

4. Trends in Enrolments in Mathematics and Science

Introduction

Enrolment trends in mathematics and particularly science were a key concern among stakeholders throughout the Committee's inquiry. Concerns were also raised that even where students do enrol and perform well in mathematics and science, they often later take up further education, training and employment in disciplines other than mathematics and/or science. The following chapter outlines trends in specific mathematics and science courses within the VCE and higher education, as well as some of the policy implications of these trends.

Enrolments in VCE Mathematics Subjects

In 2004, there were 46,600 enrolments in Victorian Certificate of Education (VCE) Unit 4 mathematics subjects, an overall increase of 15.3 per cent since 2000. Enrolments in Further Mathematics increased 28.3 per cent, while enrolments in Mathematical Methods and Specialist Mathematics increased 5.6 per cent and 5.5 per cent, respectively.

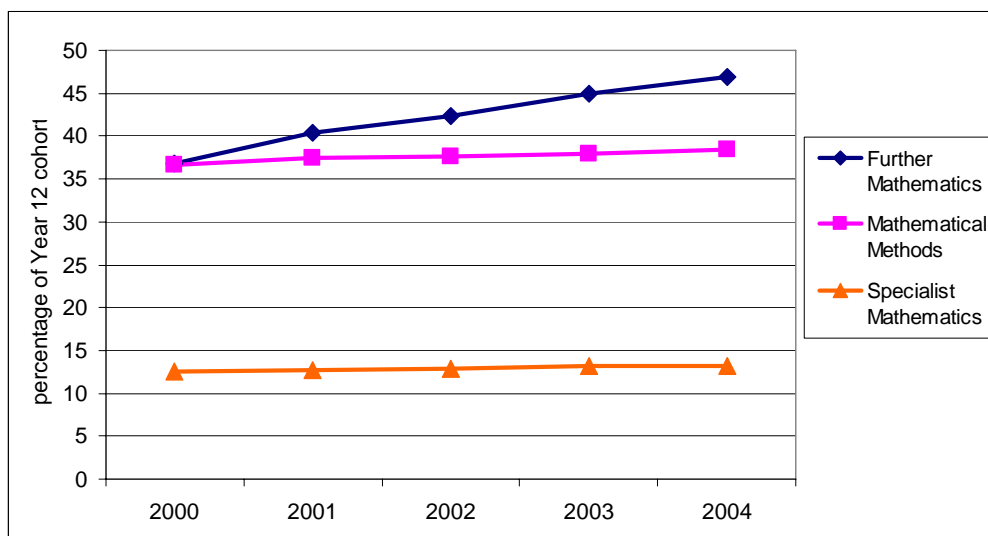
Figure 4.1 shows that there has also been an increase in the proportion of students undertaking Unit 4 VCE mathematics units.¹⁴⁹ It is important to note that substantial growth in Further Mathematics has not been at the expense of enrolments in either Mathematical Methods or Specialist Mathematics.

Compared to other Australian jurisdictions, Victorian levels of enrolment in mathematics are very positive. In 2004, 13.2 per cent of the Year 12 cohort were undertaking the most advanced mathematics subject, Specialist Mathematics. Comparable figures for other states were 10.7 per cent for South Australia, 8.4 per cent for Queensland, 8.2 per cent for Western Australia, 5.9 per cent for New South Wales and 5.3 per cent for the Northern Territory.¹⁵⁰ Refer to Chapter 3 for a summary of interstate mathematics subjects.

¹⁴⁹ In calculating the participation rates for mathematics and science enrolments, the Committee has used the number of Unit 4 English plus English as a Second Language enrolments as representative of the Year 12 cohort. This is the methodology recommended to the Committee by the Victorian Curriculum & Assessment Authority and data was supplied by the VCAA for this purpose.

¹⁵⁰ Supplementary material provided to the Committee by the Victorian Curriculum & Assessment Authority, October 2005.

Figure 4.1: Percentages of Year 12 Students Enrolling in VCE Unit 4 Mathematics (2000 to 2004)



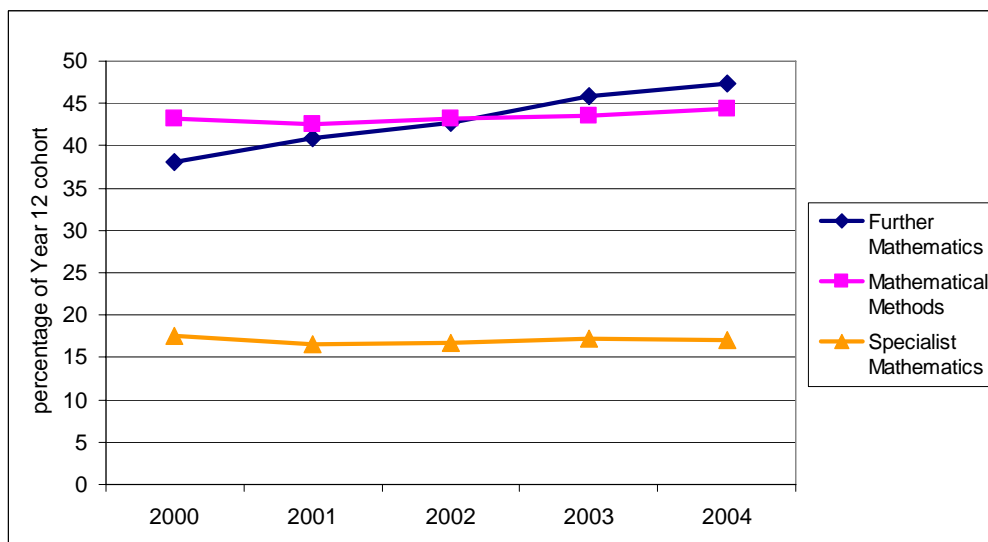
Note: Mathematical Methods includes Mathematical Methods (CAS) pilot for the years 2001 to 2004.

Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

Mathematics Enrolments by Gender

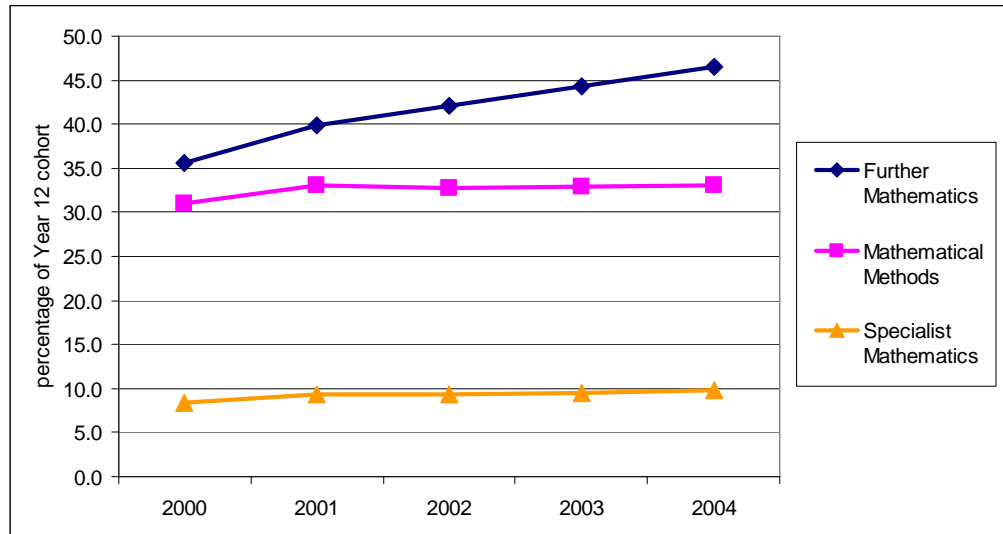
Figures 4.2 and 4.3 show trends in the proportion of male and female students enrolling in VCE mathematics over the period 2000 to 2004.

Figure 4.2: Percentages of Year 12 Students (Males) Enrolling in VCE Unit 4 Mathematics (2000 to 2004)



Note: Mathematical Methods includes Mathematical Methods (CAS) pilot for the years 2001 to 2004.

Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

Figure 4.3: Percentages of Year 12 Students (Females) Enrolling in VCE Unit 4 Mathematics (2000 to 2004)

Note: Mathematical Methods includes Mathematical Methods (CAS) pilot for the years 2001 to 2004.

Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

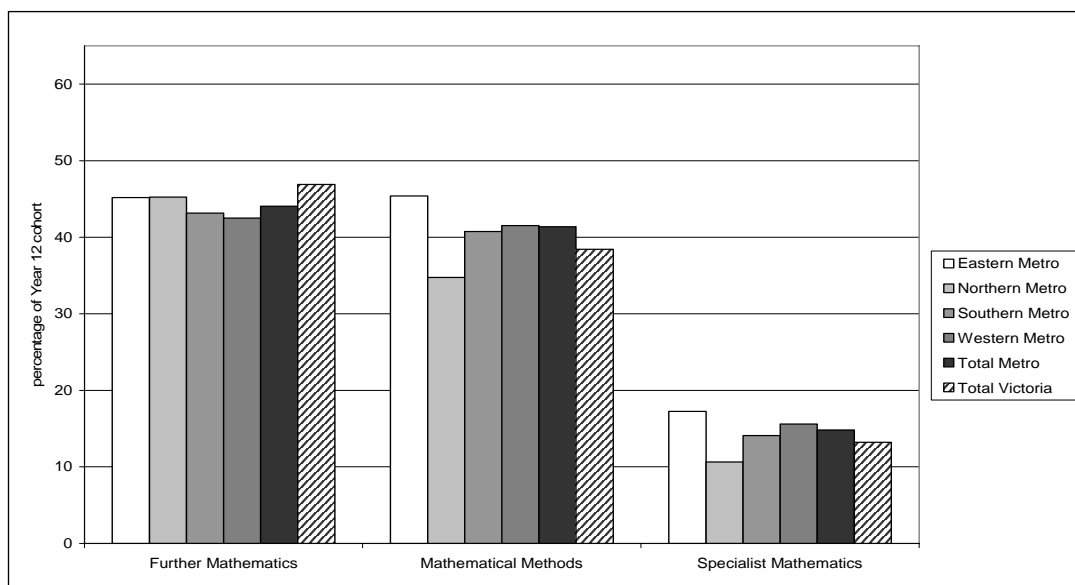
Both genders demonstrated strongest growth in Further Mathematics. Females demonstrated slightly stronger growth in all three VCE mathematics subjects compared to males, accounting for 54 per cent of growth in total enrolments in VCE mathematics over the period 2000 to 2004. Overall, female enrolments in mathematics increased by 17.8 per cent to 22,340 in 2004. Over the same period, male enrolments increased by 13.1 per cent to 24,254. Nonetheless, the proportion of females enrolled in Mathematical Methods and Specialist Mathematics remained substantially below that of male students.

Mathematics Enrolments by Region

Trends show that there is a greater tendency for metropolitan-based students to enrol in the more advanced mathematics subjects, compared with students in non-metropolitan regions. In 2004, metropolitan-based students were over-represented in Mathematical Methods and Specialist Mathematics and under-represented in Further Mathematics.

Figures 4.4 and 4.5 show the proportion of students in each Department of Education and Training region enrolling in the various mathematics subjects in 2004.

Figure 4.4: Percentages of Year 12 Students Enrolling in VCE Unit 4 Mathematics by Region (Metropolitan) (2004)[#]



Note: Mathematical Methods includes Mathematical Methods (CAS) pilot for the years 2001 to 2004.

Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

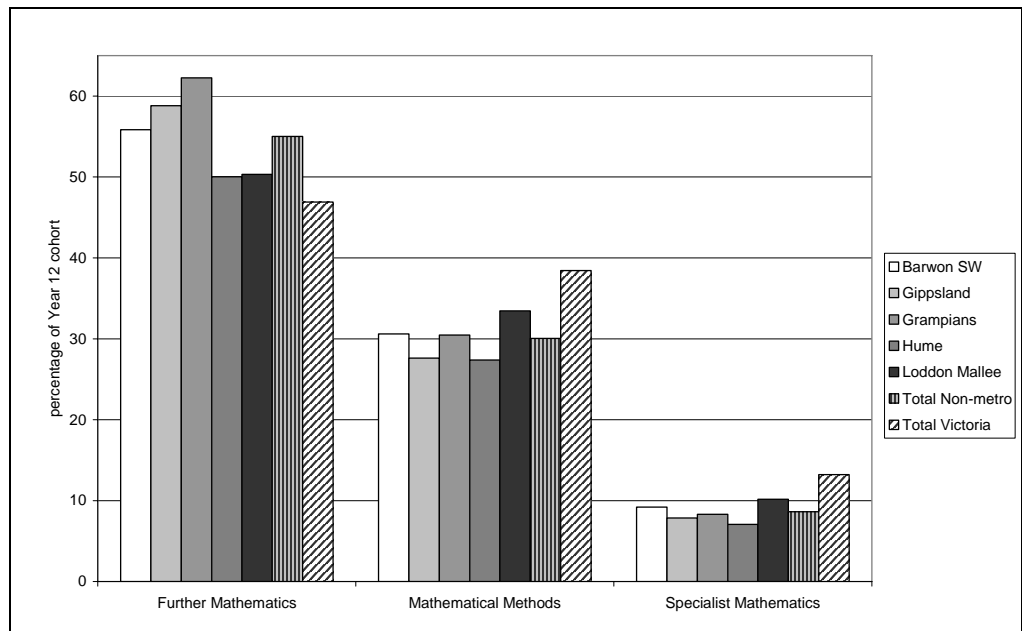
As shown in Figure 4.4, all four metropolitan regions had lower rates of enrolments in Further Mathematics than the average for Victoria in 2004. A comparison of enrolments among only the metropolitan regions, however, reveals that students from Eastern Metropolitan Region and Northern Metropolitan Region were over-represented in enrolments in Further Mathematics, while students in the other two regions were under-represented.

Significantly, students from Eastern Metropolitan Region were also over-represented in Mathematical Methods and Specialist Mathematics, while students in Northern Metropolitan Region were under-represented in these two subjects. This reveals a much stronger tendency for students in Eastern Metropolitan Region to undertake mathematics studies at all levels, compared with students in other regions. Students from Southern Metropolitan and Western Metropolitan Regions were also more likely to enrol in Mathematical Methods and Specialist Mathematics than the average for Victoria.

In comparison, students in the Northern Metropolitan Region are much less likely to enrol in mathematics subjects compared with the average for Victoria. Where they do undertake VCE level mathematics, they undertake the more advanced mathematics subjects at rates lower than the Victorian average.

[#] Please note that due to a printing error, Figure 4.4 in previous copies of this report was incorrect. The correct figure has been included in the web version, as of 18 March 2006.

Figure 4.5: Percentages of Year 12 Students Enrolling in VCE Unit 4 Mathematics by Region (Non-Metropolitan) (2004)



Note: Mathematical Methods includes Mathematical Methods (CAS) pilot for the years 2001 to 2004.

Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

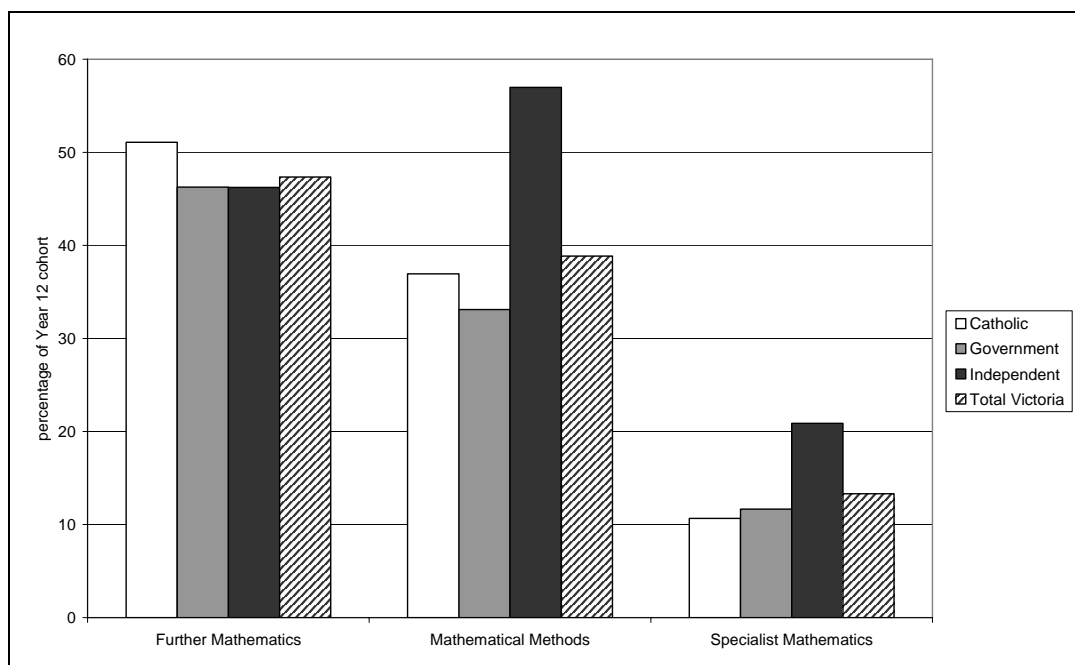
As shown in Figure 4.5, all five non-metropolitan regions had enrolments in Further Mathematics at rates above the average for Victoria in 2004 and enrolments in Mathematical Methods and Specialist Mathematics at rates below average for Victoria.

Barwon South Western Region had the highest number of VCE mathematics enrolments in 2004 and was slightly over-represented among non-metropolitan regions in all three mathematics subjects. In contrast, Hume Region was under-represented in all mathematics subjects compared to the non-metropolitan average. Loddon Mallee Region was over-represented among non-metropolitan regions in Mathematical Methods and Specialist Mathematics and under-represented in Further Mathematics.

Mathematics Enrolments by Sector

Student enrolment levels in mathematics also differ by school sector (refer to Figure 4.6).

Figure 4.6: Percentages of Year 12 Students Enrolling in VCE Unit 4 Mathematics by Sector (2004)



Note: Mathematical Methods includes Mathematical Methods (CAS) pilot for the years 2001 to 2004.

Source: Data supplied by the Victorian Curriculum and Assessment Authority, 2005.

As shown above, students in Catholic and government schools had enrolment levels in Mathematical Methods and Specialist Mathematics at rates below the average for Victoria in 2004. Students from the independent sector were substantially over-represented in these subjects. This trend is reflective of the socioeconomic profile of students in the independent sector, as discussed in Chapter 6.

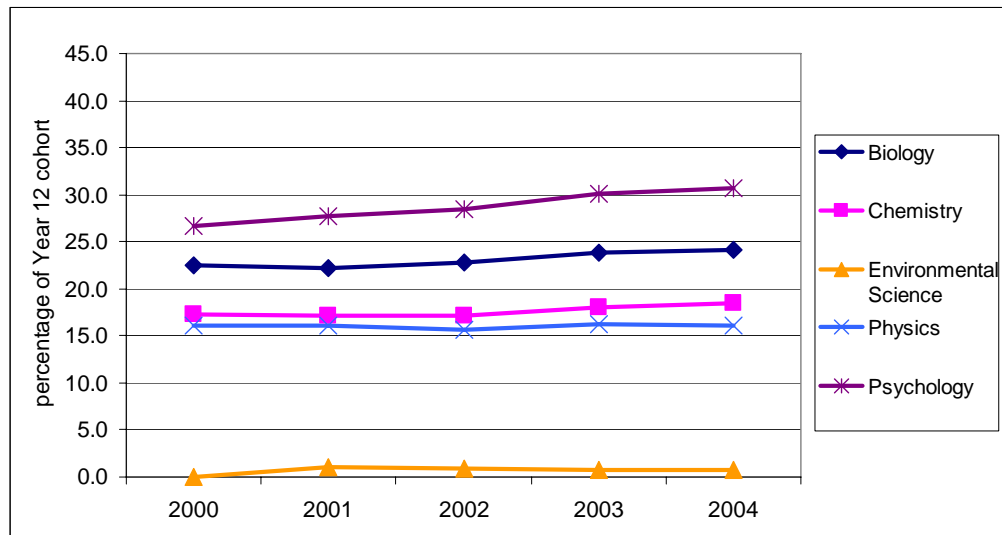
Government and independent school students were slightly under-represented in enrolments in Further Mathematics, while Catholic school students were over-represented in this subject.

Enrolments in VCE Science Subjects

In 2004, there were 42,600 enrolments in VCE Unit 4 science subjects. Growth in science enrolments between 2000 and 2004 was not as strong as mathematics, with enrolments increasing by only 9.9 per cent. Psychology experienced the greatest growth, up 16.0 per cent since 2000. Total enrolments in Physics remained steady (+0.2%) while Biology and Chemistry increased 8.0 per cent and 7.4 per cent, respectively.

Figure 4.7 shows trends in the proportion of Year 12 students undertaking science subjects over the period 2000 to 2004. It shows that Psychology had the greatest proportion of students enrolling, while Environmental Science was undertaken by only a very small proportion of total students (less than 1%).

Figure 4.7: Percentages of Year 12 Students Enrolling in VCE Unit 4 Science (2000 to 2004)



Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

The various states and territories offer a range of different science subjects at Year 12, although most states offer Biology, Chemistry and Physics as the core science subjects. Additional subjects offered by various states include Aerospace Studies, Contemporary Issues and Science, Earth Science, Engineering Studies, Environmental Science, Geology, Human Biological Sciences, Marine Studies and Psychology (refer to Chapter 3).

Enrolments in the range of science subjects vary considerably across states, even within the core science subjects. For example, while 22.6 per cent of the Victorian Year 12 cohort undertook Biology in 2004, the equivalent proportion was 21.7 per cent in New South Wales, 29.4 per cent in Queensland, and over 36 per cent in both South Australia and the Northern Territory. Year 12 enrolments in Chemistry varied from 10.9 per cent of the student population in South Australia to 23.2 per cent in the Northern Territory, while most states and territories had Year 12 enrolments in Physics of around 15–20 per cent.¹⁵¹

Australia's Teachers: Australia's Future reported on long-term national trends in Year 12 science enrolments. That study summarised the longer-term trend in science enrolments as follows:

In the sciences there has been a steady decline in the percentage of Year 12 students participating in biology, chemistry and physics that has been partly compensated by the emergence of participation in other science studies during the 1990s. Total Year 12 enrolments grew during the 1980s as a result of increases in school holding power. Consequently, when participation in biology, chemistry and physics is considered in relation to the full cohort (or as absolute numbers of students), the picture is one of a rise during the 1980s followed by a decline in 1990s. Although this decline is not dramatic there is also evidence of a decline in the numbers of students studying two or more science subjects.¹⁵²

As discussed below, participants in the inquiry were concerned about current enrolment levels of VCE science subjects in terms of their ability to meet the future needs of industry. Further, participants were concerned about varying levels of science enrolments among different student groups.

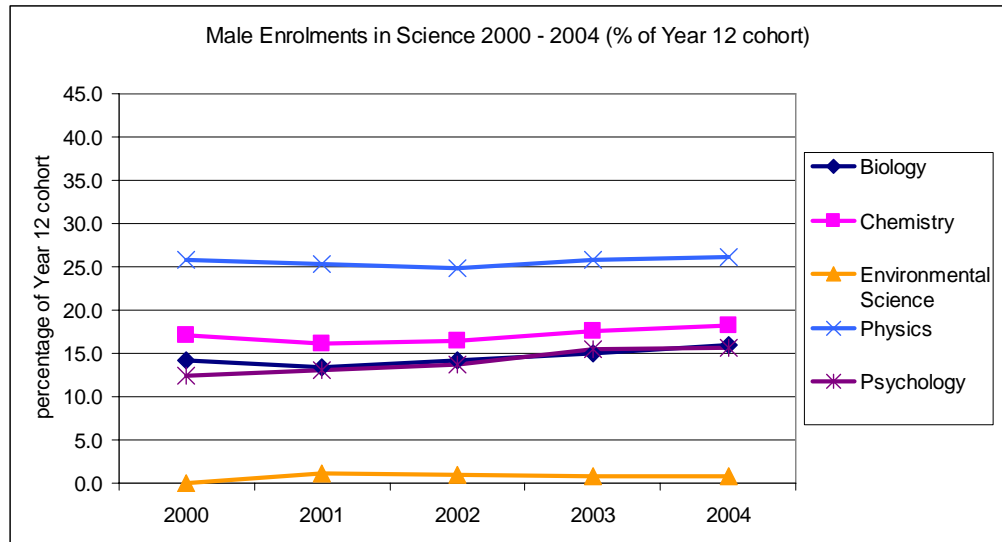
¹⁵¹ *ibid.*

¹⁵² Committee for the Review of Teaching & Teacher Education 2003, *Australia's Teachers: Australia's Future. Advancing Innovation, Science, Technology and Mathematics – Background Data and Analysis*, Commonwealth of Australia, Canberra, p.19.

Science Enrolments by Gender

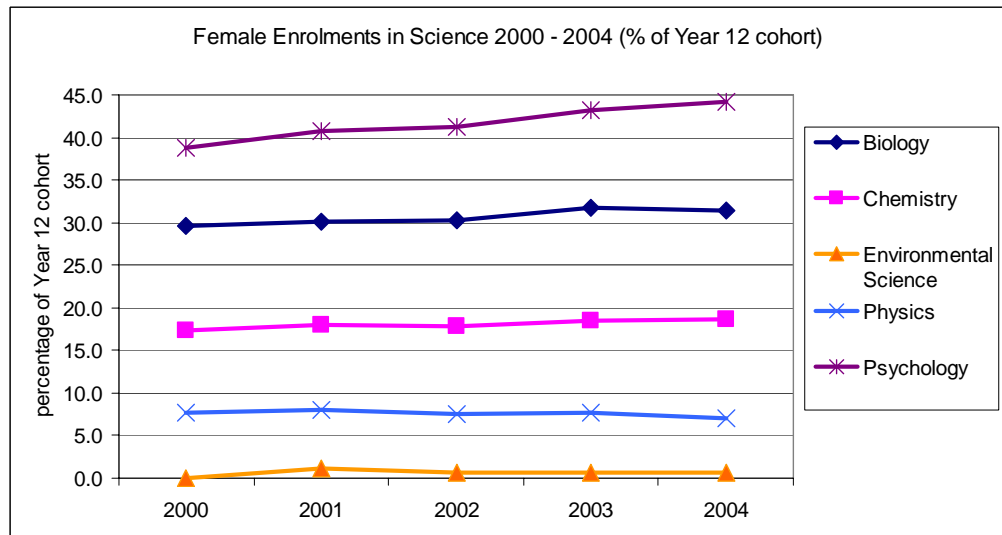
Figures 4.8 and 4.9 show significant differences in trends in the proportion of male and female students enrolling in VCE science over the period 2000 to 2004.

Figure 4.8: Percentages of Year 12 Students (Males) Enrolling in VCE Unit 4 Science (2000 to 2004)



Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

Figure 4.9: Percentages of Year 12 Students (Females) Enrolling in VCE Unit 4 Science (2000 to 2004)



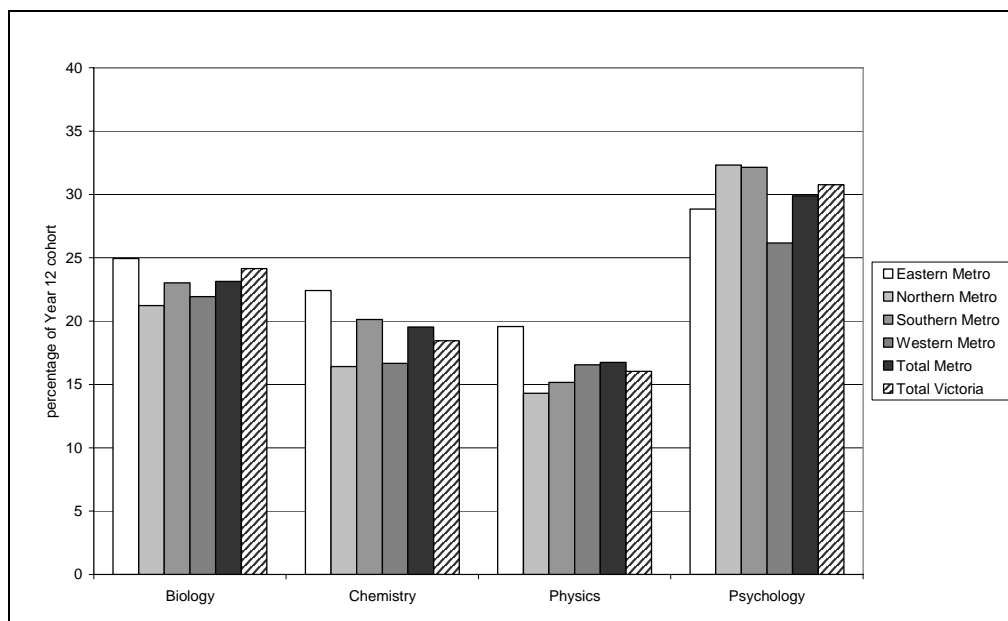
Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

Current enrolment trends in the enabling sciences were of significant concern to participants throughout this inquiry. Figure 4.8 shows that Physics enrolments for males have remained steady, with around one-quarter of males enrolling in this subject. Of concern, however, is the very low rate of female enrolments in Physics as well as the emergence of a downward trend in enrolments in this subject among females (refer Figure 4.9). Males and females enrol in Chemistry in similar proportions, while females enrol in Biology and Psychology at much higher proportions than males.

Science Enrolments by Region

Science enrolment trends among regions exhibit similar patterns as those seen in mathematics subjects. A greater proportion of metropolitan-based students undertake the enabling science subjects of Physics and Chemistry compared with the Victorian average. Conversely, a larger proportion of non-metropolitan students undertake Biology and Psychology (refer Figures 4.10 and 4.11).

Figure 4.10: Percentages of Year 12 Students Enrolling in VCE Unit 4 Science by Region (Metropolitan) (2004)



Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

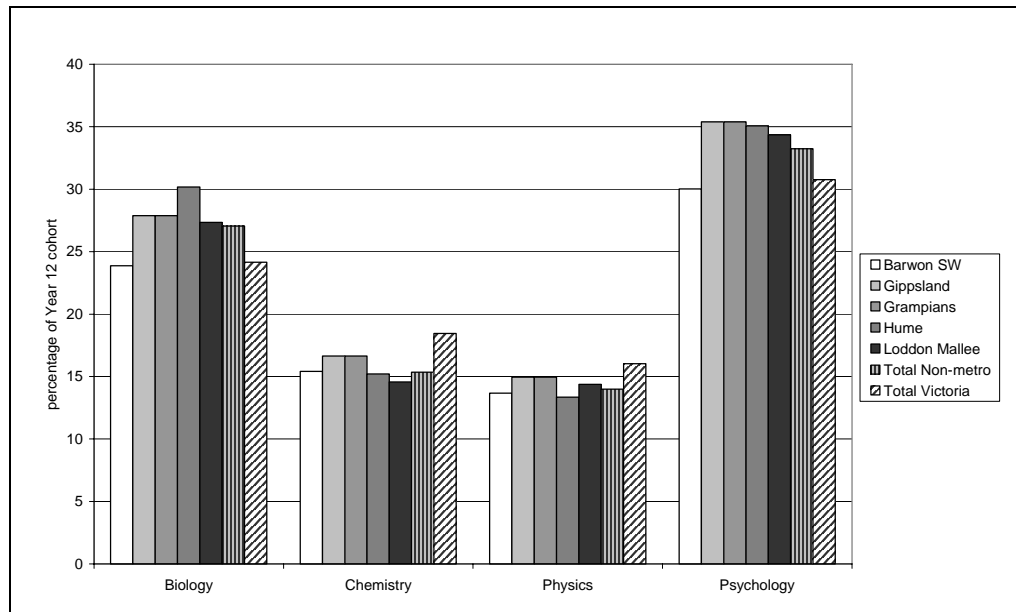
In 2004, the Eastern Metropolitan Region had enrolments in Biology, Chemistry and Physics at rates above average for both the metropolitan region and Victoria overall and was slightly under-represented in Psychology. Conversely, the Northern Metropolitan region was again under-represented in all science subjects, except Psychology, when compared with both the metropolitan and the Victorian averages.

The Western Metropolitan Region was under-represented in Biology, Chemistry and Psychology compared with the metropolitan and

Victorian averages. It was slightly under-represented in Physics compared to the metropolitan average, but slightly over-represented compared to the Victorian average.

Compared with the metropolitan average, the Southern Metropolitan Region was over-represented in Biology, Chemistry and Psychology, but under-represented in Physics.

Figure 4.11: Percentages of Year 12 Students Enrolling in VCE Unit 4 Science by Region (Non-Metropolitan) (2004)



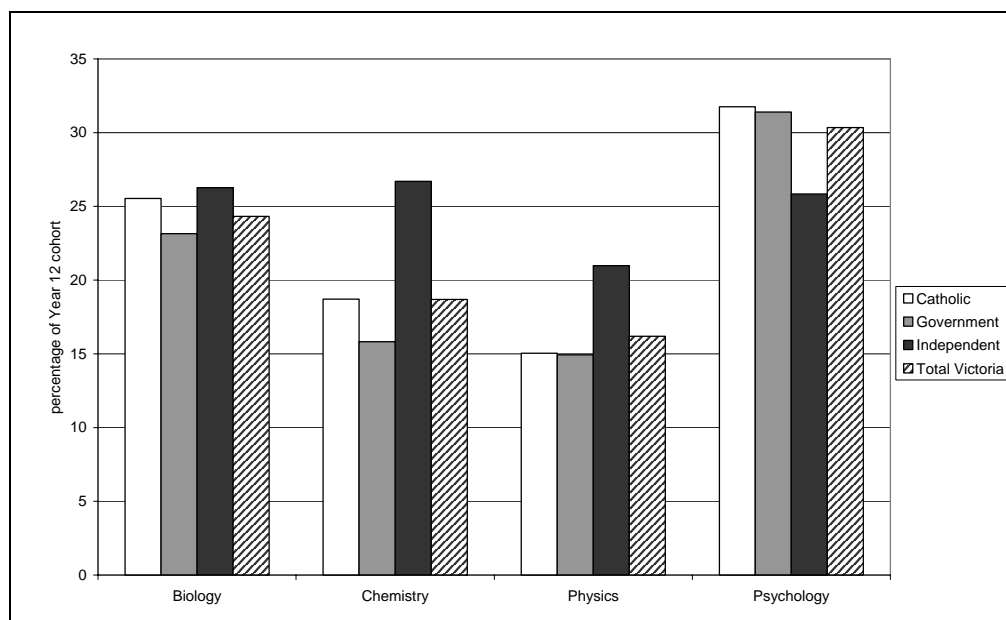
Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

Most non-metropolitan regions had enrolments in science subjects at, or close to, the average rate for non-metropolitan regions overall. In 2004, the notable variations to this pattern were Barwon South Western Region, which was under-represented in Biology and Psychology, and Hume which was over-represented in these subjects. The Grampians Region had the greatest proportion of students enrolling in Chemistry, Physics and Psychology among non-metropolitan regions, while its enrolment rate in Biology was also above both the non-metropolitan and Victorian average.

Science Enrolments by Sector

Again, enrolment rates in VCE science subjects vary considerably by sector (refer Figure 4.12).

Figure 4.12: Percentages of Year 12 Students Enrolling in VCE Unit 4 Science by Sector (2004)



Source: Data supplied by the Victorian Curriculum & Assessment Authority, 2005.

Students in the independent sector enrol in all of the science subjects, except Psychology, at rates above the average for Victoria. Enrolments in the enabling sciences are considerably higher for this sector.

Australia's Teachers: Australia's Future similarly reported that Australia-wide in 2001, participation in the three core sciences (biology, chemistry and physics) was higher in independent schools than in government schools by a factor of approximately 1.5.¹⁵³

Enrolment rates in the remaining two sectors are generally quite close (within 1–1½ percentage points) to the average for Victoria. The notable exception to this is enrolments in Chemistry within the government sector (15.8%, compared with 18.7% for Victoria).

¹⁵³ *ibid.*, p.11.

Mathematics and Science Enrolments in Higher Education

Science, engineering, mathematics and technology are integral to the knowledge and innovation economy and are of key interest to governments at all levels. Yet, without sufficient university graduates from these disciplines, governments will be unable to meet the knowledge and skill requirements of industry or the economy. Despite this, the Committee heard repeated concerns regarding the overall number of enrolments in mathematics and science related disciplines at university.

As shown in Figure 4.13, there were almost 12,750 award course completions in the Natural and Physical Sciences across Australia in 2003. There were a further 7,843 completions in Engineering and Related Technologies and 9,093 in Information Technology. Importantly, Victoria had the highest share of completions in these three broad fields of study (refer Appendix J for a comparison of course completions in other disciplines).

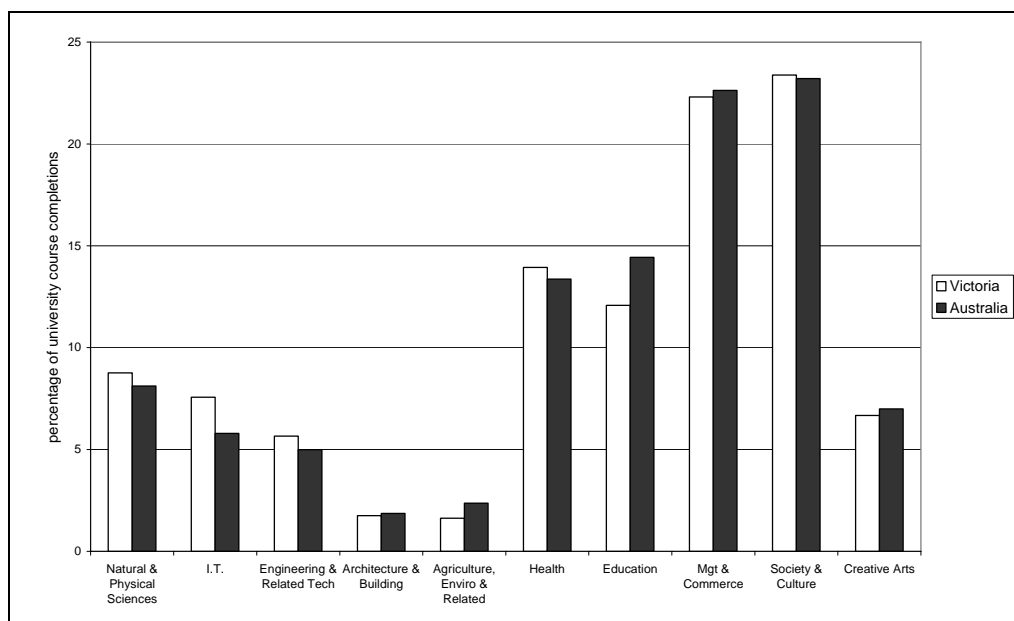
Figure 4.13: Award Course Completions for All Domestic Students by State and Broad Science Related Field of Education (2003)

State/Institution	Natural and Physical Sciences	State Share (%)	Information Technology	State Share (%)	Engineering and Related Technologies	State Share (%)
New South Wales	3,525	27.7	2,433	26.8	2,284	29.1
Victoria	3,616	28.4	3,126	34.4	2,333	29.7
Queensland	2,185	17.1	1,673	18.4	1,293	16.5
Western Australia	1,287	10.1	735	8.1	798	10.2
South Australia	1,073	8.4	430	4.7	578	7.4
Tasmania	334	2.6	226	2.5	315	4.0
Northern Territory	75	0.6	47	0.5	2	0.0
Australian Capital Territory	651	5.1	369	4.1	240	3.1
Multi-State (Australian Catholic University)	0	0.0	54	0.6	0	0.0
Total - Australia	12,746	100	9,093	100	7,843	100

Source: Adapted from Department of Education, Science & Training 2005, *Selected Higher Education Statistics Series*.

Figure 4.14 shows the proportion of Victorian university course completions accounted for by each broad field of study in 2003, compared to those for Australia overall. It shows that the proportion of course completions in the important science-related disciplines was greater in Victoria, than the average for Australia.

Figure 4.14: University Completions by Field of Study (%) (2003)



Source: Constructed by the Education and Training Committee using data from Department of Education, Science & Training 2005, *Selected Higher Education Statistics Series*.

Australia's Teachers: Australia's Future reported on nationwide university participation in the sciences and technology for the period 1990 to 2002. The key findings of this study were:

- Commencing enrolments in undergraduate courses in science-related fields varied over the period from 1990 to 2002. The overall pattern appears to have been that a post-1997 decline in commencements in the physical and natural sciences, and to a smaller extent in engineering, has been accompanied by a rise in information technology.¹⁵⁴
- Students who studied two physical sciences were more likely to proceed to university than students who studied any other combination of two science subjects and both groups were much more likely to continue to university study than those who did not study two science subjects.¹⁵⁵
- There is evidence of a fairly strong connection between specialising in science in the final year of secondary school and commencing science-related fields of education at university. Overall, 71 per cent of science specialists at Year 12 (any two science subjects) and 79 per cent of physical science specialists (two physical

¹⁵⁴ *ibid.*, p.33.

¹⁵⁵ *ibid.*, p.23.

science subjects) who enter university, study in a science-related field.¹⁵⁶

- Females provided a substantial majority of commencing enrolments in health but a substantial minority of enrolments in information technology and engineering. Females provided just a little more than half of the commencing enrolments in the natural and physical sciences and less than half in agriculture and architecture.¹⁵⁷
- Completion rates for veterinary science (almost 90%) and health (76% for nursing and 79% for other health) were substantially higher than those for arts, humanities and social science (58%), science (58%) and engineering (59%).¹⁵⁸

Many submissions and witnesses raised concerns about declining university enrolments in physics, chemistry, advanced mathematics, statistics and engineering, and/or about the ability of current levels of enrolments to meet the future needs of industry. Stakeholders raising such concerns included Science Industry Australia, Engineers Australia, Minerals Council of Australia (Victorian Division), BioMelbourne Network, Australian Institute of Physics, Victorian Institute for Chemical Sciences, Australian Council of Deans of Science and various higher education institutions.

What was not clear in the evidence, however, was the cause of declining or insufficient enrolments. Declining enrolments may be caused by a combination of factors, including:

- total levels of university funding and availability of government funded places;
- government and/or university mechanisms for allocating places among disciplines; and
- student demand for places within disciplines.

Student demand is influenced by levels of engagement and perceptions about future career paths in these disciplines, relative to those available in other areas. Student demand may also be influenced by student contribution charges. For post-2005 students, student contribution charges for units of study range from \$0–\$3,920 for

¹⁵⁶ *ibid.*, p.25.

¹⁵⁷ *ibid.*, p.21.

¹⁵⁸ *ibid.*, p.30.

national priority courses, and up to \$4,899 for Band 1 courses, \$6,979 for Band 2 courses and \$8,170 for Band 3 courses.¹⁵⁹

Much work has been undertaken by governments, industry, universities and many schools over recent years, to promote mathematics and science related studies and careers. Unfortunately, this work has not been matched by Commonwealth Government efforts to ensure qualified students interested in pursuing these disciplines can access a university place. The Committee notes that 2,000 university places nationwide were targeted towards mathematics, science and information and communications technology under *Backing Australia's Ability* in 2001, with Victoria being allocated 21.5 per cent of these places.¹⁶⁰ These nationwide places grew to around 5,470 in 2005 as students continued in their courses and will continue to be funded by the Commonwealth Government over the five years from 2006–2007.¹⁶¹ Nonetheless, these places have been allocated in the context of significant growth pressure over the past decade, as well as the elimination of marginally funded over-enrolled places from the system. This resulted in the number of domestic student commencements in Victoria dropping from around 63,300 in 2003 to 61,050 in 2004.¹⁶²

Policy Implications of Current Enrolment Trends

Current enrolment trends in Year 12 mathematics and particularly science were a key concern among stakeholders in this inquiry. Submissions and witnesses also noted that even where students do enrol and perform well in mathematics and science, they are often attracted or encouraged to take up studies and careers in other disciplines – for example, law, commerce, economics and business studies – rather than in areas such as engineering, mathematics and, to a lesser extent, science.¹⁶³ Further, despite some new university places being allocated by the Commonwealth Government, stakeholders continue to report that the overall number of university

¹⁵⁹ National priority courses are nursing and teaching. Band 1 courses include humanities, arts, behavioural science, social studies, foreign languages, visual and performing arts. Band 2 courses include accounting, commerce, administration, economics, maths, statistics, computing, built environment, health, engineering, science, surveying, agriculture. Band 3 courses include law, dentistry, medicine, veterinary science. Refer to the Department of Education, Science & Training *Going to Uni* website for more information, <<http://www.goingtouni.gov.au>>.

¹⁶⁰ Department of Education, Science & Training 2005, *Backing Australia's Ability: The Australian Government's Innovation Report 2004–05*, Commonwealth of Australia, Canberra, p.121.

¹⁶¹ Department of Education, Science & Training, 2004, *Backing Skills, Backing Australia's Ability* Fact Sheet, Commonwealth of Australia, Canberra.

¹⁶² Department of Education Science & Training 2003 and 2004, *Students: Selected Higher Education Statistics*, <http://www.dest.gov.au/sectors/higher_education/publications_resources/>, accessed on 12 January 2006.

¹⁶³ Written Submission, Engineers Australia, Victorian Division, August 2005, p.16.

places in the mathematics and science related disciplines remains insufficient to meet the needs of Victoria, its economy and its students.

It was suggested that current participation rates at secondary school and into further education and training need to be dramatically increased if Australia is to improve its innovation capacity and international competitiveness. Engineers Australia even suggested that a satisfactory target would be to have at least 50 per cent of students studying science, engineering, technology and mathematics subjects at Year 12.¹⁶⁴

Given the current and projected future skills shortage, the Committee supports the contention that education systems should set enrolment targets for certain disciplines, in schools and higher education institutions. The process of setting targets will allow governments to better identify current and future needs for education in the mathematics and science disciplines and to measure how well these needs are being met. The Committee is not, however, in a position to recommend appropriate enrolment targets, as this would require detailed economic modelling. The Committee also emphasises that in setting any future enrolment targets, governments must be mindful of the full range of valuable pathways being pursued by secondary school students. Governments should also consider potential additional resource requirements within the school and university sectors arising from any significant changes to current subject enrolment profiles.

The Committee also believes that the Commonwealth Government needs to take further action to ensure university funding and allocation of places is better targeted to meet the community's needs in mathematics and science related disciplines.

Recommendation 4.1: That the Victorian Government undertake an analysis of enrolment trends against forecast future workforce requirements and develop benchmark targets for Year 12 enrolments in the enabling science subjects (physics, chemistry and advanced mathematics).

Recommendation 4.2: That through the Ministerial Council on Education, Employment, Training and Youth Affairs, the Victorian Government work with the Commonwealth Government and other State and Territory Governments to ensure the funding and allocation of university places in mathematics and science related disciplines are sufficient to meet future industry and community needs.

¹⁶⁴ *ibid.*, p.18.

