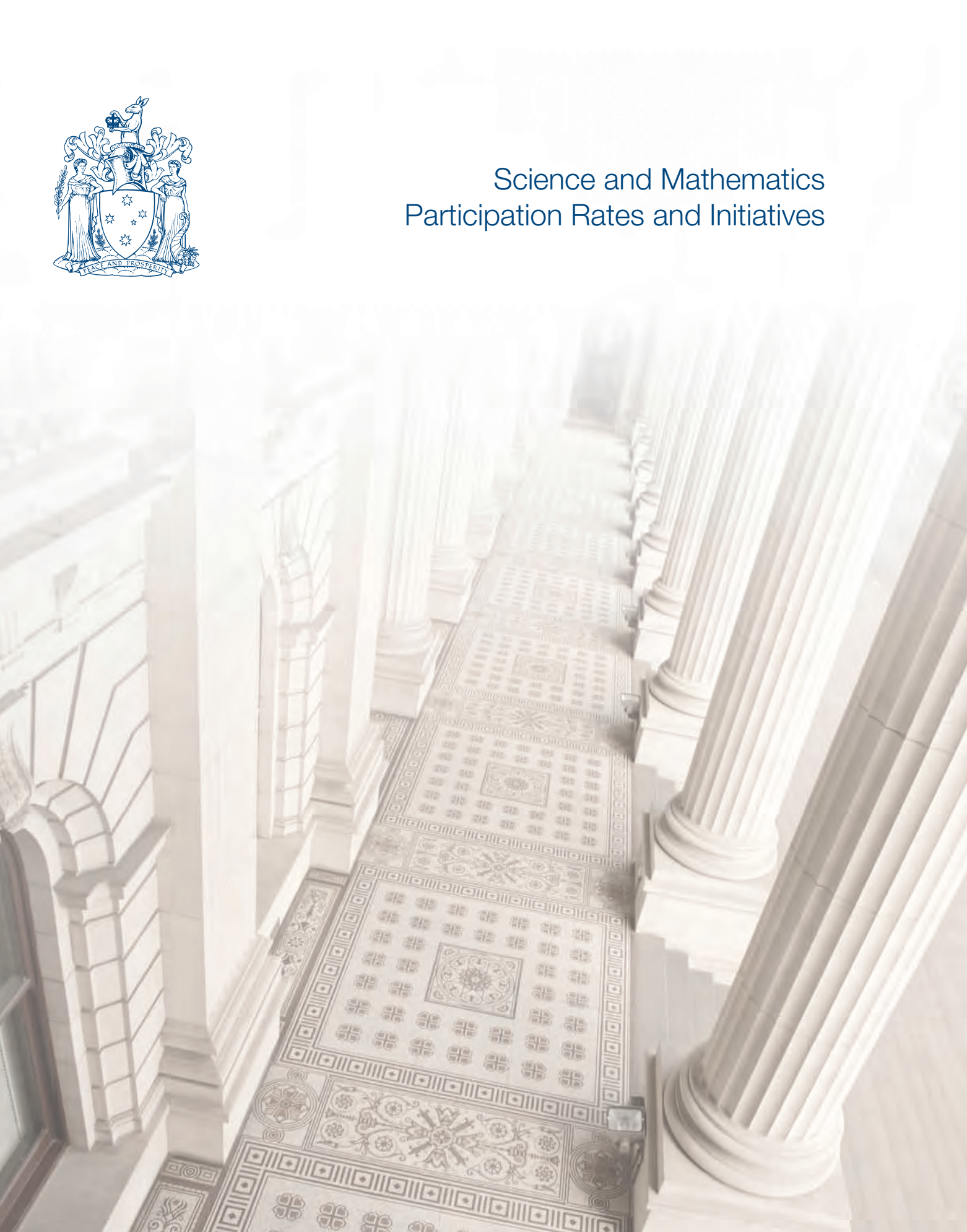




Science and Mathematics Participation Rates and Initiatives



VICTORIA

Victorian
Auditor-General

Science and Mathematics Participation Rates and Initiatives

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The Hon. Bruce Atkinson MLC
President
Legislative Council
Parliament House
Melbourne

The Hon. Ken Smith MP
Speaker
Legislative Assembly
Parliament House
Melbourne

Dear Presiding Officers

Under the provisions of section 16AB of the *Audit Act 1994*, I transmit my report on the audit of *Science and Mathematics Participation Rates and Initiatives*.

Yours faithfully



Dr Peter Frost
Acting Auditor-General

6 June 2012

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Audit summary

For decades, many Organisation for Economic Co-operation and Development (OECD) countries have become increasingly concerned about the declining proportion of their students studying science, technology, engineering and mathematics (STEM) subjects. Many Australian research studies have also highlighted a trend away from the study of what are known as the ‘enabling’ sciences—physics, chemistry and advanced mathematics.

The decline in students pursuing STEM subjects, particularly the enabling sciences, raises concern about the future supply of scientists and engineers, and its potential impact on future research, development and innovation capability.

Further, all citizens today need scientific and mathematical literacy, which underpins numerous trades and professions, and is needed to understand a range of economic, social and environmental issues.

We assessed whether Department of Education and Early Childhood Development (DEECD) initiatives have improved student participation and achievement in science and mathematics by considering whether:

- the number and proportion of students studying science and mathematics studies in senior secondary and post-secondary school is increasing
- DEECD has the required workforce to support high-quality teaching in science and mathematics
- students have access to high-quality science and mathematics facilities and equipment.

Conclusions

DEECD has not succeeded in raising achievement in science and mathematics or participation in the enabling sciences, despite a 2006 Victorian Parliamentary inquiry which found that it needed to lift participation and performance. Three years after the inquiry, DEECD released the science and mathematics education strategy but implementation of various initiatives has been slower than anticipated, and their impact small. DEECD will need to improve its planning, coordination and oversight and develop greater accountability at the school level if science and mathematics participation and achievement are to improve.

While Victoria does reasonably well in getting its students to basic levels of achievement, there is an ongoing issue with the relatively low proportion of high achieving students. The middle years of schooling reveal a persistent and significant drop-off in achievement. Low levels of achievement and student disengagement during the middle years are likely to deter and even preclude students from studying the enabling sciences at senior levels and ultimately pursuing a science or mathematics-related career.

Science and mathematics education, and student performance, are also uneven across the state. Non-metropolitan students and students from disadvantaged schools fare much worse in science and mathematics, and fewer take the subjects in the final years of schooling. They also have less access to the best quality teachers, and to programs that support the science and mathematics curriculum.

Teaching quality is the single most important school-based factor influencing student interest and achievement. However, DEECD lacks essential data, has failed to develop a robust workforce strategy, and its teacher recruitment and professional learning initiatives have had little, if any, impact on the quality of science and mathematics teaching and learning. This seriously compromises the future supply of science and mathematics skills and knowledge in the community.

Many schools, particularly in regional and disadvantaged metropolitan areas, experience difficulty in employing suitably qualified science and mathematics teachers. Consequently, significant numbers of students are encountering teachers who are teaching science and mathematics outside their field of expertise during the middle years of schooling, which is the most important time for establishing essential skills and influencing student engagement in these subjects. If not addressed, these workforce issues will have serious consequences for the breadth and quality of science and mathematics education in Victoria in the future. One particular risk is that curriculum offerings could be cut, especially in non-metropolitan and disadvantaged schools.

The quality of science and mathematics classroom infrastructure also affects student interest and teaching strategies, and this varies considerably within and between schools. Additionally, it is too early to judge whether the two main science infrastructure initiatives have improved teaching and learning as both were hindered by construction delays, poor project management and a lack of leadership from DEECD. The immediate challenge is for schools to use the new science infrastructure to implement a contemporary science curriculum, extend strategic partnerships with industry, higher education and specialist facilities, and to engage more students and lift achievement.

Findings

Student participation and achievement in science and mathematics

Participation by school leavers in post-school science and mathematics education and training remained steady between 2009 and 2010. However, there was a drop in the proportion of students studying engineering-related courses which coincides with critical skill shortages in these areas.

Overall participation in Year 12 science subjects has remained steady since 1995, while participation in Year 12 mathematics has increased. However, participation in the fundamental, enabling sciences has been decreasing over the same period.

Victorian students typically perform at or above national and international averages in science and mathematics, however, student performance is not improving. While about average for mathematics, Victoria's results in national rankings show that in science, students are lagging behind at the top levels of achievement and are over-represented at the lowest levels.

The rate of growth in student performance in science and mathematics falls steadily as they progress through the middle years of schooling, and is strongly influenced by socio-economic and location factors.

Teacher supply and demand

DEECD does not have sufficient evidence to inform its workforce decision-making. It does not have basic data about the number of science and mathematics teachers needed or currently employed. Further, it does not have basic information about the qualifications or experience of science and mathematics teachers currently teaching, or their ongoing training and development needs.

The availability and distribution of science and mathematics teachers continues to be an area of challenge. Schools, regions and other stakeholders report that quality—not quantity—of teachers is their most significant issue. Schools in rural and regional areas and socio-economically disadvantaged areas have the most difficulty attracting good quality science and mathematics teachers.

DEECD's professional learning initiatives have reached very few teachers. They have not raised standards, particularly among middle school teachers who are responsible for establishing students' foundation skills and interest in studying science and mathematics at higher levels.

Access to high-quality science and mathematics infrastructure

The standard of science laboratories and mathematics classrooms varies within and across schools.

The Commonwealth Government's *Building the Education Revolution* program is supporting science education in 43 disadvantaged secondary schools by building new science laboratories. Although the program had project management difficulties and long delays, schools are generally satisfied with their new facilities.

DEECD has doubled the number of science specialist centres to six, with the aim of creating an integrated statewide network that engages students and supports teachers. The development of the network has been affected by construction delays and a lack of coherent governance arrangements and business processes, as well as the failure of a commissioned curriculum development project to deliver the required teaching and learning resources.

DEECD achieved 84 per cent of its onsite participation target for the specialist science centre network in 2011. Participation by government school, rural and disadvantaged metropolitan students fell in 2011, compared to 2010.

Performance measures and targets

DEECD did not set appropriate targets or performance measures for the science and mathematics education strategy. None of the five targets are time bound, three are not specific and three cannot be assessed for at least four years. DEECD also has not identified the desirable number of students studying science and mathematics at varying levels to meet industry and community demand for science and mathematics skills.

Recommendations

Number	Recommendation	Page
	The Department of Education and Early Childhood Development should:	
1.	establish relevant and appropriate performance measures for science and mathematics education, and obtain the necessary data to measure progress and success	19
2.	complete its workforce data collection framework and collect, maintain, analyse and report on complete, reliable and timely data about science and mathematics teachers, and their qualifications, skills and experience	31
3.	implement a workforce strategy that supplies more and better quality science and mathematics teachers	31
4.	improve the governance and operation of the science specialist centres network to meet the participation targets for priority groups	42
5.	facilitate and maximise links and partnerships between the science specialist centres, specialist science schools and schools with new science facilities	42
6.	develop and deliver a program to improve ICT skills across the science and mathematics teacher workforce to better support them to integrate ICT into the curriculum.	42

Submissions and comments received

In addition to progressive engagement during the course of the audit, in accordance with section 16(3) of the *Audit Act 1994* a copy of this report was provided to the Department of Education and Early Childhood Development with a request for submissions or comments.

Agency views have been considered in reaching our audit conclusions and are represented to the extent relevant and warranted in preparing this report. Their full section 16(3) submissions and comments however, are included in Appendix B.

1 Background

1.1 Introduction

Victoria's economic, social and environmental goals depend on better performance in the science, technology, engineering and mathematics disciplines. As well as meeting vocational needs, science and mathematics teach students how to identify and analyse issues and make informed decisions about their health and wellbeing. For example, some of the contemporary issues requiring scientific awareness and understanding are climate, water supply, alternative energy sources, nanotechnology and biotechnology.

This audit reviewed whether student participation and achievement in science and mathematics have improved since 2006 as a result of Department of Education and Early Childhood Development (DEECD) initiatives.

1.2 Industry needs for science and mathematics skills

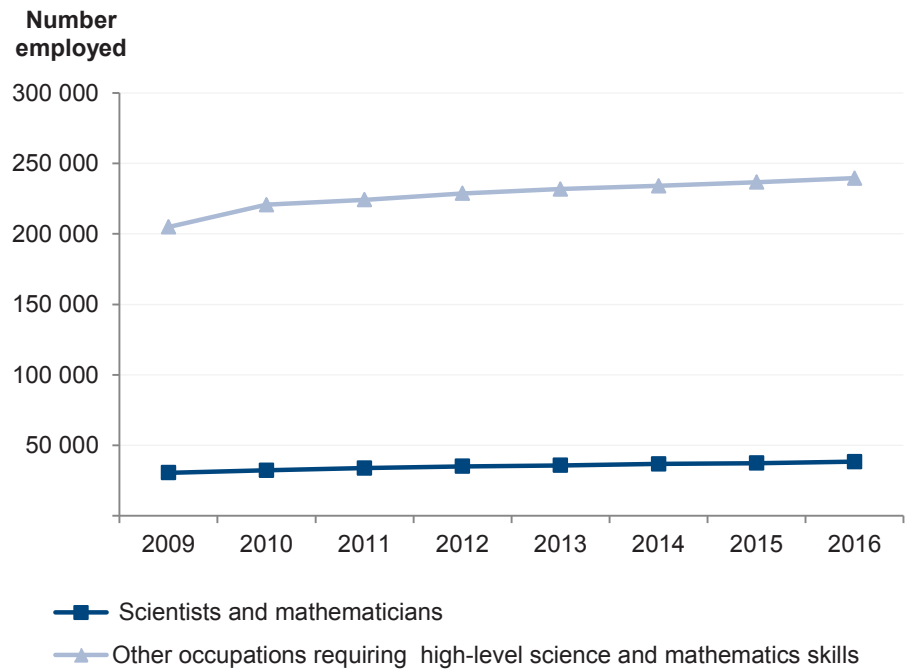
Continuous economic and employment growth depends on high levels of scientific and mathematical literacy among trades and professional workers. Industry demand for science and mathematics skills has increased since 2009, and is set to rise further.

Data from the Monash University Centre of Policy Studies (the Centre of Policy Studies) shows there were 33 800 scientists and mathematicians employed in Victoria in 2011. These occupations have grown 11 per cent since 2009, compared to 7 per cent growth for all occupations.

The demand for other professionals whose scientific and mathematical skills are considered core competencies is also growing. These include engineers, economists, accountants and surveyors. The Centre of Policy Studies conservatively estimates there were 224 000 people employed in these occupations in 2011, up 9 per cent since 2009.

It projects the demand for scientists and mathematicians will rise by 7 900 (14 per cent) between 2011 and 2016, as shown in Figure 1A. It also projects demand for other occupations requiring highly developed scientific and mathematical skills will rise by 34 700 (7 per cent).

Figure 1A
Demand for employees with science and mathematics skills in Victoria



Source: Victorian Auditor-General's Office based on Monash University Centre of Policy Studies data.

In 2011 Skills Victoria identified a range of science and mathematics-related occupations as 'in shortage' or 'specialised'. These occupations require lengthy training, so any under-supply will have a significant economic or strategic impact on the state. They include:

- civil and electrical engineering-related occupations such as:
 - draftspersons
 - technicians
 - engineering professionals
- agricultural and forestry scientists
- accountants
- surveyors and spatial scientists
- architectural, building and surveying technicians.

1.3 Victorian Parliamentary inquiry

Over the past decades, governments nationally and internationally have paid significant attention to student participation in science, technology, engineering and mathematics.

In March 2006 the Victorian Parliamentary Education and Training Committee tabled a report titled *Inquiry into the promotion of mathematics and science education*.

The inquiry found that the quality of mathematics and science education varied considerably, as did the outcomes for certain groups of students. It made 23 recommendations including:

- the need for a strategic statement addressing mathematics and science education in Victoria
- revisions to the mathematics and science curricula
- establishing targets for enrolments in the 'enabling' sciences of physics, chemistry and advanced mathematics
- strategies to overcome socio-economic and geographic disadvantages in mathematics and science education
- improvements to science laboratories and equipment in primary and secondary schools
- strategies to lift the supply and quality of mathematics and science teachers.

1.4 The science and mathematics education strategy

The government released the science and mathematics education strategy, known as *Energising Science and Mathematics Education in Victoria*, in August 2009. The strategy was part of the government's response to the findings of the 2006 Victorian Parliamentary Education and Training Committee inquiry.

The strategy outlines 22 actions covering four key areas:

- workforce capacity
- infrastructure
- strategic partnerships
- curriculum resources.

The workforce initiatives aimed to attract more teachers to science and mathematics and provide professional learning opportunities for current teachers. The main initiative, \$46 million for 200 teaching and learning coaches, ended in December 2011. Scholarship and career change programs received around \$11.25 million to attract new science and mathematics teachers, and teacher professional learning programs received \$1.2 million non-recurrent and \$1 million recurrent annual funding.

The main infrastructure initiatives were \$20 million to finish John Monash Science School and \$12 million to build three new specialist centres, and establish a statewide network incorporating all six centres. The strategy also gave \$2.8 million for information and communications technology infrastructure to enable specialist centres to link to all schools. In addition, it included the Commonwealth Government's *Building the Education Revolution Science and Language Centres for 21st Century Secondary Schools* program.

DEECD's \$2.2 million strategic partnerships initiatives were to encourage and support schools to build and sustain partnerships with industry, business, research and higher education institutions, with the aim of expanding student, teacher and parent knowledge of careers and the contemporary application of science and mathematics.

The strategy also provided \$1 million to develop contemporary science and mathematics curriculum resources for different stages of learning.

1.5 The science and mathematics curriculum

Students study a compulsory curriculum from the first year of school through to the end of Year 10. In Years 11 and 12, students choose from a wide variety of subjects.

1.5.1 The Victorian Essential Learning Standards

The Victorian Essential Learning Standards (VELS) outline the learning essentials for students between Prep and Year 10. They describe common statewide standards which schools use to plan learning programs, assess progress, and report to parents.

The VELS science curriculum covers science knowledge and understanding, and science at work. It includes the traditional disciplines of biology, chemistry, geology, environmental science, health sciences, neuroscience, physics and space sciences. It also covers the emerging disciplines of biotechnology, green chemistry, nanotechnology and synchrotron science.

The mathematics curriculum covers five areas: number; space; measurement, chance and data; structure; and working mathematically.

1.5.2 Science and mathematics in the Victorian Certificate of Education

The Victorian Certificate of Education (VCE) is the main senior secondary certificate which is usually studied over the final two years of school.

The VCE offers five science subjects, each broken into four units:

- Biology
- Chemistry
- Environmental Science
- Physics
- Psychology.

Typically, students study Units 1 and 2 in Year 11 and Units 3 and 4 in Year 12.

The VCE offers the following mathematics units:

- Foundation Mathematics Units 1 and 2
- General Mathematics Units 1 and 2
- Further Mathematics Units 3 and 4
- Mathematical Methods Computer Algebra System (CAS) Units 1, 2, 3 and 4
- Specialist Mathematics Units 3 and 4.

Further Mathematics is intended to be widely accessible. It provides general preparation for employment or further study. Mathematical Methods (CAS) and Specialist Mathematics are considered more advanced. Enrolment in Specialist Mathematics assumes a current enrolment in, or previous completion of, Mathematical Methods (CAS) Units 3 and 4.

1.5.3 The Australian curriculum

In 2008 Australian education ministers committed to develop an Australian curriculum from Foundation (known as Prep in Victoria) to Year 12.

The Australian curriculum Prep to Year 10 will be known as AusVELS in Victoria.

Education ministers endorsed the content of the Foundation to Year 10 science and mathematics curriculum in December 2010 and these subjects will be implemented in Victoria from 2013. Development of, and consultation on, the senior secondary science and mathematics curriculum continues.

Due to the transition to the Australian curriculum, this audit did not consider the existing curriculum in detail.

1.6 Teacher qualifications

Everyone who teaches in primary, secondary or special schools must be registered with the Victorian Institute of Teaching (VIT). To become registered, teachers must have an approved four-year tertiary qualification and provide evidence that they meet the Standards of Professional Practice for Full Registration.

VIT's *Specialist Area Guidelines* set out reasonable minimum level study for secondary school teaching. For science and mathematics, this will typically include four units of university study (a sub-major) in the relevant subject. The guidelines note that those teaching Years 11 or 12 may need a higher level of study than the minimum set out in the guidelines.

The Standards of Professional Practice for Full Registration describe the characteristics of effective teaching and establish the essential components of teachers' knowledge and practice. The standards expect teachers to acquire sufficient knowledge in each of the subjects they teach, even if the subject was not part of their initial teaching qualification.

1.7 Audit objective and scope

The objective of the audit was to assess whether DEECD's initiatives to improve student participation and achievement in science and mathematics have been effective. The audit considered:

- whether the number and proportion of students continuing with science and mathematics at VCE and university level is increasing
- whether DEECD has the required workforce to support high-quality teaching in science and mathematics
- whether all Victorian students have access to high-quality science and mathematics facilities and equipment.

The audit included four DEECD regional offices and the following visits and surveys:

- visits to each of the six science specialist centres and interviews with the host principals and centre directors
- interviews with leadership teams and teachers, and inspection of facilities at eight primary schools and 15 secondary schools
- surveys of teachers and Year 6 students at eight primary schools
- surveys of science and mathematics teachers, the principal and Year 9 students at eight secondary schools
- inspections of eight *Building the Education Revolution*-funded science centres
- surveys of the 43 principals of schools that received *Building the Education Revolution*-funded science centres.

1.8 Report structure

This report is structured as follows:

- Part 2 examines student participation and achievement in science and mathematics
- Part 3 examines the science and mathematics teacher workforce.
- Part 4 examines science and mathematics education infrastructure.

1.9 Audit method and cost

The audit was performed in accordance with the Australian Auditing and Assurance Standards.

The total cost was \$465 000.

2 Student participation and achievement

At a glance

Background

There are major ongoing national and international studies designed to address concerns about trends in, and the levels of, student participation and performance in science and mathematics, and their implications for the future economic and social wellbeing of the community.

Conclusion

The Department of Education and Early Childhood Development (DEECD) has failed to lift participation in the enabling sciences which are critical to future economic and industry needs. DEECD has also failed to lift achievement in science and mathematics, and has not successfully addressed the ongoing poorer performance of students from low socio-economic backgrounds and those living in rural and regional areas.

Findings

- While 60 per cent of Year 12 students studied one or more science subjects in 2011, only 39 per cent studied Biology, Chemistry or Physics. Growth in Psychology enrolments masks lower enrolments in the traditional sciences.
- 78 per cent of Year 12 students studied one or more mathematics subjects, however, the proportion of students studying Mathematical Methods (CAS) and Specialist Mathematics is declining.
- The rate of growth in student performance declines between Prep and Year 10.
- Students from low socio-economic backgrounds and rural and regional areas are consistently outperformed, on average, by their peers from high socio-economic and metropolitan backgrounds, respectively.
- DEECD did not set relevant and appropriate performance targets or measures for the science and mathematics education strategy.

Recommendation

The Department of Education and Early Childhood Development should establish relevant and appropriate performance measures for science and mathematics education, and obtain the necessary data to measure progress and success.

2.1 Introduction

Increasing Australian and international concerns about the loss of science and mathematics skills and falling student participation have led to several long-term studies. The results have been reported progressively over the past 15 to 20 years and present significant challenges.

The Victorian Government responded to these challenges with its 2009 strategy *Energising Science and Mathematics Education in Victoria*, which is designed to reverse the decline in student participation and achievement.

This Part reviews student participation and achievement historically, and looks at current student attitudes, participation and achievement based on international, national and school assessments.

2.2 Conclusion

While the overall percentage of Year 12 students participating in science and mathematics subjects has increased over time, participation in the enabling sciences is falling. If this trend continues, it could lead to industry and teacher shortages which in turn could further compound falling participation in the enabling sciences. Student interest in studying engineering and related technologies at tertiary level is also declining when there are already skill shortages in these areas.

In spite of this, the Department of Education and Early Childhood Development (DEECD) has not lifted achievement levels in the middle years, when students are developing the essential skills and interests that are required to study these subjects at more senior levels. While most students meet the very low minimum standards, there are not enough high-achieving students. Also, DEECD has not effectively addressed the much lower achievement levels of students from low socio-economic and non-metropolitan backgrounds.

DEECD did not set relevant and appropriate performance targets or measures as part of the science and mathematics education strategy. However, there are a number of key international and national assessments of student performance scheduled for completion in 2012. This provides the opportunity for DEECD to use the findings from these assessments to further develop and improve its science and mathematics education strategy.

2.3 Student participation in science and mathematics

One of the main objectives of the science and mathematics education strategy was to increase student interest in science and mathematics and encourage more students to pursue science and mathematics-related careers. However, DEECD did not set any targets for the levels of participation in science and mathematics studies required to meet economic and industry needs.

2.3.1 Post-school pathways in science and mathematics

Overall participation in science and mathematics related post-school education and training remained steady between 2009 and 2010. With industry demand for science and mathematics graduates predicted to increase, there will be greater demand on other sources of skilled labour, such as skilled migration.

While participation, or enrolment, is influenced by industry demand, the number of students applying to enrol in a subject is one of the main indicators of student interest. Of the 12 broad fields of further education, two relate directly to science and mathematics:

- natural and physical sciences, including mathematical sciences, physics and astronomy, chemical sciences, earth sciences and biological sciences
- engineering and related technologies.

Other fields such as health and commerce also include science and mathematics-related courses but their broad coverage means they also contain a large number of non-science and mathematics-related courses.

The proportion of students applying for university studies that are directly science and mathematics related has increased between 2008 and 2011. In 2011 science and mathematics-related courses accounted for 14 per cent of all university applications in Victoria (see Figure 2A). However, applications for engineering and related courses fell 3 per cent.

Figure 2A
Applications for science and mathematics-related university courses

	2008	2009	2010	2011
Natural and physical sciences	4 196	5 049	5 745	6 641
Engineering and related technologies	3 276	3 379	3 087	3 189
Total science and mathematics-related applications	7 472	8 428	8 832	9 830
Per cent of all applications that are science and mathematics related	12.5%	13.2%	13.5%	14.4%

Note: Refers to first preference applications for undergraduate courses made through the Victorian Tertiary Admissions Centre.

Source: Victorian Auditor-General's Office analysis of Victorian Tertiary Admissions Centre data.

At the same time, universities have increased the number of places offered in science and mathematics-related courses. In 2012, there were 5 949 places offered in courses in the natural and physical sciences and 2 588 places in courses in engineering and related technologies. Compared with 2011, places offered in these courses had increased by 4 per cent and 14 per cent, respectively.

DEECD has identified that 21 per cent of school leavers in 2010 were in science and/or mathematics related education and training in 2011. This had not increased since the previous year and results for individual study areas were mixed. While more students studied physical and natural sciences, there were fewer students in engineering-related university and vocational courses. This drop coincides with critical skill shortages in these areas.

2.3.2 Participation in science and mathematics at secondary school

In 2010, 51 581 students were eligible to complete the Victorian Certificate of Education (VCE). Of these:

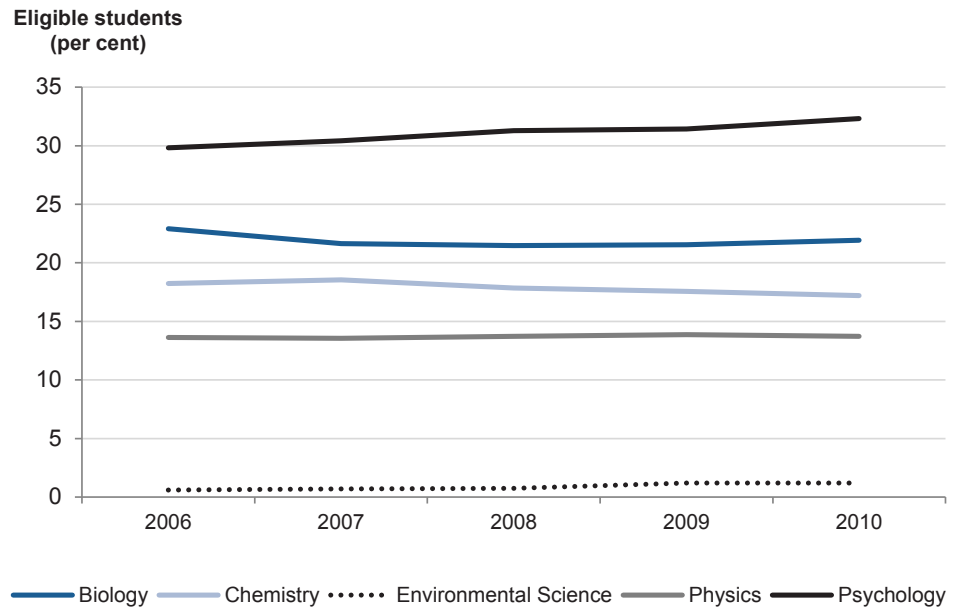
- 30 741 students (60 per cent) studied one or more Year 12 science subjects
- 19 476 students (38 per cent) studied one or more of the traditional science subjects of Biology, Chemistry or Physics in Year 12
- 40 069 students (78 per cent) studied one or more Year 12 mathematics subjects.

Participation in VCE science over time

Participation in science subjects has been relatively static since 1995, with about 60 per cent of students studying one or more Year 12 science subjects. However, the percentage of students studying at least one of the traditional science subjects fell from 43 per cent to 39 per cent, with the difference made up from the high and growing proportion of students taking Psychology, which is not one of the enabling sciences.

Figure 2B shows the percentage of students studying the five Year 12 science subjects, and highlights that in 2010, enrolments in Psychology outnumber enrolments in Chemistry, Environmental Science and Physics combined.

Figure 2B
Enrolments in Year 12 science subjects



Note: Refers to the proportion of students eligible to complete the Victorian Certificate of Education who studied a Unit 3 science subject.

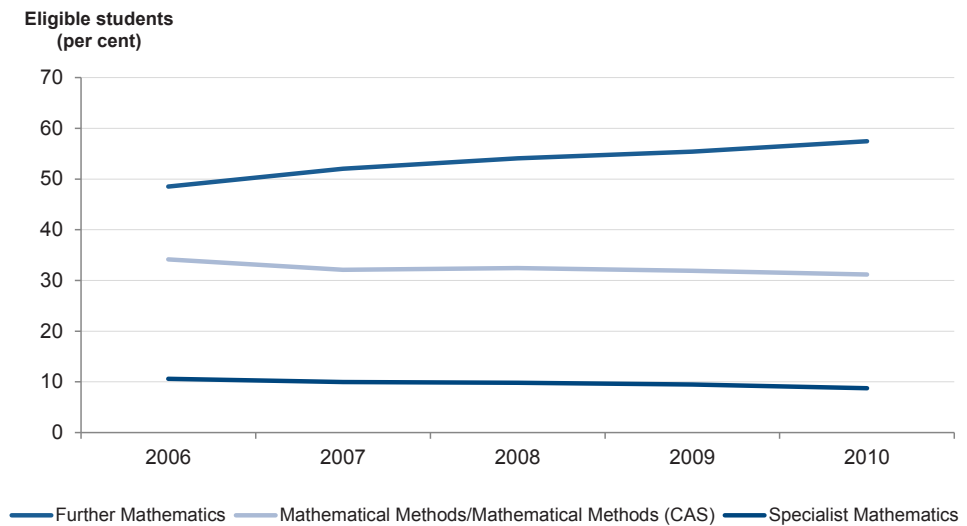
Source: Victorian Auditor-General’s Office analysis of Victorian Curriculum and Assessment Authority data.

Participation in VCE mathematics over time

Since 1995 the proportion of students studying one of the three Year 12 mathematics subjects has risen from 68 per cent to 78 per cent but the rise has only been in the least difficult, Further Mathematics. Over the same time, the proportion of students in Mathematical Methods/Mathematical Methods (CAS) and Specialist Mathematics has fallen. While it is encouraging that the more accessible and practical applications based Further Mathematics subject is helping to engage a broader population of students in mathematics, DEECD needs to carefully monitor this trend to make sure that sufficient numbers continue with more advanced mathematics subjects.

Figure 2C compares participation in Year 12 mathematics from 2006 to 2010.

Figure 2C
Enrolments in Year 12 mathematics subjects



Note: Refers to the proportion of students eligible to complete the Victorian Certificate of Education who studied a Unit 3 mathematics subject.

Source: Victorian Auditor-General’s Office analysis of Victorian Curriculum and Assessment Authority data.

2.3.3 Student views on science and mathematics

The audit surveyed Year 6 and Year 9 students from eight primary and eight secondary schools on their attitudes towards, and experiences of, studying science and mathematics. Figure 2D reports on a selection of key survey findings.

Figure 2D
Student attitudes to science and mathematics

Percentage of students who felt that:	Science		Mathematics	
	Year 6	Year 9	Year 6	Year 9
• the subject was important to their future	72.0	48.5	94.4	82.8
• the subject is fun and interesting	93.3	62.9	74.8	41.9
• learning the subject is easy	71.6	56.4	66.2	62.0
• they use lots of equipment in the subject	79.9	75.4	73.6	32.3
• they work in pairs or small groups in the subject	81.8	77.6	75.3	40.7
• their teacher gives them lots of work to do from a textbook	15.4	45.9	35.8	74.9

Source: Victorian Auditor-General’s Office survey of Year 6 and Year 9 students, February 2012.

Most of the surveyed students viewed mathematics as important to their future but not necessarily fun and interesting. In contrast, while most felt that science is fun, fewer felt it was important to their future. Students also described more traditional, less engaging teaching in mathematics, such as a heavy focus on textbook work, while they described science classes as having more engaging teaching strategies, including greater use of equipment and information and communications technology, as well as small group work.

Ninety per cent of the Year 6 students looked forward to doing science at secondary school, compared to only 60 per cent for mathematics. However, interest in pursuing these subjects had fallen by Year 9, by which time 43 per cent said they would like to study mathematics at VCE level compared to 36 per cent for science. The inability of schools to engage middle years students poses a significant and ongoing challenge to DEECD, which it has so far failed to address.

2.4 Student achievement in science and mathematics

A range of international, national, and school studies assess Australian school students on their science and mathematics achievements.

The international studies show that Victorian student performance is not improving and is, in many respects, declining. While about average for mathematics, Victoria's results in national rankings show that in science, students are lagging behind at the top levels of achievement and are over-represented at the lowest levels.

2.4.1 International science and mathematics assessments

Two international studies examine and compare student performance in science and mathematics in countries including Australia—the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). They are due to release their latest reports in 2013 and 2012, respectively. DEECD aims to increase the proportion of students achieving high standards as measured by PISA but has not set targets for the level or time frames for improvement.

Programme for International Student Assessment

Australia's rank in science literacy fell from 8th in 2006 to 10th in 2009 although its average score stayed the same. In mathematics literacy, Australia ranked 15th, falling from 13th in 2006 and showing a fall in average score from 2006.

Victoria's performance in mathematical and scientific literacy did not change significantly from 2003 to 2009. It ranked 16th in science literacy and 20th in mathematics literacy in 2009 (see Figure 2E).

However, Victoria ranked only 5th among the Australian states and territories for students in the top two achievement levels and had higher than average student numbers in the bottom two levels of achievement in science. Victoria was at the Australian average for mathematics.

Figure 2E
Victoria’s science and mathematics ranking in PISA 2009 compared to Australian and international jurisdictions

	Science	Mathematics
Victoria ranks	16th	20th
Behind	Shanghai – China Finland Hong Kong – China <i>Australian Capital Territory</i> Singapore <i>Western Australia</i> Japan Korea	Shanghai – China Singapore Hong Kong – China Korea Chinese Taipei Finland Liechtenstein Switzerland <i>Western Australia</i> Japan <i>Australian Capital Territory</i> Canada Netherlands Macao – China
Similar to	New Zealand <i>New South Wales</i> <i>Queensland</i> Canada Estonia Australia Netherlands Victoria Chinese Taipei Germany Liechtenstein <i>South Australia</i>	New Zealand <i>Queensland</i> Belgium Australia Germany Victoria <i>New South Wales</i> Estonia <i>South Australia</i>
Ahead of	Switzerland United Kingdom Slovenia Macao – China Poland Ireland Belgium Hungary United States	Iceland Denmark Slovenia Norway France Slovak Republic Austria

Note: Figure 2E shows jurisdictions at or above the Organisation for Economic Co-operation and Development average. 44 other jurisdictions sit below the average for science and 43 sit below the average for mathematics, including Tasmania and the Northern Territory.

Source: Victorian Auditor-General’s Office analysis of *PISA in Brief. Highlights from the full Australian Report: Challenges for Australian Education Results from PISA 2009*, Sue Thomson, Lisa De Bortoli, Marina Nicholas, Kylie Hillman and Sarah Buckley.

Trends in International Mathematics and Science Study

In the 2007 TIMSS, Victorian students performed at or above the international average in science and mathematics in Year 4 and Year 8, but overall performance did not improve since the previous study (see Figure 2F). Year 8 students were lagging in chemistry and physics and relatively better in biology and earth science.

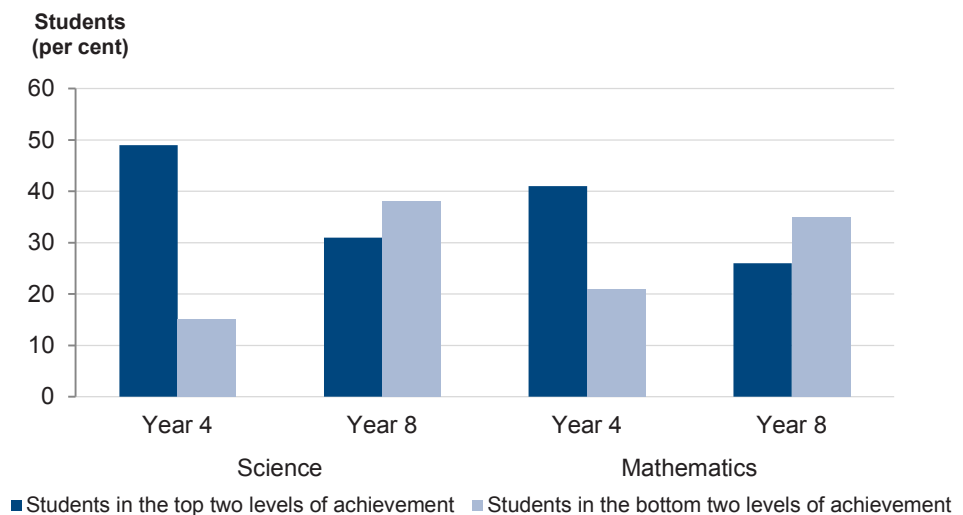
Figure 2F
Victorian Year 4 and Year 8 TIMSS performance compared to other international jurisdictions

	Year 4	Year 8
Overall science performance	Above international average	Above international average
Overall mathematics performance	Above international average	Meets international average
Change in science performance relative to other countries 2003–2007	Performance improved	No change
Change in mathematics performance relative to other countries 2003–2007	No change	Performance declined

Source: Victorian Auditor-General’s Office.

Figure 2G shows that student performance drops significantly between Year 4 and Year 8 in both science and mathematics.

Figure 2G
Victorian students in the top and bottom levels in TIMSS 2007



Source: Victorian Auditor-General’s Office analysis of *Highlights from TIMSS 2007 from Australia’s Perspective*, Sue Thomson, Nicole Wernert, Catherine Underwood and Marina Nicholas.

2.4.2 National science and mathematics assessments

While almost all students meet the minimum standard for scientific literacy and numeracy, there has not been a significant improvement in either area.

The National Assessment Program covers student numeracy achievement and scientific literacy through two studies, the National Assessment Program—Literacy and Numeracy (NAPLAN) and the National Assessment Program—Science Literacy (NAPSL).

Since 2008, NAPLAN has tested all Australian students in Years 3, 5, 7 and 9. The NAPSL has measured the scientific literacy of a sample of Year 6 students every three years since 2003. The next NAPSL assessment will be in 2012.

National Assessment Program—Literacy and Numeracy

Almost all students (about 95 per cent in each year group) meet the minimum standards for numeracy in Victoria, with little change over time. However, this minimum standard is very low and there is a significant overall decline in achievement between students from Year 3 to Year 9, where more than one in five students perform at the lowest levels.

The science and mathematics education strategy targeted more students in all year groups reaching the top two levels of numeracy achievement in NAPLAN assessments. It aims to increase the proportion of Years 3, 5 and 7 students in the top two levels of achievement by 10 per cent. It also aims to increase the proportion of Year 9 students in the top two levels of achievement by 20 per cent. However, as shown in Figure 2H, there has been little improvement in any year group. Unless the 2012 scores change dramatically then no progress has been made towards the targets.

Figure 2H
Percentage of Victorian students in the top two levels of achievement in NAPLAN against DEECD targets

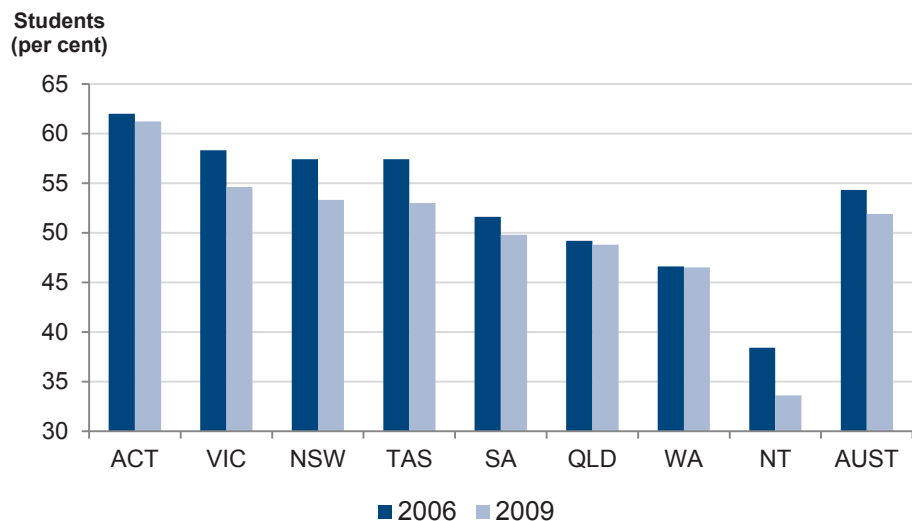
Student cohort	2008	2009	2010	2011	Target
Year 3	42.8	41.5	41.8	42.0	45.7
Year 5	25.2	29.9	31.7	26.8	32.9
Year 7	27.0	25.3	26.0	25.2	27.8
Year 9	19.4	21.9	20.4	21.6	26.3

Source: *Evaluation of the Science and Mathematics Education Strategy*, Department of Education and Early Childhood Development, December 2011.

National Assessment Program—Science Literacy

Victoria’s average score for science literacy fell slightly between 2006 and 2009. This downward trend is common to most states and Victoria had the second highest percentage of students performing at or above the proficient standard behind the Australian Capital Territory. However, almost half of its students still fell below the national proficiency standard (see Figure 2I).

Figure 2I
Students in each jurisdiction at or above the national proficient science standard in 2006 and 2009



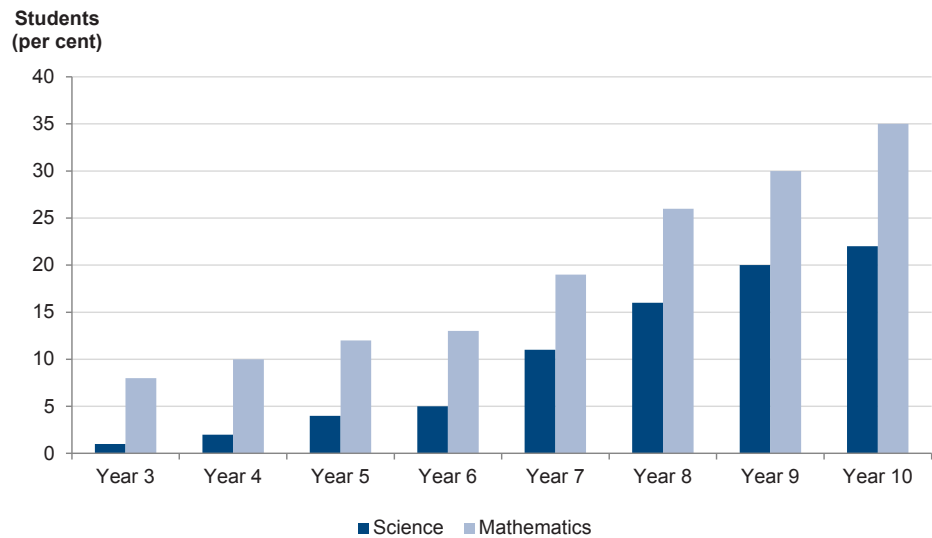
Source: Victorian Auditor-General’s Office based on Australian Curriculum, Assessment and Reporting Authority data.

2.4.3 School-based assessments

In the 2010 end of year assessment, only 10 per cent of government school students received A or B grades for science. However, almost 19 per cent received A or B grades in mathematics.

Students in government schools from Prep to Year 10 are assessed twice a year against the Victorian Essential Learning Standards. While the percentage of students receiving A and B grades in science is relatively consistent across all year groups, the mathematics average drops from 22 per cent in primary school to 12 per cent in secondary school years. This pattern of declining high level performance as students progress through schools is mirrored by a dramatic rise in the percentage of students receiving D or E grades. This declining science and mathematics performance persists through secondary school, as shown in Figure 2J.

Figure 2J
Students graded D or E by teachers in science and mathematics



Note: Based on December 2010 teacher assessments of student achievement against the Victorian Essential Learning Standards.

Source: Victorian Auditor-General’s Office analysis of Department of Education and Early Childhood Development data.

2.4.4 Differences in student achievement

The socio-economic background and location of students are major factors in poorer student achievement in science and mathematics and DEECD has made little progress in improving this.

PISA, NAPLAN and teacher judgements all demonstrate that students from the lowest socio-economic status backgrounds face the most challenges in meeting or surpassing the minimum standards in science and mathematics.

For example, in 2010, teachers gave only 6 per cent of students from low socio-economic status areas A and B grades for science and mathematics even though these students make up 29 per cent of the student population.

National and international studies show the highest achievement levels for science and mathematics in metropolitan areas, followed by regional centres, then rural and remote areas.

For example, the 2011 NAPLAN assessment showed 8 per cent of Year 3 metropolitan students were at or below the national minimum numeracy standard, compared to 15 per cent of rural students. By Year 9, these figures had increased to 20 per cent and 26 per cent, respectively.

Again, teacher judgements of student science and mathematics performance gave fewer regional students the highest grades (A or B). However, Western Metropolitan Region, an area of major socio-economic deprivation, also showed poor results as Figure 2K shows.

Figure 2K
Students graded A or B by teachers in science
and mathematics, by region

Region	Students graded A or B in science (per cent)	Students graded A or B in mathematics (per cent)
Hume	6.5	14.5
Gippsland	6.7	13.9
Grampians	7.0	16.6
Loddon Mallee	7.7	15.3
Barwon South Western	7.8	18.1
Western Metropolitan	6.3	15.6
Northern Metropolitan	9.6	17.7
Southern Metropolitan	11.1	20.7
Eastern Metropolitan	15.1	27.1
State	9.9	19.4

Note: Based on December 2010 teacher assessments of student achievement against the Victorian Essential Learning Standards.

Source: Victorian Auditor-General's Office analysis of Department of Education and Early Childhood Development data.

Recommendation

1. The Department of Education and Early Childhood Development should establish relevant and appropriate performance measures for science and mathematics education, and obtain the necessary data to measure progress and success.

3 Science and mathematics teacher workforce

At a glance

Background

Teacher quality is the most important in-school factor influencing student learning. Consequently, sound workforce planning should consistently balance supply and demand for skilled teachers, and anticipate future needs. The Department of Education and Early Childhood Development (DEECD) is responsible for sufficient well-qualified teachers being available to schools.

Conclusion

DEECD has no data on the number of science and mathematics teachers needed or employed in schools and no data on their qualifications, experience and training needs. Therefore, it cannot develop evidence-based workforce strategies or reliably monitor and evaluate its initiatives. This seriously compromises the future supply of science and mathematics skills and knowledge in the community.

Findings

- DEECD does not collect, maintain, analyse or report on complete, reliable and timely data about science and mathematics teachers and does not practise sound workforce planning.
- Schools have more difficulty recruiting science and mathematics teachers than DEECD data reflects, with teacher quality reported as the most significant issue.
- DEECD does not adequately monitor the effectiveness of its professional learning initiatives for science and mathematics teachers.

Recommendations

The Department of Education and Early Childhood Development should:

- complete its workforce data collection framework and collect, maintain, analyse and report on complete, reliable and timely data about science and mathematics teachers, and their qualifications, skills and experience
- implement a workforce strategy that supplies more and better quality science and mathematics teachers.

3.1 Introduction

The Department of Education and Early Childhood Development (DEECD) is responsible for making sure there are enough appropriately skilled and experienced science and mathematics teachers available to schools. Teachers need expertise in their subject matter, effective teaching strategies, an ability to communicate well and engage students, and to be able to set the foundations for continued study in these essential disciplines.

Robust planning for such a skilled workforce depends on current, accurate and sufficiently detailed data on teacher supply and skills, and present and future demand.

This Part examines whether DEECD initiatives have succeeded in providing primary and secondary schools with sufficient numbers of skilled teachers to offer high quality science and mathematics learning. It reviews workforce planning, teacher supply and demand, supply initiatives and professional learning and development activities.

3.2 Conclusion

Teacher quality has emerged as the most urgent issue facing government schools in their challenge to improve science and mathematics education. If unresolved, the breadth and quality of science and mathematics education will be seriously compromised. Further, the future supply of science and mathematics skills and knowledge will be under threat. One particular risk is that science and mathematics curriculum offerings could be cut, especially in non-metropolitan and disadvantaged schools.

A further risk is that parents and students with high aspirations in the sciences and mathematics may abandon government schools if they perceive non-government schools are offering higher quality education in these subjects.

As DEECD does not collect basic data on teacher numbers, demand, skills or qualifications it cannot reliably develop meaningful and effective workforce strategies or monitor and evaluate its initiatives.

3.3 Workforce planning

To plan and fund the future workforce effectively, DEECD needs to collect, maintain and analyse complete, reliable and timely data about science and mathematics teachers. Accurate, current data will allow DEECD to target teacher shortages and build teacher workforce capacity in the areas of greatest need.

Centrally collected data can also be shared with regional offices and schools for local planning.

3.3.1 Workforce data collection

DEECD does not know how many science and mathematics teachers are currently teaching in schools or how many are needed. Despite Victorian Institute of Teaching guidelines outlining recommended minimum levels of subject area study, DEECD does not know the qualifications or experience of those teaching, or their ongoing training and development needs.

DEECD collects and uses teacher workforce data from a range of sources, however, the data is of varying quality and completeness and therefore not adequate for workforce planning. DEECD does not make best use of its existing systems to collect, analyse and report on teacher workforce data.

The *Teacher Recruitment (Difficulties) Census*, which DEECD uses to find out how many government schools are having trouble recruiting in each subject area, has severe limitations. School principals, teachers and staff at DEECD regional offices have questioned the census accuracy and reliability. It does not report how many teachers are needed or currently teaching in schools. Further, it does not take into account the number or quality of applicants, or the suitability or success of the appointed teacher. Without this, it is difficult to interpret the census meaningfully and identify the extent of problems in the science and mathematics teacher workforce.

DEECD started to develop a workforce data collection framework in 2009, and there are two new national teacher workforce data projects underway. However, DEECD still does not have accurate or timely information about the workforce. It cannot make informed decisions until the framework is finished.

3.3.2 Workforce planning in schools

Many school principals do not have the skills to develop and implement effective workforce plans in their schools and DEECD has done little to support them. As a result, most schools do not have robust workforce planning. Combined with the lack of reliable workforce data, this poses a significant risk that major workforce issues are not identified or managed.

Principals of government schools are responsible for workforce planning, staffing and using appropriate merit-based selection when filling vacancies. By not providing an explicit framework or guidance on workforce planning, DEECD has not supported principals in these tasks.

During 2010 DEECD conducted a School Workforce Planning Tools Pilot Project. While most schools reported they did some form of workforce planning, activities ranged from the sophisticated to very basic. The great majority of schools (91 per cent) reported they had no systematic workforce planning and only 49 per cent identified workforce gaps during strategic planning.

Although DEECD has identified it needs to better support schools in workforce planning, it has made little progress in building capacity. As school principals become ever more autonomous, it is increasingly important that they have the necessary skills and support to manage their schools efficiently and effectively.

3.4 Teacher supply and demand

Using data on population growth, student–teacher ratios, attrition rates and enrolments in teacher education courses, DEECD forecasts whether the future supply of teachers will meet school needs. Current forecasts predict that teacher supply overall will be in balance from 2012. For example, there are likely to be 140 (0.5 per cent) surplus primary and 580 (2 per cent) surplus secondary teachers in the government and non-government school sectors. However, this aggregate picture masks significant imbalances in supply at different levels of expertise, within subject areas and across locations. Notably, there are no projections relating to supply and demand of science and mathematics teachers. Without targeted intervention, finding skilled and experienced science and mathematics teachers is likely to remain a problem, particularly in some geographical and subject areas which have a history of unmet demand.

3.4.1 Science and mathematics vacancies

Statewide and national surveys, including the Commonwealth Government’s *Staff in Australia’s Schools* survey and the Australian Education Union’s *State of Our Schools* survey, report that schools have great difficulty recruiting appropriately qualified teachers. These surveys align with the perceptions of school principals and teachers, DEECD regional staff and other stakeholders interviewed during this audit.

In the 2010 *Staff in Australia’s Schools* survey, 27 per cent of primary and 41 per cent of secondary schools reported either major or moderate difficulties filling teacher vacancies. The 2011 *State of Our Schools* survey reported that 31 per cent of government schools had difficulties filling teacher positions. Of the secondary schools, 55 per cent said mathematics teachers were their main concern compared to 21 per cent for science teachers.

Number of applications

Science and mathematics teacher vacancies typically attract fewer applications than other teaching positions. This can lead to schools appointing an applicant without the desired skills and experience, or leaving a position unfilled and resorting to other strategies such as reducing the curriculum or combining classes. This problem is more noticeable in regional areas where schools attract about half the number of applications of metropolitan schools.

Figure 3A shows that, on average, science teacher vacancies attract the fewest applicants (15) and dual mathematics and science teacher vacancies the most, at 22. Additionally, a substantial proportion of both science and mathematics teacher vacancies attract very few applicants. Over a third attract fewer than 10 applicants, including 16 per cent of science vacancies and 13 per cent of mathematics vacancies that attract four or fewer.

Figure 3A also shows that rural and regional areas had fewer applicants than metropolitan areas in 2011, and that vacancies in rural and regional areas were more likely to remain unfilled.

Figure 3A
Average number of applications for science and mathematics teacher vacancies and percentage of vacancies with no appointment, 2011

Vacancy type	Average applications per vacancy (number)			Vacancies with no appointment made (per cent)		
	Metro	Non-metro	State	Metro	Non-metro	State
Science teacher	18.4	8.1	14.9	8.5	11.8	9.6
Mathematics teacher	21.9	10.8	17.2	7.9	24.5	14.8
Dual science and mathematics teacher	29.3	12.2	22.4	8.1	15.1	10.9
Other disciplines	28.2	12.7	23.4	5.2	7.5	5.9

Source: Victorian Auditor-General's Office analysis of Department of Education and Early Childhood Development data.

Nonetheless, DEECD's *Teacher Recruitment (Difficulties) Census* shows that vacancies that failed to attract any suitable, qualified applicants through the usual recruitment process were low, falling from a peak in 2008 (see Figure 3B). DEECD attributes this drop to lower attrition in the teacher workforce following the global financial crisis. This means DEECD may experience more severe difficulties in future, as older teachers progressively leave the workforce.

Figure 3B
Number of difficult to fill vacancies reported through the Teacher Recruitment (Difficulties) Census (full time equivalent positions)

	2005	2006	2007	2008	2009	2010	2011	2012
Mathematics	69.3	76.5	99.8	111.8	58.3	69.9	41.0	24.4
Science	28.5	39.4	51.5	76.5	32.9	23.1	23.6	11.4

Source: Victorian Auditor-General's Office analysis of Department of Education and Early Childhood Development data.

Applicant quality

Compounding the problem of too few applicants is the high proportion who do not meet selection criteria, according to school principals and staff from DEECD regional offices.

The quality of applicants is a good predictor of potential recruitment problems. Schools regularly receive applications from people not qualified to teach in Victoria, or who do not have the relevant subject background.

The most common concerns voiced by 23 secondary school principals interviewed about applicant quality were:

- applicants not having effective teaching strategies for the subject or year level
- cultural or language barriers
- inadequate subject knowledge, particularly for senior level mathematics.

Managing teacher shortages

Figure 3C shows how the eight surveyed secondary schools dealt with a science or mathematics teacher shortage in 2011 or 2012. While most of the strategies allowed students to continue studying science or mathematics, some of the strategies have a risk that the quality of delivery is compromised.

Figure 3C
Strategies used to address a science or mathematics teacher shortage in 2011 or 2012 in eight surveyed secondary schools

Strategy	Number of schools	
	Science	Mathematics
Stopped offering the subject	2	0
Combined classes across subject areas	1	1
Combined classes across year levels	2	3
Required teachers to teach outside their field of expertise	2	3
Recruited teachers not fully qualified in the subject area	0	0
Recruited a teacher on a short-term contract	3	2
Shared delivery with other schools	2	2

Source: Victorian Auditor-General's Office survey of eight secondary school principals.

Principals responding to the 2010 *Staff in Australia's School* survey reported using similar strategies. For example, 42 per cent asked teachers to teach outside their field of expertise and 18 per cent reduced the curriculum offered. In that survey, 23 per cent of principals also reported hiring teachers not fully qualified in the subject area they were going to teach.

3.5 Teacher supply initiatives

Since the late 1990s, DEECD has run various programs to help government schools employ appropriately skilled and qualified teachers. However, it has not taken a strategic or coordinated approach to developing and managing its programs and cannot show that it has used its limited funding effectively.

Teacher supply initiatives vary considerably in purpose, structure, budget, participant numbers and duration. Some aim to remedy shortages of science and mathematics teachers, while others target shortages in various teaching disciplines, including science and mathematics, in disadvantaged or difficult to staff schools. However, DEECD does not specify how many science and mathematics teachers it aims to recruit or retain through these initiatives.

The *Energising Science and Mathematics Education in Victoria* strategy aimed to increase the supply of science and mathematics teachers in two ways:

- \$3.65 million to attract new science and mathematics teachers through the Mathematics and Science Graduate Scholarship initiative and the Career Change Program
- \$7.6 million to attract at least 75 high-calibre graduates, including science and mathematics graduates, to start teaching in 2010 through Teach for Australia.

DEECD is also implementing the government's 2010 election commitment to grant 400 teaching scholarships for science graduates.

Appendix A summarises the current teacher supply initiatives.

While DEECD has had some of the initiatives externally evaluated, the quality of these evaluations varies, relying often on only principal and participant perception. DEECD does not have complete or reliable evidence about:

- the number of science and mathematics teachers recruited or retained through its initiatives
- whether teachers recruited through its initiatives are being employed in the most needy schools
- whether the participants would have become science and mathematics teachers in the most needy schools even without program support.

In late 2011 DEECD commissioned Deakin University to evaluate whether its teacher quality, supply and retention initiatives are meeting government school needs. The evaluation aims to find out if the initiatives are appropriately targeted and cost effective. DEECD expects the evaluation to identify gaps and emerging issues and recommend new strategies or modifications to current programs. The final report is due in April 2013.

3.6 Teacher knowledge and skills

Teacher qualifications and professional experience are basic indicators of teacher capability. However, DEECD has decided not to collect data on teacher qualifications and the number and location of teachers teaching outside their field of study. DEECD justifies this approach by citing potential industrial issues, reduced staffing flexibility in schools and possible parental pressure.

In addition to subject knowledge, other critical attributes for effective teaching are the ability to:

- convey new ideas
- create effective learning environments
- foster productive teacher – student relationships
- work effectively with colleagues and parents.

DEECD has no framework to define or measure the workforce capabilities required to meet its science and mathematics education aims. Without this, it cannot design and follow a workforce development strategy that targets teacher needs.

3.6.1 Professional learning needs

Many schools have trouble matching suitably qualified staff to science and mathematics classes. Principals report that it is becoming harder to staff Year 12 physics, chemistry and advanced mathematics. However, audited schools reported they also had difficulty allocating high-quality teachers for Years 7 to 10 science and mathematics. This raises the risk of students becoming disengaged or performing poorly at a time when they most need to learn basic science and mathematics competencies and are making decisions about future study and careers.

The audit asked 102 primary school teachers, 67 secondary school science teachers and 77 secondary school mathematics teachers to rate themselves against critical areas of science and mathematics teaching. Figure 3D shows the results.

Figure 3D
Teachers stating that their knowledge of science and mathematics teaching is good or very good

	Primary school teachers (per cent)	Secondary school teachers (per cent)
Science teaching		
Science content	47.5	95.4
Science pedagogy/instruction	38.6	87.7
Science curriculum	40.0	81.5
Integrating ICT into science	38.0	60.0
Assessing students in science	39.0	83.1
Improving students' critical thinking or problem solving skills	43.6	N/A
Mathematics teaching		
Mathematics content	90.0	93.2
Mathematics pedagogy/instruction	86.3	83.8
Mathematics curriculum	85.3	87.7
Integrating ICT into mathematics	74.3	62.2
Assessing students in mathematics	84.3	82.4

Source: Victorian Auditor-General's Office survey of primary and secondary school teachers.

Primary school teachers

Primary school teachers were much more likely to rate their knowledge of teaching mathematics as good or very good than their knowledge of teaching science. In four out of five critical areas of mathematics teaching, more than 84 per cent of primary teachers rated their knowledge as good or very good. By comparison, less than 48 per cent of primary teachers assessed their knowledge in each of six critical areas of science teaching as good or very good.

They were also more likely to indicate they had received enough professional development in mathematics than in science. Over half said they had received sufficient professional development in each area of mathematics teaching, while less than 17 per cent said they had received sufficient professional development in each area of science teaching.

Secondary school teachers

Over 80 per cent of secondary science and mathematics teachers rated their knowledge in four out of five critical teaching areas as good or very good. Both science and mathematics teachers rated integrating information and communications technology (ICT) into the curriculum as their weakest area.

Despite the relatively high self-assessments of their teaching skills, substantial proportions of both science and mathematics teachers reported they have not had sufficient professional development. Integrating ICT and assessing students were the areas in which both secondary science and mathematics teachers were most likely to say they needed more professional development.

3.6.2 Teacher professional learning initiatives

DEECD has been neither coordinated nor strategic when delivering the professional learning programs set out in its *Energising Science and Mathematics Education in Victoria* strategy. Consequently, very few science and mathematics teachers' professional learning needs have been addressed.

The *Energising Science and Mathematics Education in Victoria* strategy has five actions directly relating to teacher professional learning:

- \$46 million for 200 Teaching and Learning Coaches
- \$1 million annually for professional learning opportunities for science and mathematics teachers
- \$1 million for a summer school for primary and secondary science and mathematics teachers
- \$200 000 for scholarships for science teachers to participate in high-status professional learning opportunities
- using the six science specialist centres to develop and deliver professional learning programs for teachers.

The teaching and learning coaches, summer school and scholarship initiatives have ended and there is no further funding. However, DEECD is now implementing the Primary Mathematics and Science Specialists Initiative, one of the government's 2010 election commitments. The initiative employs 100 specialists in primary schools for 2012 to 2013, with another 100 from 2014 to 2015. The specialists receive intensive training so that they can coach other primary school teachers in effective science and mathematics teaching.

DEECD has not taken a long term, strategic approach to teacher professional learning under the *Energising Science and Mathematics Education in Victoria* strategy. An external evaluation of the strategy commissioned by DEECD described the impact of DEECD's professional learning programs as 'modest at best'. DEECD did not make timely decisions about professional learning activities, and the success of individual programs has been mixed.

The focus for professional learning under DEECD's science and mathematics education strategy was to build:

- science and mathematics discipline knowledge
- exemplary teaching practice
- assessment and monitoring expertise
- knowledge of contemporary applications of science and mathematics
- effective use of ICT.

However, DEECD did not specify the relative priority of each of these areas, or the desired balance between professional learning for primary and secondary teachers and between science and mathematics education. It has not evaluated its professional learning programs against the focus areas, or their relative cost effectiveness.

DEECD's professional development initiatives have reached very few teachers and a much smaller proportion of primary compared to secondary teachers. While the difference can be explained by the fact that there are far more primary school teachers, overall participation rates are still low.

This audit estimates that 9 per cent of secondary general science and 14 per cent of mathematics teachers have had professional learning under the *Energising Science and Mathematics Education in Victoria* strategy. By comparison, and excluding the work of Teaching and Learning Coaches, the audit estimates that only 2 per cent of primary teachers have taken part in professional learning in mathematics and 1 per cent in science.

The amount of professional learning is therefore demonstrably insufficient to address national and international evidence that the development of student interest and engagement in science and mathematics is most under threat in the upper primary school and lower secondary school years. If teachers of middle years students are not appropriately skilled, students may lose the chance to gain the essential skills and develop an interest in studying and achieving in science and mathematics at higher levels.

Recommendations

The Department of Education and Early Childhood Development should:

2. complete its workforce data collection framework and collect, maintain, analyse and report on complete, reliable and timely data about science and mathematics teachers, and their qualifications, skills and experience
 3. implement a workforce strategy that supplies more and better quality science and mathematics teachers.
-

4 Science and mathematics infrastructure

At a glance

Background

In 2009, the Department of Education and Early Childhood Development (DEECD) and the Commonwealth Government funded a total of \$120.14 million for new school science and mathematics infrastructure under their respective strategies to improve student achievement and support the state's future demand for skilled professionals.

Conclusion

Although DEECD has improved science and mathematics infrastructure, and provided funding to support access to the science specialist centres, access to high-quality facilities and equipment remains inequitable across Victoria. Delays in delivering its two major infrastructure initiatives, together with insufficient guidance and support for the use of specialist facilities, have adversely affected the achievement of other aspects of the science and mathematics education strategy.

Findings

- Access to high-quality science and mathematics infrastructure and equipment varies within and across government schools.
- DEECD has yet to develop an effective, integrated statewide network of science specialist centres that meets its participation targets for priority groups.
- DEECD was slow to deliver the Commonwealth-funded science facilities to schools. Schools are generally satisfied with the new facilities but it is too early to judge whether teaching and learning have improved.

Recommendations

The Department of Education and Early Childhood Development should:

- improve the governance and operation of the science specialist centres network to meet the participation targets for priority groups
- facilitate and maximise links and partnerships between the science specialist centres, specialist science schools and schools with new science facilities
- develop and deliver a program to improve ICT skills across the science and mathematics teacher workforce to better support them to integrate ICT into the curriculum.

4.1 Introduction

Modern student learning environments need to support different teaching and learning styles, including self-directed and inquiry-based learning in groups or as individuals. The best environments allow students to solve problems, think critically and make decisions, thus promoting the relevance of science and mathematics in many contexts.

The *Energising Science and Mathematics Education* strategy committed \$36.2 million to new science and mathematics infrastructure, including:

- \$20 million to complete John Monash Science School
- \$12 million to build three new science and mathematics specialist centres to add to the existing three centres
- \$2.8 million for improved information and communications technology (ICT) infrastructure to link specialist science and mathematics facilities
- \$1.4 million to increase access to specialist centres for students from low socio-economic status backgrounds, and rural and remote areas.

The investment was made, in part, to achieve the Department of Education and Early Childhood Development's (DEECD) aim of increasing student interest, engagement and achievement in science and mathematics. DEECD also aims to improve teaching quality by helping teachers better engage and maintain student interest.

The Commonwealth Government also granted Victoria \$83.94 million in 2009 to build or refurbish science facilities in 43 government schools through its *Building the Education Revolution* (BER) program.

This Part examines whether the DEECD initiatives have succeeded in giving students access to high-quality science and mathematics facilities and equipment. It reviews classroom design and equipment, the BER building and refurbishing program, the specialist science and mathematics network and the two new specialist schools.

4.2 Conclusion

The science and mathematics education strategy included the construction of three additional science specialist centres to provide engaging, contemporary, real-world science learning experiences for students and teachers. However, the delay in building the three new centres, together with inadequate leadership and operating arrangements, means that DEECD has not yet developed its integrated network of six science specialist centres across Victoria. This has adversely affected the achievement of other aspects of the science and mathematics education strategy.

Construction of the BER-funded science centres has also been delayed, with more than half finished at least six months late. These delays, together with insufficient planning and support from DEECD, mean that it is not yet clear what specific role, if any, the schools with new BER science centres will have in supporting DEECD's goals for science and mathematics education.

4.3 School classrooms and laboratories

The quality of teaching is the most important factor in student achievement. However, the design, quality and equipping of school classrooms and laboratories are also important, as these factors can influence student and teacher morale and motivation, as well as teachers' ability or willingness to use more engaging teaching strategies.

4.3.1 Design of science and mathematics classrooms

The standard of classrooms and laboratories within and across the audited schools was mixed.

Primary and secondary schools need flexible learning spaces, ICT equipment, temperature controlled classrooms, appropriate lighting and good acoustics. Teachers also seek ready access to good quality equipment and learning resources, appropriate storage facilities and a variety of display spaces.

Primary school classrooms

Of 102 primary school teachers surveyed, 21 per cent said they did not have ready access to all the mathematics equipment they needed, while over half (54 per cent) said they did not have ready access to all the science equipment they needed. The cost of science equipment and consumables, and lack of access to wet areas, were also reported by teachers, principals and DEECD regional staff as barriers to teaching. This means that many students do not get enough opportunities to learn science in the middle and upper years of primary school.

Secondary school classrooms and laboratories

The 67 secondary science teachers surveyed were clear about what a well-designed and equipped contemporary science laboratory looked like. However, 29 per cent said they did not have ready access to all the science equipment they needed and 24 per cent said the science laboratories in their school did not support effective teaching.

A similar picture emerged from the 77 secondary mathematics teachers surveyed. Over a fifth (22 per cent) identified lack of access to mathematics equipment and about one fifth (21 per cent) said the mathematics classrooms in their school did not support effective teaching.

Teachers in 23 schools often commented that their school did not have dedicated classrooms for teaching mathematics, which meant less access to equipment and an inability to create interesting displays. This could significantly affect students in the middle years when concrete resources and hands-on activities are particularly important to retain student engagement and assist learning.

4.3.2 New learning spaces

In 2008 the Victorian Government committed to refurbish, replace or build 200 science classrooms, and re-equip technical science classrooms at all secondary schools. Since then, 86 (27 per cent) government secondary and primary-secondary schools have received 321 new or refurbished science facilities. The Victorian Government and the Commonwealth Government's BER program each funded 43 schools' projects.

The *Science and Language Centres for 21st Century Secondary Schools* program, which was one of three programs within the BER program, built 30 science centres and 13 dual science and language centres in Victorian Government schools. The centres typically include specialist and multipurpose classrooms, a central collaborative space, outdoor learning areas, modern ICT infrastructure, and environmentally sustainable design elements. DEECD provided videoconferencing equipment and an \$11 000 equipment grant to help fit-out each new science centre.

Only one of the centres was finished by the Commonwealth Government's extended completion date of December 2010. Twenty-four (56 per cent) centres were completed more than six months late, including eight (19 per cent) that were at least 12 months late.

Teaching and learning in the BER-funded science centres

Although most schools have been using their science centres for a relatively short time, school communities are generally satisfied with their new facilities, and principals report or anticipate improved teaching and learning in the centres.

For example, there is more collaborative lesson planning and team teaching. Nevertheless, many secondary school teachers still perceive that teaching happens within four walls and consequently are challenged by and feel less confident using flexible learning spaces. Principals report that use of technology within the centres is another challenge. This is consistent with teacher survey findings which showed integrating ICT into the curriculum is the weakest area of science and mathematics teaching.

There were signs of positive changes in students' science experiences, although it is too early to know the extent of improvements, or whether they will be sufficiently sustained to increase enrolments in senior science subjects.

By using videoconferencing facilities, schools can link with external partners for delivery of the science and mathematics curriculum. For example, two or more schools could share some science or mathematics subjects where one school is too small to offer the subject, or where a suitably qualified teacher is unavailable. Schools could also link with the science specialist centres, universities or industry. These types of activities are not yet established within schools. Given many teachers are not yet confident in integrating ICT within the curriculum, DEECD needs to better support schools and teachers to use ICT to improve the availability, breadth and quality of science and mathematics education.

Implementing the BER program

The BER program has been widely criticised for its quality, project management, delivery time lines and value-for-money, even by the independent BER Implementation Taskforce which investigated these issues. Most schools are pleased with their new science centres, but many are dissatisfied with some aspects of the building project.

The principals of the 43 schools receiving BER-funded science centres were surveyed about the building project. As shown in Figure 4A, most criticism (47 per cent) was over the timeliness of project progress and completion, with 42 per cent also dissatisfied or very dissatisfied with the flexibility in design templates. However, there were higher levels of satisfaction with value-for-money (69 per cent) and the choice of design templates (72 per cent).

Figure 4A
Principal satisfaction with BER science centre project (per cent)

	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied	Not applicable
Choice of design templates	19.4	52.8	16.7	2.8	8.3
Flexibility in design templates/ability to customise layouts and configuration	22.2	33.3	27.8	13.9	2.8
Project manager	34.3	34.3	11.4	17.1	2.9
Rectification of any defects	19.4	47.2	13.9	16.7	2.8
Timeliness of project progress and completion	13.9	36.1	30.6	16.7	2.8
Value-for-money	25.0	44.4	16.7	13.9	0.0

Source: Victorian Auditor-General's Office survey of schools receiving *Building the Education Revolution*-funded science centres, February 2012.

Although this audit did not assess the quality and durability of the finished buildings, 70 per cent of schools in the survey said they were either satisfied or very satisfied with the quality of fittings and finishes in the science centres.

Most principals were positive about the overall design of the new science centres, however, more than one third were dissatisfied with aspects such as landscaping (51 per cent), placement of fixtures such as whiteboards and gas taps (50 per cent), display areas and display boards (47 per cent), storage areas (40 per cent) and heating and cooling (37 per cent).

4.4 Science and mathematics specialist centres

DEECD aims to link the three new state-of-the-art specialist science and mathematics centres with the existing three centres to form a network across the state to be accessed by all students, and offer professional learning for teachers. They are also intended to link with John Monash Science School and the BER-funded science centres.

However, delays and poor governance and guidance have led to the specialist science and mathematics network running sub-optimally.

4.4.1 Establishment of the centres

Three science specialist centres were built before the science and mathematics education strategy, which provided \$12 million for three new centres, plus \$2.8 million for ICT infrastructure to enable outreach programs to schools.

Figure 4B shows the location, science specialisation, year of opening and funding for each of the centres.

Figure 4B
Science specialist centres

Name	Host school	Location	Specialisation	Year opened	2012 projected funding
Gene Technology Access Centre	University High School	Parkville	Cell and molecular biology	2000	\$1 018 268
Ecolinc	Bacchus Marsh College	Bacchus Marsh	Environmental science and sustainability	2005	\$1 411 460
Victorian Space Science Education Centre	Strathmore Secondary College	Strathmore	Space science	2006	\$1 369 674
BioLab	Belmont High School	Belmont	Health and sport science	2011	\$974 070
EarthEd	Mount Clear Secondary College	Mount Clear	Earth science and renewable energy	2011	\$1 081 209
Quantum Victoria	Charles La Trobe Secondary College	Heidelberg	Nanotechnology and material science, mathematical modelling, mechatronics and quantum science	2012	\$954 489

Source: Victorian Auditor-General's Office.

The three new specialist centres were due to open for the 2011 school year. However, construction delays meant that BioLab and EarthEd did not open until Term 4 of 2011, with Quantum Victoria opening in 2012.

4.4.2 Governance and operating arrangements

DEECD is responsible for the successful operation of the specialist centre network. However, it has not given sufficient guidance and support for the centres to run as an integrated statewide network capable of meeting the aims and aspirations of the science and mathematics education strategy.

There is no coordinated strategic plan, no marketing or communications plan and no consistent governance or operating arrangements.

Centre directors and principals at all six centres had concerns about the lack of clearly defined roles and responsibilities and the potential risk that created. Although DEECD has set up regular meetings between the six centre directors, the centres are still running as six disconnected entities and host principals and centre directors need to collaborate and communicate more for the network to succeed.

Due to the unclear governance and operating arrangements, the success of the specialist centres is largely dependent on the quality of the relationships between centre directors and the principals of host schools. Partnership arrangements between most of the specialist centres and their industry and university partners are also largely reliant on goodwill.

4.4.3 Access to specialist centres

The specialist centres are not spread equitably across the state. Metropolitan Melbourne is well served with three. However, the three non-metropolitan centres are located in Ballarat, Geelong and Bacchus Marsh, making access to specialist facilities difficult for students and teachers in Gippsland and northern areas of the state.

Among 16 schools visited during the audit, there was a low level of awareness and use of the centres. Additionally, there was a low level of awareness and understanding of the centres at the four audited regional offices, meaning they are unable to promote the network's benefits for student and teacher learning.

While DEECD advised that centre location is not relevant given the emphasis on outreach programs, it is too early to determine whether the programs will meet school needs and be used effectively across the state. DEECD has not evaluated whether the \$1.4 million to increase access for students from disadvantaged backgrounds and rural and remote areas has increased participation by these groups.

4.4.4 On-site participation targets

Independent modelling estimated that student participation in the centres' on-site programs could grow from around 20 000 in 2010 (with three centres operating) to over 43 000 in 2015, once all six centres are fully operational. However, the network will need a more proactive and disciplined approach if it is to meet this target.

The delayed opening of the three new centres meant that DEECD only met 84 per cent of its on-site participation target for the specialist centre network in 2011. Further, only one of the existing centres met its overall participation target, as well as the targets for participation by government schools, rural and remote schools and disadvantaged metropolitan schools.

Rural and government school student participation fell at all three centres in 2011 compared to 2010. Participation by disadvantaged metropolitan students also declined at two of the centres. Overall, 3 686 (23 per cent) fewer government school students took part in specialist centre programs during 2011, including 2 328 (31 per cent) fewer rural government school students and 464 (9.8 per cent) fewer disadvantaged metropolitan government school students. At the same time, 847 (10 per cent) more non-government students attended the centres' programs.

Neither DEECD nor the network monitors individual school participation across the network. Therefore there is no data to show which schools have used the centres or whether particular regions are over- or under-represented in the programs.

4.4.5 Outreach programs

DEECD has responded to the time, distance, cost and capacity barriers faced by many schools by encouraging and supporting outreach programs. These are delivered off-site. They may be by the internet, videoconferencing, activities packages, centre staff visiting the school, or any combination of these.

DEECD anticipated that participation in outreach programs would start at 5 000 per centre in 2012 and rise to 20 000 by 2015.

The outreach model is outlined in a memorandum of understanding with each centre, and is supported with funding, investment in the required ICT infrastructure and a liaison officer within DEECD.

However, the outreach programs have been significantly hindered by a failed \$1 million project which was commissioned to produce digital curriculum resources. An evaluation reported that DEECD has no assurance that the contracted party will address the project shortcomings and deliver the planned curriculum resources to the required standard or time lines. It also reported that even if this were to occur, the delays have already prevented the science and mathematics education strategy from meeting its objectives.

4.4.6 Professional learning

The science and mathematics education strategy aimed to use the specialist centres to develop and deliver comprehensive professional learning programs for teachers.

DEECD does not have meaningful information on the number or range of professional learning programs delivered by the specialist centres. It is important that DEECD start evaluating the quality and success of these programs.

4.4.7 Evaluation of the science centres

DEECD has commissioned an evaluation of the science and mathematics education strategy, including the six science specialist centres. The evaluation will continue until the end of 2012.

Interim findings show that overall there is 'only modest discernible impact on teachers and students'. Although the centres could influence students and teachers in beneficial ways and some schools had meaningfully integrated the specialist centre experience into their curriculum, the potential of programs was inhibited by:

- lack of school commitment to science education
- time constraints
- cost of attendance
- schools using the centres merely as an excursion opportunity.

The evaluation has not yet examined the number and profile of schools using the centres, and whether DEECD's strategies for lifting access by disadvantaged schools have been successful. Further, the evaluation will need to consider the relative success of on-site programs compared with the newer outreach model.

4.5 Specialist science schools

Specialist science schools are another significant element of the science and mathematics education infrastructure. They have the potential to improve science and mathematics education across Victoria through videoconferencing, rural and regional student hosting programs and teacher professional learning activities.

John Monash Science School is Victoria's first specialist secondary school devoted to the pursuit of excellence in science, mathematics and associated technologies. Developed as a partnership between DEECD and Monash University, the school occupies a purpose-built facility in Monash University's Clayton campus.

It offers a three-year program of studies from Year 10 to 12. The curriculum gives significantly more options and enrichment programs in science and mathematics than programs available at other secondary schools. It covers nanotechnology, marine biology, astronomy, communications technology, data analysis, climate change and sustainability.

The school opened in 2010 with just under 200 Year 10 students and is operating at capacity of 600 from 2012.

DEECD is building a specialist science sub-school as a separate campus of University High School in Parkville. It will cater for 200 students and draw heavily on the educational model at John Monash Science School. It aims to offer innovative, research-based student and teacher learning that will facilitate new practices in secondary schools across Victoria.

Recommendations

The Department of Education and Early Childhood Development should:

4. improve the governance and operation of the science specialist centres network to meet the participation targets for priority groups
 5. facilitate and maximise links and partnerships between the science specialist centres, specialist science schools and schools with new science facilities
 6. develop and deliver a program to improve ICT skills across the science and mathematics teacher workforce to better support them to integrate ICT into the curriculum.
-

Appendix A.

Teacher supply initiatives

Science Graduate Scholarships

Provides payments of up to \$11 000 to attract people with a background in science into a graduate entry teacher education course.

\$5 000 000 over 2012 to 2015 to provide 400 scholarships.

Graduate Pathways Scholarship

Provides scholarships and employment incentives for graduates in priority degree disciplines to undertake a teacher education course.

\$900 000 over 2011 to 2012. To date, 73 (86 per cent) of the 85 participants were science and/or mathematics related.

Teaching Scholarship Scheme

Provides financial incentives and employment opportunities in schools with difficult to fill vacancies to final year student teachers.

\$615 000 per year from 2010–11; \$877 000 per year from 2004–05 to 2009–10.

Of the 1 680 participants to date, 628 (37 per cent) were science or mathematics related.

Teach for Australia

Prepares outstanding graduates from all disciplines for teaching in disadvantaged schools.

\$7 600 000 over 2010 to 2012. To date, 32 (31 per cent) of the 103 participants have trained as science and/or mathematics teachers.

Career Change Program

Enables non-teaching professionals (such as engineers, scientists, mathematicians and IT specialists) and trades people with relevant experience to undertake a teacher education course while being employed as a supervised trainee teacher. A key objective is to bring industry skills and professional expertise into hard to staff schools.

\$4 599 000 over 2010 to 2012; \$5 206 000 over 2005 to 2009.

48 science and mathematics teachers have been involved in this program since 2005, representing 20 per cent of the program's 239 participants. Of the 48 science and mathematics teachers, 20 were employed in rural or provincial schools, 12 were employed in hard to staff schools and 16 were employed in metropolitan schools.

Student Teacher Practicum Scheme

Provides financial support to encourage student teachers to undertake their practicum in rural locations or outer metropolitan areas.

\$200 000 per year from 2010–11; \$250 000 per year from 2004–5 to 2009–10.

DEECD does not have data on the number of science or mathematics teachers supported by this program (1 802 participants in total over the period 2005 to 2011).

Teacher Graduate Recruitment Program

Provides employment opportunities to recent graduates.

No budget is required for this program.

DEECD does not have data on the number of science or mathematics teachers supported by this program. (10 709 participants in total over the period 2003 to 2011.)

Graduate Retention Incentive

Provides financial incentives to retain high-quality teacher graduates in hard to staff rural schools.

\$2 680 000 over 2010 to 2012.

To date, 11 (27 per cent) of the 40 participants were science and/or mathematics teachers. 10 science and mathematics participants were based in hard to staff schools and one was based in a rural or provincial school.

Refresher Training Programs

Enables former teachers to return to the classroom and provides English language skills and cultural awareness for overseas trained teachers.

\$600 000 per year.

DEECD does not have data on the number of science or mathematics teachers supported by this program (1 750 participants in total over the period 2005 to 2011).

Appendix B.

Audit Act 1994 section 16— submissions and comments

Introduction

In accordance with section 16(3) of the *Audit Act 1994* a copy of this report was provided to the Department of Education and Early Childhood Development with a request for submissions or comments.

The submission and comments provided are not subject to audit nor the evidentiary standards required to reach an audit conclusion. Responsibility for the accuracy, fairness and balance of those comments rests solely with the agency head.

RESPONSE provided by the Secretary, Department of Education and Early Childhood Development



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Early Childhood Development**

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Mr. Des Pearson
Auditor-General
Victorian Auditor-General's Office
Level 24/ 35 Collins Street
MELBOURNE VIC 3000

Dear Mr. Pearson

Re: AUDIT ACT 1994 Section 16(3) – PROPOSED AUDIT REPORT – SCIENCE AND MATHEMATICS PARTICIPATION RATES AND INITIATIVES

Thank you for the opportunity to comment, under section 16(3) of the *Audit Act 1994*, on the Proposed Draft Audit Report on *Science and Mathematics Participation Rates and Initiatives*. The Department of Education and Early Childhood Development has reviewed the report and a response is enclosed. I request that this response is published in full.

The Department accepts all six recommendations in the report and will implement them within the context of available resources, Government policies and the devolved environment in which government schools operate.

Should you wish to discuss the content of this response further, please do not hesitate to contact Mr. James Kelly, Executive Director, Audit and Risk on (03) 9637 3158.

Yours sincerely

Richard Bolt
Secretary

29/5/2012

Enc: The Department of Education and Early Childhood's response to recommendations contained in the report.



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RESPONSE provided by the Secretary, Department of Education and Early Childhood Development – continued

**VAGO Audit
Science and Mathematics Participation Rates and Initiatives 2012**

The Department welcomes the opportunity to comment on the audit report and accepts the recommendations. The Department's specific management response for each recommendation is outlined below.

Number	Recommendations
1	<p>The Department of Education and Early Childhood Development should:</p> <p>Establish relevant and appropriate performance measures for science and mathematics education, and obtain the necessary data to measure progress and success</p> <p>DEECD Response: Accept</p>
2	<p>Complete its workforce data collection framework and collect, maintain, analyse and report on complete, reliable and timely data about science and mathematics teachers, and their qualifications, skills and experience</p> <p>DEECD Response: Accept</p>
3	<p>Implement a workforce strategy that supplies more and better quality science and mathematics teachers</p> <p>DEECD Response: Accept</p> <p>Comment: The Department will implement a strategy that aims to supply more and better quality science and mathematics teachers.</p>
4	<p>Improve the governance and operation of the specialist science centres network to meet the participation targets for priority groups</p> <p>DEECD Response: Accept</p> <p>Comment: The Department is currently developing new governance arrangements for the specialist science centres and supporting centres to meet the participation targets for priority groups.</p>
5	<p>Facilitate and maximise links and partnerships between the specialist science centres, specialist science schools and schools with new science facilities</p> <p>DEECD Response: Accept</p>

RESPONSE provided by the Secretary, Department of Education and Early Childhood Development – continued

6	<p>Develop and deliver a program to improve ICT skills across the science and mathematics teacher workforce to better support them to integrate ICT into the curriculum.</p> <p>DEECD Response: Accept</p> <p>Comment: Victoria is recognised as being a leading jurisdiction with respect to incorporation of ICT in school science and mathematics curriculum, pedagogy and assessment.</p> <p>The Department agrees that the teaching workforce requires further and ongoing development of professional capacity for active and effective use of ICT as a pedagogical tool, for curriculum delivery, for assessment, and with respect to teacher technical knowledge of ICT tools and functionality for working scientifically and working mathematically.</p>
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