5. Trends in Student Achievement in Mathematics and Science

Introduction

In the context of this inquiry, the two key international studies are the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). The two studies have a different focus, with TIMSS focusing on the curriculum and what students know and PISA focusing strongly on what students can do with their knowledge. The influence of PISA and TIMSS on education policies and systems in Victoria is evidenced by the frequency with which key stakeholders, including government authorities, teacher associations, school leaders and others in the profession, referred to these studies throughout this inquiry. The Committee also notes the proposal currently before the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) for PISA to be used as the data source for national key performance measures (KPMs) for the performance of 15-year-old students in reading, mathematical and scientific literacy.\(^{165}\)

PISA and TIMSS complement state-based literacy and numeracy testing for students in Years 3, 5 and 7 and testing of other curriculum areas that are based on national sample surveys of achievement. The two key national studies of relevance to this inquiry are the annual National Report on Schooling in Australia National Benchmark Results in Reading, Writing and Numeracy for Years 3, 5 and 7 and the 2003 National Year 6 Science Assessment Report.

National Numeracy Benchmarks

In 1997, all state, territory and commonwealth education ministers agreed on the national goal that every child leaving primary school should be numerate and be able to read, write and spell at an appropriate level. To provide focus to this goal, the ministers also agreed to a sub-goal that every child commencing school from 1998 will achieve a minimum acceptable literacy and numeracy standard within four years.\(^{166}\) Agreement of these goals led to the implementation of the National Literacy and Numeracy Plan, the essential features of which are early assessment and intervention for

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students at risk of not achieving minimum numeracy and literacy goals; development of national benchmarks for each of Years 3, 5 and 7; and assessment of student progress against the benchmarks.

National Numeracy Benchmarks are used for reporting achievement in three aspects of numeracy – ‘Number sense’, ‘Spatial sense’ and ‘Measurement and data sense’ at each of Years 3, 5 and 7. The benchmarks are performance indicators that articulate nationally agreed minimum acceptable standards for numeracy at these years. The benchmarks describe minimum standards, below which students will experience difficulty in schooling. Results of national benchmarking are published in the annual National Report on Schooling in Australia.

In 2003, 95.8 per cent of Victorian Year 3 students achieved the numeracy benchmark (refer Figure 5.1). This was above the national average of 94.2 per cent but below the achievement of students in New South Wales (96.7%).

Figure 5.1: Percentage of Year 3 Students Achieving the Numeracy Benchmark by State and Territory (2003)

<table>
<thead>
<tr>
<th>State/ Territory</th>
<th>All students</th>
<th>Male students</th>
<th>Female students</th>
<th>Indigenous students</th>
<th>LBOTE students</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>96.7 ± 0.6</td>
<td>96.3 ± 0.6</td>
<td>97.1 ± 0.6</td>
<td>91.4 ± 1.9</td>
<td>95.9 ± 0.6</td>
</tr>
<tr>
<td>Victoria</td>
<td>95.8 ± 0.5</td>
<td>95.2 ± 0.5</td>
<td>96.6 ± 0.6</td>
<td>86.7 ± 2.2</td>
<td>93.9 ± 0.7</td>
</tr>
<tr>
<td>Queensland</td>
<td>92.1 ± 1.6</td>
<td>92.0 ± 1.6</td>
<td>92.7 ± 1.8</td>
<td>78.3 ± 3.7</td>
<td>90.0 ± 2.0</td>
</tr>
<tr>
<td>South Australia</td>
<td>90.1 ± 1.7</td>
<td>89.3 ± 1.7</td>
<td>90.8 ± 1.9</td>
<td>67.5 ± 5.2</td>
<td>86.0 ± 2.4</td>
</tr>
<tr>
<td>Western Australia</td>
<td>89.7 ± 2.7</td>
<td>89.7 ± 2.6</td>
<td>89.7 ± 2.8</td>
<td>67.2 ± 6.6</td>
<td>87.6 ± 3.3</td>
</tr>
<tr>
<td>Tasmania</td>
<td>93.9 ± 1.4</td>
<td>93.9 ± 1.4</td>
<td>94.1 ± 1.7</td>
<td>90.2 ± 4.0</td>
<td>94.7 ± 3.3</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>86.4 ± 2.4</td>
<td>85.8 ± 2.8</td>
<td>87.1 ± 2.6</td>
<td>65.5 ± 5.4</td>
<td>64.1 ± 5.4</td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>95.2 ± 1.1</td>
<td>94.7 ± 1.1</td>
<td>95.8 ± 1.2</td>
<td>88.2 ± 7.7</td>
<td>89.5 ± 2.6</td>
</tr>
<tr>
<td>Australia</td>
<td>94.2 ± 1.1</td>
<td>93.8 ± 1.1</td>
<td>94.7 ± 1.2</td>
<td>80.5 ± 3.7</td>
<td>93.3 ± 1.1</td>
</tr>
</tbody>
</table>

Note: The achievement percentages reported in this table include 95% confidence intervals.
(a) The methods used to identify Indigenous students and students with a language background other than English (LBOTE) varied between jurisdictions.
In 2003, Victoria had the highest proportion of Year 5 students achieving the national numeracy benchmark, with 94.7 per cent of students achieving the benchmark, compared to the Australian average of 90.8 per cent (refer Figure 5.2). The next highest performing jurisdictions at Year 5 were Tasmania (92.4%) and the Australian Capital Territory (91.9%).

**Figure 5.2: Percentage of Year 5 Students Achieving the Numeracy Benchmark by State and Territory (2003)**

<table>
<thead>
<tr>
<th>State/Territory</th>
<th>All students</th>
<th>Male students</th>
<th>Female students</th>
<th>Indigenous students</th>
<th>LBOTE students</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>91.3 ± 1.1</td>
<td>90.4 ± 1.1</td>
<td>92.2 ± 1.1</td>
<td>73.9 ± 3.0</td>
<td>90.8 ± 1.1</td>
</tr>
<tr>
<td>Victoria</td>
<td>94.7 ± 0.7</td>
<td>94.3 ± 0.7</td>
<td>95.2 ± 0.8</td>
<td>83.7 ± 3.3</td>
<td>92.2 ± 0.8</td>
</tr>
<tr>
<td>Queensland</td>
<td>86.3 ± 1.6</td>
<td>86.6 ± 1.7</td>
<td>86.4 ± 1.9</td>
<td>62.6 ± 3.4</td>
<td>83.7 ± 2.2</td>
</tr>
<tr>
<td>South Australia</td>
<td>90.7 ± 1.2</td>
<td>90.1 ± 1.3</td>
<td>91.3 ± 1.3</td>
<td>66.1 ± 4.9</td>
<td>85.8 ± 1.9</td>
</tr>
<tr>
<td>Western Australia</td>
<td>90.4 ± 2.0</td>
<td>90.0 ± 2.1</td>
<td>90.8 ± 2.1</td>
<td>66.2 ± 5.5</td>
<td>87.2 ± 3.0</td>
</tr>
<tr>
<td>Tasmania</td>
<td>92.4 ± 1.2</td>
<td>91.6 ± 1.4</td>
<td>93.3 ± 1.3</td>
<td>87.8 ± 4.1</td>
<td>93.4 ± 3.1</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>76.1 ± 2.6</td>
<td>74.6 ± 3.0</td>
<td>77.6 ± 3.2</td>
<td>43.3 ± 4.9</td>
<td>39.1 ± 5.2</td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>91.9 ± 1.7</td>
<td>91.7 ± 1.9</td>
<td>92.1 ± 1.9</td>
<td>71.6 ± 12.4</td>
<td>86.6 ± 3.2</td>
</tr>
<tr>
<td>Australia</td>
<td>90.8 ± 1.2</td>
<td>90.3 ± 1.3</td>
<td>91.4 ± 1.3</td>
<td>67.6 ± 3.9</td>
<td>89.3 ± 1.4</td>
</tr>
</tbody>
</table>

Note: The achievement percentages reported in this table include 95% confidence intervals.
(a) The methods used to identify Indigenous students and students with a language background other than English (LBOTE) varied between jurisdictions.

Achievement of the national numeracy benchmark by Year 7 students was 85.8 per cent of the total student cohort in Victoria, as against a national average of 81.3 per cent (refer Figure 5.3). The Australian Capital Territory (86.4%) slightly outperformed Victoria, while Queensland and South Australia performed at a very similar level to Victoria (85.2% for both States).
Figure 5.3: Percentage of Year 7 Students Achieving the Numeracy Benchmark by State and Territory (2003)

<table>
<thead>
<tr>
<th>State/Territory</th>
<th>All students</th>
<th>Male students</th>
<th>Female students</th>
<th>Indigenous (a) students</th>
<th>LBOTE (a) students</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales (b)</td>
<td>73.9 ± 0.8</td>
<td>72.9 ± 0.9</td>
<td>75.1 ± 0.9</td>
<td>41.1 ± 2.1</td>
<td>72.7 ± 1.0</td>
</tr>
<tr>
<td>Victoria</td>
<td>85.8 ± 0.7</td>
<td>86.3 ± 0.8</td>
<td>85.4 ± 0.9</td>
<td>64.1 ± 4.4</td>
<td>83.1 ± 1.0</td>
</tr>
<tr>
<td>Queensland</td>
<td>85.2 ± 0.6</td>
<td>85.5 ± 0.7</td>
<td>85.1 ± 0.7</td>
<td>56.9 ± 2.0</td>
<td>81.7 ± 1.4</td>
</tr>
<tr>
<td>South Australia</td>
<td>85.2 ± 0.8</td>
<td>84.9 ± 1.0</td>
<td>85.5 ± 1.0</td>
<td>54.1 ± 6.3</td>
<td>80.0 ± 2.6</td>
</tr>
<tr>
<td>Western Australia</td>
<td>84.3 ± 0.7</td>
<td>84.2 ± 0.8</td>
<td>84.5 ± 0.9</td>
<td>49.9 ± 3.3</td>
<td>78.8 ± 1.6</td>
</tr>
<tr>
<td>Tasmania</td>
<td>80.6 ± 1.1</td>
<td>80.4 ± 1.4</td>
<td>80.7 ± 1.6</td>
<td>66.5 ± 5.4</td>
<td>75.5 ± 4.5</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>68.7 ± 2.1</td>
<td>69.0 ± 2.7</td>
<td>68.3 ± 2.9</td>
<td>30.0 ± 3.6</td>
<td>27.2 ± 3.9</td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>86.4 ± 1.6</td>
<td>86.3 ± 1.8</td>
<td>86.5 ± 1.9</td>
<td>61.6 ± 12.8</td>
<td>81.0 ± 5.6</td>
</tr>
<tr>
<td>Australia</td>
<td>81.3 ± 0.8</td>
<td>81.0 ± 0.9</td>
<td>81.6 ± 0.9</td>
<td>49.3 ± 2.9</td>
<td>76.6 ± 1.2</td>
</tr>
</tbody>
</table>

Note: The achievement percentages reported in this table include 95% confidence intervals.

(a) The methods used to identify Indigenous students and students with a language background other than English (LBOTE) varied between jurisdictions.

(b) New South Wales considers that the year 7 results for New South Wales are anomalous. The national numeracy benchmark results show that:
   i. a lower proportion of New South Wales year 7 students are meeting the minimum numeracy benchmark than are meeting the reading and writing benchmarks.
   ii. a lower proportion of students are meeting the numeracy benchmark in year 7 than in year 3 and year 5.

National benchmarks represent the minimum standard of performance a student must achieve to be able to progress through his/her schooling. The national benchmark results show that New South Wales students in years 3 and 5 are consistently performing at or above the national average for reading, writing and numeracy. The New South Wales results for year 7 reading and writing are also fairly consistent with the national average.

Source: MCEETYA 2003, National Report on Schooling in Australia, p.27

It should be noted that any analysis treating students from language backgrounds other than English as a homogenous group is, to some extent, flawed. Governments are well aware that there is a very wide gap in achievement among students from different backgrounds, arising from different cultural contexts and/or different socioeconomic circumstances. Achievement among students from a refugee background, who may be dealing with a range of barriers to learning in
their initial years of schooling in Australia, is likely to be lower than that among students from a language background other than English who may have entered the country under different circumstances, such as for business migration purposes. The results for students from a language background other than English as shown in the above tables should therefore be interpreted with caution. It should further be noted that the methodology for identifying Indigenous students and students with a language background other than English varied between jurisdictions. This reiterates the need to interpret the results for these cohorts with caution.

**National Year 6 Science Assessment**

In 2003, a nationally comparable science assessment was carried out under the auspices of MCEETYA for the first time, with the intention that further assessments will occur every three years. The 2003 *National Year 6 Science Assessment Report* provides a snapshot of student performance across the national science literacy scale and an analysis of various trends across states, territories and student sub-groups. Approximately six per cent of the total Australian Year 6 student population, drawn from schools in all sectors, were sampled randomly and assessed. One hundred Victorian schools and 2,130 Victorian students were involved in the study.  

Minimum standards such as the national benchmarks for literacy and numeracy have not been set for scientific literacy. As MCEETYA argues, such benchmarks, defined as the critical level of skill and understanding without which a student will have difficulty making sufficient progress at school, are more suited to foundation areas such as reading, writing and numeracy, where deficiencies will have a significant effect on students’ future learning and functioning in society. Instead, scientific literacy is defined against proficiency standards. The proficient standard (proficiency level 3.2 or above) is a challenging level of performance that requires students to demonstrate more than minimal or elementary skills. Students who have not achieved the proficient standard have demonstrated only partial mastery of the skills and understandings for Year 6 science, while there are also students who have shown superior results and exceeded the proficient standard.

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168 Ibid., p.xii.
169 Ibid.
Three strands of scientific literacy were assessed:

1. formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence;

2. interpreting evidence and drawing conclusions, critiquing the trustworthiness of evidence and claims made by others and communicating findings; and

3. using science understandings for describing and explaining natural phenomena, interpreting reports and making decisions.

The assessed items drew on four concept areas: Life and Living; Earth and Beyond; Natural and Processed Materials; and Energy and Change.

Nationally, 58.2 per cent of students achieved or exceeded the proficient standard (refer Figure 5.4). The comparable figure for Victoria was 58.7 per cent. The Australian Capital Territory was the only jurisdiction with performance significantly above the national mean and no jurisdiction performed significantly below the national mean. The Australian Capital Territory was the only jurisdiction to achieve results that were statistically higher than Victoria’s.

\[170\] ibid., p.xiii.
### Figure 5.4: Percentage of Students at or above Scientific Literacy Proficiency Levels by State and Territory (2003)

<table>
<thead>
<tr>
<th>State/Territory</th>
<th>3.1 or Above</th>
<th>Proficient 3.2 or Above</th>
<th>3.3 or Above</th>
<th>4 or Above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.1 or</td>
<td>3.2 or</td>
<td>3.3 or</td>
<td>4 or</td>
</tr>
<tr>
<td></td>
<td>Above</td>
<td>Above</td>
<td>Above</td>
<td>Above</td>
</tr>
<tr>
<td></td>
<td>(±0.8)</td>
<td>(±2.1)</td>
<td>(±1.7)</td>
<td>(±0.2)</td>
</tr>
<tr>
<td>New South Wales</td>
<td>96.6</td>
<td>62.8</td>
<td>10.2</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>(±1.0)</td>
<td>(±2.5)</td>
<td>(±1.2)</td>
<td>(±0.1)</td>
</tr>
<tr>
<td>Victoria</td>
<td>95.6</td>
<td>58.7</td>
<td>6.4</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±0.9)</td>
<td>(±2.1)</td>
<td>(±1.1)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>Queensland</td>
<td>94.9</td>
<td>54.9</td>
<td>5.9</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±0.9)</td>
<td>(±2.1)</td>
<td>(±1.1)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>South Australia</td>
<td>95.6</td>
<td>57.0</td>
<td>6.9</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±1.2)</td>
<td>(±2.4)</td>
<td>(±1.3)</td>
<td>(±0.1)</td>
</tr>
<tr>
<td>Western Australia</td>
<td>94.9</td>
<td>54.6</td>
<td>6.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±1.0)</td>
<td>(±2.2)</td>
<td>(±1.2)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>Tasmania</td>
<td>95.0</td>
<td>59.3</td>
<td>9.4</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>(±1.4)</td>
<td>(±2.9)</td>
<td>(±1.8)</td>
<td>(±0.3)</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>89.3</td>
<td>49.4</td>
<td>6.9</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(±3.6)</td>
<td>(±5.5)</td>
<td>(±2.8)</td>
<td>(±0.0)</td>
</tr>
<tr>
<td>Australian Capital</td>
<td>97.3</td>
<td>69.8</td>
<td>13.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Territory</td>
<td>(±1.1)</td>
<td>(±3.9)</td>
<td>(±2.8)</td>
<td>(±0.5)</td>
</tr>
<tr>
<td>Australia</td>
<td>95.4</td>
<td>58.2</td>
<td>7.7</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>(±0.4)</td>
<td>(±0.9)</td>
<td>(±0.5)</td>
<td>(±0.1)</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses refer to 95 per cent confidence intervals.

Victoria had one of the lowest spread of achievement scores in Australia in this study, in contrast to the international studies reported below.

At the national level, the scientific proficiency levels showed the following trends:

- for males and females, there were no significant differences in proficiency;\(^{171}\)
- the proficiency of Indigenous students was significantly lower than that of non-Indigenous students;

\(^{171}\) Although the differences were not statistically significant in any particular state and territory or overall, the tendency for males to perform better than females was consistent in all cases.
students who spoke English at home showed significantly higher levels of proficiency than those who spoke a language other than English at home; and

- proficiency of students in remote locations was significantly below that of students in other locations.\(^{172}\)

The Committee notes that the above trends are consistent with findings of PISA and TIMSS.

### Student Achievement in PISA

The OECD launched the Programme for International Student Assessment (PISA) in 1997, in response to the need for cross-nationally comparable evidence on student performance. PISA represents a commitment by governments internationally to monitor the outcomes of education systems in terms of student achievement on a regular basis and with an internationally accepted common framework. According to the OECD, PISA is the most comprehensive international program to assess student performance and to collect data on student, family and institutional factors that can help explain differences in performance.\(^{173}\)

PISA seeks to measure how well young adults, at age 15 and therefore approaching the end of compulsory schooling, are prepared to meet the challenges of today’s knowledge societies. The assessment is forward-looking, focusing on young people’s ability to use their knowledge and skills to meet real-life challenges, rather than on the extent to which they have mastered a specific school curriculum.\(^{174}\) As noted by the OECD, this orientation reflects a change in the goals and objectives of curricula themselves, which are increasingly concerned with what students can do with what they learn at school, and not merely whether they can reproduce what they have learned.\(^{175}\)

As summarised in *PISA in Brief from Australia’s Perspective*, Australia’s results in PISA 2003 were above the OECD average in reading, mathematical and scientific literacy, as well as in problem solving and in each of the mathematical literacy subscales.\(^{176}\) All Australian states and territories performed at or better than the OECD

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\(^{174}\) Ibid.

\(^{175}\) Ibid.

average in all four domains and there were few significant differences among the states/territories.\textsuperscript{177}

An important aspect of any analysis of PISA results is the range of scores achieved by participants from each jurisdiction. A lower spread of scores means that there is a smaller gap in performance between the highest and lowest achieving students, indicating more equitable educational opportunities in that jurisdiction. Australia’s range of scores between the 5\textsuperscript{th} and 95\textsuperscript{th} percentile is narrower than the OECD average for all three literacies tested.\textsuperscript{178} Importantly, the range of scores between Australia’s 5\textsuperscript{th} and 25\textsuperscript{th} percentile, or the ‘tail’ was also less than the average for the OECD.\textsuperscript{179} This suggests that Australia has made progress in bringing the skills of the lowest achieving students closer to those of the higher achievers.\textsuperscript{180} Nonetheless, this Committee would like to see a further narrowing of the gap between Victoria’s highest achieving and lesser achieving students.

The following sections look at PISA 2003 results in the mathematics and science domains.\textsuperscript{181}

**Australia’s Performance in Mathematics**

PISA draws its mathematical content from four broad content areas:

- Space and shape, relating to spatial and geometric phenomena and relationships, often drawing on the curricular discipline of geometry.
- Change and relationships, relating most closely to algebra.
- Quantity, involving numeric phenomena, as well as quantitative relationships and patterns.
- Uncertainty, involving probabilistic and statistical phenomena.\textsuperscript{182}

As shown in Figure 5.5, four countries outperformed Australia in mathematical literacy in PISA 2003 – Hong Kong-China, Finland, Korea

\textsuperscript{177}ibid., p.5.
\textsuperscript{179}ibid.
\textsuperscript{180}ibid.
\textsuperscript{181}Note: Any differences between Australia and other countries and between various states and territories within Australia that are referred to in the following sections are statistically significant.
Australia was one of 17 countries to score significantly higher than the OECD average on mathematical literacy. Australia is in a group of 10 countries whose results are considered statistically similar – Liechtenstein, Japan, Canada, Belgium, Macao-China, Switzerland, New Zealand, the Czech Republic and Denmark.
Appendix K shows the proficiency levels on the overall mathematical literacy scale for all countries. Six per cent of Australia’s students achieved the highest mathematical literacy proficiency level (Level 6), which was slightly above the OECD average of four per cent. Hong Kong-China had the highest proportion of students achieving the highest proficiency level, with 11 per cent of its students at Level 6.\textsuperscript{185}

Twenty per cent of Australian students achieved Level 5 or higher in mathematical literacy, just over 40 per cent at Level 4 or higher and two-thirds at Level 3 or higher. Corresponding figures for the OECD as a whole were 15 per cent at Level 5 or higher, 34 per cent at Level 4 or higher and 58 per cent at Level 3 or higher. Only 14 per cent of Australian students did not reach at least Level 2, compared with the OECD average of 21 per cent.\textsuperscript{186}

In relative terms, the performance of Australian students on the uncertainty subscale was slightly better than their performance on the other three subscales, while performance on the quantity subscale was not as strong as the other three (refer Figure 5.6).\textsuperscript{187} Only Finland achieved higher performance scores than Australia in all four subscales, while Hong Kong-China outperformed Australia in three (quantity; space and shape; and uncertainty) and Liechtenstein in three (quantity; space and shape; and change and relationships).

\textbf{Figure 5.6: Proficiency Levels on the Overall Mathematical Literacy and the Mathematics Subscales (Australia) (2003)}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.6.png}
\caption{Proficiency Levels on the Overall Mathematical Literacy and the Mathematics Subscales (Australia) (2003)}
\end{figure}


There were few significant differences among the states and territories in mathematical literacy (refer Figure 5.7). However, the average performance of students in the Australian Capital Territory was significantly higher than the average achieved by students in New

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
& Overall & & & & & \\
& mathematical & & & & & \\
& literacy & & & & & \\
\hline
& Uncertainty & Change & & & & \\
& & & & & & \\
& & & & & & \\
& & & & & & \\
\hline
Level 1 & 4 & 5 & 6 & 6 & 4 & \\
Level 2 & 9 & 10 & 11 & 11 & 10 & \\
Level 3 & 19 & 19 & 18 & 23 & 18 & \\
Level 4 & 24 & 24 & 23 & 21 & 24 & \\
Level 5 & 23 & 23 & 22 & 13 & 23 & \\
Level 6 & 15 & 14 & 13 & 6 & 14 & \\
Below Level 1 & 7 & 7 & 7 & 5 & 6 & \\
\hline
\end{tabular}
\end{table}

\textsuperscript{185}ibid., p.ix.
\textsuperscript{186}ibid., p.x.
\textsuperscript{187}ibid.
South Wales, Queensland, Victoria, Tasmania and the Northern Territory. Students in Western Australia, the Australian Capital Territory and South Australia performed as well as students in Hong Kong-China, the highest performing country in mathematical literacy. The ‘tails’ for South Australia and Victoria were wider than the Australian average although still narrower than the OECD average.

The Committee notes that students in the Australian Capital Territory are likely to perform well in national and international benchmarking studies due to their higher socioeconomic status and greater access to education resources compared to many students in other states.

Figure 5.7: Proficiency Levels on the Overall Mathematical Literacy for Australian States (2003)

<table>
<thead>
<tr>
<th>Country</th>
<th>Below Level 1</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
<th>Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong - China</td>
<td>4</td>
<td>7</td>
<td>14</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>ACT</td>
<td>3</td>
<td>5</td>
<td>13</td>
<td>22</td>
<td>25</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>WA</td>
<td>7</td>
<td>7</td>
<td>16</td>
<td>23</td>
<td>25</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>SA</td>
<td>3</td>
<td>8</td>
<td>16</td>
<td>25</td>
<td>25</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>NSW</td>
<td>14</td>
<td>10</td>
<td>19</td>
<td>24</td>
<td>23</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>QLD</td>
<td>6</td>
<td>11</td>
<td>18</td>
<td>24</td>
<td>23</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>VIC</td>
<td>6</td>
<td>11</td>
<td>21</td>
<td>26</td>
<td>22</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>TAS</td>
<td>6</td>
<td>12</td>
<td>21</td>
<td>25</td>
<td>22</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>NT</td>
<td>10</td>
<td>12</td>
<td>21</td>
<td>24</td>
<td>18</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Australia</td>
<td>4</td>
<td>10</td>
<td>19</td>
<td>24</td>
<td>23</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>OECD ave</td>
<td>8</td>
<td>13</td>
<td>24</td>
<td>24</td>
<td>19</td>
<td>11</td>
<td>4</td>
</tr>
</tbody>
</table>


The Committee notes that a number of Australian states recognise international studies such as PISA as an important tool in developing education policy and programs. There has, therefore, been an expansion of programs across Australia recently, aimed at lifting the mathematical literacy of students at all levels. It will be important to continue to monitor future interstate comparisons to determine what level of success these programs have in raising standards in mathematics achievement.
5. Trends in Student Achievement in Mathematics and Science

**Australia’s Performance in Science**

Scientific literacy is concerned with scientific knowledge (including knowledge of concepts), scientific processes and scientific situations (or contexts). The scientific knowledge that was assessed in PISA 2003 was selected from the areas of physics, chemistry, biological science and earth and space science according to three criteria: relevance to everyday situations; relevance to life throughout the next decade; and knowledge required for understanding scientific processes.\(^{190}\) The interaction of these criteria with the content of the science areas produced a selection of scientific themes such as chemical and physical changes; biodiversity; genetic control; and geographical change.\(^{191}\)

Within the PISA framework, scientific processes involve the ability to acquire, interpret and act upon evidence. PISA identifies three process skills of describing, explaining and predicting scientific phenomena; understanding scientific investigation; and interpreting scientific evidence and conclusions. The scientific literacy framework identifies three main scientific situations or contexts for assessment: science in life and health; science in Earth and environment; and science in technology.\(^{192}\)

Three countries achieved better results than Australia in scientific literacy – Finland, Japan and Korea (refer Figure 5.8). In PISA 2000, only Korea and Japan outperformed Australia.\(^{193}\) Australia is in a group of nine countries that have results not significantly different from each other in scientific literacy: Hong Kong-China, Liechtenstein, Macao-China, the Netherlands, the Czech Republic, New Zealand, Canada and Switzerland.\(^{194}\) The 2003 scientific literacy mean score in Australia is not significantly different from the 2000 mean score, although the spread of scores is wider.\(^{195}\)

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\(^{190}\) ibid., p.6.

\(^{191}\) ibid.

\(^{192}\) ibid., pp.6–7.


\(^{195}\) ibid.
Figure 5.8: Student Performance in Overall Scientific Literacy for all Countries (2003)

Figure 5.9 shows multiple comparisons of overall scientific literacy performance by state. The Australian Capital Territory and Western Australia achieved means that were statistically similar, with the Australian Capital Territory performing significantly better than the remaining states. Western Australia performed significantly better than Queensland, Victoria, Tasmania and the Northern Territory but not significantly better than South Australia or New South Wales. Again, the Committee notes that a number of states and territories have recently implemented targeted science education programs in their schools. It will be interesting to monitor future results, to determine whether programs such as Victoria’s Science in Schools initiative, South Australia’s Strategic Directions for Science and Mathematics in South Australian Schools 2003–2006 and Queensland’s Spotlight on Science 2003–2006 help in raising performance standards in these states.

**Figure 5.9: Multiple Comparisons of Overall Scientific Literacy Performance by Jurisdiction (2003)**

<table>
<thead>
<tr>
<th></th>
<th>Mean SE</th>
<th>ACT</th>
<th>WA</th>
<th>SA</th>
<th>NSW</th>
<th>QLD</th>
<th>VIC</th>
<th>TAS</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>553</td>
<td>4.7</td>
<td>546</td>
<td>4.3</td>
<td>535</td>
<td>4.4</td>
<td>530</td>
<td>4.4</td>
<td>495</td>
</tr>
<tr>
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<td></td>
<td></td>
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<tr>
<td>WA</td>
<td>546</td>
<td>4.3</td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>SA</td>
<td>535</td>
<td>4.3</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSW</td>
<td>530</td>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QLD</td>
<td>519</td>
<td>6.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>VIC</td>
<td>510</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAS</td>
<td>509</td>
<td>9.5</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>NT</td>
<td>495</td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Read across the row to compare a jurisdiction’s performance with the performance of each jurisdiction listed in the column heading.

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

Student Achievement in TIMSS

The Trends in International Mathematics and Science Study (TIMSS) is conducted under the aegis of the International Association for the Evaluation of Educational Achievement (IEA). Those who established the IEA wanted to study organisational and curriculum-related issues that could not easily be investigated in a single school system or country. The sequence of studies that have followed provide the opportunity to study changes over time as well as differences among countries. 196

The 2002 TIMSS mathematics and science tests were organised along two domains: a content domain and a cognitive domain. In mathematics, the content domain comprised the areas of number, algebra, measurement, geometry and data; the cognitive domain comprised facts and procedures, using concepts, routine problems and reasoning. 197 In science, the content domain comprised the areas of earth science, life science and physical science for Year 4 participants and earth science, life science, physics, chemistry and environmental science for Year 8 participants. The cognitive domains for the science tests comprised factual knowledge, conceptual understanding and reasoning and analysis. 198

TIMSS reports achievement in terms of average score as well as in terms of international benchmarks (low, intermediate, high and advanced). Australia’s results, along with international comparisons, are summarised below. 199

Achievement in Mathematics – Year 4

A group of fourteen countries had scores significantly higher than Australia in mathematics at Year 4 level: Singapore, Hong Kong SAR, Japan, Chinese Taipei, Belgium (Flemish), Netherlands, Latvia, Lithuania, Russian Federation, England, Hungary, United States and Cyprus. Australia’s performance was very similar to the international average. In comparison, the 1994–1995 TIMSS reported Australia’s performance in Year 4 mathematics as significantly higher than the

197 S. Thomson & N. Fleming 2004, Summing it up: Mathematics achievement in Australian schools in TIMSS 2002 (TIMSS Australia Monograph no. 6), ACER, Melbourne, pp.7–8.
199 Note: Any differences in achievement identified in the following sections are statistically significant.
international average.\textsuperscript{200} This change in ranking was caused by other countries improving their performance, while Australia’s level of performance remained the same over the two studies. There was no significant gender difference in the level of mathematics achievement at Year 4 level in Australia.\textsuperscript{201}

Figure 5.10 shows the proportion of Year 4 students in each country reaching the international mathematics benchmarks. While Victoria’s performance against the benchmarks was slightly above the Australian average, it was below the average for both the Australian Capital Territory and New South Wales.\textsuperscript{202}

\textbf{Figure 5.10: Proportion of Year 4 Students Reaching International Mathematics Benchmarks (2002)}

\textsuperscript{1} Met guidelines for sample participation rates only after replacement schools were included.
\textsuperscript{1} National Disled Population does not cover all of International Disled Population.
\textsuperscript{-} Did not participate in TIMSS 1994/95 at this Year level.
\[\square\] Difference not significant.
\[\blacksquare\] Difference significant at p<0.05.


\textsuperscript{200} S. Thomson & N. Fleming 2004 \textit{Highlights from TIMSS from Australia’s Perspective: Highlights from the full Australian reports from the Trends in International Mathematics and Science Study 2002/03}, ACER, Melbourne, p.4.
\textsuperscript{201} Ibid.
\textsuperscript{202} Ibid., p.8.
Internationally, the largest differences between highest and lowest scores in the content area of mathematics were in the area of data. Australia’s average score was significantly higher than the international average in Year 4 in measurement, geometry and data. Australia’s average score was similar to the international average in patterns and relationships and lower than the international average in number.\textsuperscript{203}

\textbf{Achievement in Mathematics – Year 8}

Singapore scored higher than all other countries in mathematics at Year 8 level. Australia also performed significantly higher than the international average overall and in each of the mathematics content areas. Overall achievement in the United States, England, Scotland, New Zealand and Malaysia was similar to that of Australian students.\textsuperscript{204} As was the case at Year 4 level, Australia’s performance in Year 8 mathematics was the same as that in the 1994–1995 TIMSS, while the performance of some other countries had improved. This resulted in half of the countries that were outscored by Australia in the earlier study performing at a similar level to Australia in the TIMSS 2002–2003.\textsuperscript{205}

Achievement against the international benchmarks was better for Year 8 mathematics than for Year 4 mathematics. Overall, achievement of international benchmarks at Year 8 was equal to or greater than the international average (refer Figure 5.11). However, the proportion of Australian Year 8 students reaching each of the international benchmarks in mathematics was far less than that of the highest achieving country Singapore. Furthermore, there had been no significant improvement in Australia’s achievement from the 1994–1995 study.\textsuperscript{206}

\begin{footnotesize}
\bibitem{203} ibid., p.10.
\bibitem{204} ibid., p.5.
\bibitem{205} ibid.
\bibitem{206} ibid., p.8.
\end{footnotesize}
5. Trends in Student Achievement in Mathematics and Science

Figure 5.11: Proportion of Year 8 Students Reaching International Mathematics Benchmarks (2002)

Internationally, the largest difference between the highest and lowest performing countries was in geometry. Australia’s performance in geometry was weaker than in the other content areas, it was still higher than the international average.\textsuperscript{207} Australia’s score was significantly higher in data than in any other content areas.\textsuperscript{208}

\textbf{Achievement in Science – Year 4}

There were seven countries with scores higher than Australia in Year 4 science. These were Singapore, Chinese Taipei, Japan, Hong Kong SAR, England, United States and Latvia. Nonetheless, Australia’s performance was still significantly higher than the international average. Australia’s performance in Year 4 science was consistent across the three content areas. Consistent with the result in mathematics, Australia’s performance in Year 4 science has remained the same since TIMSS 1994–1995, while the performance of other countries has improved. Consequently, half of the participating countries now have an average score significantly higher than that of Australia, compared to only one such country in TIMSS 1994–1995.\textsuperscript{209}

Disappointingly, the proportion of Australian students in Year 4 who achieved the advanced international benchmark in science was significantly lower than in TIMSS 1994–1995. However, the proportion of Australian students achieving the other benchmarks did not change significantly. Overall, the proportion of students at each international benchmark is higher than the international average (refer Figure 5.12).\textsuperscript{210}

\textsuperscript{207} ibid., p.10.  
\textsuperscript{208} ibid.  
\textsuperscript{209} ibid., p.8.  
\textsuperscript{210} ibid., p.9.
5. Trends in Student Achievement in Mathematics and Science

Figure 5.12: Proportion of Year 4 Students Reaching International Science Benchmarks (2002)

Within Australia, the Australian Capital Territory had the highest proportion of students attaining each of the international benchmarks in Year 4 science. The Northern Territory had the lowest proportion of students reaching at least the low international benchmark.\footnote{211} Victoria’s achievement against the international benchmarks was very similar to that of the Australian average and above that of the international average.\footnote{212}

\footnote{211}ibid.
\footnote{212}ibid.
**Achievement in Science – Year 8**

In Year 8 science, Singapore and Chinese Taipei significantly outscored all other countries, although Australia also performed significantly higher than the international average. In contrast to the trends in Year 4 and Year 8 mathematics and Year 4 science, Australia showed a significant improvement in Year 8 science since the 1994–1995 study. Consequently, some of the countries that were statistically similar to Australia in the earlier study were significantly lower than Australia in 2002–2003.  

Australian students scored higher in environmental science, while the weakest area was chemistry, although achievement in this content area was still higher than the international average. The largest difference in average scores between the highest and lowest scoring countries was in physics, which was Australia’s second weakest area.

Overall, 95 per cent of Australian Year 8 science students reached the low international benchmark, with 76 per cent reaching the intermediate benchmark, 40 per cent reaching the high benchmark and nine per cent reaching the advanced benchmark (refer Figure 5.13).  

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213 ibid., p.7.  
214 ibid., p.11.  
215 ibid.  
216 ibid., p.9.
Figure 5.13: Proportion of Year 8 Students Reaching International Science Benchmarks (2002)

Students in the highest achieving state, New South Wales, performed at an equivalent level to students in Chinese Taipei and very close to the level of Singaporean students. In the same group were Korea, Hong Kong SAR, Estonia, Japan and England. Students in the Australian Capital Territory also performed at a very high level.217 The group of states around the Australian average (South Australia, Western Australia, Queensland and Victoria) had similar achievement levels as students in the United States, New Zealand and Sweden.218

Policy Implications of Current Achievement Trends

On the whole, Victoria performs very well in mathematics and science, as compared with national and international achievement benchmarks. However, there are certain groups of students who continue to not achieve to the same standards as the average for the Victorian student cohort (refer Chapter 6). Therefore, there is considerable scope for students in the middle and lower ranges of achievement to improve their levels of mathematical and scientific literacy. There also remains scope for increased improvement at the higher end of achievement, to bring the achievement levels of Victorian students up to the best in the world.

Generally, there are few statistically significant differences in performance among students across Australian states and territories. There are indications, however, that on some measures, Victoria falls within the middle range of performance levels. This Committee would like the level of performance to be raised, to match not only the best in Australia, but also internationally. In seeking to achieve this goal, the Committee believes the Victorian Government should continue to monitor the performance of various states and territories, against key policies and programs operating within those states. An analysis of different interstate and international programs and their comparative success in meeting the different needs of diverse groups of students should also be undertaken. This will offer some guidance as to what types of initiatives are most effective in raising student achievement levels. It will also facilitate better targeting of existing mathematics and science education and awareness programs, to ensure that they reach those who could most benefit from them. This issue is explored in the following chapter.

218 Ibid.
Recommendation 5.1: That the Victorian Government undertake an analysis of the comparative success of interstate and international mathematics and science education and awareness programs in engaging and assisting students from diverse backgrounds.