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Participation in Science, Mathematics and Technology in Australian Education

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ABBREVIATIONS AND ACRONYMS

ABS	Australian Bureau of Statistics
ACDS	Australian Council of Deans of Science
ACE	Australian College of Educators (formerly Australian College of Education)
ACER	Australian Council for Educational Research
DEEWR	Department of Education, Employment and Workplace Relations
ENTER	Equivalent National Tertiary Entrance Rank
FASTS	Federation of Australian Science and Technology Societies
GCCA	Graduate Careers Council of Australia
GCA	Graduate Careers Australia
GDS	Graduate Destination Survey
HECS	Higher Education Contributions Scheme
HESC	Higher Education Statistics Collection
ICT	Information and Communication Technologies
IEA	International Association for the Evaluation of Educational Achievement
KLA	Key Learning Area
LOTE	Languages other than English
LSAY	Longitudinal Surveys of Australian Youth
MCEETYA	Ministerial Council on Education, Employment, Training and Youth Affairs
TIMSS	Third International Mathematics and Science Study/Trends in International Mathematics and Science Study
OECD	Organisation for Economic Cooperation and Development
PISA	Programme for International Student Assessment

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1
INTRODUCTION

1.1 Purpose

This report was commissioned to update and extend the *Background Data and Analysis* component of the report*, Australia's Teachers: Australia's Future – Advancing Innovation, Science, Technology and Mathematics* (Committee for the Review of Teaching and Teacher Education, 2003a) that informed the *Main Report* (Committee for the Review of Teaching and Teacher Education, 2003b). In the five years since the 2003 review, there have been developments in science, technology and mathematics education that have been impacted on by initiatives in policy and practice as well by changes in the context. So that changes in science, technology and mathematics education can be properly measured the measures of participation that are used in this report parallel those that were used in the 2003 report wherever that is possible.

Since the 2003 Review, new data have been published or become available, and these data have been used to compile this report. These data collections include the *Trends in International Mathematics and Science Study* for 2002/3, the *Programme for International Student Achievement* in 2003 and 2006, the *Longitudinal Surveys of Australian Youth* 2004–06, and the *National Assessment Program – Year 6 Science Literacy* conducted for the Performance Measurement and Reporting Taskforce.

In brief this report provides updated figures on: the performance of Australian school students in science and mathematics; participation in science, mathematics, and technology in the final year of secondary school; university participation in science and technology studies; and teachers, teaching and teacher education in science, technology and mathematics.

1.2 Context

For the past 20 years most OECD economies have witnessed an increased level of participation in senior secondary and university education but a declining percentage of students studying science, technology, engineering and mathematics [referred to by the acronym STEM] (OECD, 2006a). For example, in the United Kingdom the Roberts Review of 2002 arose from a concern over supply of scientists and engineers and its potential impact on future research and development (United Kingdom, 2002). The Roberts Review to the United Kingdom Treasury argued that there had been "falls in the numbers taking physics, mathematics, chemistry and engineering qualifications" and that this had the potential to limit research, development and innovation. In the United States there has been similar concern that there are too few students, teachers and practitioners in STEM to sustain the desired levels of scientific innovation (Kuenzi, Mathews & Mangan, 2006). The National Academy of Sciences produced an influential report that drew attention to the need to "enlarge the pre-collegiate pipeline" and "increase post-secondary degree attainment" in the sciences (NAS, 2006).

In 2005 the OECD Global Science Forum documented declines in the percentages of graduates in mathematics, physics and chemistry (OECD, 2006a). The Forum concluded that governments needed to take steps to make science and technology studies more attractive. OECD analysts presented the results of a study of enrolment numbers, of contributing factors, and of potential solutions. It noted that girls and minority students were under-represented in science and technology studies, young people held stereotyped visions of science and technology careers, curricula were rigid and outdated and that teachers in primary or secondary education lacked adequate science and technology training.

In Australia it has also been argued that there has been a general trend away from the study of science and mathematics in the senior years of secondary school in Australia (Federation of Australian Scientific and Technological Societies [FASTS], 2002). In particular, it appears that there had been a decline in the proportion of students studying physics, chemistry and advanced mathematics (Dobson & Calderon 1999; Harris, Jensz, & Baldwin, 2005; Barrington, 2006; Forgasz, 2006).

The *Review of Teaching and Teacher Education in Science, Technology and Mathematics* (Chaired by Professor Kwong Lee Dow) investigated the links between the uptake of science and technology studies and teaching in these fields in primary and secondary schools. Its report was entitled: *Australia's Teachers: Australia's Future – Advancing Innovation, Science, Technology and Mathematics. Main Report* (Committee for the Review of Teaching and Teacher Education, 2003b). The review provided both a picture of education in science-related disciplines and a basis for initiatives to boost participation and effectiveness.

1.3 Outline

The second chapter of this report reviews the evidence from international surveys regarding science and mathematics learning in Australian schools. This includes information about achievement in science and mathematics by Australian school students, students' interests in science learning, science and scientific issues and some other aspects of science and mathematics teaching. The third chapter focuses on trends over the period from 1976 to 2007 in participation in science, mathematics and technology by students in the final year of secondary school. It is based on bringing together official enrolment statistics from curriculum authorities and augmenting those perspectives with survey data based on individual student information. Chapter 4 examines trends in participation in science, technology, engineering and mathematics at university. It considers entry to, and graduation from, university studies in these areas. Chapter 5 focuses on teacher education through undergraduate and graduate-entry programs including an analysis of the characteristics of individuals in teacher education programs. Characteristics of the teaching workforce in science and mathematics are examined in Chapter 6. The final chapter provides an overview and interpretation of the long-term trends in participation in science-related studies at school and university.

2
SCIENCE AND MATHEMATICS LEARNING IN AUSTRALIAN SCHOOLS: PERSPECTIVES FROM INTERNATIONAL SURVEYS

2.1 Introduction

The experience of science and mathematics learning in primary and lower secondary school is relevant to a consideration of participation in science, technology, engineering and mathematics. Those experiences can establish the sense of competence that students have in the foundations of mathematics and science and can kindle their interest in science-related fields. In this section we review information about the performance in science and mathematics by Australian school students and about some aspects of science and mathematics teaching in school. Our review does not canvas the wide array of literature but focuses on surveys based on large representative samples of schools and students.

2.2 Performance in science and mathematics by Australian school students

2.2.1 Sources of information

Information about student's knowledge and understanding of mathematics and science can be derived from the Organisation for Economic Cooperation and Development (OECD) *Programme for International Student Achievement* (PISA), the *Trends in International Mathematics and Science Study* (TIMSS) conducted by the International Association for the Evaluation of Educational Achievement (IEA) and the *National Assessment Program Science Literacy Assessment* (NAP – SL) for Year 6 conducted by the MCEETYA Performance Measurement and Reporting Task Force. PISA provides information regarding the performance of 15-year-old school students (mostly in Year 10), TIMSS provides information about the performance of students in Year 4 and Year 8 and the NAP-SL provides information about students in Year 6.

PISA and TIMSS allow students' performances to be compared across countries, over time, among jurisdictions within Australia and between groups of students. PISA and TIMSS have much in common but they provide complementary information about student achievement. Both studies are based on carefully developed assessment frameworks that define what is assessed. They are tests that are sound reliable instruments that measure accurately what they were designed to measure. PISA asks how well 15-year-old students are able to apply understandings and skills in reading, mathematics and science to everyday situations. TIMSS, on the other hand, looks at how well Year 4 and Year 8 students have mastered the factual and procedural knowledge taught in school mathematics and science curricula. TIMSS begins with a detailed analysis of Year 4 and Year 8 mathematics and science curricula and then tests curriculum content common across participating countries. In practice the patterns among countries for TIMSS for Year 8 align fairly closely with the patterns of results for PISA (but a little more closely for science than for mathematics).

2.2.2 International comparisons of achievement

On the basis of the PISA results for 2006 it can be inferred that Australian 15-year-olds perform well (on average) in the application of mathematical and scientific understandings to everyday problems. Only three (Finland, Hong Kong-China and Canada) of the 57 countries that participated in PISA 2006 significantly outperformed Australia in Scientific Literacy, meaning that Australia ranked equal fourth (Thomson & De Bortoli, 2007: 63). The average score in scientific literacy for Australia was 527 (± 5) on the PISA scale (where the OECD mean is 500 with a standard deviation of 100). By comparison the average score for Finland was 564 and that for Canada was 534.

Within the overall science score there were some differences in patterns for the component knowledge domains. The mean score in "physical systems" for Australia indicated a relative weakness with achievement in that domain being 12 points lower than its overall science performance (this difference is statistically significant). The mean scores in "Earth and space systems" and "living systems" were not significantly different from Australia's mean score for overall science (Thomson & De Bortoli, 2007: 79). In addition, there was a difference of 26 points between the performance of males and females in Australia on the physical systems domain (compared with 16 points for "Earth and space systems" and no difference on the "living systems" domain). These patterns of differences between males and females in Australia are similar to the average for OECD countries although there is considerable variation among countries.

There were also some differences in patterns for the three scientific competencies scales. Australian students did relatively better on "identifying scientific issues" (recognising issues, searching for information and recognising key features of an investigation) and relatively less well on "explaining scientific phenomena" (this refers to describing and interpreting phenomena scientifically as well as predicting, interpreting and explaining those phenomena). Australian performance on the competency concerned with using scientific evidence was similar to its overall performance.

In Mathematical Literacy in 2006, eight (Chinese Taipei, Finland, Hong Kong, Korea, the Netherlands, Switzerland, Canada and Macao) of the 57 participating countries significantly outperformed Australia, meaning that Australia ranked equal ninth (Thomson & De Bortoli, 2007: 63). The average score in mathematical literacy for Australia was 520 (± 4) compared with 548 in Finland and 531 in the Netherlands. The change in the average mathematical literacy score (the scales are equated over time through common items) for Australia between 2003 (where the mean was 524 ± 4) and 2006 was not statistically significant. For 2003 where Mathematical Literacy was the major domain it was possible to consider the subscales of mathematical literacy. In that cycle Australian students did relatively a little better on the uncertainty subscale than on mathematical literacy overall and relatively a little less well on the quantity subscale than on mathematical literacy overall. Scores on the space and shape and change and relationships subscales were almost the same as the overall mathematical literacy scores.

PISA indicates that many students in Australia, as in other countries, complete the compulsory years of school with only minimal levels of mathematical and scientific literacy. PISA identifies a basic proficiency level in each of Science Literacy and Mathematical Literacy. Students performing below this baseline are judged by the OECD to be "at serious risk of not achieving at levels sufficient to allow them to adequately participate in the 21st century workforce and contribute as productive citizens". In each of Scientific Literacy and Mathematical Literacy, 13 per cent of Australian students were below this basic proficiency level.

In TIMSS Australian students perform less well on tests of mathematical and scientific knowledge. Among the 25 countries in TIMSS at Year 4 in 2002/03, Australia ranked equal 14th in mathematics and equal 8th in science. Countries significantly outperforming Australia in Year 4 mathematics included England, USA, the Netherlands, Singapore, Japan, the Russian Federation, Hungary and Cyprus. Countries significantly outperforming Australia in Year 4 Science included England, USA, Japan, Hong Kong and Singapore. Over the period from 1994 to 2002, achievement levels in Australia remained largely static while achievement levels in many other countries increased so that some countries which were below or equal to Australia a decade ago in school science achievement (eg, Hong Kong SAR, England) and school mathematics (eg, England, Hungary) now outrank us.

Among the 46 countries in TIMSS at Year 8, Australia ranked equal 10th in mathematics and equal 9th in science. Countries significantly outperforming Australia in either Year 8 mathematics or science included England, Belgium, Netherlands, Estonia and Hungary. And while Australian performance in Year 8 science improved since 1994, half the countries we outscored in Year 8 mathematics in 1994/5 improved to perform at the same level as Australia in 2002/03.

2.2.3 Comparisons of achievement among jurisdictions within Australia

PISA and TIMSS are part of the Australian National Assessment Program and the samples are designed so that estimates can be made of the performance of jurisdictions within Australia and specified groups of students. Table 2.1 contains mathematical and scientific literacy average scores from PISA for each jurisdiction over three cycles of PISA.

The design of PISA is such that mathematical literacy was the “major” domain (i.e. had a more extensive assessment) in 2003 and scientific literacy was the major domain in 2006. For that reason the examination of differences among jurisdictions is focussed on those years. However, because the data from the other cycles replicate the patterns from those years one can be rather more confident about the precision of the estimates than is suggested by the confidence intervals for one cycle alone.

From Table 2.1 it is evident that there are differences among jurisdictions. In Scientific Literacy in 2006 the range from the second lowest (Tasmania) to the second highest (Western Australia) jurisdictions is 36 points (this basis for examining the range does not include the two territories which are the most demographically different from the other jurisdictions). In Mathematical Literacy in 2006 the corresponding range is 29 points and also references Western Australia and Tasmania. In Scientific Literacy in 2006, the average performance of students in the ACT was significantly higher than that of all states other than WA. The average performance in WA was not statistically different from the average performances in SA and NSW but was higher than that for Queensland, Victoria, Tasmania and the Northern Territory. The score for New South Wales was higher than for Victoria (the difference is statistically significant) even though the age-year level distribution and other demographic characteristics are similar.

Table 2.1 PISA mathematical and scientific literacy scores by jurisdiction

		Mathematical Literacy			Scientific Literacy		
		2000	2003	2006	2000	2003	2006
New South Wales	Mean	540	526	523	532	530	535
	Confidence interval	±13	±8	±10	±14	±9	±9
Victoria	Mean	529	511	513	515	510	513
	Confidence interval	±16	±10	±8	±16	±10	±10
Queensland	Mean	525	520	519	523	519	522
	Confidence interval	±15	±14	±9	±13	±13	±8
South Australia	Mean	526	535	520	539	535	532
	Confidence interval	±17	±10	±8	±18	±8	±10
Western Australia	Mean	547	548	531	544	546	543
	Confidence interval	±13	±8	±13	±15	±8	±13
Tasmania	Mean	517	507	502	510	509	507
	Confidence interval	±19	±18	±7	±18	±19	±9
Northern Territory	Mean	502	496	481	490	495	490
	Confidence interval	±13	±10	±12	±15	±11	±13
Australian Capital Territory	Mean	548	548	539	553	553	549
	Confidence interval	±12	±7	±11	±12	±9	±10
Australia	Mean	533	524	520	528	525	527
	Confidence interval	±7	±4	±4	±7	±4	±5

Sources: Thomson & De Bortoli (2007); Thomson, Cresswell & De Bortoli (2004); Lokan, Greenwood & Cresswell (2001)

The relative performances of the states and territories in scientific literacy for 2006 were very similar to their relative performances in PISA 2000 and 2003. In mathematical literacy in 2006 the Australian Capital Territory outperformed all other states except Western Australia; these states performed similarly to each other. Western Australia performed significantly higher than Victoria, Tasmania and the Northern Territory but not statistically different from the remaining states. The Northern Territory's score was significantly lower than any of the other states.

2.2.4 Differences among other groups of students

Two of the largest differences among specified groups of Australian students concerned socioeconomic background and Indigenous status. The difference in the scientific literacy scores between students in the lowest and highest quarters of the distribution of socioeconomic background was 87 points (which is both significant and large). The corresponding difference in mathematical literacy was 78 points. On average Indigenous students had scientific literacy scores 88 points lower, and mathematical literacy scores 80 points lower, than that of non-Indigenous students.

There were differences in PISA 2006 associated with geographic location but the differences were predominantly between students in remote locations and those in either provincial or metropolitan locations. In scientific literacy, the average score of students attending schools in remote areas was significantly lower than that of students attending schools in either provincial areas (by 47 points) or metropolitan areas (by 57 points). The corresponding differences in mathematical literacy were 40 points for provincial locations and 58 points for metropolitan locations.

In 2006 there was a difference between students who mainly spoke English at home and those who mainly spoke a language other than English at home in scientific literacy but not in mathematical literacy. In scientific literacy the difference between students with a language background other than English and other students was 23 points. In addition there was a difference between males and females in mathematical literacy but not in scientific literacy (although males performed better than females in the physical systems domain). In contrast to the finding of no difference between males and females in PISA 2003, Australian males performed significantly better than females by 14 scale points in PISA 2006.

2.3 Students' interest in science learning, science and scientific issues

2.3.1 Attitudes to learning science

In PISA 2006 students completed a questionnaire that included questions about their interest in, enjoyment of, and motivation regarding learning science as well as their attitudes to, and beliefs about, science and the environment (see Thomson & De Bortoli, 2007: 109-146).

The relationship between student views of learning science to achievement in science show different patterns within countries than between average scores for countries. Within Australia (and within most countries) the constructs of general interest in learning science, enjoyment of science learning, the importance of doing well in science, future motivation to study or work in science, and instrumental motivation to learn science were all moderately correlated with science achievement (the correlation coefficients ranged from 0.3 to 0.4). Of course these associations do not establish causality but they do indicate that these attitudes and achievement go together. Students' self-beliefs about themselves as science learners, self-efficacy (confidence in tackling new science problems) and self concept (how readily they learn science), were a little more strongly related to achievement (the correlation coefficients were 0.49 and 0.43). Most of these attitudinal dimensions were positively associated with socioeconomic background (i.e. higher scores were recorded by those from more affluent backgrounds). Males recorded more favourable attitudes than females to enjoyment of science, instrumental motivation, future orientation to study or work in science, science self efficacy and science self concept. Females recorded more favourable attitudes to the importance of doing well in science and there was no difference between males and females in their general interest in science.

In contrast to the within country pattern, there appears to be no systematic relationship between average scores for countries on the attitude scales and achievement in scientific literacy. Some countries where achievement is high have low average scores on the attitude scales. Australian students scored lower than the OECD average on general interest in learning science, enjoyment of science learning, the importance of doing well in science, and future motivation to study or work in science. Australian scores were about the same as the OECD average on the importance of doing well in science and science self-concept but above the OECD average on instrumental motivation and science self-efficacy.

2.3.2 Attitudes to science and environmental issues

Patterns of support for scientific enquiry displayed a mixed pattern of relationships. Within Australia higher levels of achievement were associated with support for the general value of science (the correlation coefficient was 0.4) and support for the personal value of science (the correlation coefficient was 0.3). Males expressed stronger support than females for both these value beliefs. When average levels of support for scientific enquiry were compared across countries, Australian students expressed slightly less support for the general value of science, and about the same level of support for the personal value of scientific enquiry, than the OECD average.

Four aspects of responsibility towards environmental issues were assessed: responsibility for sustainable development, awareness of environmental issues, concern for the environment and optimism for the evolution of selected environmental issues. Within Australia, responsibility for sustainable development and awareness of environmental issues were positively associated with scientific literacy (the correlation coefficients were 0.3 and 0.5) and with socioeconomic background. Females expressed greater responsibility for sustainable development but males recorded a greater awareness of environmental issues. Concern for the environment was not related to scientific literacy and females recorded greater concern than males. Optimism about the way selected environmental issues would evolve was only weakly (and negatively) associated with scientific literacy and was higher among males than females. When countries were compared Australian students recorded higher levels of awareness of environmental issues but lower levels of responsibility for sustainable development, concern for the environment and optimism about the ways in which various environmental issues would evolve.

2.4 Other aspects of science and mathematics in schools

2.4.1 Instructional time

National and international surveys provide perspectives on aspects of the teaching of science including the time spent teaching science and the ways in which science is taught.

Data from TIMSS in 1994 indicated that at that time in Year 4 a median of 60 minutes per week (5% of a teaching week) was allocated to the teaching of science and 300 minutes per week (20% of a teaching week) to the teaching of mathematics (Lokan, Ford & Greenwood, 1997: 213-214). Corresponding data from TIMSS in 2002 indicate that Australian Year 4 students spent an average of five per cent of their instructional time on learning science (Thomson & Fleming, 2004a: 85) with that time mostly in life science (40%) followed by earth science (30%) and physical science (20%). Thomson and Fleming (2004a) observe that this is one of the lowest allocations to science among TIMSS countries. The corresponding figure for mathematics in TIMSS 2002 was 20 per cent of the teaching week mostly concerned with number (40%), followed by patterns and relationships (18%), measurement (17%), geometry (12%) and data (11%).

Angus, Olney and Ainley (2007) conducted a detailed study of a national sample of 160 primary schools based on surveys completed by principals and a sample of teachers (349 teachers participated), a class log of activities completed by each teacher over a nominated week (in May for half the schools and in July or August for the other half), analysis of system-level data and visits to each of the participating schools that included checking the survey data and interviewing the principal and selected teachers. Class logs were used to compute the instructional time for each Key Learning Area over groups of Year levels. Over the full range of primary school science occupied 45 minutes per week (or three per cent of an average week of 1486 minutes) and mathematics occupied 263 minutes or 18 per cent of the week (Angus, Olney & Ainley, 2007: 17). More than one quarter of the teachers considered that the time allocated to science was not sufficient. Across the three studies there is a consistent picture of one fifth of the teaching time in middle primary school being allocated to mathematics and one twentieth being allocated to the teaching of science.

TIMSS also provides information about teaching time in Year 8. In 1994 the average time allocated to mathematics was 212 minutes per week and for science the figure was 194 minutes per week. These figures correspond to 14 per cent and 12 per cent respectively of the instructional time (Lokan, Ford & Greenwood, 1996: 198-199). Data from TIMSS 2002 indicate that by then there was an average of 208 minutes per week of mathematics teaching and an average of 192 minutes per week of science teaching. Both these percentages for 2002 were similar to the percentages in countries such as New Zealand, the United States and Singapore (Thomson & Fleming, 2004a, 2004b). Of the mathematics time 23 per cent was focussed on algebra, 18 per cent on geometry, 16 per cent on measurement and 14 per cent on data. The science time was divided between life sciences (26%), chemistry (23%), physics (21%), earth science (16%) and environmental science (11%). However, as shown in Table 2.2, the instructional time for science in Year 8 varied across jurisdictions to a greater extent (the range was 51 minutes per week) than the instructional time for mathematics (the range was 36 minutes per week).

The largest amount of time allocated per week in science was in Western Australia and the least was in Victoria. There is a strong association between the average amount of instructional time for science and the average PISA science literacy score for each jurisdiction[1].

Table 2.2 Instructional time for mathematics and science in Year 8 by jurisdiction: 2002

	Time (minutes per week)	
	Year 8 Mathematics	Year 8 Science
New South Wales	199	211
Victoria	215	165
Queensland	199	182
South Australia	216	206
Western Australia	233	216
Tasmania	197	172
Australia (including NT and ACT)	208	192

Source: TIMSS 2002 Database (Thomson & Fleming, 2004a, 2004b)
Note: Data for the Australian Capital Territory and the Northern Territory have not been shown separately because of the small number of classes/schools sampled in those jurisdictions.

[1] There is also an association between instructional time and TIMSS Year 8 science scores after adjusting for differences in the age of students in Year 8 (Ainley & Thomson, 2007).

2.4.2 Approaches to teaching

In 1999, a Video Study of Year 8 mathematics and science teaching practices was conducted in selected countries: Australia, the Czech Republic, Hong Kong SAR, Japan, the Netherlands, Switzerland and the United States. A nationally representative sample of 87 schools was studied in Australia with one randomly selected Year 8 lesson in each of mathematics and science being recorded by two cameras (one focussing on the teacher and the other on the class) (Hollingsworth, Lokan & McCrae, 2003; Lokan, Hollingsworth & Hackling, 2006).

Some key features evident in the Australian science lessons were that teachers were well-qualified and familiar with current ideas in science teaching and learning; 90 per cent of the lessons took place in science laboratories; new content was introduced and discussed in almost all lessons; the lessons were well-structured (Australia and Japan had strong conceptual links in the material); the science instruction predominantly featured an inquiry, inductive approach and practical activities were featured in 90 per cent of the lessons; and real-life issues with first-hand data were used to support the development of ideas in the majority of lessons (Lokan, Hollingsworth & Hackling, 2006).

The corresponding video study of mathematics lessons suggested that teachers may underestimate the ability of Year 8 students and not challenge them enough in class. A typical Australian lesson began with a review of previously learned content (an average of 36 per cent of lesson time), followed by the introduction of new content (30 per cent of lesson time), and the practising of this new content (26 per cent of lesson time) (Hollingsworth, Lokan & McCrae, 2003).

Australian Year 8 mathematics lessons appeared to have a significantly higher percentage of problems that students worked on for a very short time (less than 45 seconds) than was the case in higher-performing countries. More than three-quarters of problems set for Australian students were repetitions of one or more problems they had done earlier in the lesson, and a similar proportion could be solved in four or fewer small steps. Australian teachers rarely made explicit the mathematical relationships and connections involved in problems and were generally satisfied with students giving answers only, or simply stating the procedures used to solve the problems.

There were indications also that the curricular level of the Australian Year 8 mathematics lessons, particularly the algebra content, was lower than in most of the other six countries that took part in the study. It concluded that Australian students would benefit from more exposure to less repetitive, higher-level problems, more discussion of alternative solutions and the mathematical reasoning involved in the solutions, and more opportunity to explain their thinking.

2.5 Summary

Evidence from international surveys indicates that Australian students perform comparatively well in mathematics and science with some indications that they perform a little less well in the area of physical systems than in other aspects of science. There are indications from these studies that Australian secondary school students are not as interested in learning science or as favourably disposed to scientific enquiry or its application to environmental issues as their counterparts in other countries. Science lessons in junior secondary school in Australia feature an inquiry, inductive approach with practical activities, and they focus on real-life issues with first-hand data, to a greater extent than science lessons in other countries. Compared to other countries mathematics lessons tend to feature greater use of repetitive short problems and give less emphasis to higher-level problems with discussion of alternative solutions and mathematical reasoning. There is substantial variation among jurisdictions in the amount of instructional time for science in Year 8 and some variation in the time for mathematics.

3
YEAR 12 PARTICIPATION IN SCIENCE, MATHEMATICS AND TECHNOLOGY

3.1 Introduction

In Australia, students in Year 12 typically study five (47% of students) or six (38% of students) subjects depending on the State or Territory in which they attend school (Fullarton et al, 2003). This chapter focuses on the extent to which students study subjects from science, mathematics or technology in those five or six subjects and whether the uptake of science, mathematics and technology subjects has changed over time. The account builds on a previous analysis that followed changes in the uptake of science, mathematics or technology subjects from 1976 to 2001.

3.2 Indicators of participation in science, mathematics and technology

3.2.1 Types of indicators

In examining trends in participation in mathematics, science and technology by senior secondary school students there is an issue of which indicators should be used and whether the index applies to individuals or groups of students. Most of this chapter focuses on participation by the full cohort of Year 12 students throughout Australia but some sections refer to groups of students within that population and one section considers factors associated with science participation at the individual level. There are three indicators that are commonly used in studies of participation.

3.2.2 Enrolments

The simplest index is the number of students enrolled in each subject. However, trends in the numbers of enrolments in subjects reflect changes not only in the propensity of students to enrol in science but fluctuations in the size of the Year 12 cohort.

3.2.3 Subject participation rates

The index that is most commonly used to monitor the uptake of each subject by Year 12 students is the percentage of Year 12 students enrolled in that subject. This is calculated as the number of students enrolled in a specified subject divided by the total number of students in Year 12[2]. Values for subject participation rates can have a maximum value of 100 per cent. For example, English participation rates are around 90 per cent and for mathematics participation rates are above 80 per cent. In 2007 25 per cent of Year 12 students studied biology, 18 per cent studied chemistry and 15 per cent studied physics. This index has the advantage of being tangible, readily understood and able to be followed over time.

It is also possible in principle to use an index of similar form that refers to the percentage of students that include at least one science subject (or by analogy one subject from any other specified area) in their Year 12 program. In 2007, 55 per cent of students included at least one science subject in their course. It is more difficult to use this type of index

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2 In calculating participation rates the total Year 12 enrolment recorded by the Australian Bureau of Statistics in Schools Australia (Cat. No. 4221.0) has been used as the denominator.

because its computation requires student-based data that record for each student the set of subjects that they study. Reliable data of this form are not readily available for previous times.

3.2.4 Enrolment indices

Enrolment indices provide an indication of the level of enrolments in an area (such as a Key Learning Area) for a group of students. It is defined as the sum of the equivalent full-year enrolments in a given subject area divided by the total number of equivalent full-year enrolments in all areas. Hence the sum of the values of the enrolment index over all subject areas is 100 per cent. Given that students typically study five or six subjects, values for enrolment indices rarely exceed 25 per cent. In 2006 the value of the enrolment index for English was 20 per cent (although approximately 90 per cent of students studied English). Enrolment indices are flexible in that different subjects can be included in the index for an area depending on the curriculum structure in a jurisdiction. However, they are less clearly understood, less easy to interpret and can mask shifts within an area (such as a rise in psychology and a decline in chemistry within the science area compensating each other).

3.3 Participation in science subjects

3.3.1 Nomenclature and data

One of the issues in analysing trends in participation in science subjects concerns the nomenclature used to label the subjects studied by students. Subject labels differ between jurisdictions even though the course content (and even the textbooks that are used) can be the same (e.g. Biological Science in Queensland was essentially the same as the subject called Biology in other States or Territories). Within a given jurisdiction subject labels can change over time even though there might be minimal changes in content (e.g. in 2007 the name Biological Science was changed to Biology). Sometimes the same label can be used to describe subjects with rather different content. For the purpose of the analyses in this report the term subject title is used to cover the various subject labels deemed to be equivalent.

- Biology is taken to include Biology, Biological Science, Advanced Biology, Web of Life and Human Biology.
- Chemistry includes Chemistry and Advanced Chemistry (which existed for a limited period in the early 1990s).
- Physics includes Physics, Physics A, Physics B, Physics Pilot and Physics (electronics).
- Psychology included Psychology, Social Psychology, Behavioural Science and Behavioural Studies.
- Geology includes Geology, Earth Science, Earth and Environmental Science and Advanced Geology
- Other sciences includes a range of broader science subjects such as General Science, Multistrand Science, Senior Science and Physical Science as well as more specialised studies such as Marine Science.

Data concerning participation in science subjects in Year 12 over the period from 1976 to 2006 are recorded in Tables 3.1 (1991 to 2006) and 3.2 (1976 to 1990) [3]. The focus of the discussion in this report is on the period from 1991 to 2006 for which consistent data are available from the Department of Education, Employment and Workplace Relations (DEEWR) database compiled from State and Territory assessment and accreditation agencies.

3.3.2 Enrolments in Year 12 science subjects

Figure 3.1 displays the national enrolments in Year 12 science subjects from 1976 to 2007. These enrolments indicate a growth in numbers studying science subjects from 1976 up to 1992 but with a dip in biology enrolments in the mid 1980s. This growth in numbers studying senior science grew at the same time as the numbers of students enrolled in Year 12 increased but at a slower rate. The changes in enrolments since the peak of 1992 should be considered in the context of an average Year 12 cohort size of approximately 186,000 (ranging from 170,000 to 198,000).

For biology, chemistry and physics there were sharp declines over the period 1991 to 1995 (the enrolments in 1992 were the highest recorded) followed by smaller changes from 1996 to 2007. In the case of biology the maximum was 67,833 in 1992 and the minimum was 47,770 in 2002 (a drop of 20,063 or 42%). Those enrolments then rose to approximately 49,000 in 2006 and 2007.

In chemistry the maximum was 43,594 in 1992 and the minimum was 33,105 in 2002 (a drop of 10,489 or 24%). Those enrolments then rose to just over 35,700 in 2005 and remained at that level through 2006 and 2007. In physics there was a fall in enrolments from 1992 to 1995 after which they remained almost relatively constant at approximately 31,000 through to 2004 before falling again in to just under 29,000 in 2007. In 1992 physics enrolments were 39,690 and by 2006 they had declined to 28,730 which was a drop of 10,959 (or 28%).

Psychology enrolments began with just 1,210 students in 1990 (these are included in other sciences in Table 3.2) but jumped to 9,462 students in 1992 and thereafter grew steadily to 18,124 in 2006 (but fell to 16,858 in 2007). Geology and earth science enrolments remained at around or below 2,000 enrolments through the whole period since 1991 (although they had been higher than this in the early 1980s) but fell sharply to 1,684 in 2007.

[3] Data for the period 1990 to 2007 were provided by DEEWR as based on information provided from the assessment, curriculum and accreditation authorities in each jurisdiction. Data published by Dekkers, de Laeter and Malone (1991) were used as the source for the period from 1976 to 1989.

Table 3.1 Year 12 science participation in Australian schools: 1991 to 2007

	Year																
Science subject title	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Numbers of students enrolled																	
Biology	65852	67833	63230	54872	51498	51032	49932	49677	50339	50675	47744	47770	48532	48774	48807	49245	48964
Chemistry	42645	43594	41372	36894	35711	35466	35821	34225	34259	35130	33554	33105	34074	35230	35734	35490	35697
Physics	38260	39690	36749	31890	30673	31128	31532	30490	30622	30805	31016	30552	31141	31588	29506	28730	28931
Psychology	1731	9462	11147	11257	11794	11922	12941	13001	13446	13828	14670	15037	15824	16386	16982	18124	16858
Geology/ earth science	2350	2460	2078	1607	1257	1134	975	960	982	924	1888	1809	1865	1956	2070	1883	1684
Other sciences	14088	18292	19060	17176	16217	15976	15965	14973	14694	15240	14713	14650	14617	13823	13421	13532	16386
Percentage of Year 12 students																	
Biology	35.9	35.2	33.8	30.5	29.9	30.0	28.9	28.0	27.6	27.3	25.4	24.7	25.1	25.2	25.1	25.1	24.7
Chemistry	23.3	22.6	22.1	20.5	20.7	20.8	20.7	19.3	18.8	18.9	17.8	17.1	17.6	18.2	18.4	18.1	18.0
Physics	20.9	20.6	19.7	17.7	17.8	18.3	18.2	17.2	16.8	16.6	16.5	15.8	16.1	16.3	15.2	14.6	14.6
Psychology	0.9	4.9	6.0	6.3	6.8	7.0	7.5	7.3	7.4	7.4	7.8	7.8	8.2	8.5	8.7	9.2	8.5
Geology / earth science	1.3	1.3	1.1	0.9	0.7	0.7	0.6	0.5	0.5	0.5	1.0	0.9	1.0	1.0	1.1	1.0	0.8
Other sciences	7.7	9.5	10.2	9.5	9.4	9.4	9.2	8.4	8.1	8.2	7.8	7.6	7.5	7.2	6.9	6.9	8.3
Percentage of original Year 8 cohort																	
Biology	25.6	27.2	25.9	22.8	21.6	21.4	20.7	20.1	19.9	19.7	18.6	18.5	18.9	19.1	18.9	18.7	18.4
Chemistry	16.6	17.5	17.0	15.3	15.0	14.9	14.9	13.8	13.6	13.7	13.1	12.8	13.3	13.8	13.9	13.5	13.4
Physics	14.9	15.9	15.1	13.2	12.8	13.0	13.1	12.3	12.1	12.0	12.1	11.8	12.1	12.4	11.4	10.9	10.8
Psychology	0.7	3.8	4.6	4.7	4.9	5.0	5.4	5.3	5.3	5.4	5.7	5.8	6.2	6.4	6.6	6.9	6.3
Geology / earth science	0.9	1.0	0.9	0.7	0.5	0.5	0.4	0.4	0.4	0.4	0.7	0.7	0.7	0.8	0.8	0.7	0.6
Other sciences	5.5	7.3	7.8	7.1	6.8	6.7	6.6	6.0	5.8	5.9	5.7	5.7	5.7	5.4	5.2	5.1	6.1

Sources: *DEEWR Statistical Collection as provided by State Accreditation, Curriculum, Assessment and Certification authorities.*
ABS: Schools Australia Series, Catalogue number 6221.0

Table 3.2 Year 12 science participation in Australian schools: 1976 to 1990

Science subject title	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Numbers of students enrolled															
Biology	47733	49722	51258	51034	48865	46537	45214	47687	51450	52408	54367	57318	65647	62197	61481
Chemistry	24739	26675	28111	29274	29395	28103	29297	31707	31941	33930	34297	36124	39756	40029	37729
Physics	23779	24693	25703	26249	25695	24519	25550	27722	28318	29018	29379	30884	34203	35142	33537
Geology/ earth science	4124	4561	4508	4212	3953	3856	3526	6804	3461	3128	2960	2939	2487	2652	2403
Other Sciences	-	-	-	114	1481	4310	4545	6101	7359	8177	9 038	9 828	10768	13484	13920
Percentage of Year 12 students															
Biology	55.3	57.5	56.4	56.5	54.8	52.7	50.4	48.3	46.6	45.1	42.4	40.3	40.7	37.1	36.3
Chemistry	28.6	30.8	30.9	32.4	33.0	31.8	32.7	32.1	28.9	29.2	26.8	25.4	24.6	23.8	22.3
Physics	27.5	28.5	28.3	29.0	28.9	27.8	28.5	28.1	25.6	24.9	22.9	21.7	21.2	20.9	19.8
Geology / earth science	4.8	5.3	5.0	4.6	4.4	4.4	3.9	6.9	3.1	2.7	2.3	2.1	1.5	1.6	1.4
Other Sciences	0.0	0.0	0.0	0.1	1.7	4.9	5.1	6.2	6.7	7.0	7.0	6.1	6.7	8.0	8.2
Percentage of original Year 8 cohort															
Biology	19.3	20.3	19.8	19.6	18.9	18.3	18.3	19.6	21.0	20.9	20.6	21.4	23.4	22.4	23.2
Chemistry	10.0	10.9	10.8	11.2	11.4	11.1	11.9	13.0	13.0	13.5	13.1	13.5	14.2	14.4	14.3
Physics	9.6	10.1	9.9	10.1	10.0	9.7	10.3	11.4	11.5	11.6	11.2	11.5	12.2	12.6	12.7
Geology / earth science	1.7	1.9	1.8	1.6	1.5	1.5	1.4	2.8	1.4	1.3	1.1	1.1	0.9	1.0	0.9
Other Sciences	0.0	0.0	0.0	0.0	0.6	1.7	1.9	2.5	3.0	3.2	3.4	3.2	3.9	4.8	5.2

Source: Dekkers, de Laeter and Malone (1991)

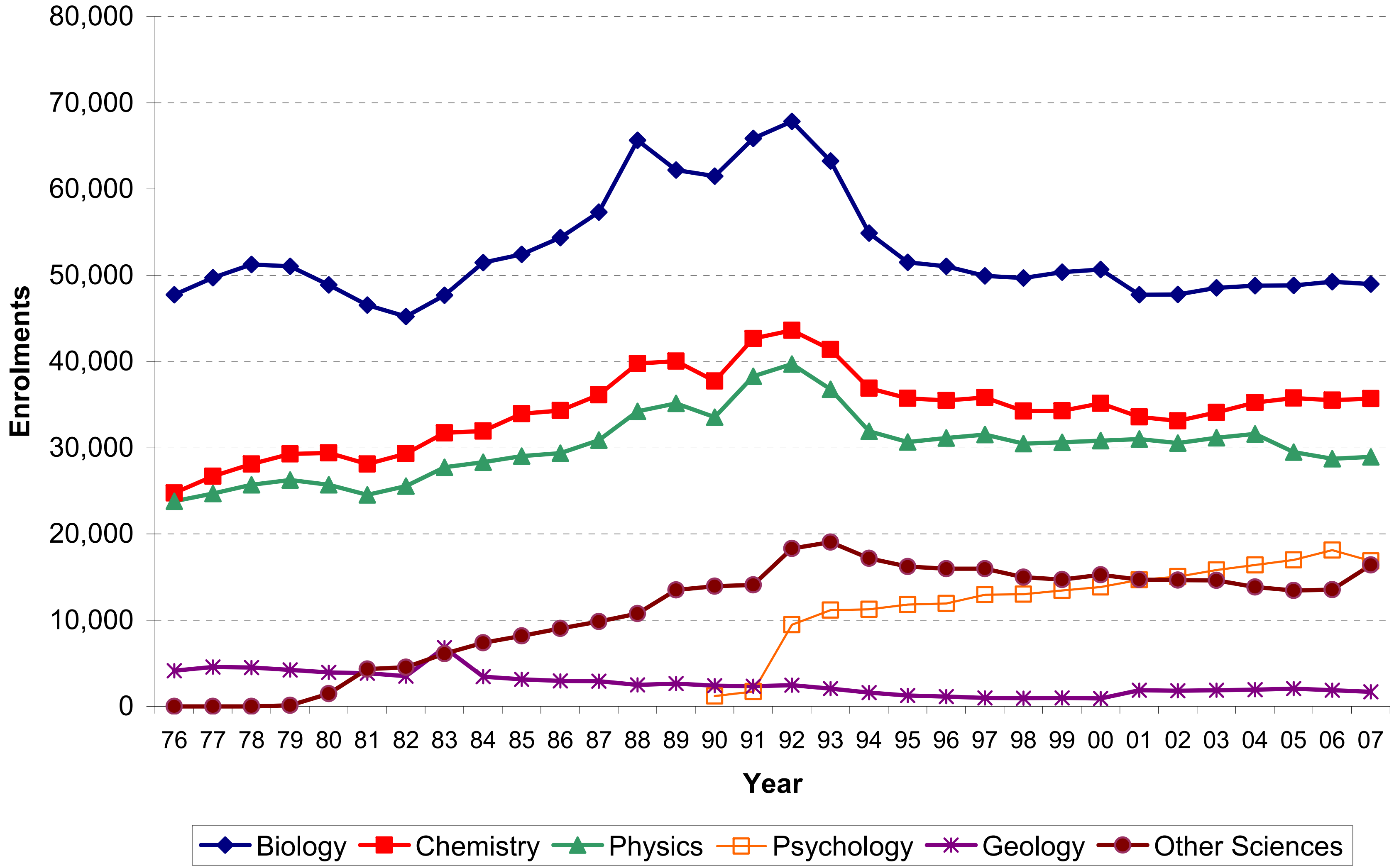

Figure 3.1 Year 12 science enrolments in Australian schools: 1976 to 2007

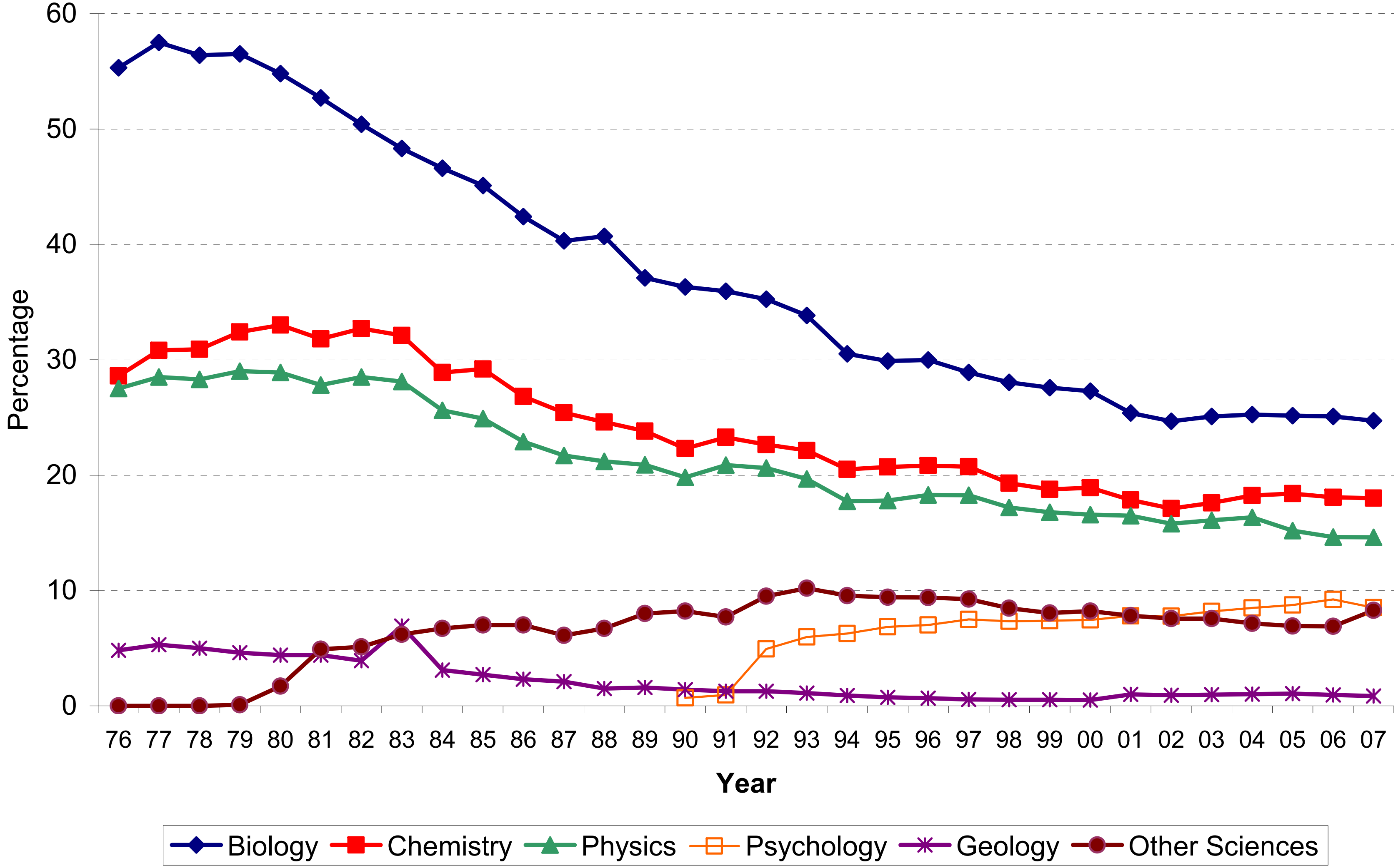

Figure 3.2 Year 12 science participation as a percentage of the Year 12 cohort in Australian schools: 1976 to 2007

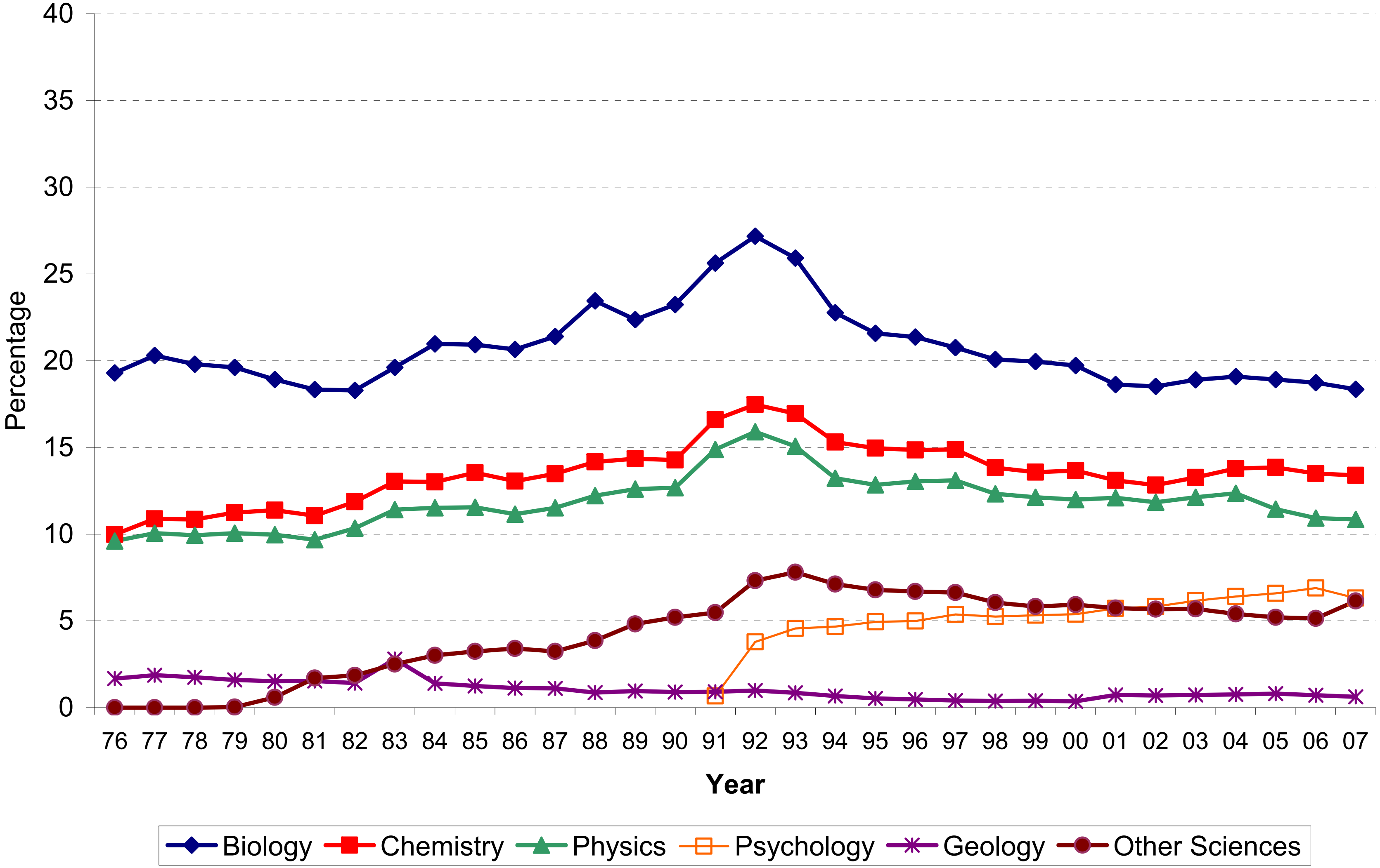

Figure 3.3 Year 12 science participation as a percentage of previous Year 8 cohort in Australian schools: 1976 to 2007

The term “other science” includes a variety of subjects such as “multi-strand science”, “senior science”, “physical science”, “environmental science”, integrated science”, “general science” and “marine science” that have been part of the provision in various jurisdictions at different times. The largest subjects in this group are multi-strand science in Queensland and senior science in New South Wales. Typically they have been provided to extend the range of science beyond the traditional core science disciplines. The highest combined enrolment was in 1993 (just under 19,060) after which enrolments fell to a little under 15,000 in 1998 then continued to decline through to a minimum of 13,421 in 2006. In 2007 there was an increase to 16,186 largely as a result of an increase in senior science in New South Wales.

3.3.3 Participation in science subjects as a percentage of the Year 12 cohort

Tables 3.1 and 3.2 record the numbers and percentages of Year 12 students enrolled in each of the major science subjects over the period from 1976 to 2007[4]. Those data are also displayed in Figures 3.1, 3.2 and 3.3. For the three largest enrolment science subjects there has been an overall general decline in participation rates since 1976 that has continued through the period of focus (since 1991) to 2002. From 2003 onwards participation in biology has stabilised, participation in chemistry has risen slightly and participation in physics has continued to decline.

Figure 3.2 shows a steady decline in biology participation[5]. From 1991 to 2002, there was a decline from 36 to just under 25 per cent for all biology enrolments and from 32 to 22 per cent if human biology is excluded from that total. The participation for human biology declined from around four per cent in 1991 to two and one half per cent in 2007[6].

Participation rates in chemistry and physics had peaked in 1980 at 33 per cent for chemistry and 29 per cent for physics. In 1991 the participation rates were 23 per cent and 21 per cent respectively and by 2007 the participation rates had declined to 18 per cent for chemistry and less than 15 per cent for physics.

Psychology emerged as a significant subject in 1992 with a participation of around five per cent, which grew to reach nine per cent by 2006 before falling to 8.5 per cent in 2007[7].

Geology and earth science has had a participation rate of approximately one per cent since 1992 (but with a dip between 1997 and 2000). Participation rates in “other science” was around 10 per cent in 1992 to 1994 but declined to approximately seven per cent in 2004 to 2006 but rose to just over eight per cent in 2007.

4 For the period prior to 1976 there are few systematic national data but Ainley (1978: 409) indicated that in Victoria there was a substantial rise in participation in biology between 1969 and 1975 (to 42 per cent) but a decline in chemistry and physics participation to 28 and 24 per cent respectively.

5 Biology participation rates include human biology in Western Australia. Although separate data are available for biology and human biology for the period from 1991 to 2007 enrolments have been combined to provide consistency with the earlier data.

6 Enrolments in the subject human biology are concentrated in one state: Western Australia.

7 Psychology is mainly concentrated in Victoria and its classification as a school subject in the sciences is sometimes contested.

3.3.4 Participation rates in science as a percentage of the whole cohort

From 1982 to 1992 there was a substantial rise in the apparent retention rate to Year 12 from 35 to 77 per cent after which there was a decline to 74 per cent in 2007[8]. An indicator of the percentage of the full cohort that participates in various science subjects provides a complementary perspective on trends in science participation. In Figure 3.3 participation rates that reference an estimate of the full cohort have been displayed[9]. Figure 3.3 also shows that, during the period from 1992 to 2007, there was a decline in the percentage of the full cohort who progressed to Year 12 and studied a science subject. In biology the decline was from 27 to 18 per cent, in chemistry it was from 18 to 13 per cent and for physics it was from 16 to 11 per cent. Other science fell from seven to six per cent (five per cent in 2006) and psychology grew from four to six per cent (seven per cent in 2006).

3.3.5 Combinations or clusters of science studies

This section provides information on the proportions of Year 12 students who studied different combinations of science subjects. These data are important because taking multiple science subjects in one's final year of secondary school provides an indication of that student's academic orientation, and can influence their future academic and career options, choices and pathways (Fullarton, Walker, Ainley, & Hillman, 2003).

Table 3.3 provides data on the percentage of Year 12 students in 1998, 2001 and 2004–06 who undertook various combinations of science subjects. These data were derived from the *Longitudinal Surveys of Australian Youth* (LSAY) over the three respective waves[10]. The table shows that the most common combination of science subjects across each of the LSAY waves was chemistry and physics, while the least common combination was physics and biology. Further, while the proportion of Year 12 students studying most science combinations has remained relatively stable, the proportion of students studying chemistry and physics has gradually declined over time. Further inspection of the table shows that the *total* percentages of Year 12 students studying chemistry or physics have declined over time, albeit the decline has been slightly larger for physics.

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8 The apparent retention rate is the number of students in Year 12 in a given year expressed as a percentage of the number of students in the first year of secondary school five or six (depending on the jurisdiction) years previously. Although it has limitations as an indicator for a school, school system or jurisdiction, it is a widely used indicator at a national level.

9 In practice, this means the cohort that commenced secondary school five or six years previously. The cohort participation rate was computed from the participation rate among Year 12 students and the apparent retention rate for that year.

10 Caution should be taken when comparing the 1998 and 2001 data with the 2004–06 data in Table 3.3, due to differences in the way the samples were derived. The 2004–06 data (LSAY 2003) were based on the national sample of students who participated in the 2003 OECD PISA surveys. The sample is a nationally representative sample of students who were 15-years of age in 2003. This cohort differs from the earlier LSAY cohorts, which were grade-based samples. Due to state differences in average age at which children begin schooling, the 2003 LSAY sample was spread across a range of grades, with the majority in Year 10 when first interviewed. The statistics reported in Table 3.3 are based on data for Year 12 in 2004, 2005 and 2006.

Table 3.3 Percentages of Year 12 students undertaking combinations of science subjects for 1998, 2001, 2004–06

Science combination	Percentage of Year 12 students		
	1998	2001	2004-06[a]
Chemistry and physics	11.4	9.7	8.6
Chemistry and biology	6.7	6.3	6.2
Physics and biology	2.4	2.8	2.6
Chemistry, physics and biology (included in figures above)	1.4	1.9	1.5
Chemistry total[b]	20.3	17.9	18.0
Physics total[b]	20.1	16.6	15.5
Biology total[b]	25.1	25.4	26.0

[a] *Data used to calculate percentage of Year 12 students was collected over a three-year period (2004-2006).*
[b] *Percentages recorded are based on nationally representative samples but the totals may differ slightly from those derived from enrolment data because of sampling error.*
Notes: Sample sizes were 5,009 in 1998; 6,910 in 2001; 7,827 in 2004–06
Source: Longitudinal Surveys of Australian Youth.

Data in Table 3.3 are based on the *Longitudinal Surveys of Australian Youth* (LSAY) and refer to the years from 1998 to 2006. A national cross-sectional survey of the subjects studied by a sample of 22,000 Year 12 students indicated that 17.5 per cent of Year 12 students combined physics and chemistry (including 2.3 per cent who combined physics chemistry and biology) (Ainley, 1993). The corresponding percentages for those including a combination of chemistry and biology and physics and biology were 7.5 per cent and 3.3 per cent. The trend since 1990 is one of a substantial decline in the percentage of students studying two sciences in Year 12.

3.3.6 Who studied science in Year 12 in 2001 and 2004–06?

This section provides further detail about Year 12 students who studied science in 2001 and 2004–06 respectively. Specifically, the percentages of Year 12 students studying biology, chemistry or physics, by various group characteristics, (e.g., sex) are provided. These percentages were derived from the LSAY, and are set out in Table 3.4.[11]

Those data show that studying physics or chemistry in Year 12 is strongly related to earlier achievement in mathematics. Table 3.4 categorises Year 12 students in 2001 and 2004–06 into one of four equal-sized groups based on their results on a mathematics test while they were in Year 9. Across both timeframes, Year 12 students in the highest mathematics score quarter were more likely to participate in chemistry and physics than were students in the remaining three groups; while chemistry and physics were least likely to be studied by students in the lowest mathematics score group.

In 2001 students from the top achievement group were eight times more likely to study chemistry or physics than students from the bottom achievement group. In 2004-06 the corresponding ratios had increased to 11 times more likely for chemistry and 15 times more likely for physics. However for biology there was much less association with earlier mathematics proficiency and that association appeared to be non-linear.

[11] See footnote 10

Table 3.4 Percentages of Year 12 students studying science by various grouping characteristics for 2001, 2004 to 2006

Groups	2001			2004–2006		
	Biology	Chemistry	Physics	Biology	Chemistry	Physics
Sex						
Male	18.3	19.8	25.4	19.3	18.9	23.0
Female	31.6	16.3	9.2	32.5	17.1	8.1
Socioeconomic Status (SES) [a b]						
Lowest SES	21.0	12.2	11.4	22.3	12.4	11.3
Lower SES	24.0	15.1	15.5	27.1	15.2	13.6
Higher SES	30.2	20.2	18.0	25.2	16.6	14.4
Highest SES	28.9	26.3	23.3	29.0	26.3	22.5
Parental language background [c]						
English speaking	26.7	17.3	15.3	27.0	15.5	13.6
Other than English	21.0	20.3	22.6	22.8	26.0	21.5
Earlier mathematics achievement [d e]						
Lowest Mathematics score	17.9	4.8	4.7	14.7	3.3	2.2
Lower Mathematics score	28.7	12.2	9.5	21.8	7.9	5.9
Higher Mathematics score	31.8	19.9	18.7	31.6	16.8	13.1
Highest Mathematics score	24.8	37.2	36.7	31.1	36.9	34.3
School sector [f]						
Government	22.5	15.5	14.9	24.3	16.1	18.0
Catholic	28.4	18.7	16.8	26.4	16.7	14.1
Independent	33.1	26.6	23.4	30.8	26.3	21.6
Location [g]						
City	24.6	18.2	17.4	24.7	18.5	16.3
Rural	26.6	17.3	15.4	29.5	17.6	13.2

[a] *In 2001, socioeconomic status was based on parental occupations scaled on the ANU4 scale and shown as quartiles.*
[b] *In 2004, socioeconomic status was based on parental occupations scaled on the International Standard Classification of Occupations (ISCO, range 16-90) and shown as quartiles.*
[c] *Parental language background is based on country of birth of parents.*
[d] *In 2001, earlier mathematics achievement is shown as quartiles based on scores from test in Year 9.*
[e] *In 2004, earlier mathematics achievement is shown as quartiles based on all five plausible values from the PISA mathematics test taken at age 15.*
[f] *School sector refers to the school in which Year 12 was undertaken.*
[g] *Location is based on home address of student.*
Source: Longitudinal Surveys of Australian Youth

Socioeconomic background was strongly associated with studying chemistry or physics in Year 12. The participation rate in chemistry and physics among Year 12 students from the highest of four socioeconomic groups was almost twice that of students from the lowest socioeconomic group. Participation in biology was less strongly associated with socioeconomic background being 30 per cent greater among the highest compared to the lowest socioeconomic group.

Male Year 12 students were more likely to study physics than biology whereas female students were more likely to study biology. The percentages of males and females studying chemistry were more evenly balanced with a slight propensity for a greater percentage of males to be enrolled in chemistry. These patterns are evident for both 2001 and 2004–06. Further, while the proportion of males studying physics or chemistry decreased slightly from 2001 to 2004–06, it increased slightly for biology. On the contrary, the number of females studying biology and chemistry increased slightly, while the number studying physics decreased slightly over the same time frame.

Participation in biology was higher among students whose parents were from an English speaking country compared to those from a language background other than English, and was almost twice as likely to be studied by these students as either chemistry or physics. On the other hand, students whose parents were from a predominantly non- English speaking country had higher rates of participation in physics (with similar rates in chemistry).

Table 3.4 also shows that Year 12 students from Independent schools are more likely than Year 12 students from either Government or Catholic schools to study science, with the biggest discrepancy occurring for chemistry. These trends were evident in both 2001 and 2004–06.

Finally, differences between city and rural schools were small with a slightly higher participation rate in chemistry and physics among city schools and a slightly higher participation rate in biology among rural schools. These trends were evident in both 2001 and 2004–06.

It is of interest that these patterns of participation are similar to those documented for 1988 and 1990 (Ainley, 1993). Those analyses showed that 36 per cent of students from the top quarter of Year 9 numeracy achievements studied the combination of physics and chemistry Year 12 compared to five per cent from the bottom quarter. Nearly twice the percentage of students from a language background other than English studied this combination as for students of an English-speaking language background (26% compared to 14%). Nineteen per cent of students from the highest quarter of the socioeconomic distribution studied chemistry and physics compared to 12 per cent from the lowest quarter.

In summary, the data indicate a strong association between participation in particular science subjects in Year 12 and various characteristics, including; earlier mathematics achievement, socioeconomic background, sex, parental language background, school sector and location.

3.4 Participation in advanced mathematics subjects in Year 12

3.4.1 Measuring participation in mathematics subjects

Categorising senior secondary students in terms of mathematics participation is somewhat more difficult than for science participation. Although more than 80 per cent of Year 12 students participate, those subjects differ widely in the complexity of the mathematics that they include and the foundation that they provide for further study in mathematics-related disciplines. Those mathematics subjects are embedded in structures that differ among jurisdictions and which change over time. It is difficult to compare mathematics participation across jurisdictions in subjects that may differ widely and caution should be exercised interpreting trend analyses because of changes to mathematics curricula over time. In addition, alternative programs, such as the

International Baccalaureate, mean that a number of eligible students do not study Year 12 and do not therefore participate in Year 12 subjects (Forgasz, 2006)[12].

3.4.2 Participation in advanced mathematics subjects

In this analysis attention is focussed on participation in advanced mathematics subjects. Advanced (or high-level) mathematics subjects are defined as "subjects that are prerequisite or assumed knowledge for university courses in engineering and physical, mathematical and computer sciences" (Fullarton et al, 2003) or "subjects involving specialised or advanced mathematics, leading to tertiary studies in which mathematics is an integral part of the discipline" (Dekkers & Malone, 2000). The present analysis begins with a consideration of participation rates in selected "advanced" mathematics subjects (see Forgasz, 2006) for each jurisdiction. Data for the period from 1991 to 2007 are shown in Table 3.5. The data from 1995 to 2007 are represented graphically in Figure 3.4.

In a number of jurisdictions there were declines in participation over the period from 1991 to 2000.

- In New South Wales participation in 3-Unit Mathematics declined from 28 to 17 per cent of Year 12 and participation in 4-Unit Mathematics declined from approximately eight per cent to four per cent.
- In Victoria a new structure was introduced with the Victorian Certificate of Education in 1993 and there was a "drop" associated with that change which could possibly have reflected differences in the way mathematics courses were organised. In Victoria enrolments in Specialised Mathematics grew from 1994 to peak in 1997 before declining through the remainder of the 1990s.
- In Queensland there was a decline in participation in Mathematics C (or its predecessor Mathematics II) from the early 1990s to the end of the decade (aside from the discontinuity associated with the change in structure in 1993).
- In South Australia participation in Mathematics 2 remained fairly constant in the early 1990s and declined at the end of the decade.
- In Western Australia participation in Calculus declined steadily from just under 14 per cent in 1992 to just over 10 per cent in 2000.
- In Tasmania participation in Mathematics 3 declined from a little under six per cent to a little under four per cent between 1994 and 2000.
- In the Australian Capital Territory data are only available from 1996 onwards and showed that participation was fairly uniform at approximately 11 per cent between 1996 and 2000 (actually peaking in 1998).
- In the Northern Territory participation in Mathematics 2 declined from nine per cent to under six per cent over the period from 1992 to 2000.

[12] If students studying for the International Baccalaureate have a greater propensity to include advanced mathematics the growth of this program could contribute to an apparent decline in participation in the advanced mathematics subjects for which enrolments are recorded.

Table 3.5 Percentage of Year 12 students participating in selected advanced mathematics subjects, 1991 to 2007

	Year																
	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07
New South Wales																	
3 Unit Mathematics[a]	28.2	25.1	23.3	22.5	20.6	19.6	18.5	17.6	17.0	16.7							
4 Unit Mathematics[a]	8.3	7.6	7.1	6.1	4.6	4.2	4.1	3.8	4.0	3.9							
Mathematics Extension											20.7	20.6	21.2	22.5	21.2	20.2	19.1
Victoria																	
Change and Approximations Extensions[b]	20.7	20.2	na														
Specialist Mathematics[b]				10.5	11.2	12.8	14.0	13.7	13.2	12.7	12.4	12.4	12.6	12.5	11.4	10.5	9.8
Queensland																	
Mathematics C[c]	15.8	12.8	13.7	10.9	12.6	10.6	10.2	8.4	8.4	8.1	8.2	7.6	7.8	8.4	8.1	7.8	7.8
South Australia																	
Specialist Mathematics[d]	13.5	13.8	13.2	12.3	11.8	12.0	13.4	11.5	11.3	11.2	10.2	9.7	8.6	9.0	8.2	7.9	8.0
Western Australia																	
Calculus[e]		13.9	13.6	12.7	12.5	11.4	10.9	10.5	10.9	10.2	9.2	8.4	9.3	8.2	8.2	7.3	7.7
Tasmania																	
Mathematical Methods[f]				13.0	9.4	9.5	9.6	8.4	6.1	6.7	7.8	6.6	5.9	5.5	5.7	6.8	6.9
Mathematics Specialised				5.6	5.1	5.3	5.2	4.7	4.0	3.6	5.1	4.8	5.8	5.8	5.5	5.0	5.8
Northern Territory																	
Specialist Mathematics[h]	7.6	9.5	9.3	7.7	6.2	6.5	6.1	6.9	6.6	5.6	6.4	6.2	4.6	5.5	5.0	5.6	2.8
Australian Capital Territory																	
Advanced Mathematics Extended[i]						10.8	11.1	11.8	11.5	10.7	10.8	10.7	10.8	11.8			
Specialist Mathematics[i]															10.4	9.6	9.4

a Both 3-unit and 4-unit mathematics are shown. In 2001 a new structure was introduced that provided for mathematics and mathematics extensions. In 2001 there were 11,818 students in mathematics extensions (the participation rate was therefore 20.7 per cent) and in 2002 there were 12,143 students in the subject.

b Specialist Mathematics was introduced as part of a structure that involved Mathematical Methods and Further Mathematics in 1993. Prior to 1993 the closest equivalent was designated change and approximations (extensions) for which the participation rates were 17.5 per cent, 20.7 per cent, and 20.2 per cent in 1990, 1991 and 1992 respectively.

c A change in nomenclature was introduced over 1993 and 1994 in Queensland. Mathematics B and C replaced Mathematics II so that students studying advanced mathematics studied both. Data shown for 1991 and 1992 refer to Mathematics II and data for 1993 and 1994 combine Mathematics II and Mathematics C since both forms were offered concurrently.

d Prior to 2003, Specialist Mathematics was referred to as Mathematics 2.

e Calculus is considered the most advanced form of mathematics although the distinctions in mathematics subjects are based on function and content rather than level of complexity.

f Mathematical Methods was formerly known as Mathematics Stage 2. It was arguably not an advanced subject from 2003.

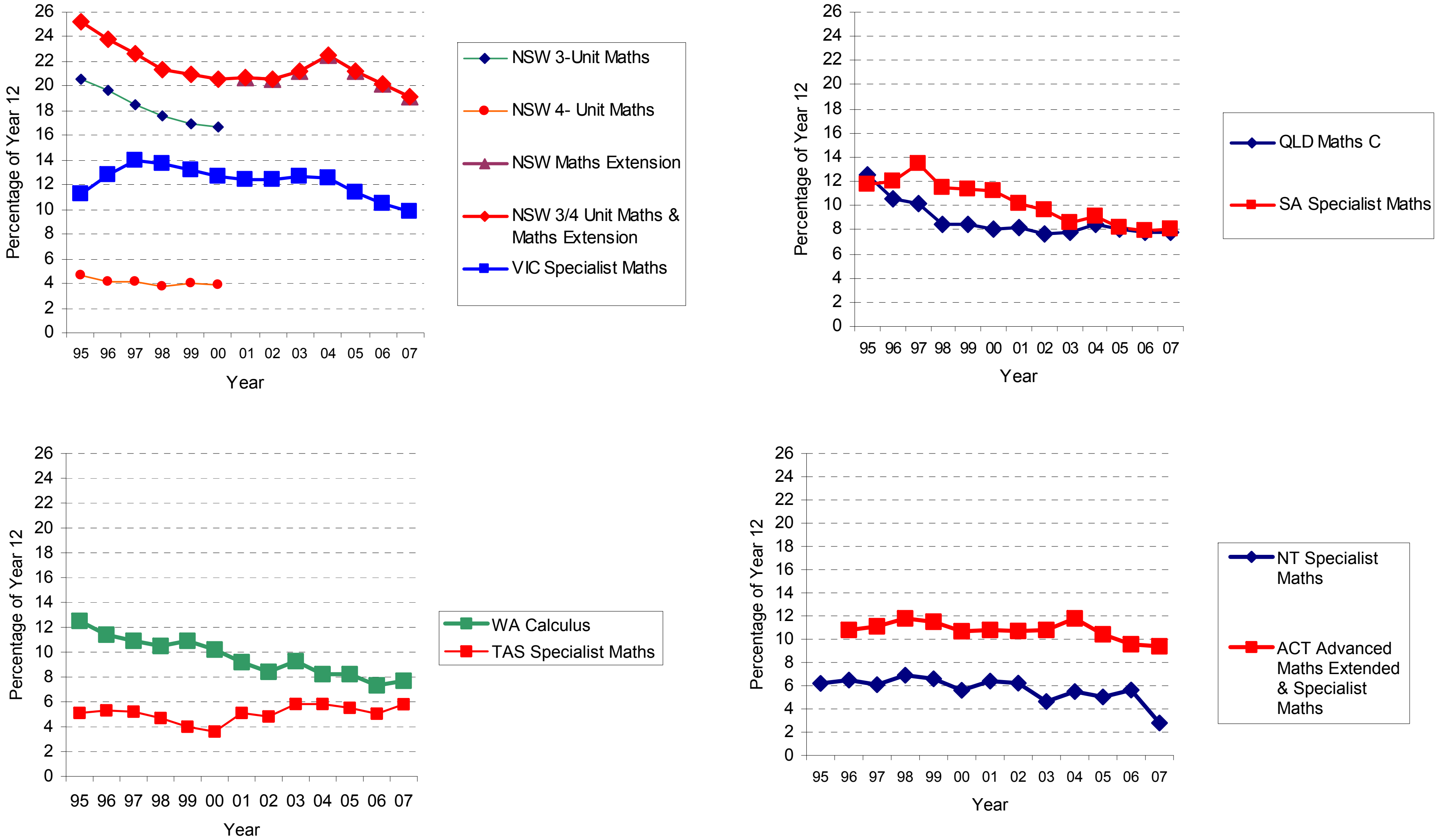
g Prior to 2004, Mathematics Specialised was referred to as Mathematics Stage 3.

h Prior to 2003, Specialist Mathematics was referred to as Mathematics 2.

i Advanced Mathematics Extended was discontinued from 2005 and replaced by Specialist Mathematics.

Sources: DEEWR Statistical Collection as provided by state accreditation, curriculum, assessment and certification authorities and ABS School Enrolment Data.

Figure 3.4 Participation in selected Advanced Mathematics subjects as a percentage of the Year 12 cohort: 1995 to 2007



Sources: DEEWR Statistical Collection as provided by state accreditation, curriculum, assessment and certification authorities and ABS School Enrolment Data.

In general the trend from 1991 to 2000 was for participation in these "advanced" mathematics subjects to decline but in ways that were not uniform across jurisdictions or steady over time.

From 2001 onwards trends in participation in "advanced" mathematics subjects were a little different than during the 1990s. Between 2000 and 2004 participation rates rose by two percentage points in Mathematics Extension in New South Wales with smaller rises of approximately one percentage point in Tasmania and the Australian Capital Territory but fell by approximately two percentage points in Specialist Mathematics in South Australia and Calculus in Western Australia. Participation rates in other "advanced" mathematics subjects were approximately constant over the short period.

Since 2004 there is evidence of a decline in participation rates in advanced mathematics subjects. The decline in three years to 2007 was approximately three percentage points for Mathematics Extension in New South Wales and Specialist Mathematics in Victoria and a little more than two percentage points in Specialist Mathematics in the Australian Capital Territory. There were declines of approximately one percentage point for Specialist Mathematics in South Australia and half a percentage point for Calculus in Western Australia and Mathematics C in Queensland. For Mathematics Specialised in Tasmania there was a small increase in participation from 2005.

Looking at participation rates in each of the advanced mathematics subjects taken by Year 12 students it seems reasonable to conclude that there is evidence of a beginning of a decline over the short period from 2004 to 2007. This emerging decline comes after a period of stabilisation from 2001 to 2004 and a general but uneven decline through the 1990s. Writing about the decline in advanced mathematics during the 1990s, Fullarton et al. (2003) argued that part of the reason for this decline was that high level mathematics was no longer a pre-requisite for a number of university courses. Fullarton et al (2003) also observed that in a number of states, it became uncommon for Year 12 students to participate in more than one mathematics subject.

3.4.3 Trends in participation in mathematics subjects of different types

One approach to establishing a general picture of trends in mathematics participation at Year 12 is to classify mathematics subjects into categories. Such classifications are typically based on the intended purpose of the subject (e.g., as a pre-university subject) rather than on the content of what is taught (Forgasz, 2006). Dekkers and Malone (2000) described a three-level model to categorise Year 12 mathematics courses. This model describes mathematics courses as high level, intermediate or low level:

- subjects involving specialised or advanced mathematics, leading to tertiary studies in which mathematics is an integral part of the discipline;
- subjects involving a level of mathematical competence which provides a satisfactory background for tertiary studies in which mathematics content is minimal; and
- subjects which do not provide a suitable mathematical foundation for any tertiary studies.

Fullarton et al. (2003) described a similar model and defined the three levels as advanced, intermediate and fundamental (or basic). The classification adopted for the present report has been shown in Table 3.6. It builds on the approaches described above but incorporates a number of new subjects introduced since 2005.

Table 3.6 Classifications for Year 12 mathematics subjects across jurisdictions, as at 2007

	Category of Subject		
	Advanced	Intermediate	Fundamental
NSW	**Mathematics Extension 1&2**	**Mathematics**	**General Mathematics**
	Mathematics 3U Mathematics 4U Mathematics Extension	Mathematics 2U Mathematics in Society	Mathematics in Practice Board endorsed subjects
Vic	**Specialist Maths**	**Mathematics Methods**	**Further Mathematics**
Qld	**Mathematics C**	**Mathematics B Logic**	**Mathematics A**
		Mathematics B Mathematics logic	Board registered subjects
SA	**Specialist Mathematics**	**Mathematical Studies**	**Mathematics methods** **Mathematics applications**
	Mathematics 1 Mathematics 2	Mathematics 1S Mathematics 1D	School assessed subjects Quantitative methods
WA	**Calculus**	**Applicable mathematics**	**Discrete Mathematic** Modelling with Mathematics
Tas	**Specialist mathematics**	**Mathematics Methods**	**Applied mathematics**
	Mathematics (stage 3) Analysis & statistics	Mathematics (stage 2) Algebra & geometry	School assessed subjects
NT	**Specialist Mathematics**	**Mathematical Studies**	**Mathematics methods** **Mathematics applications**
	Mathematics 2	Mathematics 1D Mathematics 1S	School assessed subjects Quantitative methods
ACT	**Specialist Mathematics**	**Mathematics Methods**	**Applicable Mathematics**
	Advanced Mathematics extended Advanced Mathematics	Mathematics 2 Mathematics	Mathematics T Accredited subjects

Note: Subject names shown in bold are current defined courses in 2006. Other names shown are either unspecified groupings (e.g. accredited subjects) or recent subjects that have ceased or are being phased out.

Sources: Adapted from Forgasz (2006), Fullarton et al (2003), Dekkers and Malone (2000).

Dekkers and Malone (2000) showed a steady increase in Year 12 participation in ‘Low level’ mathematics which was matched by decreased participation in ‘High level’ and ‘Intermediate level’ mathematics.

Barrington (2006) reported that there has been a trend toward greater participation in the less academically-challenging mathematic course. For example, there was an increase in the proportion of Year 12 students participating in ‘Fundamental mathematics’ from 37 per cent of the Year 12 cohort in 1995 to 46 per cent in 2004. On the contrary, the proportion of students taking ‘Advanced mathematics’ declined (14% in 1995; 12% in 2004) as did the proportion of students taking ‘Intermediate mathematics’ (27% in 1995;

23% in 2004) (Barrington, 2006). Figure 3.5 shows enrolments in three categories of Year 12 mathematics subjects from 1995 to 2004. The graph indicates that there were increases in participation in Year 12 Fundamental mathematics from 1995 to 2000, which was followed by a small decline in 2001. There was an increase in Fundamental mathematics participation numbers across the following two years, before declining slightly again in 2004. Participation in Intermediate mathematics remained relatively stable from 1995 to 1999, before increasing slightly in 2000. There were some fluctuations in Intermediate mathematics enrolment numbers between 2000 and 2004. Participation in Advanced mathematics also remained relatively stable from 1995 to 1999, before decreasing by almost 6 000 enrolments in 2000.

Table 3.7 records the numbers of students enrolled in various mathematics subjects in Year 12 since 2001 with those subjects grouped as “advanced”, “intermediate”, and “other” mathematics. The term “other” is preferable to “fundamental” because the group contains such a wide variety of subjects. In reading the table it is important to note that subjects that appear under the same name in different states and territories may not necessarily have the same content or level of complexity and that the grouping of the subjects in three levels is an artificial grouping.

Figure 3.6 plots the trends in the percentage of Year 12 enrolments in these groups of mathematics subjects. The period from 2001 to 2007 is represented because it covers a period during which changes to mathematics curriculum structures were relatively smooth.

The representation in Figure 3.6 shows that over this period there was a decline in participation in advanced mathematics, a larger decline in participation in intermediate mathematics and a rise in participation in other mathematics. The pattern described by Barrington (2006) appears to have continued in general terms.

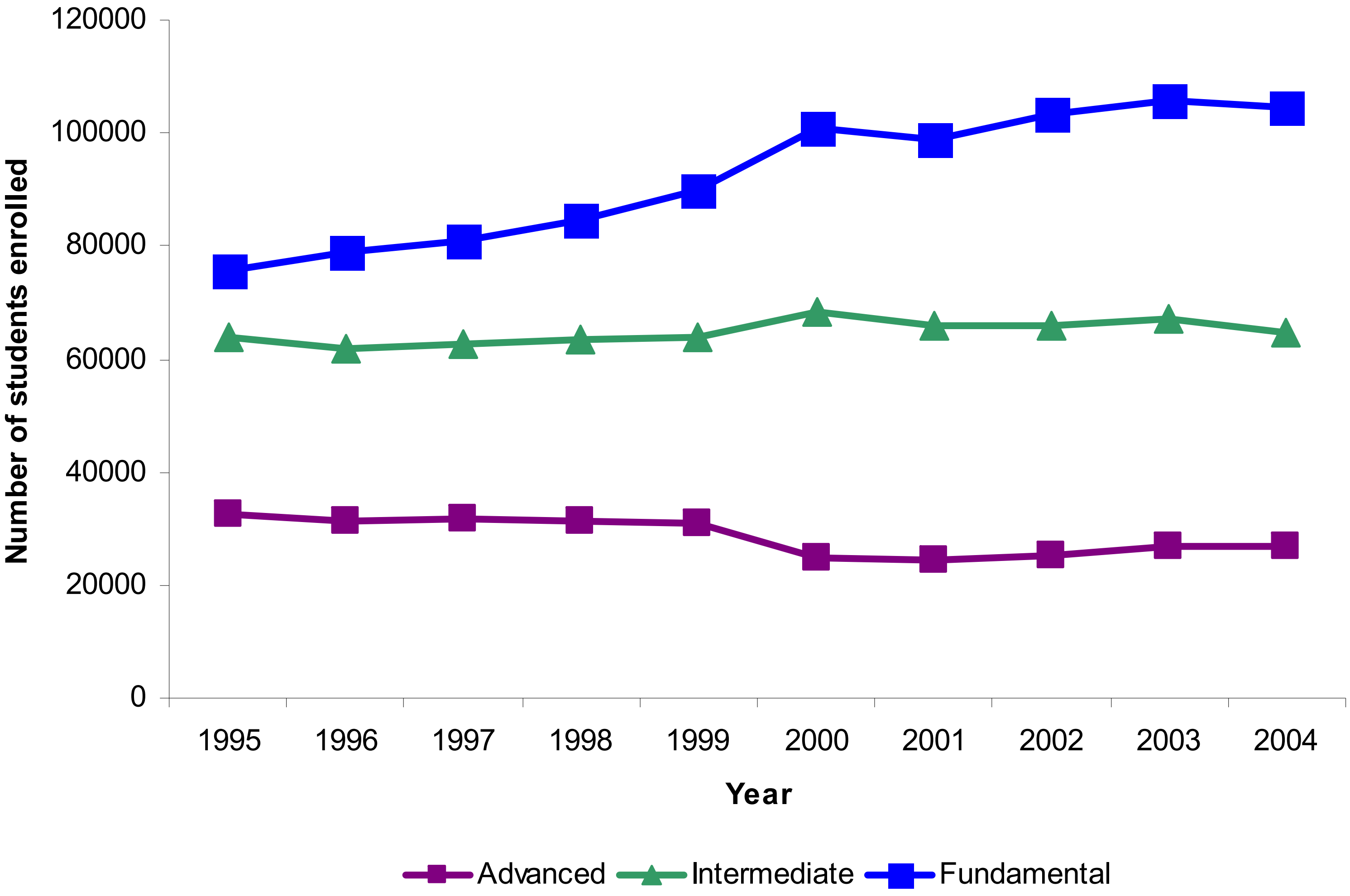


Figure 3.5 Participation in three categories of Year 12 mathematics subjects from 1995 to 2004
Source: Forgasz (2006).

Table 3.7 National enrolments in mathematics subjects from 2001 to 2007

	2001	2002	2003	2004	2005	2006	2007
ADVANCED MATHEMATICS							
Mathematics extension	11,818	12,143	12,551	13,497	12,682	12,171	11,626
Specialist mathematics	5,990	6,163	7,518	7,719	7,486	7,133	6,475
Mathematics C	3,230	3,114	3,175	3,430	3,317	3,226	3,343
Mathematics 2	1,446	1,366					
Calculus	1,801	1,702	1,824	1,627	1,655	1,467	1,555
Mathematics stage 3	252	249	292				
Advanced mathematics	1,679	1,613	1,736	1,600	4		
Total	26,216	26,350	27,096	27,873	25,144	23,997	22,999
INTERMEDIATE MATHEMATICS							
Mathematics	21,885	20,213	19,912	19,809	19,106	18,144	17,762
Mathematical methods	17,730	18,090	18,689	19,185	19,261	19,280	18,013
Mathematics B	16,333	16,354	16,483	16,317	16,534	15,988	16,270
Mathematics 1 (D)	1,397	1,321					
Mathematics 1 (S)	2,874	2,968					
Mathematical studies			3,877	3,574	3,487	3,305	3,241
Applicable maths / applications	4,718	4,646	4,666	4,282	5,815	5,354	5,437
Mathematics stage 2	386	341	296				
Total	65,323	63,933	63,923	63,167	64,203	62,071	60,723
OTHER MATHEMATICS							
General mathematics	30,431	31,438	29,955	29,455	28,757	29,329	29,448
Further mathematics	19,088	20,384	21,552	22,181	22,745	24,468	25,639
Mathematics A	20,082	20,755	21,241	21,246	21,565	22,015	23,102
Logic	285	279	279	303	305	1	
Quantitative methods	161	190					
Modelling with mathematics							5,145
Discrete mathematics	7,358	7,745	7,784	7,771	7,749	7,623	8,081
Applied mathematics	879	833	763	680	641	685	629
Mathematics T/other mathematics	1,360	1,423	1,449	1,384	9	1	
TOTAL	79,644	83,047	83,023	83,020	81,771	84,122	92,044

Sources: DEEWR Statistical Collection as provided by State Accreditation, Curriculum, Assessment and Certification authorities.

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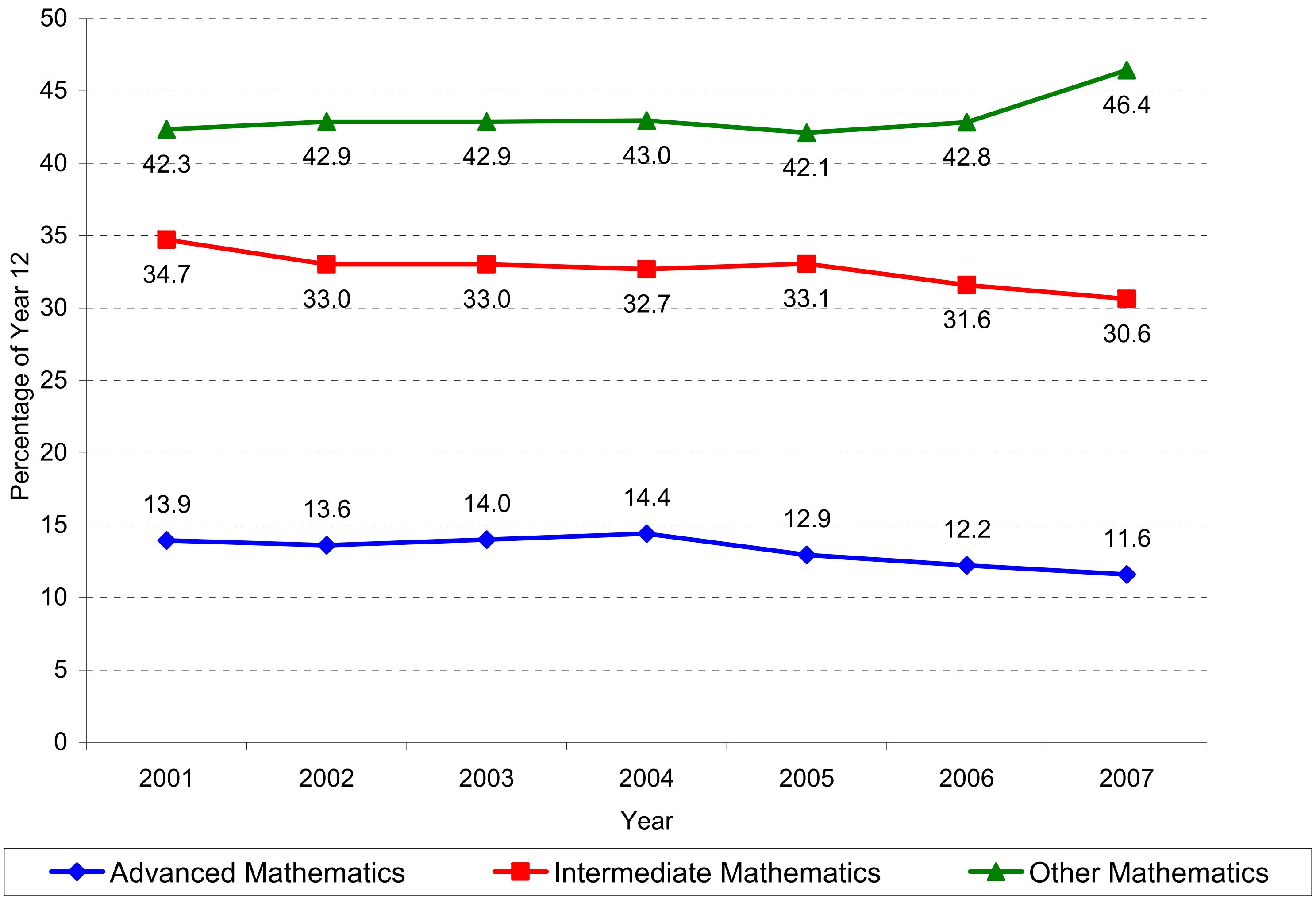

Figure 3.6 Participation rates for three categories of Year 12 mathematics subjects from 2001 to 2007

Table 3.8 Year 12 enrolments and participation rates in technology subjects, 1995 to 2007

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Enrolments													
Agriculture and related studies	3102	3250	4531	3107	3405	3453	4129	4254	3875	3667	4203	1970	3405
Food and home science	8446	7352	7092	6852	6905	9364	13873	14066	14353	14411	14056	16156	16329
Information technology	31353	34182	35347	36087	37822	42640	47464	45844	42330	35698	33688	28198	28668
Hospitality studies	21946	979	1546	2012	2428	3777	7560	8612	9345	8934	12967	8819	12307
Technical studies (ex hospitality)		22702	23113	22585	23365	25530	23341	24021	24365	23963	28963	25759	31415
TOTAL		68465	71629	70643	73925	84764	96367	96797	94268	86673	93877	80902	92124
Participation rates for Year 12 Students													
Agriculture and related studies	2.9	1.9	2.6	1.8	1.9	1.9	2.2	2.2	2.0	1.9	2.2	1.0	1.7
Food and home science	5.9	4.3	4.1	3.9	3.8	5.0	7.4	7.3	7.4	7.5	7.2	8.2	8.2
Information technology	18.2	20.0	20.5	20.4	20.7	22.9	25.2	23.7	21.9	18.5	17.4	14.4	14.5
Hospitality studies	12.7	0.6	0.9	1.1	1.3	2.0	4.0	4.4	4.8	4.6	6.7	4.5	6.2
Technical studies (ex hospitality)		13.3	13.4	12.7	12.8	13.7	12.4	12.4	12.6	12.4	14.9	13.1	15.8

Sources: DEEWR Statistical Collection as provided by state accreditation, curriculum, assessment and certification authorities and ABS School Enrolment Data.

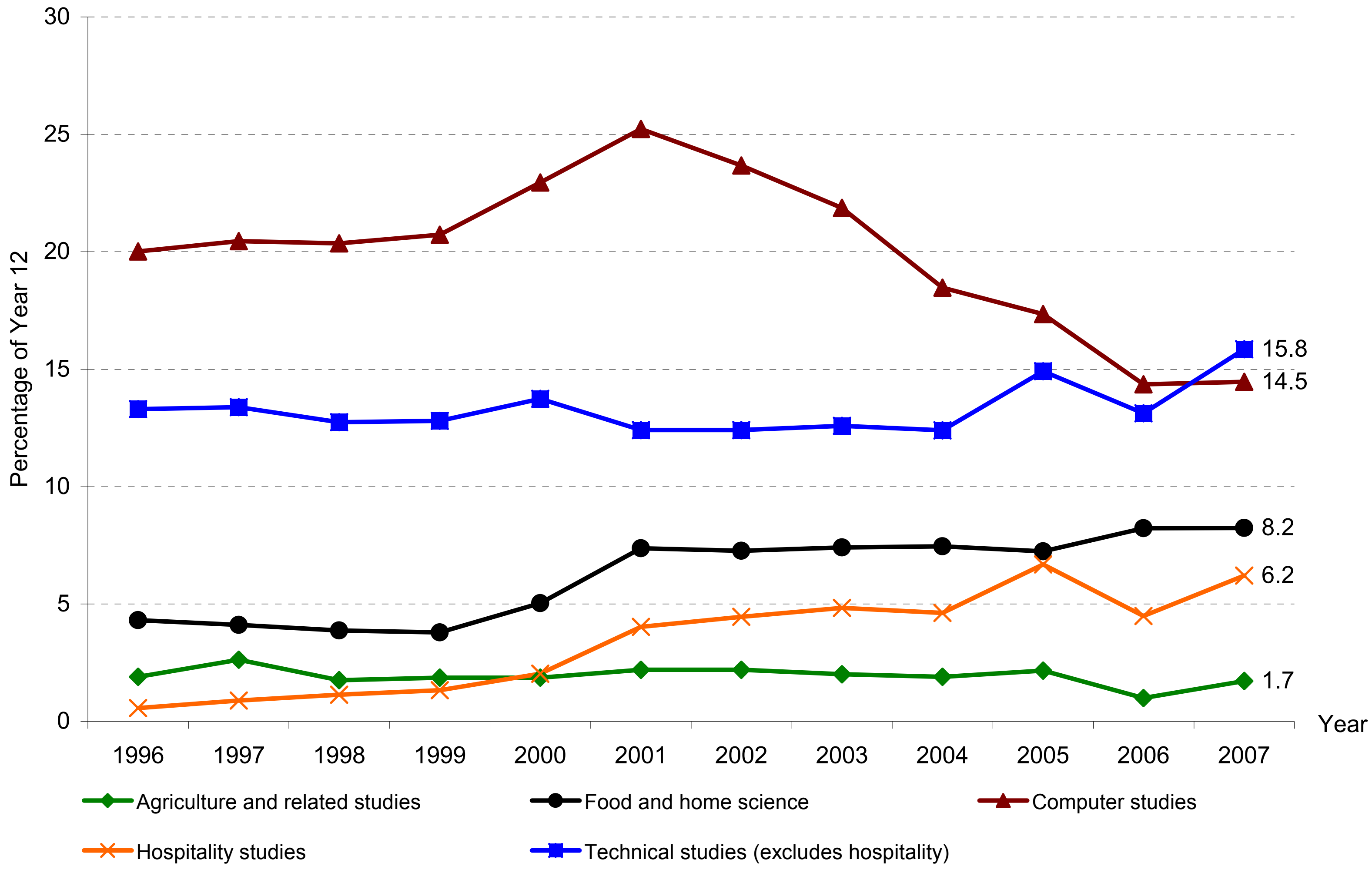

Figure 3.7 Year 12 technology participation as a percentage of the Year 12 cohort in Australian schools: 1996 to 2007

3.5 Participation in technology subjects in Year 12

3.5.1 Trends in participation in technology

Documenting trends for participation in Year 12 technology subjects is complex because of the number of different labels used to define subjects in the area. In addition there is a myriad of small enrolment subjects that change from year to year. To simplify the representation of data, Table 3.8 combines technology subjects into one of five clusters; information technology (or computer technology) technical studies, food and home science, hospitality and agriculture. The data are represented as total enrolments (but note that one student could enrol in more than one subject in the area).

Information technology includes subjects such as computing applications, software design and development, information technology, information systems, information processing and management. In the case of information technology, the cumulative figure represents participation by individuals because few students take more than one subject in the area (Fullarton et al. 2003).[13]

Technical studies include subjects such as materials and technology, design and technology, technology studies, textiles and design, technology design and development and graphics. In the case of technical studies, it is a little more common for students to study more than one subject from the area so these statistics possibly overstate the extent of participation by individuals in technical studies.

Figure 3.7 shows the trends in participation rates, as a percentage of the Year 12 cohort, for technology subjects in Year 12 over the period from 1996 to 2007. A previous report showed that participation in Information Technology had risen from eight per cent in 1991. These data show that participation in Information Technology continued to increase from 20 per cent in 1996 to 25 per cent in 2001 after which it declined to 14 per cent in 2007.

Participation in technical studies had increased substantiality from eight per cent in 1991 to 13 per cent in 1992, and remained quite stable until 1996. Since 1996 participation in technical studies has remained constant at approximately 13 per cent except for a rise to 16 per cent in 2007.

Hospitality studies have shown a substantial increase in participation over this period, although from a low base. In 1996 the participation rate for hospitality studies was less than one per cent but over the period from 2003 to 2007 participation averaged five per cent with a peak of just fewer than seven per cent in 2005 and reaching six per cent in 2007.

Participation rates in Food and Home Science had been relatively constant at just less than five per cent through the 1990s, increased in 2000 and 2001 to reach seven per cent at which level it remained until 2005, and rose in 2006 and 2007 to eight per cent. In summary, participation in this cluster has increased but not uniformly.

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13 In 2001, LSAY data suggest that 24.9 per cent of Year 12 students studied one subject from the area and 2.0 per cent of students studied more than one subject (Fullarton et al. 2003). In 1998, the corresponding figures were 23.4 and 1.0 per cent respectively (Fullarton & Ainley 2000). In 1993, the corresponding figures were 20.1 and 0.3 per cent (Ainley et al. 1994).

For the most part, participation rates in agriculture have remained stable but low over time at approximately two per cent. In 2006 participation dropped to just one per cent but recovered to two per cent in 2007.

3.5.2 Patterns of participation in technology

Fullarton et al. (2003) document some of the characteristics of participants in subjects from the technology area. In 2001, participation in information technology was stronger amongst males than females (by a factor of two) and:

- a little lower among those of higher compared to lower socioeconomic status;
- lower among students with higher levels of achievement in Year 9;
- a little higher in government than independent schools; and
- a little greater in city than rural locations.

There was little difference in the participation rates of those with a language background other than English compared with those of an English-speaking background.

Participation in technical studies was predominantly male (the ratio was four to one) and:

- less among students of higher compared to lower socioeconomic status;
- higher among students of an English-speaking background compared with a language background other than English;
- lower among students with higher levels of achievement in Year 9;
- higher in government than independent schools; and
- a little greater in rural than city locations.

Table 3.9 Values of enrolment indices for Key Learning Areas from 1996 to 2007

	Year											
	96	97	98	99	00	01	02	03	04	05	06	07
English	19.4	19.3	19.6	19.5	18.9	19.4	19.5	19.5	19.6	19.3	19.5	17.8
Mathematics	18.1	18.3	18.2	18.1	18.0	18.5	18.5	18.3	18.4	17.9	17.9	17.9
SOSE	23.2	22.7	22.3	22.3	22.4	20.7	20.7	20.7	20.8	21.1	21.4	21.3
Science	17.2	17.1	17.1	16.8	16.3	15.5	15.2	15.4	15.6	15.3	15.5	15.1
Arts	7.0	7.1	7.3	7.5	7.7	7.9	8.0	8.1	8.1	8.3	8.5	8.8
Languages	2.9	2.9	2.8	2.8	2.7	2.8	2.8	2.8	2.9	2.9	2.8	2.7
Technology	8.0	8.2	8.4	8.6	9.4	10.4	10.3	9.9	9.2	9.8	8.5	9.6
Health and PE.	4.2	4.4	4.4	4.4	4.4	4.9	5.1	5.2	5.3	5.5	6.0	6.8

Sources: DEEWR Statistical Collection as provided by state accreditation, curriculum, assessment and certification authorities.

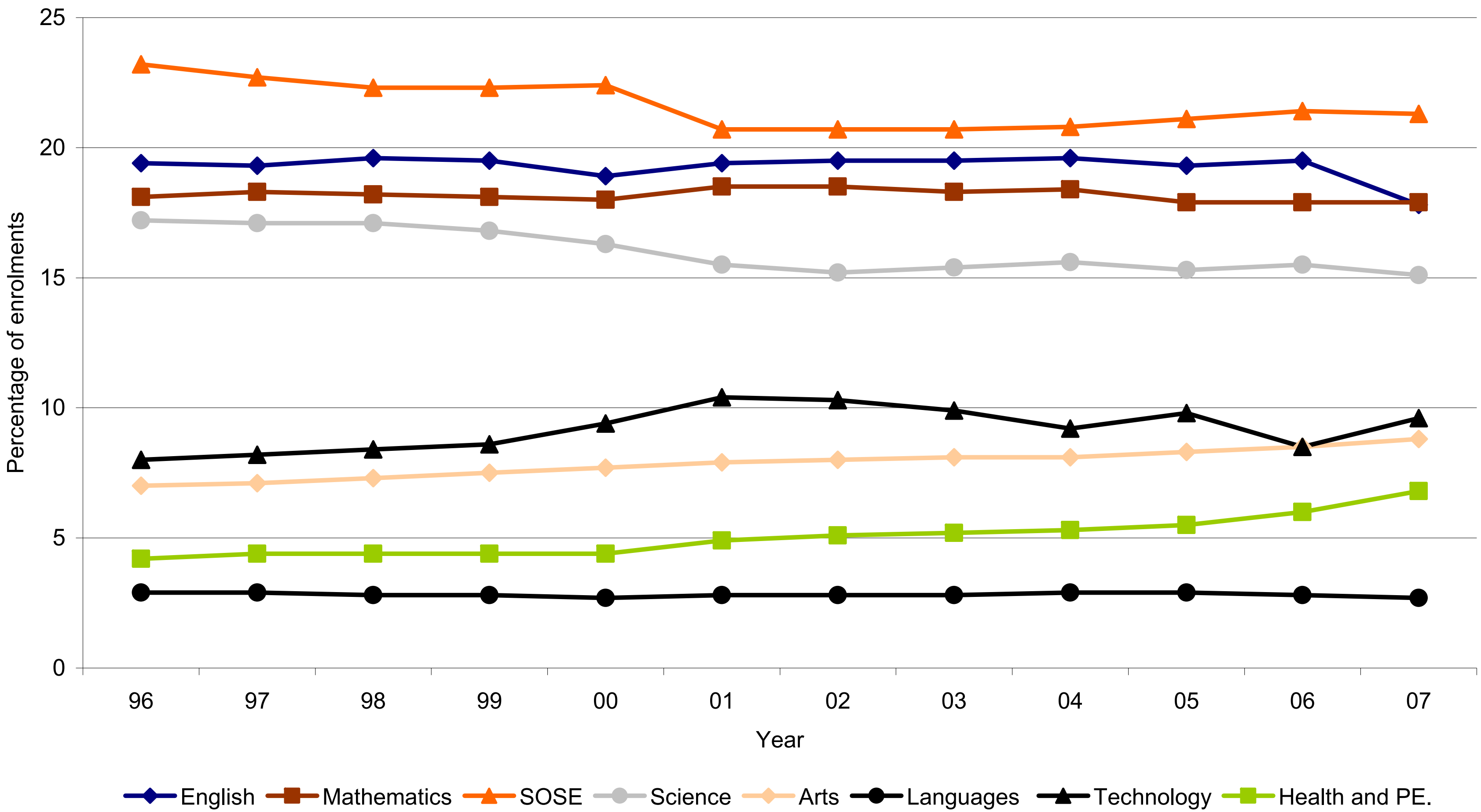

Figure 3.8 Percentage of subject enrolments by Key Learning Area: 1996 to 2006

3.6 Enrolment indices for Key Learning Areas

Table 3.9 records values of enrolment indices for Key Learning Areas (KLA) from 1996. Since the sum of the values for these indices for each year is 100 the data reflect the relative share of enrolments for each KLA. As noted previously in this chapter this index is relatively less sensitive to change because of the metric and because changes within KLAs can cancel out for the KLA as a whole. These data indicate a relative decline for the science KLA (but mainly up to 2002), a relatively constant level for mathematics and an increase for technology from 1996 to 2002 followed by a small decline from 2002 to 2007. There have been increases for the arts and for health and physical education and decreases for studies of society and environment. These data have also been plotted in Figure 3.8.

3.7 Summary

A number of changes in enrolment patterns are evident from the analysis of national data presented in this section. Since 1976 the total number of students studying science in Year 12 has increased slightly, but this has been accompanied by a large increase in the number of students enrolled in Year 12. Consequently there has been a steady decline in the percentage of Year 12 students participating in biology, chemistry and physics over the years 1976 to 2007 that has been only partly compensated by the emergence of participation in other science studies during the 1990s. 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 the 1990s. Since 2001 the rate of decline has continued but at a slower rate. This means that the pool from which students of science-related studies are drawn has diminished, with potential consequences for participation in university studies in science, engineering, mathematics and technology beyond school.

Trends in mathematics participation are more difficult to identify because of changes in course structures and nomenclature for defining and labelling mathematics subjects. Overall, participation in mathematics among Year 12 students is very high but over time, there has been a decline in participation in “Advanced” and “Intermediate” mathematics.

During the 1990s there was an increase in participation in information technology. In 2001, one quarter of Year 12 students included an information technology subject in their course. However by 2007 this had dropped to just over one in seven. Participation in technical studies has remained steady from 1996 to 2007 with approximately one student in seven including a technical subject in their course. Studies in hospitality have grown but even after that growth only one in every 20 students studies a subject from this field.

4
UNIVERSITY PARTICIPATION IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS

4.1 Introduction

Much of the focus of international attention on participation in science, technology, engineering and mathematics has been on declines in the percentages of graduates in those fields (OECD, 2006a). This has been expressed in terms of a concern over supply of scientists and engineers and its potential impact on future research and development. As one example the Roberts Review to the United Kingdom Treasury argued that there had been "falls in the numbers taking physics, mathematics, chemistry and engineering qualifications" and that this had the potential to limit research, development and innovation. In the United States there has been similar concern that there are too few students, teachers and practitioners in science, technology, engineering and mathematics to sustain the desired levels of scientific innovation (Kuenzi, Mathews & Mangan, 2006).

This section of the report examines participation in university courses in science, technology, engineering and mathematics. It considers entry to courses in these fields by making use of cross-sectional commencing student data from the Higher Education Statistics Collection (HESC) maintained by the Department of Employment, Education and Workplace Relations (DEEWR) as well as longitudinal data from the Longitudinal Surveys of Australian Youth (LSAY) in which cohorts are followed individually from school to university (and elsewhere).

It also examines numbers of completions using the HESC data. Although there will always be an issue of defining the scope of the field the section focuses on the major science-based broad fields of education: science, information technology, engineering, architecture, agriculture and health.

4.2 Entry to science, mathematics and technology studies in higher education

4.2.1 Commencing undergraduate students

Table 4.1 records commencing enrolments for domestic students in undergraduate courses in science related fields for the period 2001 to 2006. Undergraduate courses refer to enrolments in bachelor honours, bachelor pass and diploma courses. Trends in numbers of commencements are shown in Figure 4.1.

In 2006, 15 per cent of these commencing enrolments were in health, just fewer than 10 per cent were in the natural and physical sciences, six per cent were in engineering and related fields, just over three per cent were in information technology, just under three per cent were in architecture and building, and two percent were in agriculture and environmental studies.

In total just a little fewer than four in ten (39%) domestic undergraduate commencements were in science-related fields.

Table 4.1 Domestic undergraduate commencing students by broad field of education from 2001 to 2006

	Year					
	2001	2002	2003	2004	2005	2006
Natural & Physical Sciences						
Number	18,488	17,825	17,708	18,292	17,692	17,611
Percentage	10.4	10.1	10.6	11.0	10.1	9.8
Information Technology						
Number	12,474	11,553	9,950	8,224	7,023	6,171
Percentage	7.0	6.6	6.0	5.0	4.0	3.4
Engineering & Related Technologies						
Number	11,170	11,114	10,898	10,655	10,619	11,046
Percentage	6.3	6.3	6.5	6.4	6.0	6.1
Architecture & Building						
Number	3,703	3,607	3,708	3,830	4,351	5,028
Percentage	2.1	2.1	2.2	2.3	2.5	2.8
Agriculture, Env. & Related Studies						
Number	4,940	4,777	4,717	4,734	3,697	3,438
Percentage	2.8	2.7	2.8	2.9	2.1	1.9
Health						
Number	20,886	21,940	21,192	21,957	25,074	27,901
Percentage	11.8	12.5	12.7	13.3	14.3	15.5
Total science-related						
Number	70,138	68,869	66,302	65,653	66,844	69,481
Percentage	39.5	39.2	39.8	39.6	38.0	38.5
Total domestic undergraduate commencements	177,694	175,666	166,499	165,682	175,712	180,390

Source: Selected Higher Education Statistics, Students (DEEWR): Commencements for Domestic Undergraduate students by Broad field of education

In 2006 females provided a substantial majority (74%) of commencing undergraduate enrolments in health but a substantial minority in information technology (18%) and engineering (14%). Females provided just a little more than half of the commencing enrolments in the natural and physical sciences (53%) and agriculture (51%) and less than half in architecture and building (41%). In comparison the percentages of females in the commencing undergraduate enrolments in non-science fields were: 75 per cent in education, 65 per cent in society and culture, 63 per cent in the creative arts and 51 per cent in management and commerce.

Over the six-year period from 2001 to 2006 there was a substantial increase in the number of undergraduate domestic commencements in health (approximately a 35 per cent increase) and a substantial decline in undergraduates domestic commencements in information technology (a drop of approximately one half of the number in 2001). As shown in Figure 4.1 the other changes over this time were smaller. There were small declines in the natural and physical sciences as well as in agriculture and environmental studies and a small increase in architecture and building. Overall, during this six-year span there was a small decline in the numbers of domestic undergraduate commencements in science-related fields of education.

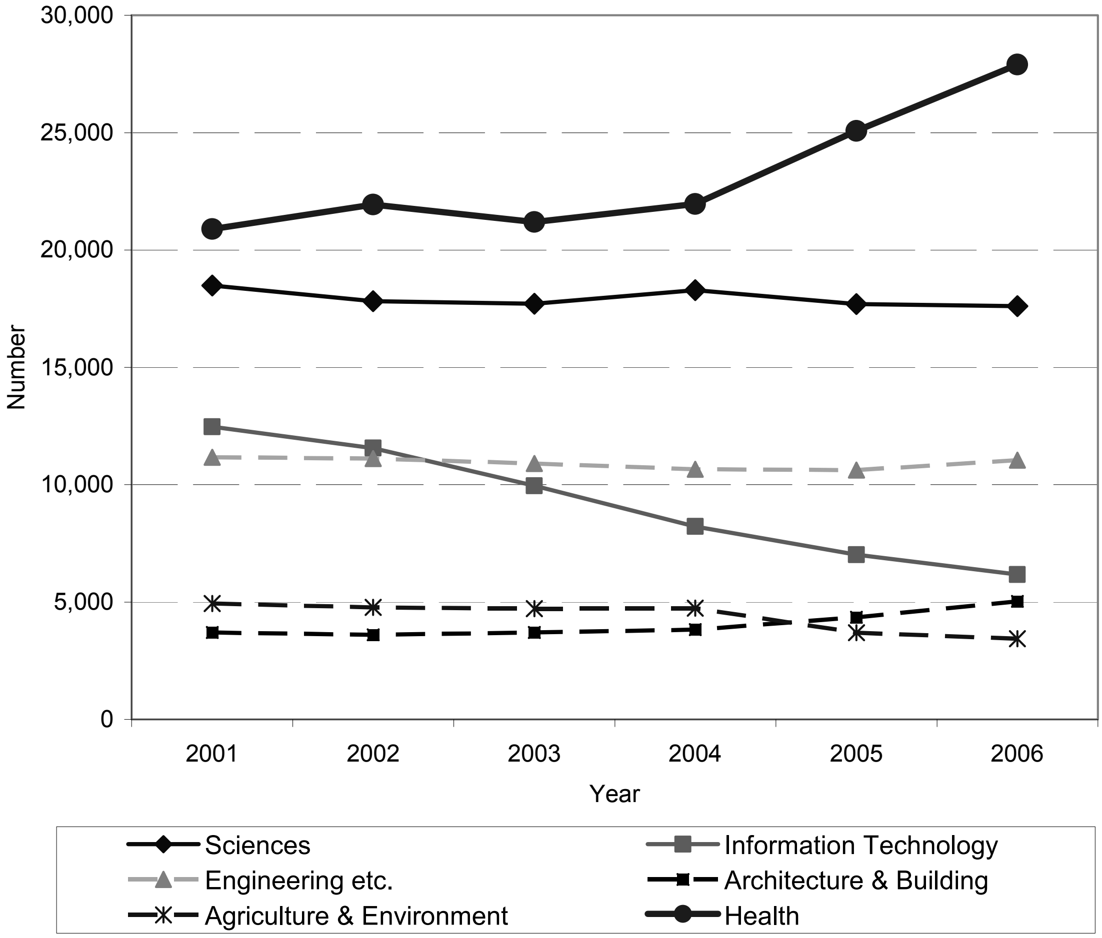

Figure 4.1 Trends in commencing domestic enrolments in science-related fields from 2001 to 2006

The previous report covering the period from 1990 to 2002 noted fluctuations in the percentage commencing domestic enrolments in science-related fields rather than a large change. Over this period there was an increase in information technology.

4.2.2 Tertiary entry ranks for science-related fields of education

One of the concerns expressed in relation to the uptake of science-related studies at university has been a perceived decline in the academic background of entrants to those fields. Table 4.2 provides information about the median ENTER scores for each of the broad fields of education from 2001 to 2006. The data also provide an indication of the spread of scores by showing the 10th and 90th percentiles for entry to each broad field of education.

Those data suggest that there has been a substantial decline in the academic background (as measured by the median ENTER scores) of commencements in information technology and following peaks in 2004 in teacher education and the creative and performing arts. Enter scores for the natural and physical sciences and for engineering appear to have remained relatively high over this period.

Table 4.2 Median Tertiary Entrance Ranks (ENTER) with 10th and 90th percentiles for Broad Fields of Education: 2001 to 2006

	2001			2002			2003			2004			2005			2006		
	P10	Median	P90	P10	Median	P90	P10	Median	P90	P10	Median	P90	P10	Median	P90	P10	Median	P90
Natural and Physical sciences	69	**87**	98	70	**88**	98	70	**88**	98	71	**88**	98	68	**87**	98	68	**87**	98
Information Technology	69	**86**	97	69	**85**	97	66	**82**	96	66	**81**	95	63	**79**	95	62	**78**	94
Engineering and related technologies	71	**90**	98	71	**89**	98	71	**89**	98	73	**89**	98	72	**88**	98	71	**89**	98
Architecture and Building	68	**85**	95	69	**85**	95	69	**85**	96	70	**86**	96	70	**86**	96	69	**84**	96
Agriculture, Environmental and Related Studies	59	**78**	92	60	**77**	92	60	**76**	91	61	**77**	91	59	**76**	93	60	**77**	93
Health	64	**85**	98	66	**84**	98	67	**85**	98	68	**86**	98	66	**85**	98	65	**85**	98
Education	64	**78**	91	67	**80**	91	68	**81**	91	69	**82**	92	64	**79**	92	63	**77**	91
Management and Commerce	67	**85**	97	68	**86**	97	68	**86**	97	68	**86**	97	68	**86**	97	64	**85**	97
Society and Culture	64	**84**	97	66	**85**	97	68	**86**	97	70	**87**	98	67	**86**	97	65	**85**	97
Creative Arts	65	**85**	96	66	**86**	97	68	**87**	97	68	**87**	97	65	**84**	96	63	**83**	96

Source: DEEWR Higher Education Statistics Collection.

In terms of the 10th percentile there is a similar picture but with the biggest drop from 2004 to 2006 being for society and culture. There was drop in the 10th percentile of ENTER scores for the natural and physical sciences between 2004 and 2006.

4.2.3 Longitudinal data on transition

Data from the *Longitudinal Surveys of Australian Youth* (LSAY) provide a complementary perspective on the post school destinations of Year 12 students from 1998. From these data it is possible to investigate the post-school educational destinations in the period up to two years after completing school. This allows the consideration of those who proceed to further study but possibly not in the immediate post-school year. In Table 4.3 the general post-secondary destinations (in relation to further study) have been tabulated for two groups of students in each of two cohorts. In each cohort the first group is students who studied two physical sciences (physics and chemistry) in Year 12 and the second is those who studied any two science subjects in Year 12. The first cohort is those who completed Year 12 in 2004 or 2005 (this was drawn from those who participated in PISA in 2003) and the second cohort (which was reported in the previous report) is those who completed Year 12 in 1998 (who were sampled when they were in Year 9 in 1995).

Table 4.3 Percentages of students who completed Year 12 in various educational destinations by extent of science study in Year 12

Destination in first year after Year 12	Two physical science subjects in Year 12		Two science subjects in Year 12		All Year 12 students
	Yes	No	Yes	No	
Cohort 1: students who completed Year 12 in 2004/5					
University	77	38	67	36	42
TAFE	5	19	10	20	18
Apprenticeship/traineeship	4	14	6	14	13
No education or training	14	29	17	30	28
Total	100	100	100	100	100
(n)	517	5214	1059	4672	5731
Cohort 2: students who completed Year 12 in 1998					
University	86	44	77	40	48
TAFE	3	24	9	25	22
Apprenticeship/traineeship	5	14	7	15	13
No education or training	6	18	7	20	17
Total	100	100	100	100	100
(n)	526	4,939	1,109	4,356	5,465

Note: Analyses by Sheldon Rothman and Julie McMillan.
Source: Longitudinal Surveys of Australian Youth.

Those data indicate that students who studied two physical sciences were more likely to proceed to university than students who studied any two science subjects and both groups were much more likely to continue to university study than those who did not study two science subjects. From the cohort that completed Year 12 in 2004 or 2005, 77 per cent of those who studied two physical science subjects proceed to university compared to 67 per cent who studied any two sciences and 42 per cent of other Year 12 students.

Table 4.4 Field of education in tertiary education by extent of physical science study in Year 12 for students who completed Year 12 in 2004 and 2005

	Two physical science subjects in Year 12		Fewer than two physical science subjects in Year 12	
Field of education	University	TAFE	University	TAFE
Science-related				
Natural & physical sciences	24.8	12.3	8.8	2.5
Information technology	4.1	4.8	4.3	6.7
Engineering & related technologies	30.6	36.4	4.0	8.9
Architecture and building	2.2	2.1	2.8	5.2
Agriculture, environmental & related studies	1.1	3.4	1.1	2.5
Health	19.5	11.4	11.9	4.2
Other				
Education	1.0	0.0	9.0	0.9
Management and commerce	9.6	14.1	23.0	25.5
Society and culture	6.1	7.3	22.6	19.1
Creative arts	0.9	0.0	12.1	15.8
Food, hospitality and personal services	0.0	8.1	0.3	7.4
Mixed field programmes/ Field not known	0.0	0.0	0.2	1.4
Total	100	100	100	100
(n)	397	25	2005	996

Table 4.5 Field of education in university or TAFE by extent of any science study in Year 12 for students who completed Year 12 in 2004 and 2005

	Two or more science subjects in Year 12		Fewer than two science subjects in Year 12	
Field of education	University	TAFE	University	TAFE
Science-related				
Natural and physical sciences	24.6	10.6	5.9	1.8
Information technology	2.6	3.1	5.0	7.1
Engineering and related technologies	19.3	10.1	3.8	9.5
Architecture and building	1.6	1.6	3.2	5.5
Agriculture, environmental and related studies	1.9	2.9	0.7	2.5
Health	23.9	12.8	8.6	3.4
Other				
Education	3.3	1.3	9.5	0.9
Management and commerce	9.4	15.6	25.6	26.3
Society and culture	11.6	21.5	23.4	18.5
Creative arts	1.7	11.4	13.9	15.8
Food, hospitality and personal services	0.1	9.1	0.2	7.3
Mixed field programmes/ Field not known	0.0	0.0	0.2	1.5
Total	100	100	100	100
(n)	712	106	1689	915

Note: Analyses by Sheldon Rothman and Julie McMillan.
Source: Longitudinal Surveys of Australian Youth.

Even though there was a lower propensity for all Year 12 students to proceed to University from the class of 2004/5 than from the class of 1998, the relative probabilities of entering university for physical science specialists compared to other science specialists and all Year 12 students remained similar. Those who specialised in the physical sciences were 12 to 15 per cent more likely than those who specialised in the sciences in general to commence university. Science specialists in general were 60 per cent more likely than other Year 12 students to commence university. Physical science specialists were 80 per cent more likely to commence university than Year 12 students in general. These relative probabilities held constant across the two cohorts.

Data from LSAY also allow an analysis of the fields of study for the first post-secondary course of study of these Year 12 students. Data for the cohort that completed Year 12 in 2004/5 are recorded in Table 4.4.

As shown in Table 4.4, 82 per cent of those who studied two physical science subjects in Year 12 and studied at university studied in a science or technological field. For this group the most common broad field of education was engineering and related fields (31%), followed by the natural and physical sciences (25%) and then health (20%).

Table 4.5 indicates that 74 per cent of those who studied any two science subjects and continued to university studied in a science-related field. For this group the most common fields were the natural and physical sciences (25%) and health (24%) followed by engineering and related fields (19%).

For both groups of science specialists who entered university the most common non-science fields of study were society and culture (6.1% for the physical science specialists and 11.6% for the science specialists), management and commerce (9.6% and 9.4% respectively). Overall, more than 70 per cent of science specialists and more than 80 per cent of physical science specialists from Year 12 who entered university, studied in a science-related field.

Seventy per cent of physical science specialists from Year 12 who pursued studies in TAFE continue to study in science-based areas especially in engineering and related fields (studied by 36 per cent of this group). Only 41 per cent of the more general science specialists (those who studied any two sciences) who went to a TAFE institution then studied in a science-related field such as engineering or the natural and physical sciences.

Figure 4.2 represents the percentage of university entrants, with different Year 12 subject backgrounds, who studied in various fields of education at university.

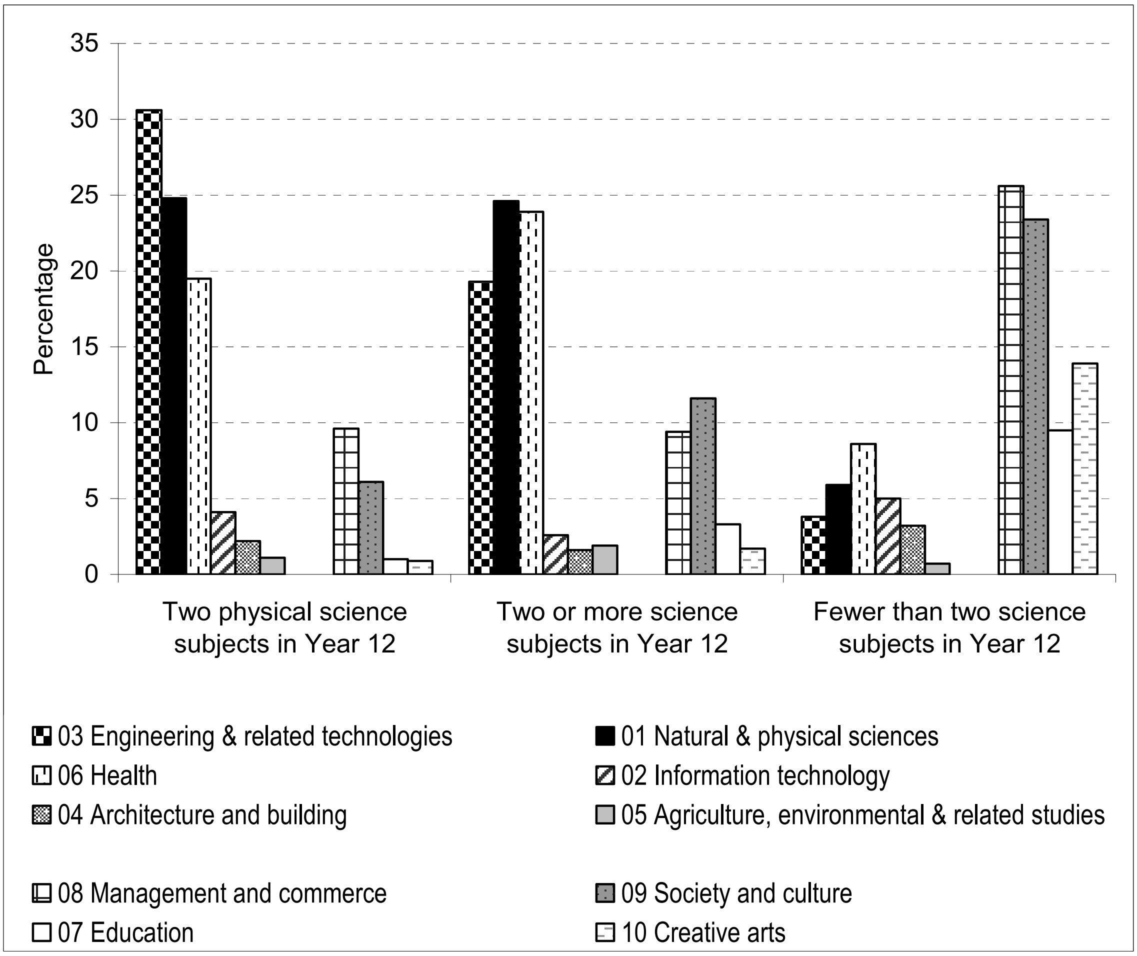

Figure 4.2 Percentage distribution across fields of study at university by science background of students who completed Year 12 in 2004/5

4.3 Course transfer, attrition and completion

4.3.1 Previous studies of course completion

In the previous report on participation in science, technology, engineering and mathematics, reference was made to completion rates in science-related fields of study (Committee for the Review of Teaching and Teacher Education, 2003a). Urban et al. (1999:18) had analysed a longitudinal database of 130,000 domestic students who enrolled in an undergraduate course at the start of 1992 and found that completion rates varied by field of study. Management and commerce, the natural and physical sciences and society and culture showed the lowest completion rates with between 35 and 40 per cent of students enrolled in these courses not completing. Completion was also low among engineering students. Completion rates were highest in veterinary science, health, education and law. However, after taking into account differences in the characteristics of students in these fields of education (including ENTER scores), Urban et al. (1999:19) concluded that field of study had significant effects on completion only in health.

Martin et al. (2001) followed similar procedures making use of additional information on the 1992 cohort and corresponding data from the 1993 entry cohort (of just over 130,000 students).

Completion rates for veterinary science (almost 90 per cent) and health (77 per cent) were substantially higher than those for society and culture (58 per cent), science (58 per cent) and engineering (59 per cent). From these analyses it could be concluded that around 58 per cent of students entering a science or engineering course, but around 79 per cent of those entering a health course and 76 per cent of those entering nursing, would have completed that course within seven years after commencement. Undergraduate science students, along with their peers in society and culture, appeared to be the least likely to complete their courses. It is possible that students begin courses in these fields with less clear goals than students entering courses in other fields of study and are more likely to change goals during their course (possibly dropping out of study). It is also possible that employment options for these general courses may appear less clear to students during their course.

4.3.2 Recent studies of progress through courses

Since those analyses that were referenced in the previous report (Committee for the Review of Teaching and Teacher Education, 2003a) two new analyses based on longitudinal data have been published. Both of these refer to students entering university from school rather than to the wider range of students included in administrative data bases.

The first of these studies refers to course transfer and attrition in the first year of university (McMillan, 2005:28). McMillan reported that among young people who first commenced higher education in 1999 or 2000, 13 per cent had changed courses within the higher education sector by 2001, and 14 per cent left the higher education sector after one or two years. Course change was highest among students in the natural and physical sciences (22%), then medicine, dentistry and veterinary science components of health (17%), society and culture (17%), and engineering and related technologies (13%). These fields of education effects were significant after allowing for differences in student characteristics such as their ENTER scores. Field of education was associated with attrition. Attrition rates were low in all areas of health (7% to 9%). Attrition was relatively high in architecture and building (23%), creative arts (17%), and society and culture (17%). Attrition in engineering (11%), the natural and physical sciences (13%) and information technology (15%) were near the average. Field of education remained statistically significant after controlling for the socio-demographic and academic mix of students.

The second of these new studies on course completion focused on a cohort of students who began university between 1998 and 2001 and were followed through until 2004 (Marks, 2007). Of that group 66 per cent had completed the course in which they first enrolled, 16 per cent had withdrawn, 11 per cent had changed course and 8 per cent were continuing. Course completion varied widely with field of education. Course withdrawal was very high in Information Technology (23%), followed by Architecture and Building (20%), Society and Culture (19%) and the Creative Arts (18%). For the natural and physical sciences the course completion rate was 64 per cent with 14 per cent having withdrawn, 16 per cent having changed course and six per cent continuing. For engineering and related technologies the course completion rate was 58 per cent with 17 per cent continuing, 13 per cent having withdrawn and 12 per cent having changed course. Marks (2007) also shows that most of the differences in completion rates are associated with differences in student background among the fields and especially differences in ENTER scores with course completion being much higher among those with higher ENTER scores.

4.3.3 Undergraduate course completions

Table 4.6 provides information regarding completions by domestic students from undergraduate courses (bachelor honours, bachelor pass and diploma) in science-related fields of study over the years from 2001 to 2006 together with total undergraduate domestic completions over the same period.

Table 4.6 Domestic undergraduate award completions by broad field of education from 2001 to 2006

		Year					
		2001	2002	2003	2004	2005	2006
Natural & Physical Sciences							
	Number	11,362	10,832	10,866	11,365	11,727	11,801
	Percentage	11.1	10.2	10.0	10.2	10.6	10.6
Information Technology							
	Number	5,419	6,193	6,543	6,273	5,659	4,646
	Percentage	5.3	5.8	6.0	5.7	5.1	4.2
Engineering & Related Technologies							
	Number	6,340	6,199	6,199	6,548	5,994	6,371
	Percentage	6.2	5.8	5.7	5.9	5.4	5.7
Architecture & Building							
	Number	2,295	2,328	2,361	2,358	2,583	2,719
	Percentage	2.2	2.2	2.2	2.1	2.3	2.4
Agriculture, Env. & Related Studies							
	Number	2,846	2,775	2,913	2,625	2,413	2,261
	Percentage	2.8	2.6	2.7	2.4	2.2	2.0
Health							
	Number	13,633	14,294	14,273	15,090	15,299	15,958
	Percentage	13.3	13.5	13.1	13.6	13.8	14.4
Total science-related							
	Number	41,389	42,109	42,557	43,599	43,009	43,014
	Percentage	40.4	39.7	39.0	39.3	38.8	38.7
Total domestic undergraduate completions		102,518	106,162	109,167	110,980	110,856	111,027

Source: Students, Selected Higher Education Statistics (DEEWR): Award course completions for Domestic Undergraduate students by Broad field of education

The general pattern of domestic undergraduate completions is that the total number of domestic graduates from undergraduate courses in science-related fields makes up a little less than 40 per cent of all such graduates, yielding just fewer than 40,000 graduates in 2006.

Over the period from 2001 to 2006 there has been a small increase in the number of domestic undergraduate course completions in science-related fields of education. However, that increase has not kept pace with the increase in the total number of domestic undergraduate course completions. The net result has been a decline in the percentage of domestic undergraduate course completions from 40.4 to 38.7 per cent.

The trends in domestic undergraduate course completions for science-related broad fields of education are illustrated in Figure 4.3. Those data indicate a substantial increase in completions for the health field of education and a substantial decline (since a peak in 2003) in completions in information technology.

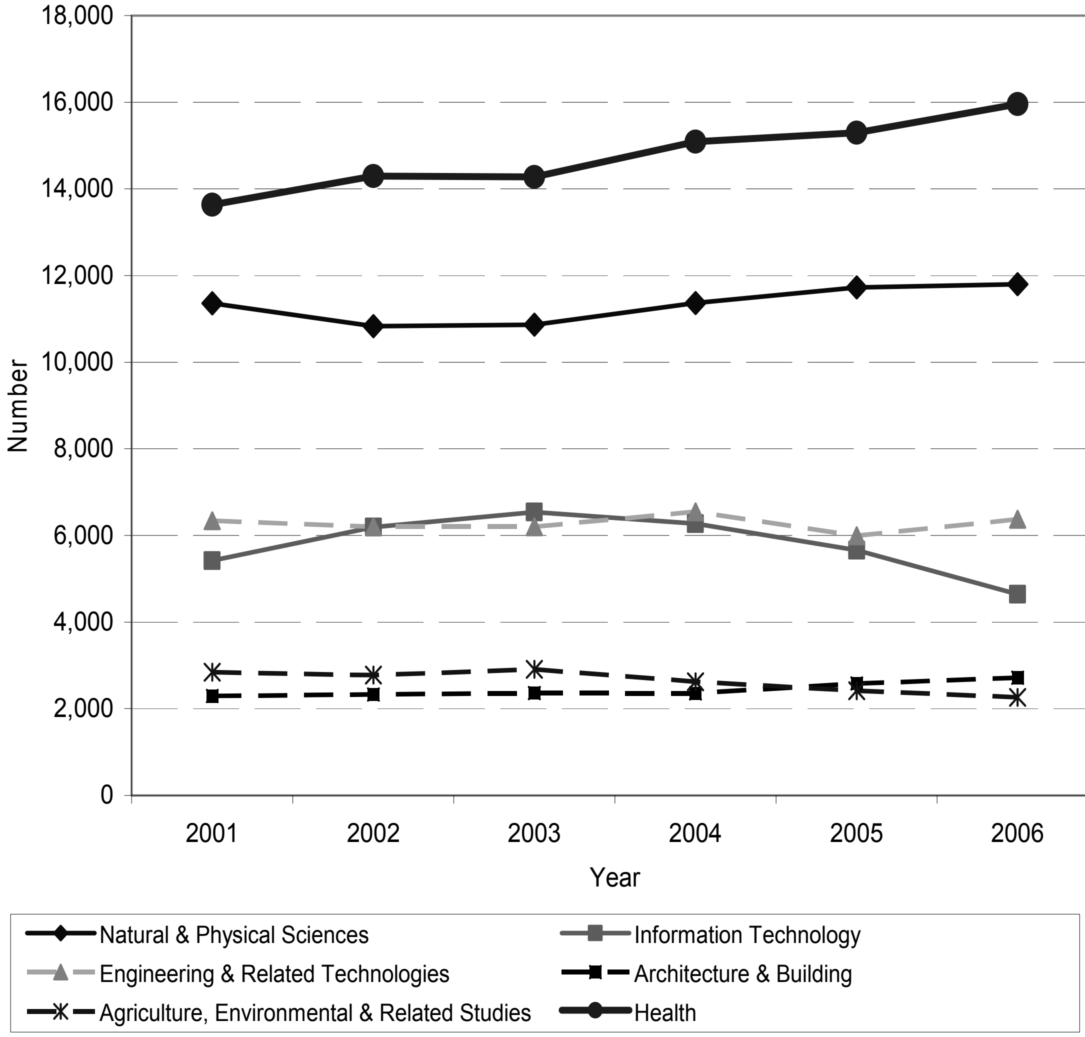

Figure 4.3 Trends in completions of science-related fields of education from 2001 to 2006

In the natural and physical sciences there was a decline in 2002 and 2003 followed by a recovery from 2004 to 2006 resulting in numbers a little greater than in 2001. Completions in engineering and related fields have remained fairly constant over the six-year period. Completions in the two small fields of agriculture and environment and architecture and building have remained constant.

Table 4.7 Percentage distributions of completions and commencements across science-related fields of education for two paired years

	2005 Completions	2006 Commencements	2001 Completions	2002 Commencements
Natural & Physical Sciences	10.6	9.8	11.2	11.2
Information Technology	5.1	3.4	5.5	7.1
Engineering & Related Technologies	5.4	6.1	6.4	7.3
Architecture & Building	2.3	2.8	2.1	2.0
Agriculture, Environmental & Related Studies	2.2	1.9	2.9	2.5
Health	13.8	15.5	13.4	11.9
Total	38.8	38.5	41.5	42.0

Source: Students, Selected Higher Education Statistics (DEEWR)

Although there are fluctuations in these completions data, there does not appear to be a noticeable decline in the percentage of graduations in science-related fields of study. If the distribution of commencements for 2006 is compared with completions for 2005 (as is shown in Table 4.7), there does appear to be an indication of an increase in health participation and a decline in participation in information technology. This is different from the pattern observed in 2001 and 2002 which reflected an increase in information technology and a decline in health participation.

4.4 Summary

Commencing enrolments by domestic students in undergraduate courses in science-related fields varied over the period from 2001 to 2006. The overall pattern appears to have been of decline in information technology and a rise in health with a steady state in the physical and natural sciences, and in engineering. A similar steady state was evident in architecture and agriculture. There is evidence of a strong connection between specialising in science in the final year of secondary school and commencing science-related fields of education at university. Three-quarters (77%) of those studying two physical science subjects, and two thirds (67%) of those studying any two science subjects in school continued to university. Four out of five (82%) of those physical science specialists, and three quarters (74%) of the more general science specialists, who went to university studied in a science-related field. Completions in science-related fields reflect the flow through of the pattern for commencements. There has been growth in health and a decline in information technology.

5
TEACHER EDUCATION

5.1 Introduction

Each year more than 20,000 university students graduate from initial teacher training programs. The search for appropriate policy responses in relation to participation of students in science, mathematics and technology needs to be informed by data about the characteristics of those teacher training graduates and their capacities to contribute to the teaching of science, mathematics and technology. This chapter examines the numbers and backgrounds (and especially their backgrounds in science) of those commencing teacher education and teacher training, their fields of specialisation and the extent to which they begin work as teachers following graduation.

5.2 Initial teacher education

5.2.1 Commencements

In Figure 5.1 trends in domestic student commencements in postgraduate (other than masters) and undergraduate initial teacher education courses are illustrated.

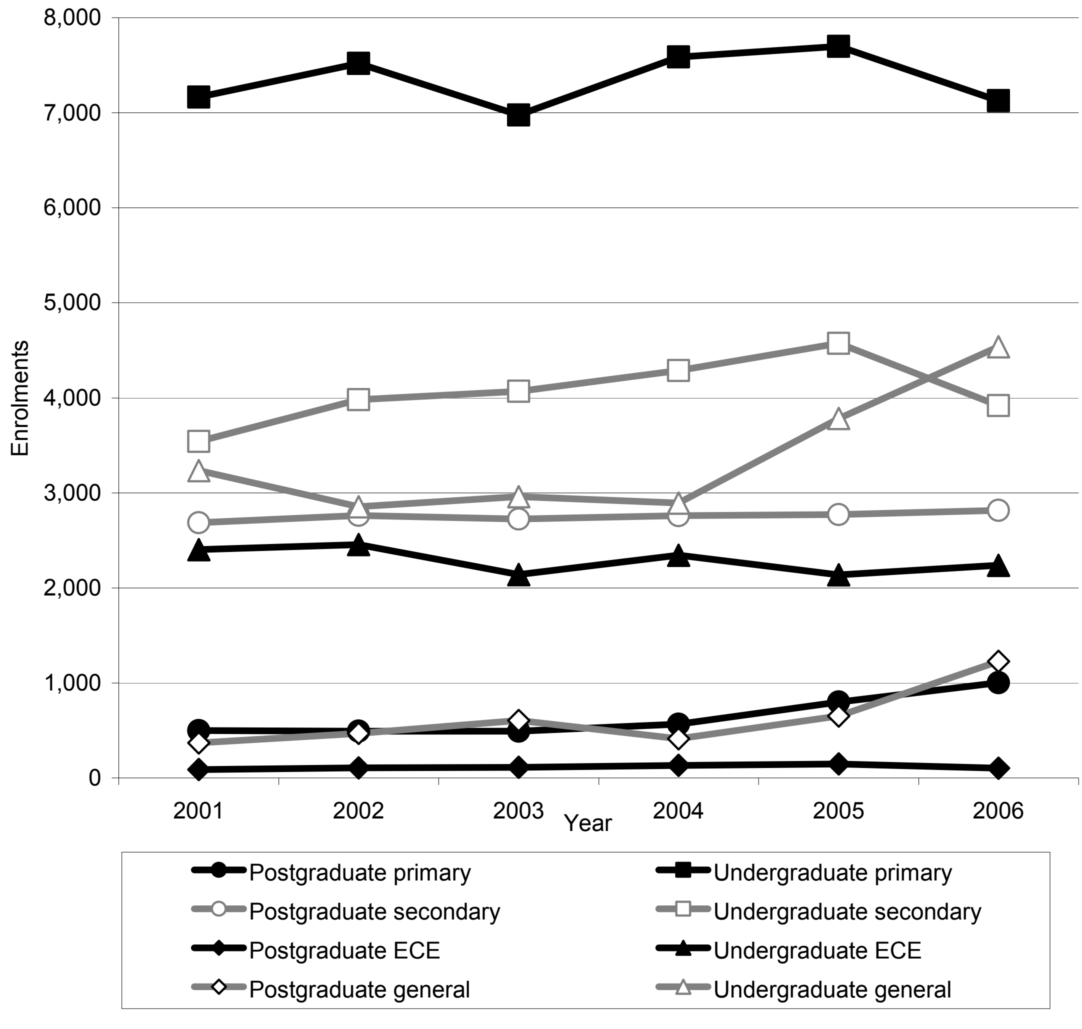

Figure 5.1 Commencing domestic enrolments in initial teacher education courses for selected fields of education and level of course, 2001 to 2006

Table 5.1 Commencing domestic students enrolled in initial teacher education courses by detailed field of education and level of course, 2001 to 2006

	Primary	Secondary	Unspecified Level	Early Childhood	Specialist	Total
2001						
Masters: course work	22	37	18	1	0	78
Other postgraduate	499	2,687	368	89	145	3,788
Undergraduate	7,166	3,541	3,234	2,403	682	17,026
2002						
Masters: course work	7	6	15	3	5	36
Other postgraduate	493	2,764	470	106	163	3,996
Undergraduate	7,519	3,980	2,854	2,455	670	17,478
2003						
Masters: course work	9	3	20	4	8	44
Other postgraduate	492	2,725	604	112	156	4,089
Undergraduate	6,977	4,068	2,961	2,141	618	16,765
2004						
Masters: course work	13	7	27	4	15	66
Other postgraduate	566	2,759	412	133	203	4,073
Undergraduate	7,587	4,287	2,892	2,343	575	17,684
2005						
Masters: course work	6	7	19	9	17	58
Other postgraduate	799	2,771	652	146	213	4,581
Undergraduate	7,700	4,573	3,784	2,139	554	18,750
2006						
Masters: course work	5	6	20	55	17	103
Other postgraduate	1,002	2,815	1,227	104	274	5,422
Undergraduate	7,128	3,920	4,539	2,238	375	18,200

Source: Selected Higher Education Statistics, Students, (DEEWR)
Notes: Detailed fields of education have been collapsed to form the five groups shown.
Specialist refers to special education, higher education, vocational education, nurse education, teacher librarianship.

Table 5.1 provides data on domestic student commencements in initial teacher education courses at various levels from 2001 to 2006.

In these data it is evident that there has been an increase in commencements in general initial teacher education courses not specified as either primary or secondary and this is evident for both undergraduate and postgraduate courses. In addition there is evidence of a small but steady rise in postgraduate commencements in initial primary teacher education since 2003. Between 2005 and 2006 there was a decline in undergraduate commencements in primary and secondary education.

In the Lee Dow review of teaching and teacher education in the sciences (Committee for the Review of Teaching and Teacher Education, 2003a) it was noted that commencements by domestic students in teacher education courses declined from the beginning of the 1990s to 1994 and increased from 1995 to 2002. The overall growth in commencements from 1995 onwards was more a result of a growth in initial primary teacher education courses than of growth in initial secondary teacher education. There was also a growth in commencements in initial general teacher education programs. It was also noted that there had been a net rise over the period from 1990 to 2002 in commencements in graduate courses in secondary teacher education and a small decline in commencements in undergraduate secondary teacher education courses.

5.2.2 Bases for entry

There is a number of ways to commence an initial teacher training course. Table 5.2 details the numbers entering teacher education programs. The two most common ways are entry following successful completion of another tertiary course, and successful completion of the final year of secondary school. Together these sources made up approximately 70 per cent of the entrants to teacher training in 2006. There is also a number of individuals who transfer from an incomplete tertiary course (14%) enter on the basis of having undertaken a TAFE program (10%) or enter on another basis such as an assessment by the institution, employment experience, a professional qualification or another basis (20%).

Table 5.2 Bases for admission to initial teacher training courses

		2001	2002	2003	2004	2005	2006
Completed secondary education[a]							
	Number	6146	5761	5348	5334	6119	6991
	Percentage	29.3	26.8	25.6	24.5	26.2	29.5
Higher education course							
	Number	8826	9362	9781	10,536		
	Percentage[b]	30.0	31.1	33.5	33.8	10,636	10,367
Incomplete higher education course						45.5	43.3
	Number	2543	2675	2772	3159		
	Percentage[b]	12.2	12.4	13.3	14.5		
TAFE Course (complete or incomplete)							
	Number	1588	2034	1895	2089	2318	2304
	Percentage	7.6	9.5	9.1	9.6	9.9	9.7
Other[c]							
	Number	4361	4353	3874	3864	4316	3947
	Percentage	20.9	20.2	18.5	17.7	18.5	16.6
TOTAL		20,921	21,510	20,898	21,823	23,389	23,725

Source: Australia. Parliament, House of Representatives Standing Committee on Education and Vocational Training (2007). Top of the Class. Canberra: Commonwealth of Australia. Table 3, Page 52. for 2001 through 2004
DEEWR Higher Education Statistics Collection for 2005 and 2006

Notes: [a] *Includes a very small number who complete through TAFE (0.5%) as well as the vast majority who complete through school.*
[b] *The percentages for the combined higher education categories (complete plus incomplete) over 2001, 2002, 2003 and 2004 are 42.2, 43.5, 46.8 and 48.3 per cent.*
[c] *Includes mature age or other special provisions, assessment by institution, employment*

It is evident from the data in Table 5.2 that there was a decline in the proportion entering teacher training on the basis of a completed secondary education from 2001 to 2004 but an increase in 2005 and 2006. Concomitantly there was an increase in the numbers entering teacher training on the basis of a higher education course (both complete and incomplete) from 2001 to 2004 followed by a decline in those numbers in 2005 and 2006.

The House of Representatives report of its inquiry into teacher education noted that those who enter teacher education direct from school are selected primarily on the basis of academic achievement in their end of school assessment as represented by their ENTER score and university graduates who enter teacher education programs are selected primarily on their Grade Point Average (Australia, 2007). The report observed that a wider range of processes was used in the selection of mature-age applicants including interviews, referee reports and industry recognised qualifications and experience. There is also a range of provisions under equity and access programs that utilise other criteria.

The House of Representatives inquiry into teacher education noted that “mature-age” entrants constituted a significant proportion of the intake to teacher training in some institutions (Australia, 2007: 51-53). Mature-age entrants include those entering teacher-training as a career change and may include entrants under access and equity programs. When there are substantial numbers of mature–age entrants there appear to be associated modifications to course design and structure (although the question of cause and effect is not clear). A report by Lawrance and Palmer (2003) examined practices and innovations in initial teacher education for science, mathematics and technology in 36 universities. The report includes case studies of innovative practice including issues associated with the recruitment of people from other careers entering teacher training.

5.3 Characteristics of teacher education students

5.3.1 Entry requirements

An issue that is of significance in discussions about teacher education is the academic background of students entering teacher education courses. This is often focused on the tertiary entry scores (or strictly the tertiary entry percentile ranks) required as the minimum to gain normal admission from school to a teacher education course. The data in Table 5.3 indicate that over the period from 2001 to 2004 there was an increase in the tertiary entrance scores required for admission to undergraduate teacher education courses. There was a small improvement in the median scores (from 78 to 82) and a more marked improvement in the 10^{th} percentile (from 64 to 70). The latter suggested that the improvement had been mostly at the lower end of the distribution of minimum entry requirements. However, the data for 2005 and 2006 indicate a slipping back in the academic requirements for entry to initial undergraduate teacher education programs.

Table 5.3 Tertiary Entrance Score statistics for commencing undergraduate teacher education students entering on the basis of a completed secondary education

	ENTER Score Characteristics		
	10th Percentile	Median	90th Percentile
2001	64	78	90
2002	68	80	91
2003	69	81	91
2004	70	82	92
2005	64	80	92
2006	64	78	91

Source: Australia (House of Representatives Standing Committee on Education and Vocational Training) (2007). Top of the Class. Canberra: Commonwealth of Australia. Appendix F, pp 210-219 plus DEEWR Statistics for 2006.

The Australian Mathematical Sciences Institute (AMSI) argues that of the 31 institutions offering undergraduate teacher education programs in 2005 only four universities required Year 12 mathematics as a pre-requisite for entry to teacher education and only a further eight require Year 11 Mathematics (AMSI, 2005). Fifteen of the programs specified mandatory mathematics content (as well as mathematics education) as part of the course (with a further 12 specifying mathematics education content alone).

5.3.2 Other background characteristics

Table 5.4 records the results of an examination of the characteristics of students in teacher education courses, compared to other university courses undertaken using data from the Longitudinal Surveys of Australian Youth (LSAY). The analyses parallel those previously reported for an earlier cohort from LSAY (Committee for the Review of Teaching and Teacher Education, 2003a).

The data in Table 5.4 are based on a cohort of young people who had been selected in a nationally representative sample of more than 10,000 when they were in Year 9 in 1998. Those who continued uninterrupted through school completed Year 12 in 2001. Their progress has been followed each year since 1998. These analyses are based on the group of 3,500 who had participated in university study and with whom contact had been maintained up to and including 2004. Longitudinal data enables educational and occupational status to be measured at a time or cumulatively to show whether a person ever participated in a particular educational or occupational activity. In addition, it enables these status attainment data to be linked to background information gathered earlier.

In the analyses presented in Table 5.4 the characteristics of those who had been in initial teacher education at any time since leaving school and up to 2004 are compared with those who participated in other fields of education at university. Most of those in initial teacher education had been in undergraduate education courses rather than graduate courses.

Table 5.4 presents a picture consistent with other data regarding the characteristics of those participating in initial teacher education programs (Carrington and Pratt, 2003). However, it provides a measure of the extent of difference between those students and other university students and adds perspectives that have not been possible to obtain from cross-sectional data.

Table 5.4 Characteristics of students in initial teacher education and other university courses: Students entering courses 2002 to 2004

Characteristic	Category	Percentage of students in category	
		Initial teacher education	Other university courses
Gender			
	Male	22.1	44.9
	Female	77.9	55.1
Parental Occupation			
	Professional	47.1	64.3
	Clerical	13.7	9.9
	Skilled	22.5	15.9
	Semi/unskilled	16.7	9.8
Parental Education			
	Higher Education (at least one parent)	37.6	50.4
	Trade/Technical	28.6	22.8
	Complete secondary	19.5	17.8
	Not complete secondary	14.3	9.1
Parental Birthplace			
	Australia (both parents)	69.3	57.2
	Other English speaking (at least one parent)	15.6	15.5
	Non-English speaking (at least one parent)	15.1	27.3
Location in Year 9			
	State capital	41.9	55.9
	Urban region	20.3	16.2
	Large provincial city	12.9	9.2
	Small provincial city	6.9	2.6
	Other rural	18.0	16.1
School sector			
	Government	59.0	47.5
	Catholic	25.4	29.0
	Independent	15.7	23.5
Year 9 achievement			
	Highest (>1 sd)	19.8	36.1
	High (> mean)	44.7	44.9
	Low (< mean)	27.2	15.6
	Lowest (>1 sd)	8.3	3.4
Numbers		217	3482

Source: *Longitudinal Surveys of Australian Youth based on the cohort of students in Year 9 in 1998 who were followed through to the end of 2004. Analyses by Kylie Hillman.*

Notes:

Information on background characteristics not available for all respondents, but the totals are based on the overall frequency count.

Location based on the MCEETYA categories (Jones, 2005).

Parental occupation based on father's occupation and the mother's occupation if father's missing.

Parental education based on the highest attainments of fathers and mothers.

Parental country of birth based on one parent (father or mother) being from a country where English is not the predominant language.

The data in Table 5.4 indicate the preponderance of young women in these initial teacher education programs. Young women make up 78 per cent of those in these courses compared with 55 per cent of other university courses. According to data from the DEEWR Higher Education Statistics Collection the percentage of females commencing in teacher education in undergraduate courses was 76 per cent in 2003 and 2004 which is within the confidence interval for the percentage based on the LSAY sample. In 2006 the overall percentage of females in teacher education was 70 per cent being made up of 75 per cent in undergraduate courses and 70 per cent in postgraduate courses.

According to the LSAY data there were several characteristics of students entering teacher education programs that differed from entrants to other university courses.

- Teacher education students were more drawn from the middle and bottom of the socioeconomic distribution (in terms of parental occupation and education) compared with other university students.
- Compared to other university students, teacher education students were more frequently from families of Australian born parents and less frequently from families whose parents came from a country where the main language was not English.
- Those in initial teacher education courses were less likely than their peers in other university courses to have grown up in state capital cities and a little more likely to have grown up in provincial cities and rural areas.
- Those who entered teacher education were more likely to have come from a government and less likely to have come from an independent or Catholic school than their peers in other university courses.
- In terms of school achievement in reading and mathematics in Year 9, students in initial teacher education were less likely than their peers in other courses to come from the highest achievement group (the difference is 20 compared to 36 per cent) and more likely to have been from the low or lowest groups (the difference was 35 compared to 19 per cent). This evidence is consistent with data on tertiary entry score requirements for teacher education courses.

This picture of the social and demographic characteristics of teacher education students is similar to that reported for an earlier cohort of students entering teacher education in the period from 1999 to 2001 (Committee for the Review of Teaching and Teacher Education, 2003a). Any differences with those earlier data are likely to be a result of sampling and changes in coding structures.

5.3.3 Graduates from science-related fields of study

A previous section of this chapter focussed on overall commencements in initial teacher education courses and the immediately preceding section focused on characteristics of entrants to undergraduate initial teacher education courses. This section reports on the percentages of graduates from science-related fields of education that enter teacher training or teaching. Table 5.5 provides an overview of the destinations of graduates from science related fields in 2000 and 2005 and is based on data derived from the Graduate Destinations Survey (GDS) conducted annually by Graduate Careers Australia (GCA). The GDS involves a survey of the population of university graduates and has a response rate of approximately 60 per cent. So as to provide a picture of graduate entry to teacher education the percentage data from the GDS survey have been combined with numbers for bachelor pass and bachelor honours graduates from science-related fields of education taken from the DEEWR *Higher Education Statistics Collection*.

Table 5.5 Percentages of science, mathematics, engineering and technology bachelor degree graduates working full-time in schools or in teacher training for 2001 and 2006

	Males	Females	Persons
2001			
Engineering/surveying	0.2	0.7	0.4
Computer science	0.6	1.3	0.8
General/Life science	4.5	5.1	5.1
Mathematics	4.5	8.5	6.1
Physical science, chemistry, geology	3.1	3.4	3.3
Science related fields of study: Science and engineering	1.6	3.9	2.5
Estimated numbers in pool of science-related graduates	12,900	8,200	21,100
Estimated numbers of science graduates to teacher training	210	320	530
2006			
Engineering/surveying	0.7	1.4	0.4
Computer science	1.2	2.0	1.4
General/Life science	6.1	6.3	6.2
Mathematics	3.7	8.4	5.4
Physical science, chemistry, geology	3.8	4.8	2.7
Science related fields of education: Natural and physical sciences, information technology, engineering	2.1	4.4	3.0
Estimated numbers in pool of science-related graduates	14,100	8,800	22,900
Estimated numbers of science graduates to teacher training	300	390	690

Sources: Graduate Careers Australia. Based on tables supplied by Bruce Guthrie.
DEEWR Higher Education Statistics Collection

Notes: (a) Data for persons includes a small number of respondents for whom sex was not specified.
(b) Percentages refer to the numbers defined by each cell. As a result of there being more male than female graduates in the science-related fields specified a smaller percentage of males from some science related fields could result in a larger number of males from that field entering teacher training.

In 2006 three per cent of graduates from the science-based fields of education specified in Table 5.5 entered either initial teacher education or teaching directly. Given that there were approximately 22,900 domestic bachelors pass and bachelor honours completions from the natural and physical sciences, information technology and engineering broad fields of education in 2005, this suggests that there were approximately 690 graduate entrants from these science fields. There were approximately 21,100 domestic bachelor pass and bachelor honours completions from the science and engineering broad fields of study[14] in 2000. This suggests that there were approximately 530 graduate entrants to teacher education from these fields. The figure for 2006 was an increase of 0.5 percentage points over the figure for 2001 or in terms of numbers an increase of 160 over 530 from the corresponding science fields in 2001.

Overall a greater number of female than male bachelor pass or honours graduates from these science fields of education enter teacher training. In 2006 females constituted approximately 56 per cent of the graduates from science fields that entered teacher training. In 2001 the corresponding figure was 60 per cent.

The largest source of entrants, either in terms of percentages or numbers, to teaching preparation or teaching was general or life sciences. In both 2001 and 2006 approximately two-thirds of science graduates entering teacher education or teaching came from the general or life sciences. A relatively high percentage of graduates in mathematics entered teacher education or teaching but the number who had specialised in mathematics was relatively small. In 2006, just fewer than three per cent of graduates from the physical sciences entered teacher education or teaching but the number from this specialisation was a little greater than the number from mathematics. Very few graduates from engineering or information technology entered teacher education or teaching.

5.4 Teacher education graduates

5.4.1 Fields of specialisation

The Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) has identified significant recruitment difficulties in the secondary key learning areas of Science, Mathematics, Technology and Languages other than English through its reports on *Demand and Supply of Primary and Secondary School Teachers in Australia*[15]. At primary level, the most recent MCEETYA reports concluded that there was an adequate supply of generalist primary teachers, although recruitment difficulties were experienced in some geographic locations. In the previous report data regarding specialisations for intending secondary teachers in 2001 were derived from a report by Ballantyne et al. (2003). Evidence on specialisations for this report has been derived from a survey of final year teacher education students in 2005 (DEST, 2006)[16]. Those data are recorded in Table 5.6.

The data in Table 5.6 are not strictly comparable with those derived from Ballantyne et al (2003) for 2001 because the focus of that report was on more specific fields of science (Physics and Chemistry but not Biology) and on senior secondary mathematics rather than mathematics in general.

14 The difference in nomenclature reflects a changed classification structure from 2002 onwards. Information technology was part of the science broad field of study in 2000.

15 See MCEETYA reports published in 2005 (http://www.mceetya.edu.au/public/demand.htm) and 2003 (http://www.mceetya.edu.au/public/demand2003.htm)

16 The survey used a mix of printed forms (distributed in class or by mail) and electronic forms. The achieved sample was 1875 students.

Table 5.6 Distributions of specialisations among final year teacher education students intending to teach in secondary schools

	First Learning Area	Second Learning Area	Total
Mathematics	9.4	5.3	14.7
Science	16.9	9.9	26.8
Technology	4.9	4.4	9.3
English	14.2	7.2	21.4
Study of Society and Environment	20.3	15.7	36.0
Arts	11.8	4.9	16.7
Languages other than English	5.8	3.2	9.0
Health and Physical Education	13.0	1.7	14.7
Other or not stated	3.6	26.8	

Source: DEST (2006) Survey of final year teacher education students. Table 2, page 5.
Notes: a) The second learning area was only included if it was different from the first learning area.
b) N=1875

The data in Table 5.6 indicate a predominance of studies of society and environment along with English as the specialisations among final year secondary teacher education students. Fifteen per cent of final year teacher education students indicated mathematics as one of their two areas of specialisation and more than one quarter (27%) indicated one or more sciences as one of their two areas of specialisation. Fewer than one in ten final year secondary teacher education students had a specialisation in technology. Seven per cent of final year teacher education students indicated a combination of mathematics and science in their first or second areas of specialisations.

Among final year primary teacher education students there were few with specialisations in mathematics science and technology. Seven per cent indicated either a first or second specialisation in mathematics, six per cent indicated a first or second specialisation in science and nine per cent indicated a first or specialisation in technology.

The specialisations among secondary teacher education graduates can be compared with the distribution of time across learning areas in schools. Information about the share of the curriculum by learning area (based on LSAY) is shown in Table 5.7. The 2003 LSAY cohort was based on the national sample of students who participated in the 2003 OECD Programme for International Student Assessment (PISA) tests. The sample is a nationally representative sample of students who were 15 years of age in 2003. Due to State differences in average age at which children begin schooling, the 2003 LSAY sample was spread across a range of grades, with the majority in Year 10 when first interviewed. The statistics reported here are based on data for Year 12 enrolments in 2004, 2005 and 2006.

Table 5.7 Average percentage of enrolments in Year 12 in each key learning area in Australian schools for 1993, 1998, 2001 and 2004 to 2006

Learning area	Enrolment share			
	1993	1998	2001	2004-6
English	18.3	18.9	19.5	19.7
Mathematics	18.0	17.9	17.4	16.8
Studies of society and environment	23.0	20.3	20.0	19.0
Science	17.3	15.4	14.1	14.3
Arts	6.9	6.7	7.8	8.6
Languages other than English	1.8	1.9	1.9	1.9
Technology	10.7	13.7	14.2	13.0
Health and physical education	3.9	5.2	4.9	5.5

Source: Subject Choice Survey for 1993 (Ainley et al. 1994); Longitudinal Surveys of Australian Youth for 1998 and 2001 (Fullarton et al. 2003); Longitudinal Surveys of Australian Youth unpublished data for 2004/2006, Tables prepared by Kylie Hillman.

It can be noted that the curriculum share among the eight learning areas in Year 12 has changed only slightly between 2001 and 2006 most notably in terms of a decline in technology and a rise in health and physical education.

There are fewer data about curriculum share available for the secondary school years up to and including Year 10. In the previous report (Committee for the Review of Teaching and Teacher Education, 2003a) information from a 2001 curriculum survey in Victoria was used. However, as shown in Chapter 2, those data probably understate the curriculum share in science. As a consequence we adjusted the notional shares to reflect the data about the time allocated to mathematics and science reported from the TIMSS reports (Thomson & Fleming, 2004a,b).

The data from that survey indicated that time was fairly evenly dispersed across all eight key learning areas but with more time allocated to the areas of English and mathematics and less to languages. A reasonable estimation of curriculum share in the Years up to and including Year 10 would be that approximately 15 per cent of teaching time was allocated to each of English and mathematics, 14 per cent was allocated to science and studies of society and environment, 11 per cent on each of technology, the arts, and health and physical education, and nine per cent of teaching time was allocated to languages other than English.

If these estimates are combined (with appropriate weighting) with the curriculum share for Years 11 and 12 it is possible to generate an approximate estimate of the curriculum share in terms of allocated class teaching time for each area and compare those data with the areas of specialisation among secondary teacher education graduates. The time allocations generated are English (17%), mathematics (16%), studies of society and environment (15%), science (14%), technology (12%), arts (10%), health and physical education (10%) and languages (7%). It should be emphasised that the estimates are only approximate at best. However, it would appear that the specialisations among graduates exceeds the curriculum share in studies of society and environment and science but is less than the curriculum share in mathematics and technology.

These estimates do not constitute an estimate of supply and demand because the supply of teachers includes, in addition to new graduates, teachers returning from leave, former teachers returning to teaching, teachers moving from the pool of relief and casual teachers, and teacher migrating to Australia. In addition the demand for teachers in particular specialisations does not simply depend on existing curriculum share but on differential loss through retirement and resignation.

5.4.2 Course completions

Information from the DEEWR Higher Education Statistics Collection provides an indication of trends in completions from initial teacher education courses from 2001 to 2006. Summary data recorded in Table 5.8 show a steady rise in completions (whether for all completions or just completions of initial teacher education courses). A focus on primary and initial secondary teacher education shows a clearer trend than for all of teacher education. In those two key areas there appears to have been an increase from 2001 to 2006. This continues the increase previously noted from 1999 to 2001 that had followed the period of stagnation from 1996 to 1999.

Table 5.8 Initial teacher education course completions by domestic students from 2001 to 2006

	2001	2002	2003	2004	2005	2006
All domestic initial teacher education completions						
Primary	4,546	4,901	5,398	5,667	5,968	5,853
Secondary	3,916	4,524	4,781	4,927	4,956	4,930
Unspecified level	2,555	2,583	2,478	2,709	2,486	3,135
Early childhood	1,310	1,503	1,760	1,651	1,654	1,540
Specialist	446	542	597	560	501	546
Total	12,773	14,053	15,014	15,514	15,565	16,004
Total all teacher education	18,199	20,004	20,546	20,530	20,945	21,841

Source: Selected Higher Education Statistics, Students, (DEEWR)
Notes: Detailed fields of education have been collapsed to form the five groups shown.
Specialist refers to special education, higher education, vocational education, nurse education, teacher librarianship.

The trends in completions for each of the categories (the concatenated detailed fields of education) are shown in Figure 5.2. Overall there was an increase of one quarter (25%) in completions of initial teacher education courses by domestic students over the period from 2001 to 2006. The increase in domestic completions in initial primary teacher education over the period was 29 per cent and for initial secondary teacher education was the increase was 26 per cent. For initial courses of unspecified level the increase was a little less than one quarter (23%). Completions in early childhood education increased by just fewer than one fifth (18%) and in specialist courses by a little more than one fifth (22%).

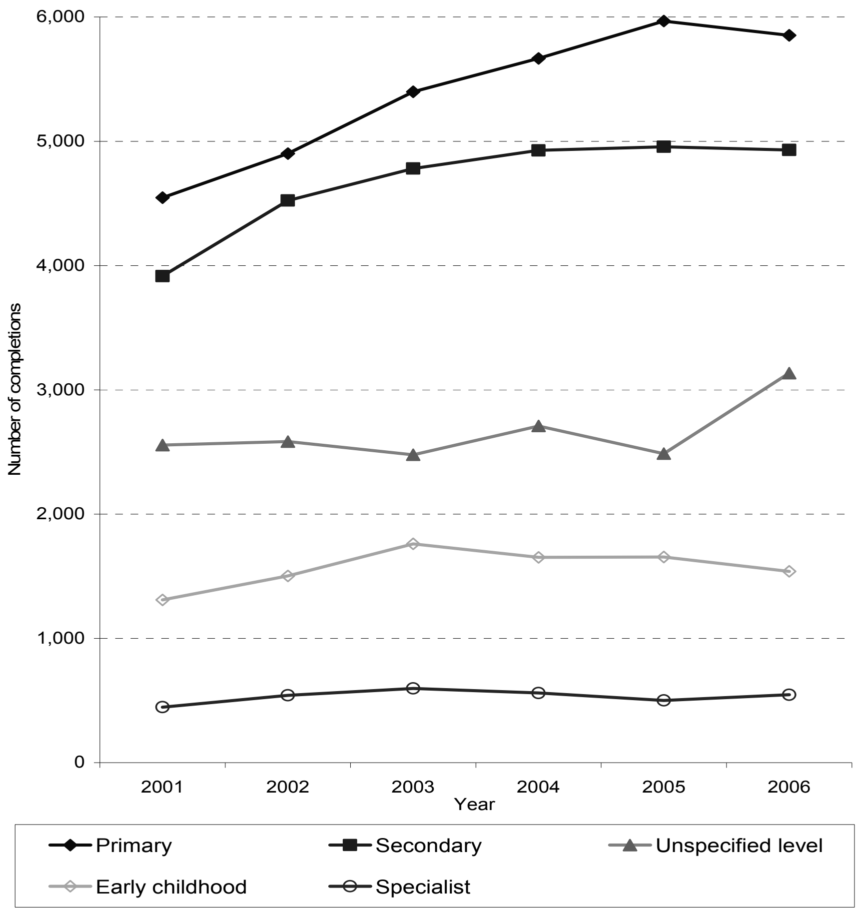

Figure 5.2 Trends in domestic completions in selected fields of initial teacher education, 2001 to 2006

5.4.3 Destinations

In the previous report information about the destinations of graduates in 2001 from teacher education courses was obtained from the *Graduate Destination Surve*y (GCA, 2002). For the present it was possible to use destinations data for 2006 from the same source to provide a comparison over the five-year period (GCA, 2007). Those data are recorded in Table 5.9.

The data from the graduate destinations surveys shown in Table 5.9 indicate that just over half (51%) of the graduates from initial teacher education courses in 2005 were working full-time in education in April 2006 following completion of their course. A further quarter of the graduates (25%) were working on a part-time basis. Just over one-tenth (11%) were working full-time in other industries, one in 20 (5%) were engaged in further study and seven per cent were not working (made up of three per cent who were seeking work and four per cent who were not seeking work). The 51 per cent of graduates working in education was made up of 29 per cent working in government or public schools, 15 per cent working in private or non-government schools and two per cent in higher education and five per cent in other educational institutions (such as TAFE).

There were some relatively small differences between male and female education graduates. A higher percentage of male graduates than female graduates were working in education (and specifically school education) and in other employment. In contrast a higher proportion of female graduates were working part-time (the majority not seeking full-time work) or not working.

The data in Table 5.9 also indicate some differences in destinations of teacher education graduates between 2001 and 2006. In 2006 a smaller percentage of graduates was working full-time in schools (the drop was eight percentage points). In contrast a larger percentage was working part-time but not seeking full-time work (the increase was just under five percentage points). In addition slightly larger percentages (two percentage points in each) were working in higher education and other industries.

Table 5.9 Percentages of graduates of teacher education courses from 2000 in various activities in April 2001 and from 2005 in various activities in April 2006

	Males	Females	Persons
Graduates from 2000 in 2001			
Education (full-time)			
Schools	53.1	52.8	52.8
Higher education	4.3	1.8	2.4
Other education	2.9	3.1	3.1
Total education	60.3	57.7	58.3
Working part time and seeking full-time work	10.6	9.8	10.0
Working part-time and not seeking full time work	6.3	10.1	9.3
Other employment	10.1	7.7	8.2
Further study (teacher training)	2.4	2.9	2.8
Further study (not teacher training)	5.6	5.1	5.2
Not working and seeking work	2.6	3.6	3.4
Not working or not available for work	2.1	3.0	2.8
Graduates from 2005 in 2006			
Education (full-time)			
Schools	47.4	43.6	44.4
Higher education	3.0	1.5	1.9
Other education	6.0	4.8	5.0
Total education	56.4	49.8	51.3
Working part time and seeking full-time work	9.7	12.0	11.5
Working part-time and not seeking full time work	9.3	15.1	13.8
Other employment	12.8	9.9	10.6
Further study (teacher training)	1.1	1.6	1.5
Further study (not teacher training)	4.1	3.5	3.6
Not working and seeking work	0.5	3.3	3.2
Not working or not available for work	3.7	4.8	3.7

Source: Graduate Careers Australia (2007). Based on tables supplied by Bruce Guthrie.
Notes: Data for persons includes a small number of respondents for whom sex was not specified. Number of respondents: 7,270 (for 2001) and 12,801 (for 2006).

It was also possible to use data from a follow up survey of 690 former teacher education students conducted in July of 2006 (DEEWR, 2006). Relevant data are recorded in Table 5.10. Respondents were asked their current teaching employment status.

The majority (85%) reported that they were currently working as a teacher. This is higher than the 75 per cent (full time and part-time) recorded by the GCA survey and the difference could arise from differential non-response in the DEEWR survey (the response rate was low) and from other differences in methodology. Of the remainder, five per cent were currently looking for work as a teacher and ten per cent were not working and seeking work as a teacher.

In terms of current status a higher percentage of female graduates (88%) were working as teachers than were male teacher education graduates (77%). A little over half (57%) were employed on limited term contracts (typically of four to 12 months duration), 28 per cent had permanent employment and 15 per cent working as casual or relief teachers. A little over one-quarter of new teachers (28%) were asked to teach outside their area of qualification with this being most frequently for teachers qualified as teachers of society and environment teaching English (and vice versa) and teachers qualified in science teaching mathematics (but not the other way around).

Table 5.10 Destinations of former teacher education students from 2005

Level/area	Current Status		
	Not working or looking for work as a teacher	Looking for work as a teacher	Working as a teacher
Early childhood	13.6	5.1	81.4
Middle schooling	8.3	8.3	83.3
Primary	7.3	5.3	87.3
Secondary	10.5	4.6	84.9
Special education	0.0	0.0	100.0
Other	30.8	0.0	69.2
Total	9.5	4.9	85.6

Source: DEEWR (2006) Survey of former teacher education students.

5.5 Summary

From 2001 to 2006 there have been increased numbers of students commencing teacher education courses. Over this time there has been a small but steady rise in postgraduate commencements in primary and secondary teacher education since and recently (towards the end of this period) a decline in undergraduate commencements in primary and secondary education. There has also been an increase in commencements in general teacher education courses not specified as either primary or secondary. The period since 2001 has seen an increase in the numbers of people completing teacher education courses. The increase in completions has been greatest in secondary teacher education but there has also been an increase in primary teacher education completions.

There has been no observable change in the social and academic composition of teacher education students. Compared to other university students, those who participate in undergraduate teacher education are predominantly female, a little less likely to come from professional backgrounds, a little less likely to have parents who had participated in higher education, less likely to have parents who migrated from a country where the major language was not English, more likely to have come from a non-metropolitan location, less likely to have attended an independent secondary school, and were less often drawn from the highest achieving group of students in the middle stages of secondary school.

6
CHARACTERISTICS OF THE TEACHING WORKFORCE

6.1 Introduction

Understanding the structure of the teaching workforce is an important element in understanding changes in the uptake of science, mathematics and technology studies in school and subsequently in university. Information about patterns of entrants to, and graduates from, teacher training courses can inform some of the prospects for change in the workforce composition but information about the current workforce helps to establish current capacities in science, mathematics and technology. This section provides some general characteristics of the teaching workforce and some specific characteristics of teachers of mathematics, science and technology. It draws on information from administrative data, from surveys of samples of teachers and from surveys of teachers of science.

6.2 General characteristics of the teaching workforce

6.2.1 Age profile

Recent data from the *Survey of Staff in Australia's Schools* (SiAS) based on the years 2006-7 suggests that 32 per cent of primary school teachers and 33 per cent of secondary school teachers are older than 50 years (McKenzie, Kos, Walker & Hong, 2008). As shown in Table 6.1 the age distribution shows an age by level of school interaction. A higher proportion of male secondary teachers (37%) than either male or female primary teachers or female secondary teachers (for each of these groups the figure is 30 or 32 years) are older than 50 years. The ageing of the teaching workforce appears to be particularly concentrated among male secondary school teachers.

Table 6.1 Percentage of teachers older than 50 years of age by level and gender

	Sex		
Level of school	Females	Males	Total
Primary	30.3	31.6	31.6
Secondary	30.3	37.4	33.3
Total	30.3	35.5	32.0

Source: McKenzie, Kos, Walker & Hong (2008). Staff in Australia's schools 2007. DEEWR: Canberra. Based on Tables 3.2 and 3.5.
Note: These data exclude people employed as teachers who are in designated leadership positions in schools.

These data can be placed in a longer term perspective by comparing SiAS with the previous surveys of teachers conducted by the Australian College of Educators (ACE). In 1963 20 per cent of teachers were aged more than 50 years, in 1979 the figure was six per cent, in 1989 it was nine per cent and in 1999 the percentage was 18 per cent. The data can also be compared to the OECD figures for 2004 of 28 per cent of primary teachers, 32 per cent of lower secondary and 35 per cent of upper secondary teachers being older than 50 years (OECD, 2006b).

At the other end of the age profile, 17 per cent of the teachers in the SiAS 2007 survey 2007 were 30 years of age or younger. This is a little smaller than the 1999 figure of 20 per cent and somewhat smaller than the figures from 1989 (26%) and 1979 (53%). Overall, the effect is that there has been a shift in the age distribution of the teaching workforce over the past two decades resulting in an increase in the percentage of teachers older than 50 years and a decline in the percentage 30 years of age or younger. Over the longer time span the loss of the younger end of the age distribution has been noticeable.

Other data from administrative records confirm that the average age of teachers has increased over time. The median age of teachers rose from 34 years in 1986 to 43 years in 2001 (ABS, 2003), and to 45 years in 2003 (MCEETYA, 2003). This increase is possibly associated with the ageing of the existing teacher population coupled with higher attrition rates of younger beginning teachers.

The age profile of teachers differs across school sectors and jurisdictions. Government school teachers tend to be older than non-government school teachers (ABS, 2006; MCEETYA, 2003). Among the government school systems, South Australia had the highest percentage of teachers aged 50 years or older (32% of primary teachers and 43% of secondary teachers) and Queensland had the lowest percentage (23% of primary teachers and 25% of secondary teachers). In non-government schools, approximately 27 per cent of secondary teachers were aged 50 years or over (MCEETYA, 2003).

6.2.2 Sex composition

A report on trends in the sex composition of the school education workforce in 2003 noted the steady increase in the percentage of teachers who were female over a 20-year period (ABS 2003: 103). In 1982 the ratio of female to male teachers was 1.4 whereas in 2002 the ratio was 2.1. The report also notes that the ratio of female to male teachers was larger in the primary teaching workforce (where the ratio rose from 2.4 in 1982 to 3.8 in 2002) than in the secondary (where the ratio rose from 0.8 in 1982 to 1.2 in 2002). More recent data has shown that trend has continued (ABS, 2007). Table 6.2 shows the increase in the percentage of teachers who are female over the period from 1996 to 2006.

Table 6.2 Percentage of primary and secondary school teachers who are female, 1996 to 2007

	Year											
	96	97	98	99	00	01	02	03	04	05	06	07
Primary	76.2	76.9	77.5	78.0	78.3	78.7	79.1	79.1	79.4	79.7	79.8	80.3
Secondary	52.6	53.1	53.5	54.1	54.4	54.9	55.1	55.3	55.6	56.0	56.6	56.8

Sources: ABS (2007) Australian Social Trends, Data Cube. cat. no. 4102.0
ABS (2008) Schools Australia 2007. cat. No. 4221.0 (for 2007)

There are differences among States and Territories in the sex composition of the school teaching workforce but these differences have diminished since 1996. In 2001, South Australia had the lowest percentage of female teachers in its secondary schools (53%) and primary schools (77%). The Australian Capital Territory and the Northern Territory had the equal highest percentages of females in their primary schools (82%) and the two highest percentages of females in their secondary school teachers (61% and 60% respectively). Over the period from 1996 to 2007 the gap between highest and lowest has closed.

6.2.3 Age and sex of teachers from an international perspective

It is possible to use the teacher survey data from the Trends in International Mathematics and Science Study (TIMSS) to examine the age and sex composition of the primary school teacher workforce from an international perspective (Mullis et al, 2004, Martin et al, 2004). Relevant data based on the questionnaire concerned with the teaching of mathematics have been summarised in Table 6.3. Information for the full range of countries that participated in the study can be found in the full reports for mathematics and science.

Table 6.3 Percentage of Australian Year 4 students whose teachers have specified characteristics compared with selected other countries for 2002 and 2003

	% Female		% ≥ 50 years old		Years teaching	
	%	SE	%	SE	Mean	SE
Australia	75	4.2	19	3.0	20	0.9
Belgium Flemish	78	2.7	14	2.1	16	0.7
Chinese Taipei	80	2.9	7	2.2	11	0.7
England	73	4.2	21	3.5	12	1.0
Hong Kong SAR	73	4.3	17	3.9	13	1.1
Hungary	94	1.8	19	3.2	19	0.8
Japan	63	3.8	23	3.6	19	0.8
Netherlands	64	4.6	28	3.9	16	1.1
New Zealand	81	2.5	19	2.3	12	0.6
Ontario Canada	76	3.8	28	4.5	13	0.9
Scotland	93	2.2	29	4.3	16	0.9
Singapore	84	2.9	15	2.7	10	0.8
United States	85	2.0	31	2.7	14	0.6
International average	80	0.6	21	0.7	16	0.2

Source: Mullis et al., 2004.

Notes: Standard errors for countries indicate the precision of the sample statistics and are approximately three or four percentage points.
Data are based on responses of teachers with respect to the teaching of mathematics. Only in Chinese Taipei were significantly different estimates generated for Year 4 science.
Years specified as 2002 and 2003 to correspond with data collection times that match the stage in the school year in northern and southern hemispheres.

It can be noted that that, for Australia, the percentage of females is within one standard error (and therefore well within the confidence interval) of the estimate based on the ABS data for 2002 (see Table 6.2). However, the percentage of teachers of Year 4 who are 50 years of age or older from these survey data is somewhat lower than the estimate from SiAS of the percentage of teachers who are older than 50 years in the full primary school teacher workforce of (19% compared to 30%).

On the basis of these data from TIMSS it appears that the Australian primary school teacher workforce is a little less predominantly female than the international average. Specifically Australia has a lower percentage of female primary school teachers than Hungary, Scotland, the United States or Singapore and a higher percentage than the Netherlands and Japan. In terms of the percentage of teachers who are 50 years of age or older Australia's primary teaching workforce (at least at Year 4) appears similar to the international average and similar to England and New Zealand. In Australian primary schools there is a lower percentage of teachers aged 50 or greater than in the United States, Scotland, the Netherlands or Canada but a higher percentage of such teachers than in Chinese Taipei or Belgium.

6.2.4 Qualifications

Table 6.4, taken from the SiAS report presents information on the qualifications in education held by teachers and leaders (McKenzie et al, 2008). Respondents were asked to indicate each qualification that they hold but the data do not reflect a notion of "highest" qualification so that a person recorded as having a Masters degree probably also holds a Bachelors Degree. Sixty-two per cent of primary teachers hold a Bachelor pass or honours degree in Education, 57% of secondary teachers, 66% of primary leaders and 61% of secondary leaders. Thirty-one per cent of secondary teachers and 17 per cent of primary teachers held a graduate diploma in education (this would be the initial education qualification for a person who first graduated in another discipline).

Table 6.4 Percentages of teachers and leaders who hold qualifications in education

	Teachers		Leaders	
	Primary %	Secondary %	Primary %	Secondary %
Certificate (non university)	8	7	9	6
Diploma (non university)	19	8	24	9
Certificate (university)	3	3	5	5
Diploma (university)	27	25	37	35
Bachelor degree	59	53	64	55
Bachelor degree with honours	3	4	2	6
Graduate certificate	4	7	6	8
Graduate diploma	17	31	30	34
Masters degree	6	8	26	34
Doctoral degree	<0.5	1	1	2
Other	3	4	6	4

Source: McKenzie, Kos, Walker & Hong (2008). Staff in Australia's schools 2007. DEEWR: Canberra. Table 4.1.
Note: Individuals can be recorded in more than one cell in each column because each person can hold multiple qualifications.

A number of teachers held higher degrees in education (six per cent of primary and nine percent of secondary teachers). Higher degrees are more frequently held by school leaders than teachers.

It is difficult to make direct comparisons of these data with the surveys conducted by the Australian College of Educators (ACE) over previous years because those surveys report the highest qualification in education rather than multiple qualifications and because the SiAS data separates teachers and leaders. The ACE surveys had shown that the teaching profession had become better qualified in education studies over the period from 1979 to 1999 (Dempster et al., 2000; Logan, Dempster, Chant & Warry, 1990; Bassett, 1980). However some points of comparison are possible. The 1999 ACE survey reported that 44 per cent of teachers had a Bachelors degree as their highest qualification and a further eight per cent held a higher degree in education (and therefore presumably also held a bachelor degree). That estimated 52 per cent in 1999 compares with the SiAS estimate of 62 per cent for primary teachers and 57 per cent for secondary teachers. In 1999 19 per cent of teachers held a graduate diploma of education as their highest qualification and in 2007 the figure was 17 per cent of primary and 31 per cent of secondary teachers.

It is less clear that there has been an improvement in qualification levels in fields other than education. As indicated in Table 6.5 the SiAS survey for 2007 showed that 15 per cent of primary teachers and 43 per cent of secondary teachers hold a Bachelors degree (pass or honours) in a field other than Education. This amounts to 29 per cent of all teachers. A small number of these primary teachers and four per cent of these secondary teachers also hold higher degrees in field other than education. The comparison is with the 31 per cent of teachers in the 1999 ACE survey who had a Bachelor degree as their highest qualification, and a further three per cent who held a higher degree as their highest qualification in a field other than education (Dempster et al, 2000). However, there is sufficient uncertainty about both sets of estimates that it is not possible to conclude that there has been any real change between 1999 and 2007.

Table 6.5 Percentages of teachers and leaders who hold qualifications in fields other than education

	Teachers		Leaders	
	Primary %	Secondary %	Primary %	Secondary %
Certificate (non university)	12	13	9	8
Diploma (non university)	4	5	3	2
Certificate (university)	1	1	1	1
Diploma (university)	2	3	2	3
Bachelor degree	13	36	11	29
Bachelor degree with honours	2	7	2	7
Graduate certificate	1	1	1	1
Graduate diploma	2	4	3	3
Masters degree	1	4	2	6
Doctoral degree	<0.5	1	<0.5	1
Other	7	6	7	5

Source: McKenzie, Kos, Walker & Hong (2008). Staff in Australia's schools 2007. DEEWR: Canberra. Table 4.2.
Note: Individuals can be recorded in more than one cell in each column because each person can hold multiple qualifications.

6.2.5 Income

According to the OECD data shown in Table 6.6 Australian teacher salaries in 2004 were comparable with those in other OECD countries in commencing salaries and in terms of salaries after 15 years. The OECD data also provide an indication of salaries at the top of the scale with minimum training. For Australia those are the same as the salaries after 15 years. For the OECD as a whole that figure is $42,357 for primary teachers, $45,277 for lower secondary teachers and $48,197 for upper secondary teachers. The comparisons at that point suggest that scales in some OECD countries extend further and grow more over time than in Australia but not in England the United States or Finland.

Table 6.6 Annual statutory teachers' salaries in public institutions in 2004 at starting salary, after 15 years of experience in equivalent US dollars

	Primary			Lower secondary			Upper secondary		
	Begin	15 Years	End Scale	Begin	15 Years	End Scale	Begin	15 Years	End Scale
Australia	29,712	43,991	43,991	30,062	44,139	44,139	30,062	44,139	44,139
OECD	*25,727*	*35,099*	42,347	*27,560*	*37,488*	45,277	*28,892*	*40,295*	48,197
European	*26,006*	*34,684*	41,945	*27,926*	*36,911*	44,401	*29,055*	*40,064*	48,039
England	28,769	42,046	42,046	28,769	42,046	42,046	28,769	42,046	42,046
United States	32,703	39,740		31,439	40,088		31,578	40,043	
Finland	27,922	32,541	32,541	32,407	38,318	38,318	34,825	43,526	43,526

Source: OECD (2006b) Education at a Glance. Paris: author. Table D 3.1
Note: Figure for 15 years refers to no additional qualifications and minimum training.

Information shown in Table 6.7, from the Graduate Careers Australia (GCA) graduate destination survey for 2007, suggests that the median commencing salary for education graduates compares well with those from other fields of education. The median starting salary for teacher education graduates in 2007 was $46,000 per year. Median starting salaries for dentistry, medicine, optometry, engineering and earth science exceeded this commencing salary. Median commencing salaries for all other fields were the same or less than those for teacher education graduates.

The data in Table 6.7 also indicate that between 2001 and 2007 the position of education graduates improved a little relative to other fields of education. The increase in the median starting salary for education graduates was $10,000 compared with an increase of $8,000 across all fields of education.

Within Australia an issue that is as important as starting salaries and comparisons with other countries is earnings in relation to other occupations. Banks (2008) argues that over 20 years from 1983 to 2003 female teachers' earnings fell from 114 per cent to 103 per cent of non-teachers' pay and male teacher's pay fell from 108 per cent to 91 per cent of non-teacher pay. Banks argues that shifts such as this affect teacher recruitment and retention especially in fields of education (such as science and information technology) where there are numerous other employment opportunities and for teachers who are seen to be highly able and sought after by other employers.

Table 6.7 Commencing salaries for graduates by field of study for 2001 and 2007

Field	2007	2001	Change 01 to 07
Dentistry	$68,000	$46,400	$21,600
Optometry	$56,500	$43,000	$13,500
Medicine	$51,000	$45,000	$6,000
Earth Science	$50,000	$35,900	$14,100
Engineering	$50,000	$40,000	$10,000
Education	$46,000	$36,000	$10,000
Mathematics	$46,000	$37,000	$9,000
Law	$45,000	$36,000	$9,000
Social Work	$44,000	$35,000	$9,000
Computing Science	$43,200	$40,000	$3,200
Paramedical	$43,000	$33,200	$9,800
Psychology	$42,900	$33,000	$9,900
Biological Science	$41,000	$33,000	$8,000
Accounting	$40,000	$33,500	$6,500
Agricultural Science	$40,000	$30,000	$10,000
Architecture & Building	$40,000	$30,000	$10,000
Economics & Business	$40,000	$32,500	$7,500
Veterinary Science	$40,000	$34,000	$6,000
Social Science, Other	$39,400	$33,000	$6,400
Humanities	$38,000	$32,000	$6,000
Physical Science	$37,000	$35,000	$2,000
Art & Design	$35,000	$30,000	$5,000
Pharmacy (pre-registration)	$34,000	$25,000	$9,000
All Fields	$43,000	$35,000	$8,000

Sources: Graduate Careers Council of Australia (2001) Graduates in 2001, Gradstats No. 6. Carlton, Author. http://www.graduatecareers.com.au/content/vi
Graduate Careers Council of Australia (2007) Graduates in 2007, Gradstats No. 12. Carlton, Author. http://www.graduatecareers.com.au/content/view/full/24

6.3 Characteristics of science, mathematics and technology teachers in secondary school

6.3.1 Sources of information

There are three major sources of information about the characteristics of those teaching science, mathematics and technology in Australian schools that have become available since the report on *Background Data and Analysis for the Review of Teaching and Teacher Education* was published (Committee for the Review of Teaching and Teacher Education, 2003a). These are the survey of secondary school science teachers conducted for the *Australian Council of Deans of Science* (ACDS) (Harris, Jensz & Baldwin, 2005); the *Survey of Staff in Australia's Schools* (SiAS) conducted for DEEWR (McKenzie, Kos, Walker & Hong, 2008), the data about teachers of Year 8 mathematics and science gathered as part of the *TIMSS 2002-3* achievement surveys (Mullis et al, 2004).

6.3.2 Age composition

The ACDS survey indicates that 37 per cent of male science teachers and 19 per cent of female science teachers were older than 50 years of age (Harris et al, 2005). At the other end of the age spectrum 25 per cent female science teachers were less than 30 years of age, compared to 13 per cent of males. The average age of male science teachers was 44 years and that of female science teachers was 39 years.

Direct comparisons with SiAS data for the whole secondary teacher work force are uncertain because of the different years in which the surveys were conducted (2004 and 2007), the limits on precision associated with any sample survey and potential bias arising from low response rates. However, in general terms it would appear that female science teachers are younger than female teachers overall. According to SiAS the average age of male teachers in 2007 was 46 years and that of female secondary school teachers was 43 years.

6.3.3 Demographic characteristics

According to the surveys of nationally representative samples of mathematics classes conducted for the IEA TIMSS 2002-3, approximately half of the Year 8 mathematics classes were taught be females (Mullis et al. 2004: 234). This was less than in Hungary, Slovak Republic, Belgium, Singapore or the United States, similar to England, Scotland, New Zealand, Hong Kong and Sweden and greater than in Japan and the Netherlands. Relevant data are recorded in Table 6.8.

There appears to be less variation in the age composition of the teachers of Year 8 mathematics although Australian Year 8 mathematics classrooms are less often taught by teachers over 50 years of age than in several European countries and more often than in Japan, Hong Kong and South Africa.

Table 6.8 also records information about teachers of Year 8 science classes based on the TIMSS 2002-3 (Martin et al, 2004). Those data indicate that Australian Year 8 students have science lessons taught by women teachers less often than the international average and specifically less often than in the Slovak Republic, Hungary, Belgium, Serbia and Singapore but more often than in the Netherlands or Japan. Also according to the data in Table 6.8 Year 8 science students in Australia were taught by teachers aged 50 years or older with approximately the same frequency as the international average. The percentage of students taught by teachers aged 50 years or older was less than in Serbia, Scotland, Slovakia or Sweden and greater than for Hong Kong or South Africa.

Table 6.8 Percentage of Australian Year 8 mathematics and science students whose teachers have specified characteristics compared with selected other countries for 2002 and 2003

	% Female		%≥ 50 years old		Years of teaching	
	%	SE	%	SE	Mean	SE
Mathematics						
Australia	49	4.7	24	3.7	16	0.8
Belgium Flemish	75	2.6	18	2.9	18	0.8
Chinese Taipei	46	4.1	18	3.3	14	0.9
England	54	6.2	23	0.5	16	0.1
Hong Kong SAR	53	4.3	10	2.3	12	0.7
Hungary	85	2.6	35	3.8	22	0.8
Japan	32	3.8	16	3.1	17	0.7
Netherlands	32	4.7	25	3.8	17	1.0
New Zealand	45	4.7	26	3.0	14	1.0
Scotland	50	4.7	29	3.9	16	1.0
Serbia	53	3.9	55	4.0	22	0.9
Singapore	67	2.3	20	2.1	12	0.7
Slovak Republic	79	3.6	39	4.3	21	1.1
South Africa	40	3.3	5	1.6	11	0.6
Sweden	44	3.6	37	3.2	14	0.8
United States	65	2.7	32	2.9	15	0.7
International average	58	0.5	23	0.5	16	0.1
Science						
Australia	46	3.6	21	3.2	15	0.8
Belgium Flemish	71	2.9	18	2.6	15	0.8
Chinese Taipei	41	4.1	19	3.1	13	0.8
England	55	4.5	23	3.7	13	1.1
Hong Kong SAR	41	4.6	9	2.6	12	0.9
Hungary	74	1.9	31	2.3	21	0.5
Japan	20	3.1	18	3.0	18	0.8
Netherlands	27	2.0	31	3.0	16	0.7
New Zealand	50	5.8	21	3.3	12	0.8
Scotland	45	3.3	40	3.3	18	0.7
Serbia	69	2.0	45	2.1	20	0.5
Singapore	64	2.6	21	2.3	12	0.6
Slovak Republic	78	1.9	39	2.7	20	0.7
South Africa	49	4.1	4	1.2	10	0.5
Sweden	45	3.6	34	2.7	13	0.7
United States	54	3.1	30	2.9	14	0.7
International average	60	0.5	22	0.4	15	0.1

Note: Standard errors for countries indicate the precision of the sample statistics and are approximately three or four percentage points.
Years specified as 2002 and 2003 to correspond with data collection times that match the stage in the school year in northern and southern hemispheres.
Sources: Mullis et al., 2004; Martin et al., 2004.

6.3.4 Teaching experience

SiAS provides perspectives on the experience of teachers who teach mathematics, science and technology (McKenzie et al, 2008). Information regarding the percentage of teachers of different subjects who have taught that subject for more than five years is shown in Table 6.9. The median value for the percentage of teachers with more than five years experience in the subject is 58 per cent. This median is about the same as that for English teachers (58%). The data also indicate that mathematics teachers tend to be more experienced than science or technology teachers. Teachers of environmental science, earth science and psychology are, on average, less experienced than teachers of other sciences.

Table 6.9 Percentage of Australian teachers of specified subjects with more than five years teaching experience in that subject, 2007

Currently teaching these subjects:	Percentage with more than five years teaching experience in that subject
English	59
Mathematics	67
Science	
Biology	60
Chemistry	58
Earth sciences	31
Environmental sciences	32
Physics	61
Psychology/Behavioural studies	43
Science – General	57
Technology	
Computing	62
Food technology	61
Graphic communication	53
Information technology	59
Media studies	51
Textiles	54
Wood or Metal technology	59

Source: McKenzie, Kos, Walker & Hong (2008). Staff in Australia's schools 2007. DEEWR: Canberra. Table 6.12.

6.3.5 Qualifications

As a result of the ACDS survey Harris et al (2005) report that in the sample of science teachers that they surveyed:

- 45 per cent had completed three or more years of biology study at tertiary level and a further nine per cent had competed two years of biology study;
- 34 per cent had completed three or more years of chemistry study at tertiary level and a further 18 per cent had competed two years of chemistry study;
- 17 per cent had completed three or more years of physics study at tertiary level and a further 12 per cent had competed two years of physics study;

In addition eight per cent had completed three or more years of Geology study with a further four per cent have completed two years of Geology study. Harris et al (2005) note that younger teachers were more likely to have studied a major in Biology, and less likely to have studied Physics, compared to older teachers.

The SiAS report relates teachers' science, mathematics and technology qualifications to current fields of teaching (McKenzie et al, 2008). Data from that report are contained in Table 6.10. If it is accepted that three or more years of university study in a field should be the basis for teaching in that field at Years 11 and 12 then nearly four out of five Biology teachers, three-quarters of Chemistry teachers and only three out five Physics teachers, meet that requirement. Applying the same criterion to mathematics the data indicate that just a little more than three out of five senior school mathematics teachers meet the requirement of three years of university study in mathematics. Only two out of every five teachers of Information Technology in senior school have studied in that discipline for three years at university. If the criterion for being qualified to teach a subject in senior secondary school was set at two years of university study in the field the percentages would obviously be different but still one quarter of physics teachers, one fifth of senior mathematics teachers, and nearly half of the senior information technology teachers, would not meet that less stringent criterion.

Table 6.10 Teachers teaching in selected areas: qualifications, experience and professional learning activities

Current field of teaching	Percentage of teachers in field in each category			
	Years of tertiary education in field			Have training in teaching methodology in field
	Two years	Three or more years	Total with two or more years	
Biology 11 -12	7	78	85	66
Chemistry 11-12	14	73	87	74
Physics 11-12	16	60	76	72
General Science 7/8-10	6	38	44	56
Mathematics 11-12	13	68	81	75
Mathematics 7/8-10	11	53	64	60
Information Technology 11-12	13	40	53	46
Information Technology 7/8-10	7	24	31	26

Note: *General science 7/8 – 10 refers to teachers teaching General Science and not Biology Chemistry or Physics at Years 11 and 12.*
Source: *McKenzie, Kos, Walker & Hong (2008). Staff in Australia's schools 2007. DEEWR: Canberra. Table 6.14.*

If it is accepted that two years of university study in a field should be a requirement for teaching that field in junior secondary school (that is up to Year 10) then three fifths of those mathematics teachers and only one third of those information technology teachers would meet that requirement. Among those who teach general science, but do not also teach a senior science discipline, a little more than two fifths meet the requirement. Of course many general science classes are taught by teachers who also teach a specialised science discipline in Years 11 and 12.

Table 6.11 Percentage of Year 8 students whose teachers report having a major area of study in science in selected other countries for 2002 and 2003

	Biology		Physics		Chemistry	
	%	SE	%	SE	%	SE
Australia	60	3.6	24	3.0	52	3.8
Belgium (Flemish)	63	3.2	37	3.3	43	3.4
Chinese Taipei	25	3.9	67	3.9	75	3.7
Hungary	39	1.7	20	1.3	26	1.5
Italy	54	3.5	6	1.8	3	1.1
New Zealand	59	4.6	31	4.3	53	5.9
Serbia	30	1.1	32	1.1	44	1.3
SouthAfrica	53	4.1	37	3.7	27	3.6
HongKong, SAR	37	4.2	34	4.1	37	4.8
Japan	35	4.3	33	3.4	42	4.4
Korea	35	3.3	27	3.5	25	2.9
Netherlands	29	1.9	16	2.3	16	2.2
Norway	32	4.5	16	3.3	23	4.1
Scotland	50	3.1	44	3.0	59	3.1
Singapore	47	2.7	51	2.4	63	2.6
Slovenia	58	1.6	34	1.7	57	1.9
Sweden	61	3.1	53	3.2	64	3.1
United States	46	3.3	14	2.3	25	2.7
England	59	4.1	39	4.5	47	4.8
International Avg.	46	0.5	32	0.4	40	0.5

Note: *Standard errors for countries indicate the precision of the sample statistics and are approximately three or four percentage points.*
Years specified as 2002 and 2003 to correspond with data collection times that match the stage in the school year in northern and southern hemispheres.
Source: *Martin et al 2004: 258.*

The ACE survey of 1999 indicated that 70 per cent of Year 12 mathematics teachers in 1999 had a three-year university study in mathematics and approximately 82 per cent had completed two or more years of university study in mathematics (Dempster et al.,2000). Other data from the ACE surveys indicate that there has been little change in the percentage of Year 12 mathematics teachers with three or more years of university study over the past 40 years, with the figure hovering between 70 and 75 per cent, except for a drop in 1979 to 65 per cent. A comparison of the 1999 data with the SiAS survey indicates that there has been little change between 1999 and 2007 in the percentage of mathematics teachers in Years 11 and 12 who are appropriately qualified. The percentage of Years 11 and 12 teachers of information technology who have three years of university study in that field appears to have declined from 1999 to 2007 (from approximately 48 to 40 per cent). For biology, chemistry and physics it is not possible to make the same comparison because the figure for 1999 was reported as an overall one of 83 per cent having studied three years in a science field compared with the more specific figures for 2007 of 78, 73 and 60 per cent for biology, chemistry and physics respectively. A problem with reporting in subject specific terms is that some fields of university study such as biochemistry, and many of the emerging fields of science study at university such as biotechnology or genetic engineering study, do not map uniquely on to the subjects that are studied in senior secondary school.

According to the TIMSS 2003 surveys a teacher with a major area of study in mathematics taught approximately 60 per cent of Year 8 mathematics classes (Mullis et al. 2004: 234) which is a little higher than the 53 per cent suggested by Table 6.10 (depending on how the term “major” was interpreted). In terms of Year 8 science teaching the TIMSS 2002-3 data indicate that 94 per cent of students were taught by teachers who had completed a university degree and 80 per cent of those had a major study in a field of science (Martin et al, 2004: 254-256). In other words 75 per cent of Year 8 students were taught science by a teacher who had completed a major study in a science discipline. Some of those teachers also taught a specialist discipline in Year 11 or 12 and some taught only junior secondary science.

The TIMSS 2002-3 survey data indicate that Year 8 science in Australia is most often taught by a teacher with a major study in biology and rather less often by a teacher with a major in physics (Martin et al, 2004: 258). As shown in Table 6.11 Australia is one of the countries in which there is a high percentage of Year 8 students taught by teachers with a major in biology. Other countries with around 60 per cent of Year 8 science teaching being by biology majors are Belgium, Sweden, New Zealand and England. In contrast in Hong Kong, Japan, Korea, Norway, Chinese Taipei and the Netherlands the corresponding figure is less than 40 per cent.

Australia also has a relatively small percentage (24%) of its Year 8 students taught science by a teacher with a major in physics. Other countries with fewer than 30% of students taught science by graduates with physics majors were Korea, Hungary, Norway, the Netherlands, the United States and Italy. In contrast in Chinese Taipei, Sweden, and Singapore more than 50 per cent of students were taught by teachers with a major in physics. Australia is about in the middle of the table in having just over half of its Year 8 students taught science by teachers with a major in chemistry.

6.4 Science and mathematics qualifications of primary school teachers

The TIMSS 2002-3 survey also reports on the mathematics and science qualifications of Year 4 teachers (Martin et al, 2004). It does so in terms of the percentages of Year 4 students taught by teachers with different levels of qualification. As shown in Table 6.12, in Australia 72 per cent of Year 4 students in Australia were taught by teachers without a major in science or mathematics. This was similar to the figures for Scotland, the United States, England, New Zealand and Canada; all of which had more than 60 per cent of Year 4 students taught by such teachers. In contrast in Hong Kong, Russia, Chinese Taipei and Singapore fewer than 50 per cent of classes were taught by teachers without a major in mathematics or science.

Table 6.12 Percentage of Year 4 students whose teachers report having a major area of study in science in selected other countries for 2002 and 2003

	With primary education specialisation and						Science or maths major and without a specialisation in primary education		Other	
	without a major in science or maths		with a major in science		With a major in maths not science					
	%	SE	%	SE	%	SE	%	SE	%	SE
Australia	72	4.1	14	2.9	9	2.6	1	0.5	4	1.4
Belgium(Flemish)	59	3.2	25	3.5	11	2.4	2	1.2	2	0.7
Chinese Taipei	28	3.2	30	3.8	4	1.6	17	3.4	22	3.6
England	64	4.3	8	2.6	7	3.0	5	1.8	16	2.7
Hong Kong SAR	43	5.1	22	3.8	6	2.7	8	2.4	21	3.9
Japan	54	4.1	14	3.0	6	2.1	3	1.4	23	3.6
New Zealand	63	3.2	17	2.6	13	2.1	1	0.6	5	1.4
Ontario Canada	63	5.1	8	2.1	3	1.8	5	2.1	21	3.9
Russia	35	3.7	52	4.0	7	2.0	1	0.8	5	1.6
Scotland	79	3.6	6	2.0	7	2.2	1	0.1	7	2.3
Singapore	23	3.4	32	3.7	19	3.1	15	2.6	12	2.8
United States	73	2.9	8	1.7	5	1.5	3	1.0	10	1.8
International Av.	50	0.8	23	0.7	7	0.5	8	0.4	13	0.5

Note: Standard errors for countries indicate the precision of the sample statistics and are approximately three or four percentage points.
Years specified as 2002 and 2003 to correspond with data collection times that match the stage in the school year in northern and southern hemispheres.
Source: Martin et al 2004: 258.

6.5 Summary

Over the period since 2003 the trends towards an ageing teaching workforce have continued so that now almost one third of teachers are 50 years of age or older. This aging is particularly evident among male secondary school teachers. At the same time the percentage of females in the teaching workforce has continued to increase. By 2007, 80 per cent of primary school teachers and 57 per cent of secondary school teachers were women.

Compared with other countries the percentage of teachers aged over 50 years of age is about the same as the international average and the percentage of females in the teaching workforce is a little less than the international average (although there is considerable variability among countries). Commencing salaries for teachers compare favourably with those for other graduates and have increased at a similar or slightly greater rate than those for other fields. Those salaries appear to be comparable to, or slightly greater than, salaries in comparable countries.

There is some evidence that women science teachers may have a younger age profile than other teachers. A little less than half of Australia's teachers of mathematics, and also of science, in the junior secondary school are women. This is a little less than the international average. The age distribution of science and mathematics teachers in junior secondary schools is very similar to the international pattern. In areas such as mathematics and information technology there appears to be a shortage of appropriately qualified teachers in secondary schools both for the years up to Year 10 and for Years 11 and 12. Although the position with respect to science is more ambiguous there also appears to be a shortage of teachers qualified appropriately to teach science. This is especially evident for information technology, mathematics and general science up to Year 10. In primary school teaching only a small percentage of teachers identify themselves as having completed a major study in mathematics or science as part of their tertiary studies.

7
CONCLUSION

Participation in senior secondary school science has declined over the 30-year period from 1976 to 2007. In 1976, 55 per cent of Year 12 students studied biology, 29 per cent studied chemistry and 28 per cent studied physics. In 2007 the corresponding percentages were 25 per cent, 18 per cent and 15 per cent.

During the 1980s one interpretation of decline in science participation was that science subjects were continuing to attract similar numbers as previously but had not attracted an equivalent share of the expansion of the holding power of Year 12. However, since the mid-1990s school retention rates have stabilised and yet science participation has continued to decline.

Although participation in advanced mathematics in Year 12 is harder to track over such a long period, partly because of changes in curriculum structure and organisation, there is evidence from every State and Territory of declines since the mid-1990s of participation in the advanced levels of studies in mathematics. These trends continue the declines noted from earlier periods.

There are different patterns evident for various elements of technology. Participation in information technology (or computer) studies rose from the mid-1990s to peak in 2001 and then decline through to 2006 and 2007. Participation in food technology grew over the period but participation in technical studies (including trades-related studies) remained fairly constant with approximately 13 per cent of Year 12 students including one or more of these studies in their course.

Analyses of longitudinal data show that the uptake of science-related studies at university is stronger amongst those who specialise in science studies in the final year of school which in turn is influenced by student's proficiency in mathematics when they are in middle secondary school. University commencements in the natural and physical sciences have remained steady since 2001 but with an increase in the health field of education and a decline in information technology. It does appear that the roots of science-based study at university lie in what happens in secondary school and possibly at earlier stages of schooling.

There are substantial variations among the States and Territories in the time allocated to science in the junior secondary years. Across all the jurisdictions very little time is given to science in the primary school years. Generating higher levels of participation in science-related studies at university appears to be partly dependant on strengthening science education in school. Strengthening school science education can come partly from organisation and curriculum by ensuring that more time is allocated to science in school programs and by enhancing curricula.

Enhancement of the curriculum in science studies involves relating content and process more strongly to the experience of young people and connecting what is studied in schools to the emergent fields of science such as biotechnology which involve contributions from two or more of the foundation areas of science. In terms of primary schools one might consider making even stronger use of curriculum resources such as *Primary Connections* that are accessible to, and able to be used by, a wide range of teachers. In the senior secondary years there is a sense that school science is not sufficiently connected to recent developments in science.

Strengthening school science education also depends on deepening teacher expertise in science. Deepening teacher expertise depends on recruiting into teaching a greater proportion of people with backgrounds in science, enhancing the science base of practising teachers in science and giving consideration to having specialist science teachers in primary schools. Specialist science teachers in primary schools could provide a core of expertise in those schools.

The challenge remains to be able to recruit graduates from science-related fields into teaching and teacher training. From the perspective of science teaching this is an important challenge because entrants to undergraduate teacher education courses do not possess strengths in mathematics or science. Students who participated in undergraduate teacher education programs were less often from the highest achievement group in school, predominantly female and, compared to other university students, tended to come from middle rather than upper socioeconomic backgrounds, and non-metropolitan rather than metropolitan locations.

Overall commencements in initial teacher education increased since 1996 and since 2001 the increase has been more in “general” courses than either primary or secondary education. However, an increase in the percentage of commencements in teacher training from graduates (rather than undergraduates) up to 2004 appears to have been reversed in 2005 and 2006. There had been an increase observed in the small proportion of graduates from science-related fields entering teaching or teacher training between 2001 and 2006. It is not clear whether that has continued and whether it will flow through to completions

The teaching workforce has become better qualified, and especially in secondary schools, it has undergone a further shift in age distribution so that one third of teachers (and 37% of male secondary teachers) are now older than 50 years of age. There is thus a substantial challenge in teacher recruitment in secondary schools and a further challenge of enhancing the basis of science expertise among primary teachers. These are challenges being faced by many other countries. Perhaps schemes to off-set Higher Education Contribution Scheme (HECS) charges may provide an incentive to attract science graduates to teaching even if that is not always for a life-time career.

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