in an algebraic expression. Slightly, but still significantly, more Year 8 students in Australia were able to correctly answer this multiple choice item (71%). Over 90 per cent of students in the top performing countries (Hong Kong, Korea and Singapore) were able to successfully complete this item.

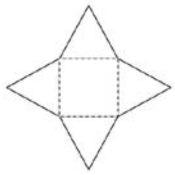
Figure A2.8 presents an item belonging to the content domain *geometry* and the cognitive domain *knowing* that students who performed at the Intermediate benchmark were likely to complete correctly.

Country	Percent Full Credit		
Japan	89	(1.2)	↑
Finland	89	(1.1)	↑
Australia	87	(1.2)	↑
Korea	85	(1.3)	↑
New Zealand	84	(1.7)	↑
Singapore	83	(1.4)	↑
England	82	(2.1)	↑
United States	81	(1.0)	↑
Slovenia	81	(1.7)	↑
Lithuania	78	(1.7)	↑
Hungary	77	(1.9)	↑
Hong Kong	77	(2.0)	↑
Russian Federation	75	(1.7)	↑
Norway	74	(2.4)	↑
Chinese Taipei	74	(1.7)	↑
Chile	70	(1.8)	↑
Italy	70	(2.3)	↑
Israel	66	(1.9)	↑
Sweden	65	(1.9)	↑
Kazakhstan	60	(2.4)	
Ukraine	59	(3.1)	
International Avg.	**58**	**(0.3)**	
Turkey	57	(1.8)	
Malaysia	53	(1.8)	↓
Thailand	51	(2.4)	↓
United Arab Emirates	50	(1.4)	↓
Bahrain	49	(2.5)	↓
Romania	47	(2.2)	↓
Macedonia, Rep. Of	47	(2.5)	↓
Iran	45	(2.2)	↓
Tunisia	44	(1.9)	↓
Jordan	42	(1.8)	↓
Armenia	41	(1.9)	↓
Qatar	40	(2.7)	↓
Palestinian Nat'l Auth.	37	(2.1)	↓
Saudi Arabia	37	(2.2)	↓
Georgia	37	(2.5)	↓
Oman	36	(1.5)	↓
Morocco	35	(1.4)	↓
Indonesia	27	(2.2)	↓
Syrian Arab Republic	26	(2.4)	↓
Lebanon	22	(2.2)	↓
Ghana	10	(1.3)	↓

Content Domain: Geometry

Cognitive Domain: Knowing

Description: Given a net of a three-dimensional object, completes a two-dimensional drawing of it from a specific viewpoint



The shape shown above is cut out of cardboard. The triangle flaps are then folded up along the dotted lines until they touch the edges of the flaps next to them.

Complete the diagram below to show what the shape would look like when viewed from directly above.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.8 Intermediate international benchmark – mathematics example 2

Australia was one of the top performing countries on this geometry item (along with Japan and Finland), with over 85% of students able to draw a pyramid from its net. Internationally, only 58 per cent of students were able to successfully complete this item.

Year 8 mathematics – Performance at the Low international benchmark

Students at this level have an elementary understanding of whole numbers and decimals and can do basic computations, including evaluating simple algebraic equations. They can match tables to bar graphs and read a simple line graph.

Figure A2.9 presents an item belonging to the content domain *number* and the cognitive domain *knowing* that students who performed at the Low benchmark were likely to complete correctly.

Country	Percent Full Credit		
Singapore	94	(0.8)	↑
Malaysia	91	(1.2)	↑
Hong Kong	91	(1.5)	↑
Kazakhstan	90	(1.8)	↑
Lithuania	90	(1.5)	↑
Russian Federation	90	(1.2)	↑
Chinese Taipei	89	(1.1)	↑
United States	89	(1.0)	↑
Hungary	88	(1.3)	↑
Italy	88	(1.6)	↑
Korea	87	(1.5)	↑
Slovenia	85	(1.7)	↑
Armenia	84	(1.9)	↑
Tunisia	82	(1.8)	↑
Israel	82	(1.4)	↑
Australia	82	(2.0)	↑
Norway	81	(1.9)	↑
Lebanon	81	(1.7)	↑
Japan	81	(1.6)	↑
Ukraine	80	(2.4)	↑
United Arab Emirates	79	(1.2)	↑
Sweden	79	(1.7)	↑
England	79	(2.4)	↑
Finland	79	(1.8)	↑
International Avg.	**72**	**(0.3)**	
Morocco	72	(1.7)	
Qatar	72	(1.5)	
New Zealand	70	(2.9)	
Romania	69	(2.5)	
Saudi Arabia	65	(2.5)	↓
Macedonia, Rep. of	65	(2.6)	↓
Georgia	64	(2.9)	↓
Thailand	64	(2.4)	↓
Chile	58	(2.2)	↓
Indonesia	57	(2.2)	↓
Palestinian Nat'l Auth.	56	(1.9)	↓
Oman	49	(1.6)	↓
Turkey	48	(1.8)	↓
Bahrain	43	(2.3)	↓
Iran	42	(2.2)	↓
Jordan	36	(1.7)	↓
Ghana	36	(2.1)	↓
Syrian Arab Republic	31	(2.4)	↓

Content Domain: Number

Cognitive Domain: Knowing

Description: Adds a two-place and a three-place decimal

$42.65 + 5.748 =$

Answer: 48.398

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.9 Low international benchmark – mathematics example 1

Australian students performed above the international average on this addition item, with 82 per cent of Year 8 students able to complete the problem correctly. Internationally, 72 per cent of students, on average, were able to do so.

Figure A2.10 presents an item belonging to the content domain *algebra* and the cognitive domain *knowing* that students who performed at the Low benchmark were likely to complete correctly.

Country	Percent Correct		
Korea	92	(1.0)	↑
Chinese Taipei	91	(1.0)	↑
Singapore	91	(1.1)	↑
Russian Federation	91	(1.6)	↑
United States	89	(1.0)	↑
Japan	86	(1.5)	↑
Kazakhstan	86	(1.9)	↑
Hong Kong	83	(1.8)	↑
Lithuania	83	(1.8)	↑
Ukraine	81	(2.5)	↑
Hungary	81	(1.7)	↑
Armenia	81	(1.8)	↑
Italy	80	(2.1)	↑
Slovenia	78	(2.1)	↑
Finland	78	(1.8)	↑
Romania	75	(1.9)	↑
Sweden	75	(1.7)	↑
England	73	(2.9)	
Israel	72	(2.2)	
Macedonia, Rep. Of	71	(2.3)	
Australia	71	(2.6)	
International Avg.	**71**	**(0.3)**	
Norway	70	(2.5)	
Georgia	68	(2.2)	
Qatar	66	(1.6)	↓
Turkey	66	(1.8)	↓
Jordan	65	(2.2)	↓
Indonesia	65	(2.4)	↓
Chile	65	(2.1)	↓
Syrian Arab Republic	65	(2.3)	↓
United Arab Emirates	64	(1.4)	↓
Bahrain	64	(2.1)	↓
Tunisia	62	(2.0)	↓
New Zealand	61	(2.6)	↓
Lebanon	60	(2.6)	↓
Palestinian Nat'l Auth.	59	(1.8)	↓
Saudi Arabia	57	(2.4)	↓
Thailand	56	(2.2)	↓
Iran	51	(2.5)	↓
Ghana	49	(2.1)	↓
Oman	48	(1.5)	↓
Malaysia	47	(2.1)	↓
Morocco	45	(1.8)	↓

Content Domain: Algebra
Cognitive Domain: Knowing
Description: Evaluates a simple algebraic expression

$$y = \frac{a+b}{c}$$

$a = 8$, $b = 6$, and $c = 2$

What is the value of y?

● 7
Ⓑ 10
Ⓒ 11
Ⓓ 14

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.10 Low international benchmark – mathematics example 2

On average, internationally, 71 per cent of students were able to correctly evaluate a simple algebraic expression. In Australia, Year 8 students performed at the international average, with 71 per cent successfully answering this item.

Year 8 science – Descriptors of performance at the international benchmarks

Table A2.5 provides the descriptors for the international benchmarks for science at Year 8. As Table A2.5 shows, students at the advanced international benchmark in Year 8 communicate an understanding of 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.

At Year 8, 35 per cent of the assessment items were devoted to assessing the *biology content domain*. According to the TIMSS 2011 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 (20% of the assessment), 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 (25% of the assessment), 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 (20% of the assessment), 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.

Table A2.5 Descriptions of the TIMSS international benchmarks for science

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

Year 8 science – Performance at the Advanced international benchmark

Year 8 students achieving at the Advanced international benchmark demonstrated an understanding of complex and abstract concepts in all content domains. They also combined information from several sources to solve problems and draw conclusions, and could provide written explanations to communicate scientific knowledge. 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 A2.11 shows an item, belonging to the content domain *chemistry* and the cognitive domain *knowing,* likely to be answered correctly by students who are performing at the Advanced benchmark.

Country	Percent Full Credit		
England	59	(2.6)	↑
New Zealand	50	(2.5)	↑
United States	46	(1.5)	↑
Chinese Taipei	44	(2.0)	↑
Russian Federation	44	(2.4)	↑
Singapore	44	(1.9)	↑
Australia	42	(2.3)	↑
United Arab Emirates	37	(1.3)	↑
Finland	36	(2.3)	↑
Hong Kong	35	(1.9)	↑
Norway	32	(2.5)	↑
Japan	30	(2.1)	↑
Saudi Arabia	30	(2.1)	↑
Syrian Arab Republic	30	(2.4)	↑
Slovenia	30	(2.1)	↑
Jordan	28	(2.0)	↑
Ukraine	27	(2.5)	
International Avg.	**24**	**(0.3)**	
Bahrain	23	(1.4)	
Israel	23	(2.0)	
Korea	23	(1.6)	
Lebanon	22	(2.3)	
Qatar	22	(2.2)	
Lithuania	21	(1.9)	
Palestinian Nat'l Auth.	21	(1.8)	
Sweden	18	(1.5)	↓
Tunisia	18	(1.6)	↓
Kazakhstan	17	(2.0)	↓
Romania	17	(1.6)	↓
Oman	17	(1.4)	↓
Iran	17	(1.7)	↓
Hungary	15	(1.4)	↓
Armenia	14	(1.5)	↓
Malaysia	10	(1.2)	↓
Italy	9	(1.3)	↓
Turkey	8	(1.2)	↓
Thailand	8	(1.3)	↓
Chile	7	(0.9)	↓
Indonesia	6	(0.9)	↓
Macedonia, Rep. of	5	(1.1)	↓
Morocco	4	(0.5)	↓
Georgia	3	(1.0)	↓
Ghana	1	(0.4)	↓

Content Domain: Chemistry

Cognitive Domain: Knowing

Description: Describes two things that might be observed as a chemical reaction takes place

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

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

1. A temperature change

2. gas bubbles

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 2 of 2 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.11 Advanced international benchmark – science example 1

To receive full credit on this item, students had to describe two changes that take place during a chemical reaction. On average across the participating countries, only 24 per cent of students were able to do this. Forty-two per cent of Australian Year 8 students successfully completed this item, which was significantly higher than the international average. England was the top performer on this item, with 59 per cent of students able to list two changes that take place during a chemical reaction.

Figure A2.12 shows an item belonging to the content domain *physics* and the cognitive domain *applying* that students who performed at the Advanced benchmark were likely to complete correctly.

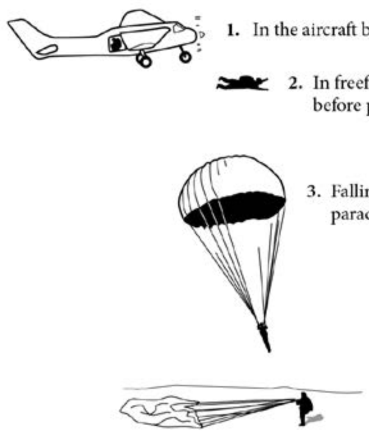
Country	Percent Correct		
Korea	63	(2.0)	↑
Finland	59	(2.1)	↑
Israel	54	(2.3)	↑
Japan	49	(2.1)	↑
Sweden	49	(2.1)	↑
Slovenia	47	(2.7)	↑
Singapore	45	(1.7)	↑
Hungary	45	(2.3)	↑
England	43	(2.9)	↑
Lithuania	42	(2.3)	↑
Ukraine	40	(2.3)	↑
Russian Federation	38	(2.6)	↑
United States	37	(1.4)	↑
Hong Kong	36	(2.3)	↑
Chinese Taipei	35	(2.0)	
Turkey	34	(1.9)	
Palestinian Nat'l Auth.	34	(2.1)	
Norway	32	(2.2)	
International Avg.	**32**	**(0.3)**	
Jordan	30	(1.9)	
Armenia	30	(2.3)	
Australia	30	(2.5)	
New Zealand	29	(2.0)	
United Arab Emirates	28	(1.2)	↓
Italy	26	(2.2)	↓
Qatar	26	(2.5)	↓
Lebanon	26	(2.1)	↓
Bahrain	25	(1.9)	↓
Syrian Arab Republic	25	(2.0)	↓
Ghana	22	(1.7)	↓
Kazakhstan	22	(2.4)	↓
Oman	22	(1.4)	↓
Thailand	22	(1.6)	↓
Iran	22	(1.7)	↓
Romania	22	(1.9)	↓
Saudi Arabia	20	(1.6)	↓
Macedonia, Rep. of	20	(2.0)	↓
Georgia	20	(2.4)	↓
Chile	19	(1.4)	↓
Morocco	16	(1.2)	↓
Malaysia	16	(1.4)	↓
Tunisia	16	(2.0)	↓
Indonesia	13	(1.5)	↓

Content Domain: Physics

Cognitive Domain: Applying

Description: Recognizes that the force of gravity acts on a person regardless of position and movement

The figure shows a parachute jumper in four positions.



In which of the positions does the force of gravity act on the jumper?

Ⓐ Position 2 only.

Ⓑ Positions 2 and 3 only.

Ⓒ Positions 1, 2 and 3 only.

● Positions 1, 2, 3, and 4.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.12 Advanced international benchmark – science example 2

On average across participating countries, 32 per cent of students answered this item correctly. The performance of Australian students was equal to the international average, with 30 per cent of students responding correctly. There was great variation across countries in the proportion of students able to provide a correct answer to this item, ranging from 13 to 63 per cent.

Figure A2.13 shows an item belonging to the content domain *Earth Science* and the cognitive domain *reasoning* that students who performed at the Advanced benchmark were likely to complete correctly.

Country	Percent Full Credit		
Iran	48	(2.3)	↑
Japan	43	(2.2)	↑
Italy	38	(2.6)	↑
United States	37	(1.7)	↑
Israel	34	(2.2)	↑
Chinese Taipei	32	(2.1)	↑
Russian Federation	31	(2.1)	↑
Slovenia	29	(2.2)	↑
Korea	28	(1.8)	↑
England	28	(2.8)	↑
New Zealand	27	(2.2)	↑
Australia	27	(2.2)	↑
Sweden	24	(1.5)	↑
Lithuania	23	(1.8)	↑
Singapore	22	(1.6)	↑
Romania	21	(2.2)	
Kazakhstan	20	(2.4)	
Ukraine	20	(2.2)	
Norway	20	(2.0)	
Hong Kong	19	(2.2)	
International Avg.	**18**	**(0.3)**	
Finland	18	(1.6)	
Jordan	17	(1.7)	
Chile	15	(1.4)	↓
United Arab Emirates	15	(1.0)	↓
Syrian Arab Republic	13	(1.8)	↓
Hungary	12	(1.3)	↓
Oman	10	(0.9)	↓
Macedonia, Rep. of	9	(1.4)	↓
Turkey	8	(1.2)	↓
Armenia	8	(1.2)	↓
Georgia	8	(1.4)	↓
Thailand	8	(1.1)	↓
Palestinian Nat'l Auth.	7	(0.9)	↓
Qatar	6	(1.2)	↓
Indonesia	5	(0.8)	↓
Morocco	5	(0.7)	↓
Malaysia	5	(0.7)	↓
Bahrain	5	(0.6)	↓
Lebanon	3	(0.8)	↓
Saudi Arabia	3	(0.8)	↓
Tunisia	2	(0.6)	↓
Ghana	-	-	

Content Domain: Earth Science

Cognitive Domain: Reasoning

Description: States what fossil evidence would support the idea that two continents were once joined

Two continents are separated by water.

Geologists are looking for evidence that the two continents were once joined.

What fossil evidence would support this idea?

The same species of extinct animals are found on the two continents

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.13 Advanced international benchmark – science example 3

Students found this item challenging. Across countries, on average, 18 per cent of students were able to provide a correct answer. Australian Year 8 students' performance was above average, with 27 per cent answering correctly. However, 48 per cent of students in the top performing country, Iran, were able to do so.

Year 8 science – Performance at the High international benchmark

Year 8 students achieving at the high benchmark demonstrated understanding of concepts, related to science cycles, systems and principles. They also demonstrated some scientific inquiry skills, and were able to combine and interpret information from various sources, analyse and draw conclusions and provide short explanations conveying scientific knowledge.

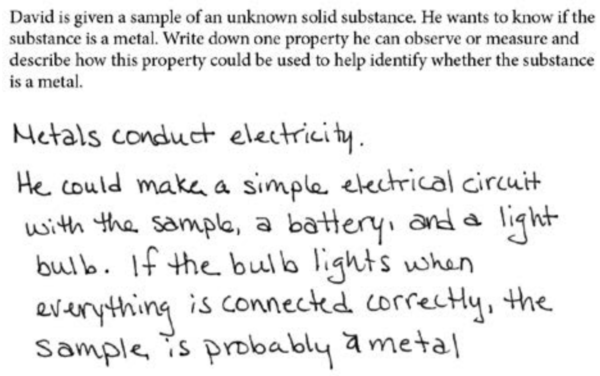
Figure A2.14 shows an item belonging to the content domain *chemistry* and the cognitive domain *reasoning* that students who performed at the High benchmark were likely to complete correctly.

Country	Percent Full Credit		
Japan	72	(2.4)	↑
Slovenia	69	(2.2)	↑
Singapore	64	(2.0)	↑
England	61	(2.9)	↑
Israel	58	(2.1)	↑
Chinese Taipei	56	(2.5)	↑
Hong Kong SAR	52	(2.5)	↑
Kazakhstan	49	(2.8)	↑
United States	48	(1.4)	↑
Russian Federation	48	(2.1)	↑
Hungary	46	(2.0)	↑
Sweden	45	(2.4)	↑
Jordan	45	(2.2)	↑
Finland	44	(2.6)	↑
Lithuania	42	(1.9)	↑
New Zealand	41	(2.7)	↑
Ukraine	41	(2.6)	↑
Iran, Islamic Rep. of	40	(2.0)	h
Australia	38	(2.0)	
International Avg.	**35**	**(0.3)**	
Norway	34	(2.3)	
Palestinian Nat'l Auth.	32	(2.1)	
Saudi Arabia	31	(2.3)	
Armenia	31	(2.1)	↓
Korea, Rep. of	31	(1.6)	↓
Bahrain	29	(1.8)	↓
Turkey	29	(1.6)	↓
Qatar	28	(2.1)	↓
United Arab Emirates	24	(1.3)	↓
Italy	24	(2.2)	↓
Ghana	23	(1.9)	↓
Romania	22	(2.3)	↓
Macedonia, Rep. of	22	(2.4)	↓
Lebanon	21	(2.3)	↓
Thailand	20	(1.9)	↓
Malaysia	18	(2.0)	↓
Syrian Arab Republic	17	(2.0)	↓
Georgia	16	(2.0)	↓
Tunisia	15	(1.4)	↓
Oman	15	(1.1)	↓
Chile	13	(1.4)	↓
Indonesia	10	(1.1)	↓
Morocco	7	(0.8)	↓

Content Domain: Chemistry

Cognitive Domain: Reasoning

Description: States what fossil evidence would support the idea that two continents were once joined



SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.14 High international benchmark – science example 1

On average, across countries, 35 per cent of students were able to correctly identify a property of metals and describe how this property could be used to identify a substance as a metal. Australian students performed at a level equal to the international average, with 38 per cent providing a correct answer. Around 70 per cent of students in Japan and Slovenia, the top performing countries on this item, were able to successfully complete this item.

Figure A2.15 shows an item belonging to the content domain *physics* and the cognitive domain *knowing* that students who performed at the High benchmark were likely to complete correctly.

Country	Percent Correct		
Korea	82	(1.4)	↑
Slovenia	80	(2.0)	↑
Russian Federation	77	(2.0)	↑
Israel	75	(2.0)	↑
Singapore	73	(1.8)	↑
Finland	73	(2.0)	↑
United States	73	(1.5)	↑
Sweden	72	(1.9)	↑
Kazakhstan	71	(2.4)	↑
New Zealand	70	(2.3)	↑
Hungary	70	(2.1)	↑
Norway	68	(2.8)	↑
Bahrain	67	(2.1)	↑
Ukraine	67	(2.6)	↑
England	65	(2.3)	↑
Turkey	63	(1.7)	↑
Saudi Arabia	63	(2.0)	↑
Australia	62	(2.1)	h
United Arab Emirates	60	(1.3)	
Iran	60	(2.2)	
Armenia	59	(2.8)	
Romania	59	(1.9)	
Lithuania	59	(2.5)	
International Avg.	**58**	**(0.3)**	
Georgia	56	(2.2)	
Italy	56	(2.5)	
Chinese Taipei	56	(1.9)	
Malaysia	53	(2.2)	↓
Hong Kong	52	(2.2)	↓
Chile	51	(2.2)	↓
Oman	50	(1.8)	↓
Japan	50	(2.3)	↓
Macedonia, Rep. of	49	(2.4)	↓
Qatar	47	(2.1)	↓
Jordan	46	(1.9)	↓
Thailand	41	(1.9)	↓
Palestinian Nat'l Auth.	40	(1.8)	↓
Syrian Arab Republic	37	(2.1)	↓
Lebanon	37	(2.5)	↓
Indonesia	35	(2.3)	↓
Morocco	33	(1.6)	↓
Tunisia	32	(2.1)	↓
Ghana	31	(1.8)	↓

Content Domain: Physics

Cognitive Domain: Knowing

Description: Recognizes what happens to molecules of a liquid as the liquid cools

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

● They slow down.

Ⓑ They speed up.

Ⓒ They decrease in number.

Ⓓ They decrease in size.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.15 High international benchmark – science example 2

This item is relatively less difficult than the previous item, with 58 per cent of students, on average, internationally, able to successfully demonstrate their understanding of concepts related to fundamental scientific principles. Australian students performed above the international average, with 62 per cent answering correctly. More than 80 per cent of students in Korea provided a correct answer.

Figure A2.16 shows an item belonging to the content domain *Earth science* and the cognitive domain *applying* that students who performed at the High benchmark were likely to complete correctly.

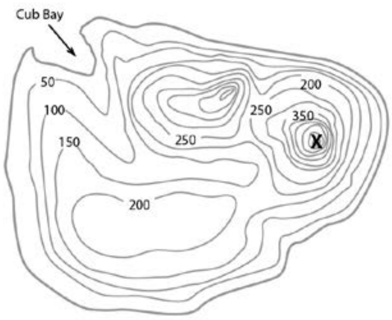
Country	Percent Full Credit		
Finland	84	(1.4)	↑
Chinese Taipei	81	(1.7)	↑
Slovenia	70	(1.8)	↑
Singapore	68	(2.2)	↑
Russian Federation	67	(2.1)	↑
Hungary	66	(2.3)	↑
Hong Kong	64	(2.5)	↑
Norway	61	(2.2)	↑
Australia	61	(2.4)	↑
Lithuania	60	(2.5)	↑
Korea	60	(2.1)	↑
United States	59	(2.0)	↑
Ukraine	57	(2.5)	↑
England	56	(2.8)	↑
Italy	54	(2.2)	↑
Japan	52	(2.2)	↑
Israel	47	(2.7)	↑
New Zealand	45	(2.7)	↑
Sweden	43	(2.1)	↑
International Avg.	**38**	**(0.3)**	
Kazakhstan	35	(3.2)	
Iran	31	(2.5)	↓
Turkey	31	(1.8)	↓
Romania	30	(2.2)	↓
Macedonia, Rep. of	28	(2.9)	↓
Malaysia	27	(1.8)	↓
Georgia	25	(2.4)	↓
United Arab Emirates	23	(1.1)	↓
Thailand	22	(1.7)	↓
Chile	22	(1.5)	↓
Saudi Arabia	22	(2.2)	↓
Jordan	21	(1.7)	↓
Bahrain	21	(1.7)	↓
Armenia	20	(2.1)	↓
Qatar	18	(1.6)	↓
Syrian Arab Republic	17	(2.3)	↓
Palestinian Nat'l Auth.	15	(1.8)	↓
Lebanon	11	(1.7)	↓
Morocco	10	(0.8)	↓
Tunisia	10	(1.5)	↓
Indonesia	9	(1.2)	↓
Oman	9	(1.2)	↓
Ghana	4	(1.0)	↓

Content Domain: Earth Science

Cognitive Domain: Applying

Description: Interprets a contour map to recognize a topographical representation of a mountain top

Tiger Island



The diagram above shows a topographic map of Tiger Island. The lines on the map are contour lines that connect points at the same elevation. The elevations shown are in meters.

A. What geographical feature is found at point **X**? mountain top

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.16 High international benchmark – science example 3

Australian students performed above the international average of 38 per cent correct on this item, with 61 per cent able to correctly interpret the information provided in the contour map. There was wide variation across countries on this item (ranging from 4% to 84% of students answering correctly), indicating that this topic may be more widely taught in some countries than others.

Year 8 science – Performance at the Intermediate international benchmark

Students performing at the Intermediate international benchmark were able to recognise and apply their understanding of basic scientific knowledge in various contexts. They were also able to interpret information from tables, graphs and pictorial diagrams, and drew conclusions, as well as communicating their understanding through brief descriptive responses.

Figure A2.17 shows an item belonging to the content domain *biology* and the cognitive domain *reasoning* that students who performed at the Intermediate benchmark were likely to complete correctly.

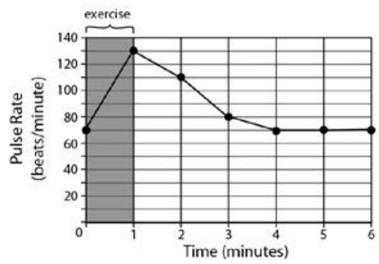
Country	Percent Correct		
Japan	82	(1.7)	↑
Korea	80	(1.6)	↑
Finland	80	(1.9)	↑
Italy	79	(1.9)	↑
Russian Federation	75	(1.9)	↑
Singapore	75	(1.6)	↑
Sweden	75	(1.7)	↑
Israel	74	(1.7)	↑
Lithuania	74	(2.0)	↑
Norway	73	(2.5)	↑
United States	73	(1.2)	↑
Slovenia	71	(1.9)	↑
England	69	(2.6)	↑
Australia	66	(2.3)	↑
Chinese Taipei	64	(2.0)	↑
New Zealand	62	(1.9)	↑
Chile	62	(2.0)	↑
Romania	61	(1.9)	
Hong Kong	60	(2.3)	
Malaysia	60	(1.8)	
Turkey	60	(1.9)	
International Avg.	**57**	**(0.3)**	
Ukraine	56	(3.0)	
United Arab Emirates	54	(1.5)	↓
Iran	51	(1.9)	↓
Georgia	49	(2.6)	↓
Tunisia	49	(2.1)	↓
Hungary	48	(2.1)	↓
Saudi Arabia	46	(2.3)	↓
Bahrain	46	(2.1)	↓
Lebanon	46	(2.5)	↓
Indonesia	46	(2.2)	↓
Thailand	45	(2.1)	↓
Macedonia, Rep. of	45	(2.3)	↓
Kazakhstan	44	(2.3)	↓
Qatar	43	(2.2)	↓
Jordan	43	(2.3)	↓
Armenia	42	(2.2)	↓
Morocco	42	(1.4)	↓
Oman	42	(1.5)	↓
Palestinian Nat'l Auth.	38	(1.9)	↓
Syrian Arab Republic	32	(2.6)	↓
Ghana	30	(1.5)	↓

Content Domain: Biology

Cognitive Domain: Reasoning

Description: Interprets a graph showing changes in pulse rates before, during, and after exercise and recognizes what can be concluded from the graph

John measures his pulse rate before he exercises. It is 70 beats per minute. He exercises for one minute and measures his pulse rate again. He then measures it every minute for several minutes. He draws a graph to show his results.



What can be concluded from his results?

- Ⓐ His pulse rate increased by 50 beats per minute.
- Ⓑ His pulse rate took less time to slow down than to increase.
- Ⓒ His pulse rate after 4 minutes was 80 beats per minute.
- ● His pulse rate returned to normal in less than 6 minutes.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.17 Intermediate international benchmark – science example 1

This item required students to interpret a graph and recognise what could be concluded from the data presented in the graph. Internationally, on average, 57 per cent of students could answer the question correctly. Australia placed above the international average, with 66 per cent of students successfully completing this item. However, in the top performing countries (Japan, Korea and Finland), 80 per cent or more were able to provide a correct answer.

Figure A2.18 shows an item belonging to the content domain *Earth science* and the cognitive domain *applying* that students who performed at the Intermediate benchmark were likely to complete correctly.

Country	Percent Full Credit		
Finland	92	(1.2)	↑
Hong Kong	85	(1.6)	↑
Singapore	83	(1.5)	↑
Chinese Taipei	82	(1.6)	↑
Korea	81	(1.6)	↑
Russian Federation	79	(1.7)	↑
England	79	(2.5)	↑
Israel	79	(2.1)	↑
Sweden	78	(1.9)	↑
Lithuania	76	(1.6)	↑
Slovenia	76	(2.2)	↑
Hungary	74	(2.1)	↑
New Zealand	72	(2.3)	↑
Australia	71	(2.0)	↑
Italy	71	(2.1)	↑
United States	71	(1.4)	↑
Japan	71	(2.2)	↑
Ukraine	69	(2.7)	↑
Norway	67	(2.2)	
Chile	66	(1.9)	
International Avg.	**63**	**(0.3)**	
Tunisia	62	(2.1)	
United Arab Emirates	62	(1.3)	
Thailand	61	(2.3)	
Oman	60	(1.7)	
Bahrain	59	(2.0)	↓
Iran	58	(2.2)	↓
Jordan	57	(2.1)	↓
Romania	56	(2.2)	↓
Saudi Arabia	56	(2.5)	↓
Kazakhstan	55	(2.9)	↓
Georgia	54	(2.8)	↓
Turkey	54	(2.1)	↓
Lebanon	50	(2.8)	↓
Malaysia	49	(2.2)	↓
Armenia	47	(2.7)	↓
Syrian Arab Republic	46	(2.7)	↓
Palestinian Nat'l Auth.	45	(1.9)	↓
Indonesia	45	(2.5)	↓
Qatar	45	(2.3)	↓
Morocco	44	(1.6)	↓
Macedonia, Rep. of	37	(2.7)	↓
Ghana	14	(1.5)	↓

Content Domain: Earth Science

Cognitive Domain: Applying

Description: Given a starting point, orders the processes involved in the water cycle

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

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

2 Water vapor rises in warm air.

5 Water travels along a river to the sea.

1 Water evaporates from the sea.

3 Water vapor is cooled and forms clouds.

4 Clouds move and water falls on land as rain.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The answer shown illustrates the type of student response that was given 1 of 1 points.

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.18 Intermediate international benchmark – science example 2

The international average per cent correct for this item was 63 per cent. However, the percentage of students answering correctly varied greatly across countries (ranging from 14% to 92%), indicating that the processes of the water cycle may be taught more widely in some countries than others. Australian Year 8 students performed well on this item, with 71 per cent able to place the processes of the water cycle in the correct order.

Year 8 science – Performance at the Low international benchmark

At the low benchmark, Year 8 students were able to recognise some basic facts from the life and physical sciences and interpret simple pictorial diagrams, complete simple tables and apply their knowledge to practical situations.

Figure A2.19 shows an item belonging to the content domain *biology* and the cognitive domain *applying* that students who performed at the Low benchmark were likely to complete correctly.

Country	Percent Correct		
Japan	95	(0.9)	↑
Finland	94	(1.0)	↑
Korea	93	(0.9)	↑
Singapore	92	(1.0)	↑
Slovenia	91	(1.4)	↑
Jordan	91	(1.1)	↑
United States	90	(0.8)	↑
Israel	90	(1.4)	↑
Chinese Taipei	89	(1.2)	↑
England	88	(1.7)	↑
Hong Kong	88	(1.5)	↑
Russian Federation	88	(1.5)	↑
Italy	88	(1.6)	↑
Hungary	87	(1.4)	↑
Armenia	87	(1.4)	↑
Tunisia	87	(1.2)	↑
Ukraine	86	(2.2)	
United Arab Emirates	86	(1.0)	↑
Australia	86	(1.5)	
Bahrain	85	(1.4)	
Saudi Arabia	85	(1.4)	
New Zealand	85	(1.6)	
Lithuania	84	(1.7)	
Turkey	84	(1.3)	
Palestinian Nat'l Auth.	84	(1.3)	
International Avg.	**83**	**(0.2)**	
Sweden	83	(1.5)	
Romania	83	(1.5)	
Norway	82	(1.6)	
Qatar	82	(1.8)	
Syrian Arab Republic	81	(1.7)	
Oman	81	(1.2)	↓
Morocco	80	(1.6)	↓
Chile	80	(1.5)	↓
Kazakhstan	79	(1.7)	↓
Thailand	77	(1.8)	↓
Georgia	76	(2.8)	↓
Lebanon	76	(2.2)	↓
Iran	75	(1.8)	↓
Indonesia	70	(2.3)	↓
Ghana	69	(1.5)	↓
Malaysia	69	(1.7)	↓
Macedonia, Rep. of	63	(2.4)	↓

Content Domain: Biology

Cognitive Domain: Applying

Description: Recognizes that genetic material is inherited from both parents

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

Which statement is correct about their genetic makeup?

Ⓐ The boy and girl inherit genetic material from the father only.

Ⓑ The boy and girl inherit genetic material from the mother only.

● The boy and girl inherit genetic material from both parents.

Ⓓ The boy inherits genetic material from the father only and the girl inherits it from the mother only.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.19 Low international benchmark – science example 1

On average, across countries, this item was relatively easy and was answered correctly by 83 per cent of Year 8 students. More than 60 per cent of students in all participating countries were able to answer this item correctly. In Australia, the per cent correct was 86 per cent, not significantly different to the international average.

Figure A2.20 shows an item belonging to the content domain *chemistry* and the cognitive domain *knowing* that students who performed at the Low benchmark were likely to complete correctly.

Country	Percent Correct		
Japan	99	(0.3)	↑
Chinese Taipei	98	(0.5)	↑
Lebanon	97	(0.9)	↑
Slovenia	96	(0.7)	↑
Romania	94	(1.3)	↑
Hungary	93	(1.0)	↑
England	92	(1.3)	↑
Russian Federation	92	(1.1)	↑
Armenia	91	(1.1)	↑
Singapore	91	(1.1)	↑
Korea	90	(1.4)	↑
Italy	90	(1.2)	↑
Hong Kong	89	(1.6)	↑
Indonesia	89	(1.5)	↑
Ukraine	88	(1.5)	↑
Kazakhstan	88	(1.6)	↑
Macedonia, Rep. of	88	(1.4)	↑
Qatar	87	(1.5)	
Syrian Arab Republic	87	(1.5)	
Israel	86	(1.5)	
Oman	86	(1.6)	
Jordan	86	(1.4)	
United States	86	(1.1)	
Lithuania	85	(1.6)	
International Avg.	**85**	**(0.2)**	
Palestinian Nat'l Auth.	85	(1.2)	
Australia	84	(2.0)	
Norway	84	(1.8)	
New Zealand	84	(1.6)	
Turkey	83	(1.6)	
United Arab Emirates	83	(1.1)	
Morocco	82	(1.3)	↓
Sweden	81	(1.4)	↓
Finland	81	(1.9)	↓
Chile	80	(1.8)	↓
Ghana	79	(1.6)	↓
Bahrain	79	(1.5)	↓
Saudi Arabia	75	(1.8)	↓
Tunisia	73	(2.1)	↓
Thailand	73	(1.7)	↓
Georgia	68	(1.9)	↓
Malaysia	67	(1.9)	↓
Iran	59	(2.3)	↓

Content Domain: Chemistry

Cognitive Domain: Knowing

Description: Recognizes the chemical formula of carbon dioxide

What is the chemical formula for carbon dioxide?

Ⓐ CO

● CO_2

Ⓒ C

Ⓓ O_2

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

↑ Percent significantly higher than international average
↓ Percent significantly lower than international average
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Figure A2.20 Low international benchmark – science example 2

The international average per cent correct for this item was 85 per cent, with the per cent correct of participating countries ranging from 59 per cent in Iran to 99 per cent in Japan. Australian Year 8 students performed at the international average, with 84 per cent able to correctly identify the chemical formula of carbon dioxide.

Appendix

3

International comparison tables

Table A3.1 International multiple comparison tables – TIMSS 2011 mathematics

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.

Country	Average Scale Score		Korea	Singapore	Chinese Taipei	Hong Kong	Japan	Russian Federation	Israel	Finland	United States	England	Hungary	Australia	Slovenia	Lithuania	Italy	New Zealand	Kazakhstan	Sweden	Ukraine	Norway	Armenia	Romania	United Arab Emirates	Turkey	Lebanon	Malaysia	Georgia	Thailand	Macedonia, Rep. of	Tunisia	Chile	Iran	Qatar	Bahrain	Jordan	Palestinian Nat'l Auth.	Saudi Arabia	Indonesia	Syrian Arab Republic	Morocco	Oman	Ghana
Korea	613	(2.9)				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Singapore	611	(3.8)				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Chinese Taipei	609	(3.2)				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Hong Kong	586	(3.8)	↓	↓	↓		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Japan	570	(2.6)	↓	↓	↓	↓		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Russian Federation	539	(3.6)	↓	↓	↓	↓	↓		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Israel	516	(4.1)	↓	↓	↓	↓	↓	↓					↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Finland	514	(2.5)	↓	↓	↓	↓	↓	↓					↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
United States	509	(2.6)	↓	↓	↓	↓	↓	↓									↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
England	507	(5.5)	↓	↓	↓	↓	↓	↓										↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Hungary	505	(3.5)	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Australia	505	(5.1)	↓	↓	↓	↓	↓	↓										↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Slovenia	505	(2.2)	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Lithuania	502	(2.5)	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Italy	498	(2.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓				↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
New Zealand	488	(5.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Kazakhstan	487	(4.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Sweden	484	(1.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Ukraine	479	(3.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Norway	475	(2.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓			↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Armenia	467	(2.7)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓			↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Romania	458	(4.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
United Arab Emirates	456	(2.1)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Turkey	452	(3.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Lebanon	449	(3.7)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Malaysia	440	(5.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Georgia	431	(3.8)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Thailand	427	(4.3)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Macedonia, Rep. of	426	(5.2)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Tunisia	425	(2.8)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Chile	416	(2.6)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		↓				↑	↑	↑	↑	↑	↑	↑	↑	↑
Iran	415	(4.3)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓									↑	↑	↑	↑	↑	↑
Qatar	410	(3.1)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑	↑
Bahrain	409	(2.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑
Jordan	406	(3.7)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑
Palestinian Nat'l Auth.	404	(3.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑
Saudi Arabia	394	(4.6)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑
Indonesia	386	(4.3)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑
Syrian Arab Republic	380	(4.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑
Morocco	371	(2.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑
Oman	366	(2.8)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓			↑
Ghana	331	(4.3)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	

Significance tests were not adjusted for multiple comparisons. Five percent of the comparisons would be statistically significant by chance alone.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

Table A3.2 International multiple comparison tables – TIMSS 2011 science

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.

Country	Average Scale Score		Singapore	Chinese Taipei	Korea	Japan	Finland	Slovenia	Russian Federation	Hong Kong	England	United States	Hungary	Australia	Israel	Lithuania	New Zealand	Sweden	Italy	Ukraine	Norway	Kazakhstan	Turkey	Iran	Romania	United Arab Emirates	Chile	Bahrain	Thailand	Jordan	Tunisia	Armenia	Saudi Arabia	Malaysia	Syrian Arab Republic	Palestinian Nat'l Auth.	Georgia	Oman	Qatar	Macedonia, Rep. of	Lebanon	Indonesia	Morocco	Ghana
Singapore	590	(4.3)		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Chinese Taipei	564	(2.3)	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Korea	560	(2.0)	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Japan	558	(2.4)	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Finland	552	(2.5)	↓	↓	↓			↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Slovenia	543	(2.7)	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Russian Federation	542	(3.2)	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Hong Kong	535	(3.4)	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
England	533	(4.9)	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
United States	525	(2.6)	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Hungary	522	(3.1)	↓	↓	↓	↓	↓	↓	↓	↓						↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Australia	519	(4.8)	↓	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Israel	516	(4.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Lithuania	514	(2.6)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
New Zealand	512	(4.6)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Sweden	509	(2.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Italy	501	(2.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Ukraine	501	(3.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Norway	494	(2.6)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Kazakhstan	490	(4.3)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Turkey	483	(3.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Iran	474	(4.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Romania	465	(3.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
United Arab Emirates	465	(2.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Chile	461	(2.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Bahrain	452	(2.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Thailand	451	(3.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Jordan	449	(4.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Tunisia	439	(2.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Armenia	437	(3.1)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Saudi Arabia	436	(3.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓						↑	↑	↑	↑	↑	↑	↑	↑	↑
Malaysia	426	(6.3)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓										↑	↑	↑	↑	↑
Syrian Arab Republic	426	(3.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑	↑
Palestinian Nat'l Auth.	420	(3.2)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑
Georgia	420	(3.0)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑
Oman	420	(3.2)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓							↑	↑	↑	↑	↑
Qatar	419	(3.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓								↑	↑	↑	↑
Macedonia, Rep. of	407	(5.4)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓					↑	↑
Lebanon	406	(4.9)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑
Indonesia	406	(4.5)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↑	↑
Morocco	376	(2.2)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		↑
Ghana	306	(5.2)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	

Significance tests were not adjusted for multiple comparisons. Five percent of the comparisons would be statistically significant by chance alone.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.