Australian Government
Department of Education, Science and Training

# Australia's Teachers: Australia's Future

## Advancing Innovation, Science, Technology and Mathematics

### BACKGROUND DATA AND ANALYSIS

COMMITTEE FOR THE REVIEW OF TEACHING AND TEACHER EDUCATION OCTOBER 2003

Backing Australia's Ability

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# Explanatory Note

The Review of Teaching and Teacher Education is an initiative under the Commonwealth Government's $3 billion innovation statement *Backing Australia's Ability*, which was launched by the Prime Minister. The purpose of the Review was to identify strategies which will increase the numbers of talented people who are attracted to teaching as a career, especially in the fields of science, technology and mathematics education, and build a culture of continuous innovation at all levels of schooling in Australia.

The Committee's report is presented in three volumes: an *Agenda for Action*, a *Main Report* and *Background Data and Analysis*. The *Agenda for Action* presents the Review Committee's main findings and conclusions and a range of actions the Committee believes need to be taken. The *Main Report* presents the reasoning and argument based on evidence from a wide variety of sources that underpin the *Agenda for Action*; and the *Background Data and Analysis* presents much of the data supporting the views formed during the course of the Review.

Further information is available on the Review website at www.dest.gov.au/schools/teachingreview.

# 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) |
| DEST | Department of Education, Science and Training |
| DETYA | Department of Education, Training and Youth Affairs |
| ENTER | Equivalent National Tertiary Entrance Rank |
| FASTS | Federation of Australian Science and Technology Societies |
| GCCA | Graduate Careers Council of 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 for Education, Employment, Training and Youth Affairs |
| TIMMS | Third International Mathematics and Science Study |
| OECD | Organization for Economic Co-operation and Development |
| PISA | Programme of International Student Assessment |

# Contents


**Tables** . . . vii

**Figures** . . . ix

**1. Introduction** . . . 1

**2. Year 12 Participation in Science, Mathematics and Technology** . . . 3

Participation in the sciences in the final year of secondary school . . . 3

Participation as a percentage of Year 12 enrolments . . . 3

Participation as a percentage of the whole cohort . . . 5

Enrolments in Year 12 science subjects from 1976 to 2001 . . . 7

Science participation prior to 1976 . . . 7

Combinations or clusters of science studies . . . 8

Who studies science in Year 12? . . . 9

Participation rates in mathematics in the final year of secondary school . . . 12

Participation in technology subjects in Year 12 . . . 16

Trends . . . 16

Patterns of participation in technology . . . 18

Summary . . . 19

**3. University Participation in the Sciences and Technology** . . . 21

Entry to science mathematics and technology studies in higher education . . . 21

Commencing student information . . . 21

Longitudinal data on transitions . . . 23

Victorian data on the transition from Year 12 to university . . . 27

Entry requirements for science and engineering . . . 28

Completion rates for undergraduate courses . . . 30

Undergraduate course completions . . . 31

Summary . . . 33

**4. Teacher Education** . . . . . . . . . . 35
Initial teacher education courses in Australia . . . . . . . . . . 35
Commencements in initial teacher education: trends from 1990 . . . . . . . . 36
Characteristics of teacher education students . . . . . . . . . . 38
Course completions . . . . . . . . . . 41
Overall completions from initial teacher education . . . . . . . . . . 41
Variation in completions . . . . . . . . . . 42
Patterns among levels of schooling in course completions for 2001 . . . 43
Completions from different course structures . . . . . . . . . . 44
Course completions by area of secondary specialisation . . . . . . . . . . 44
Course structure and secondary specialisations . . . . . . . . . . 46
Graduates from science-related fields of study . . . . . . . . . . 49
Destinations of graduates from initial teacher education courses . . . . . . . 51
Summary . . . . . . . . . . 52
**5. Characteristics of the Teaching Workforce** . . . . . . . . . . 53
General characteristics of the profession . . . . . . . . . . 53
Age profile . . . . . . . . . . 53
Gender composition . . . . . . . . . . 56
Qualifications . . . . . . . . . . 57
Income and earnings . . . . . . . . . . 58
Interstate mobility . . . . . . . . . . 60
Characteristics of science teachers . . . . . . . . . . 60
Teachers of Year 8 mathematics and science . . . . . . . . . . 60
Teachers of Year 12 mathematics, science and technology . . . . . . . . . 62
Summary . . . . . . . . . . 64
**6. Some Issues Associated with Demand and Supply of Teachers** . . . 65
Supply issues and assumptions . . . . . . . . . . 65
New graduates from initial teacher education courses . . . . . . . . . . 66
Demand issues and assumptions . . . . . . . . . . 67
Approaches to projecting the balance of supply and demand . . . . . . . . . 71
Summary . . . . . . . . . . 74
**7. Conclusion** . . . . . . . . . . 75
**References** . . . . . . . . . . 77

## Tables

Table 1 Selected science participation rates from 1962 to 1969 . . . . . . . . . . . 7

Table 2 Percentages of Year 12 students undertaking combinations of science subjects for 1998 and 2001 . . . . . . . . . . . . . . . . . . . . . . 8

Table 3 Percentages of Year 12 students from different groups studying various science subjects for 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

Table 4 Trends in participation rates in selected advanced mathematics subjects from 1991 to 2002 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15

Table 5 Percentage of Year 12 enrolments in technology subjects (1991 to 2002) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 17

Table 6 Domestic undergraduate commencing students who are new to higher education by broad field of education from 1990 to 2002 . . . . 22

Table 7 Percentage of students who completed Year 12 in 1998 in various educational destinations by extent of science studies in Year 12 up to two years after completing school . . . . . . . . . . . . . . . . . . . . . . 24

Table 8 Percentage of students who completed Year 12 in 1998 in various fields of study by extent of science studies in Year 12 . . . . . . . . . . . . . 26

Table 9 Percentages of students who completed Year 12 in 1997 with various science specialisations entering university fields of study (Victoria) . . . 27

Table 10 Completion rates for university undergraduate courses by broad field of study for 1992 and 1993 entry cohorts . . . . . . . . . . . . . . . . . . . 29

Table 11 Completions from science-related undergraduate courses rates by non-overseas students from 1997 to 2001 . . . . . . . . . . . . . . . . . . . . 31

Table 12 Percentage distributions of 2001 completions and 2002 commencements across science-related fields of education . . . . . . . 33

Table 13 Characteristics of initial teacher education courses with completions in 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 35

Table 14 Characteristics of students in initial teacher education and other university courses from 1999 to 2001 . . . . . . . . . . . . . . . . . . . . . 40

Table 15 Initial teacher education course completions by domestic students from 1990 to 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 41

Table 16 Numbers of teacher education course completions for 2001 . . . . . . . 43

Table 17 Structural characteristics of initial teacher education courses and completions for 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 44

Table 18 Numbers of course completions by secondary specialists by selected specialisations for 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . 45

| | | |
|---|---|---|
| Table 19 | Characteristics of courses and completions associated with various specialisations for 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 48 |
| Table 20 | Percentages of engineering, science and mathematics bachelor degree graduates working full-time in schools or in teacher training for 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 49 |
| Table 21 | Percentages of graduates of teacher education courses from 2000 in various activities in April 2001. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 51 |
| Table 22 | Percentage distributions showing gender of teachers for 1963, 1979, 1989 and 1999. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 57 |
| Table 23 | Percentages showing highest qualification in education held by Year 12 teachers for 1979 and 1999 . . . . . . . . . . . . . . . . . . . . . . . . | 57 |
| Table 24 | Percentage distributions showing initial qualifications of teachers for 1999. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 58 |
| Table 25 | Estimated full-time average weekly ordinary time earnings ($) for educational professionals for 2001 . . . . . . . . . . . . . . . . . . . . . . . . . | 58 |
| Table 26 | Occupation at February 2002 by whether changed State/Territory of usual residence from February 2001 to February 2002 by occupation at February 2001 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 60 |
| Table 27 | Percentage of Australian Year 8 students whose teachers report having a major area of study in mathematics compared with selected other countries for 1998-99 . . . . . . . . . . . . . . . . . . . . . . . . . . | 61 |
| Table 28 | Percentage of Australian Year 8 students whose teachers report having a major area of study in science compared with selected other countries for 1998-99 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 62 |
| Table 29 | Percentages showing highest qualification held by Year 12 mathematics, science and technology teachers by gender for 1999. . . . | 63 |
| Table 30 | Percentages showing highest qualification held by Year 12 mathematics, science and technology teachers by school sector for 1999. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 64 |
| Table 31 | Average percentage of time allocated to each key learning area in Victorian government schools by selected year levels for 2001. . . . | 68 |
| Table 32 | Average percentage of enrolments in Year 12 in each key learning area in Australian schools for 1993, 1998 and 2001. . . . . . . . . . . . . . . . | 69 |
| Table 33 | Projected supply of teachers from 2000 to 2005 . . . . . . . . . . . . . . . . . | 71 |

# Figures


| | | |
|---|---|---|
| Figure 1 | National participation rates among Year 12 students in science subjects from 1976 to 2002 | 4 |
| Figure 2 | National participation rates among full cohorts of secondary students in Year 12 science subjects from 1976 to 2002 | 5 |
| Figure 3 | Enrolments in Year 12 science subjects from 1976 to 2002 | 6 |
| Figure 4 | Participation in three types of mathematics subjects at Year 12 from 1990 to 1999 | 12 |
| Figure 5 | Aggregate enrolments in three types of Year 12 mathematics subjects from 1990 to 1999 | 14 |
| Figure 6 | Participation in information technology and technical studies subjects from 1991 to 2002 | 16 |
| Figure 7 | Numbers of enrolments in technology subjects from 1991 to 2002 | 17 |
| Figure 8 | Trends in commencing domestic enrolments new to higher eduction in bachelor degree courses from 1990 to 2002 | 23 |
| Figure 9 | Percentage distribution across fields of study at university by science background of students who completed Year 12 in 1998 | 25 |
| Figure 10 | Distribution of median ENTER scores for minor fields of education within science for 2001 | 28 |
| Figure 11 | Distribution of median enter scores for minor fields of education within engineering for 2001 | 29 |
| Figure 12 | Trends in completions of science-related fields of education from 1997 to 2001 | 32 |
| Figure 13 | Commencing domestic students in various initial teacher education courses from 1990 to 2002 | 37 |
| Figure 14 | Commencing domestic students in initial teacher education courses from 1990 to 2002 | 38 |
| Figure 15 | Percentage of teachers employed by age and gender for 2001 | 54 |
| Figure 16 | Percentage of primary teachers aged 45 years and older by sector and State or Territory for 2001 | 55 |
| Figure 17 | Percentage of secondary teachers aged 45 years and older by sector and State or Territory for 2001 | 55 |
| Figure 18 | Age distribution of teachers for 1963, 1979, 1989 and 1999 | 56 |
| Figure 19 | Commencing salaries for graduates by field of study for 2001 | 59 |

# 1. Introduction

In general the performance of Australian secondary school students in mathematics and science is high by international standards. The *Third International Mathematics and Science Study* (TIMSS), conducted in 1994, found that Australian performance in mathematics in the junior secondary years was lower than only eight (out of 45) countries (Lokan, Ford & Greenwood 1996: 15-16). The performance of Australian students was significantly better than countries such as New Zealand, England and the United States. The performance of Australian students was similar to the performance of students in Canada, Ireland, Sweden and France. In science, only four countries outperformed Australia: Singapore, Korea, Japan and the Czech Republic. Australia recorded science achievement levels similar to England and the United States, as well as most of the countries that were similar to it in mathematics.

In the 1999 TIMSS study, Australian students' performance in mathematics was again well above the international average (by about 0.4 standard deviation units) (Mullis et al. 2000: 32). Australia was significantly lower than five countries (Singapore, Korea, Chinese Taipei, Japan and Flemish Belgium). It was not different from a second group of countries that included the Netherlands, Canada, Finland and the Czech Republic. It performed significantly better than countries such as the United States, England and New Zealand. In science Australia also performed above the international average (by about 0.5 standard deviation units) (Martin et al. 2000: 32). In science, only Chinese Taipei scored significantly higher than Australia. Australia was not different from a group of countries that included Singapore, Japan, Korea, the Czech Republic, England, Canada and Hong Kong. It outperformed countries such as the United States, New Zealand and Italy.

The most recent evidence on student performance is from the 2000 Programme for International Student Achievement (PISA) study of 15-year-olds conducted for the Organization for Economic Co-operation and Development (OECD) in over 30 industrialised countries. Australian students performed well above the OECD average in mathematical and scientific literacy as well as in reading literacy (Lokan, Greenwood & Cresswell 2001: 20-33). Students in Japan were the only ones who performed significantly better than Australian students in mathematical literacy. Japanese and Korean students were the only national groups that performed significantly better than Australian students in scientific literacy.

International survey studies provide consistent evidence that Australian students are performing at levels that can be regarded as very good. However, there are issues that deserve attention. First, there is no evidence that the absolute performance of Australian students has improved over time. Afrassa and Keeves (1999) concluded that there was a decline in the mathematics performance of 13-year-olds over the 30 years from 1964 to 1994. The magnitude of that decline was approximately 0.3 standard deviations, a non-trivial amount. Second, although Australian students' performance has been good overall, there is some evidence that the problems through which students learn mathematics in Australian junior secondary classrooms lack depth and are repetitious compared to those in other high performing countries (Hollingsworth et al. 2003). Third, there have been a number of suggestions that participation in mathematics, science and technology at school and university may not be matching emerging employment opportunities that depend on conceptual understanding. Fourth, there are questions of whether the future availability of teachers with expertise in mathematics, science and technology will be sufficient to support and nurture continued relatively high performance by Australian students.

# 2. Year 12 Participation in Science, Mathematics and Technology

A view that there has been a "swing from science" is evident in a number of commentaries on trends in subject enrolment statistics for the final year of secondary school (Dobson & Calderon 1999; FASTS 2002). A general trend away from the study of science in the senior years of secondary has been observed in other OECD countries as well as Australia. Similar concerns were expressed more than 30 years ago in Australia (Stranks 1969) and in England (Council for Science Policy 1968).

In examining trends in participation in mathematics, science and technology by senior secondary school there is an issue of which indicators should be used. One commonly used indicator is the participation rate for each subject (or subject area) calculated as the enrolment in a specified subject divided by the total Year 12 enrolment.[1] A second indicator is the cohort participation rate expressed as the number of students studying a particular subject divided by the number of students in the original cohort from which the students were drawn. A third is to simply use the number of students enrolled in each subject.

## Participation in the sciences in the final year of secondary school

### Participation as a percentage of Year 12 enrolments

Figure 1 shows national participation rates (expressed as a percentage of all Year 12 enrolments) in science subjects over the 25-year period from 1976 to 2002.[2] Figure 1 shows a steady decline in biology participation from 1977 onwards.[3] The decline has been from 58 per cent in 1977 to 25 per cent in 2002. Over the period from 1990 to 2002, the decline was from 36 to 25 per cent for all biology enrolments and from 31 to 22 per cent

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1 In calculating participation rates, the total Year 12 enrolment recorded by the Australian Bureau of Statistics has been used as the denominator. This provides a more stable base than the number of entries for the Year 12 examination, which has been a changing proportion of all Year 12 students.

2 Data for the period 1990 to 2001 were provided by DEST 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. In each case the percentages are based on ABS Year 12 enrolment statistics published in Schools Australia (Cat. No. 4221.0).

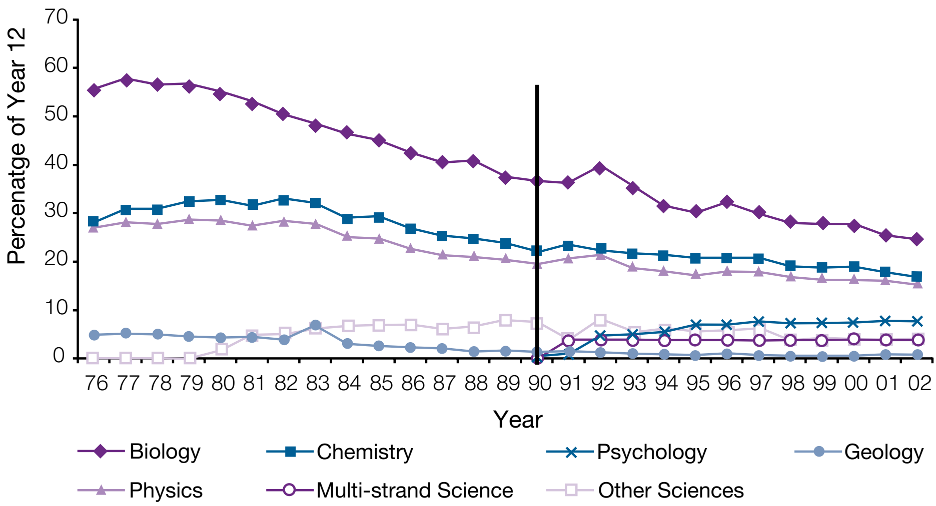
3 Biology participation rates include human biology in Western Australia. Although separate data are available for biology and human biology for the period from 1990 to 2001 enrolments have been combined to provide consistency with the earlier data. This provides consistency with the earlier data series.

if human biology is excluded from that total. The participation for human biology declined from around four per cent in 1990 to just over two per cent in 2002.[4]

Over the period covered by the data in Figure 1, participation rates in chemistry and physics rose slightly during the late 1970s and peaked in 1980 at 33 per cent for chemistry and 29 per cent for physics. From that time there was a steady decline in the participation rates for each to 17 per cent for chemistry and 16 per cent for physics in 2002.

Participation in other sciences is also shown in Figure 1. Although the classification is not always clear, the data suggest small but significant enrolments in other sciences during the 1990s. Multistrand science had a participation rate consistently about four per cent over the period from 1991 to 2002. Psychology emerged as a significant subject in 1992 with a participation of around five per cent, which grew to reach a little under eight per cent by 2002.[5]

**Figure 1: National participation rates among Year 12 students in science subjects from 1976 to 2002**




Notes: Data for the period 1990 to 2002 provided by DEST based on information provided from the assessment, curriculum and accreditation authorities in each jurisdiction. Data for the period from 1976 to 1989 taken from Dekkers et al. (1991). Percentages based on ABS Year 12 enrolment statistics: Schools Australia (Cat. No. 4221.0).

Source: Dekkers et al. (1991), DEST Statistical Collection and ABS: '*Schools Australia*' (figures taken from 1976 to 2002 publications) (Catalogue No. 4221.0) (2003a).

[4] Enrolments in the subject human biology are concentrated in one state: Western Australia.

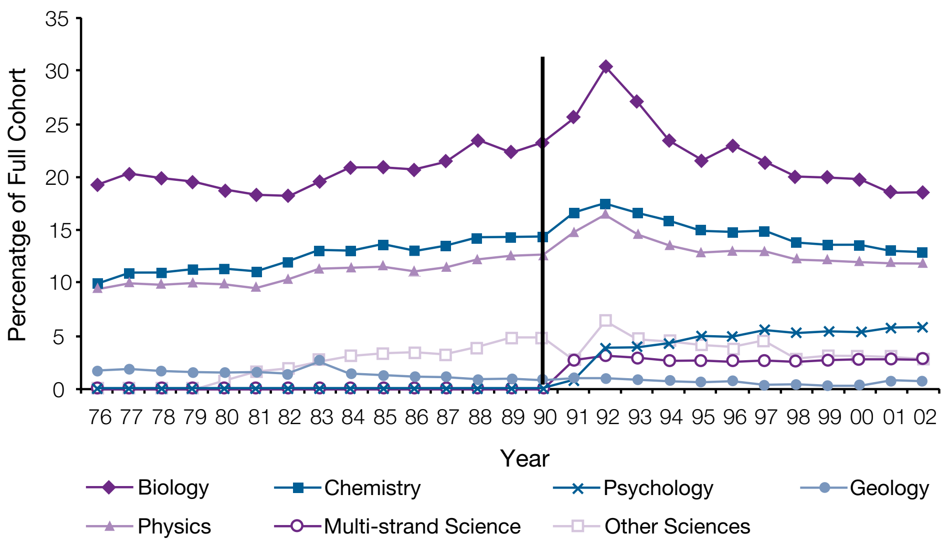
[5] Psychology is mainly concentrated in Victoria and its classification as a school subject in the sciences is sometimes contested.

Geology declined through the 1980s so that in the 1990s the participation rate was one per cent or less. The participation rate for the category "other science" increased during the 1980s (during which time it was classified by Dekkers et al. (1991) as "alternative science") to eight per cent in 1989 after which it declined to around four per cent during the 1990s.

## Participation as a percentage of the whole cohort

Over the period from 1976 to 2002 there were substantial changes in the holding power of schools that are reflected in the apparent retention rates to Year 12.[6] 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 75 per cent in 2002. For this reason it has been argued that 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 2 participation rates that reference the full cohort have been displayed.[7]

**Figure 2: National participation rates among full cohorts of secondary students in Year 12 science subjects from 1976 to 2002**




Source: Dekkers et al. (1991), DEST Statistical Collection 1991 to 2002 and ABS: Schools Australia (Catalogue No. 4221.0).

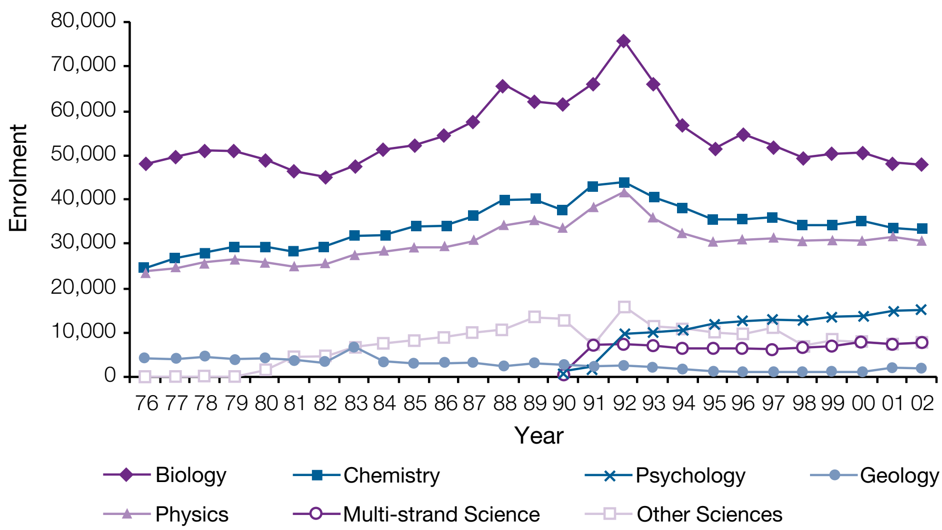
[6] The apparent retention rate is the number of students in Year 12 in a given year expressed as a percentage of the number of students in the first year of secondary school five or six (depending on the jurisdiction) years previously. Although it has limitations as an indicator for a school, school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

[7] 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.

The trends in Figure 2 show that the percentage of successive "parent" cohorts of students entering secondary school that went on to study a science subject in Year 12 increased during the period from 1981 to 1992. This applied to participation in biology, chemistry and physics, although it should be noted that the increase was not as rapid as the increase in school holding power overall.

There was an increase from 18 per cent in 1981 to 30 per cent in 1992 of a full cohort studying biology in Year 12. The corresponding increase for chemistry was from 11 to 18 per cent and for physics was from 10 to 17 per cent. Participation in "other" (or alternative) science increased from two to six per cent over the same period. Figure 2 also shows that, during the period from 1992 to 2002, 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 30 to 19 per cent, in chemistry it was from 18 to 13 per cent and for physics it was from 17 to 12 per cent. There was also relatively little change in this index of participation for the other science subjects identified in Figure 2.

**Figure 3: Enrolments in Year 12 science subjects from 1976 to 2002**




Source: Dekkers et al. (1991) and DEST Statistical Collection 1991 to 2002

## Enrolments in Year 12 science subjects from 1976 to 2001

Figure 3 records the national enrolments in Year 12 science subjects from 1976 to 2001. The trends shown in this figure are similar to those shown in Figure 2 although they reflect changes not only in the propensity of students from the cohort to enrol in science but fluctuations in the size of the cohort.

In terms of absolute enrolments the shift over the 1990s is illuminating. From 1991 to 2002 there was a decline of 14,603 in biology enrolments (from 57,629), 9,540 in chemistry enrolments (from 42,645) and 7,708 in physics enrolments (from 38,260). The shift over the period has been steady and cumulative.

## Science participation prior to 1976

Although it is not possible to assemble national comparable data continuously for the period prior to 1976, Lee Dow (1971) provides information for a number of states for selected years. Data for several jurisdictions are provided in Table 1. These data are expressed as a percentage of those taking the full final year examination and are therefore not strictly comparable with the data in Figure 1 that references the Year 12 population.

**Table 1: Selected science participation rates from 1962 to 1969**

| | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|---|---|---|---|
| **Victoria** | | | | | | | | |
| Biology | 18.0 | | 19.8 | | 24.4 | | 25.1 | 29.1 |
| Chemistry | 39.2 | | 37.9 | | 37.6 | | 36.0 | 35.0 |
| Physics | 41.5 | | 40.3 | | 37.9 | | 36.8 | 35.3 |
| **Queensland** | | | | | | | | |
| Chemistry | | 59.9 | 59.7 | 54.0 | 51.5 | 46.7 | 46.1 | 43.4 |
| Physics | | 57.0 | 55.9 | 50.7 | 48.1 | 43.5 | 41.2 | 39.0 |
| **South Australia** | | | | | | | | |
| Biology | | | | 30.6 | 32.4 | 30.5 | 35.9 | 38.0 |
| Chemistry | | | | 50.4 | 57.5 | 56.8 | 55.5 | 49.1 |
| Physics | | | | 54.0 | 57.8 | 57.5 | 56.4 | 50.4 |

Note: Rates are expressed as a percentage of those taking the full final year examination.
Source: Lee Dow (1971).

From these data it appears that the participation rates for Year 12 in these science subjects were higher than in the 1970s and that there was evidence of a decline in participation in chemistry and physics but a rise in participation in biology. Ainley (1978: 409) indicated that in Victoria there was a further 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.

## Combinations or clusters of science studies

The approach to examining participation in science subjects that has been adopted in the preceding sections has been to focus on specific subjects such as biology, chemistry and physics. Another perspective is to examine the combinations of subjects studied in Year 12. It is the package of subjects taken in combination that provides an indication of students' orientations and which influences their future options, choices and pathways. Data reported from the Longitudinal Surveys of Australian Youth (LSAY) provide additional perspectives on subject combinations.

One of these perspectives is in terms of the percentage of Year 12 students who study at least one science subject as part of their course. LSAY data indicate that 55 per cent of the cohort in Year 12 in 2001 studied at least one science subject (Fullarton et al. 2003). This represented a decline from the 1998 Year 12 cohort (60 per cent) and the 1993 Year 12 cohort (68 per cent).

A second perspective is in terms of the percentage of students taking various combinations of science subjects. The percentages of Year 12 students undertaking various combinations in 1998 and 2001 are recorded in Table 2. One combination of particular interest, because of its tradition as a foundation for further science-based studies, is that involving two physical sciences (chemistry and physics). Just under 10 per cent of the 2001 Year 12 cohort undertook a course of study that included both chemistry and physics. This compared with just over 11 per cent in 1998, and estimates of 13 per cent in 1993 and 15 per cent in 1990.

**Table 2: Percentages of Year 12 students undertaking combinations of science subjects for 1998 and 2001**

| Combination | Percentage of Year 12 | |
|---|---|---|
| | 1998 | 2001 |
| Chemistry and physics | 11.4 | 9.7 |
| Chemistry and biology | 6.7 | 6.3 |
| Physics and biology | 2.4 | 2.8 |
| Chemistry, physics and biology (included in figures above) | 1.4 | 1.9 |
| Chemistry total[a] | 20.3 | 17.9 |
| Physics total[a] | 20.1 | 16.6 |
| Biology total[a] | 25.1 | 25.4 |

[a] 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 are 5,009 for 1998 and 6,910 for 2001.

Source: Longitudinal Surveys of Australian Youth.

The detail from the 2001 Year 12 cohort is illuminating. Just fewer than 18 per cent studied chemistry including just fewer than 10 per cent taking it in combination with physics and just over six per cent in combination with biology and two per cent with both physics and biology. The remaining two per cent of Year 12 chemistry included chemistry with either another science subject or no other science subjects. In 1998, when 20 per cent had studied chemistry, 11 per cent had studied chemistry with physics and over six per cent had studied it with biology and two per cent studied chemistry without either physics or biology.

In 2001, physics was studied by 16.6 per cent of students including almost three per cent who studied physics with biology as well as the previously mentioned combinations involving physics and chemistry. This means that just over four per cent of students studied physics without combining that study with either chemistry or biology. In 1998, 20 per cent of students had studied physics and six per cent had studied the subject without combining it with chemistry or biology.

Just over 25 per cent of Year 12 students studied biology in 2001. For nine per cent this was in combination with chemistry or physics (or both) but for 16 per cent the study of biology was not combined with either of these subjects. Similar percentages were recorded for 1998.

## Who studies science in Year 12?

Information about who chooses to study science subjects in Year 12 is available from LSAY (Fullarton et al. 2003; Fullarton & Ainley 2000) from national sample surveys of subject choice in the early 1990s (Ainley et al. 1994) and several publications by Teese and Polesel (2003). There is considerable overlap in the perspectives from these sources. Teese and Polesel (2003) provide additional information about the effects of regional location and Fullarton et al. (2003) provide information about the influence of earlier achievement in school. Data in Table 3 are derived from LSAY for those studying Year 12 in 2001 (Fullarton et al. 2003).

**Table 3: Percentages of Year 12 students from different groups studying various science subjects for 2001**

| Characteristic | Group | Biology | Chemistry | Physics |
|---|---|---|---|---|
| Gender | Male | 18.3 | 19.8 | 25.4 |
| | Female | 31.6 | 16.3 | 9.2 |
| Socioeconomic Status [a] | Lowest SES | 21.0 | 12.2 | 11.4 |
| | Lower SES | 24.0 | 15.1 | 15.5 |
| | Higher SES | 30.2 | 20.2 | 18.0 |
| | Highest SES | 28.9 | 26.3 | 23.3 |
| Parental language background [b] | English speaking | 26.7 | 17.3 | 15.3 |
| | LBOTE | 21.0 | 20.3 | 22.6 |
| Earlier mathematics achievement [c] | Lowest Mathematics score | 17.9 | 4.8 | 4.7 |
| | Lower Mathematics score | 28.7 | 12.2 | 9.5 |
| | Higher Mathematics score | 31.8 | 19.9 | 18.7 |
| | Highest Mathematics score | 24.8 | 37.2 | 36.7 |
| School sector [d] | Government | 22.5 | 15.5 | 14.9 |
| | Catholic | 28.4 | 18.7 | 16.8 |
| | Independent | 33.1 | 26.6 | 23.4 |
| Location [e] | City | 24.6 | 18.2 | 17.4 |
| | Rural | 26.6 | 17.3 | 15.4 |

[a] Socioeconomic status is based on parental occupations scaled on the ANU4 scale and shown as quartiles.

[b] Parental language background based on country of birth of parents.

[c] Earlier mathematics achievement shown as quartiles based on scores from test in Year 9.

[d] School sector refers to the school in which Year 12 was undertaken.

[e] Location based on home address of student.

Source: Longitudinal Surveys of Australian Youth

The following is a summary of the differences associated with the factors represented by the groupings shown in Table 3.

- **Gender** The participation rate in physics for males is nearly three times that for females whereas the participation rate in biology for females is nearly twice that for males. For chemistry the participation rate for males is a little greater than that for females.

- **Socioeconomic status** In chemistry and physics the participation rate for Year 12 students from the highest of four socioeconomic groups is more than twice that for students from the lowest socioeconomic group. In biology the difference between the top and bottom socioeconomic groups was less than in chemistry and physics and was highest for the third of the four groups.
- **Parental language background** Participation in chemistry and physics was lower among those whose parents were from Australia, or another predominantly English-speaking background country, than for those whose parents came from a country where the main language was not English. In biology the reverse was the case.
- **Earlier achievement in mathematics** There was strong association between participation in chemistry and physics and earlier proficiency in mathematics (as measured by a test in Year 9). Participation among the top quarter of students was more than seven times that of the bottom quarter and was almost twice that of the second highest achieving quarter of students.
- **School sector** Participation in all three sciences was higher in independent schools than in government schools by a factor of approximately 1.5.
- **Location** 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.

What emerges from these data is the strong association of participation in chemistry and physics with earlier proficiency in mathematics, the association with higher socioeconomic status with participation in physics and chemistry, and the association of gender with participation in physics and biology (but in opposite directions).

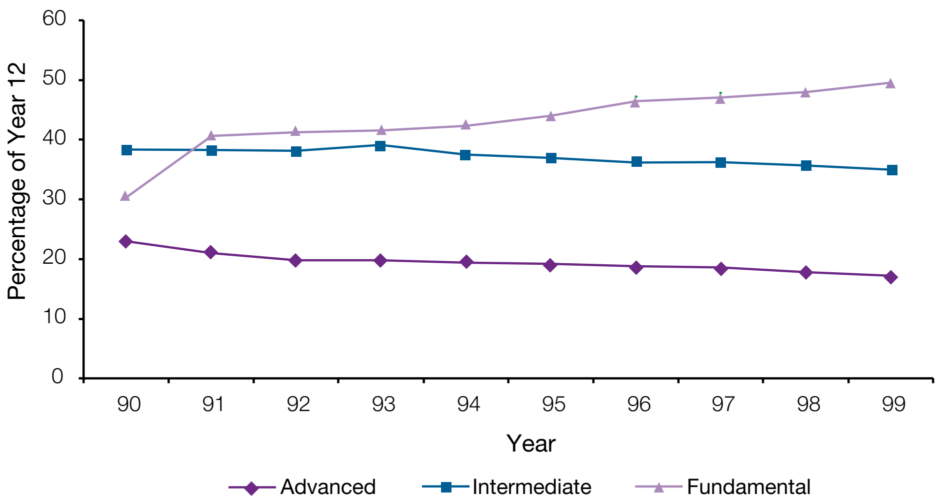
These influences remain evident in multivariate analyses of influences on participation (Fullarton et al. 2003). Associations with parental language background and school sector are also evident but to a smaller extent. In addition to these influences, other work has identified an influence of “investigative” interests (as assessed in Year 10) on participation in physics and chemistry (Elsworth et al. 1999). Prior school experiences are influential in terms of the development of proficiency and interest.

## Participation rates in mathematics in the final year of secondary school

Participation in mathematics among Year 12 students is more difficult to document than participation in science. This is because approximately 84 per cent of Year 12 students include one or more mathematics subjects in their Year 12 course of study[8] so that any analyses of either patterns or trends requires information about participation in different forms of mathematics.

Fullarton et al. (2003) suggest that mathematics courses could be classified as fundamental (courses that cover basic skills and do not usually feed into further studies), intermediate (provide a basis for university study other than those drawing specialist mathematical expertise) and advanced (subjects that are prerequisite or assumed knowledge for university courses in engineering and the physical, mathematical or computer sciences).[9] On this basis Fullarton et al. (2003) estimated that in 2001, 23 per cent of Year 12 students studied basic mathematics, 26 per cent studied intermediate mathematics and 36 per cent studied advanced mathematics.

**Figure 4: Participation in three types of mathematics subjects at Year 12 from 1990 to 1999**




Source: Dekkers and Malone (2000).

[8] Fullarton et al. (2003) suggest that there has been a small decline of three percentage points since 1998.

[9] This follows a schema originally used by Dekkers et al. (1991). Fullarton et al. classified mathematics courses as follows. Fundamental/ Basic mathematics – cover basic mathematics skills and are terminal in their nature (that is, they do not usually feed into further studies); Intermediate level mathematics –while not assumed knowledge for university subjects or courses, are useful for students who wish to pursue study in areas such as the social sciences or psychology, where techniques such as those found in statistics are applied; and Advanced mathematics – prerequisites or assumed knowledge for university courses in engineering and physical, mathematical and computer sciences.

Dekkers and Malone (2000), using a different classification to Fullarton, suggest a decline in enrolments in advanced level and intermediate mathematics subjects between 1990 and 1999, with concomitant rises in participation in fundamental level mathematics.[10] This has occurred partly because the most advanced level mathematics is no longer a prerequisite for the number of university courses that it once was, and also partly because, in a number of states, more than one mathematics subject is not commonly undertaken at Year 12 level. Data recorded by Dekkers and Malone (2000) have been recorded as percentages of the Year 12 population for each year and recorded in Figure 4.[11]

Figure 5 represents the same trends in mathematics participation in terms of aggregate enrolments in different types of mathematics subjects. Between 1990 and 1999 there was a decline of 7,828 enrolments in advanced mathematics (from 38,731) and an increase of 38,240 enrolments in fundamental mathematics (from 51,855) with relatively little net change in intermediate level mathematics enrolments.

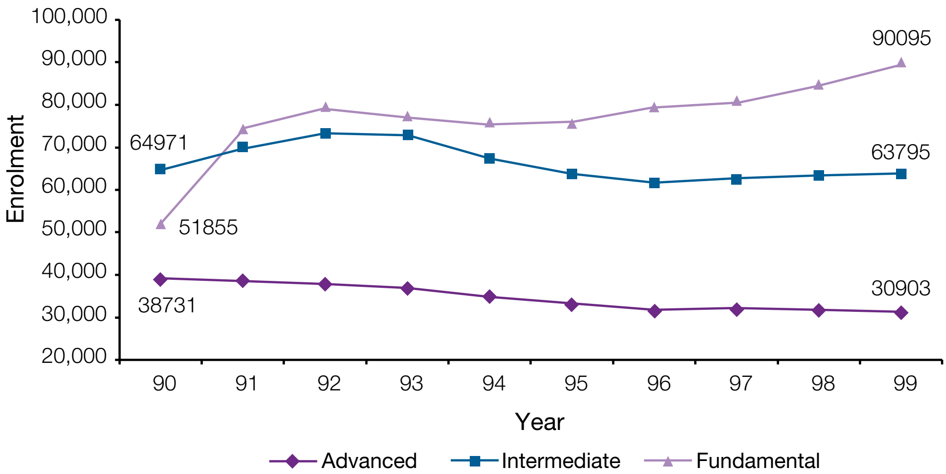
A problem in using a classification such as this is that the classification of mathematics is often contested and the structures of mathematics subjects may differ among jurisdictions at any point in time and may change over time within any jurisdiction. Table 4 provides details regarding subjects that could be considered among the most advanced in each jurisdiction since 1991.

[10] The Dekkers and Malone classification of Year 12 mathematics subjects was as follows:

| State/Territory | Advanced | Intermediate | Fundamental |
|---|---|---|---|
| NSW | Mathematics 3U<br>Mathematics 4U<br>Mathematics Extension | Mathematics 2U<br>Mathematics in Society | Mathematics in Practice<br>Board endorsed subjects |
| Vic | Specialist Mathematics | Mathematics Methods<br>Further Mathematics | |
| Qld | Mathematics C | Mathematics B Logic | Mathematics A<br>Board registered subjects |
| SA | Mathematics 1<br>Mathematics 2 | Mathematics 1S<br>Mathematics 1D | School assessed subjects<br>Quantitative methods |
| WA | Applicable Mathematics<br>Calculus | Discrete Mathematics | School assessed subjects |
| Tas | Analysis & statistics<br>Applied Mathematics | Mathematics<br>Algebra & geometry | School assessed subjects |
| NT | Mathematics 2 | Mathematics 1D<br>Mathematics 1S | School assessed subjects<br>Quantitative methods |
| ACT | Advanced Maths extended<br>Advanced Mathematics | Mathematics 2<br>Mathematics | Accredited subjects |

[11] In the Dekkers and Malone classification students can be classified in more than one category depending on the combination of mathematics being studied.

**Figure 5: Aggregate enrolments in three types of Year 12 mathematics subjects from 1990 to 1999**




Source: Dekkers and Malone (2000).

These data indicate a generally small, but neither universal nor monotonic, trend towards declining participation rates in these advanced mathematics subjects. Small declines have generally been evident since 1997. In New South Wales, there was a decline from 1991 to 2000 in both 4-unit and 3-unit Mathematics. In 2001, a new structure was introduced that provided for mathematics and mathematics extensions. In 2001, the participation rate for mathematics extensions was 20.7 per cent. In Victoria, there was an increase in the participation rate for Specialist mathematics after it was introduced in 1994 to 1997 after which there has been a small decline. In Queensland, there appears to have been a decline in Mathematics C participation since it became fully established in 1995.

Fullarton et al. (2003) use national sample data from LSAY to document the associations between student and school characteristics with participation in various forms of mathematics in Year 12. Participation in advanced mathematics is higher among males than females, higher among those of high rather than low socioeconomic status, higher among those with parents of a language background other than English, and much higher among those with higher earlier levels of achievement in mathematics. In addition, there are higher levels of participation among those from independent schools than government schools and among those from city compared to rural schools. Dekkers and Malone (2000) indicate that in 1999 females made up 39 per cent of those in advanced mathematics (a decline from 41 per cent in 1990), 51 per cent of those in intermediate mathematics courses (a rise from 47 per cent in 1990) and 53 per cent of those in fundamental mathematics courses (a decline from 57 per cent in 1990).

**Table 4: Trends in participation rates in selected advanced mathematics subjects from 1991 to 2002**

| | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mathematics subject** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** | **00** | **01** | **02** |
| **New South Wales** | | | | | | | | | | | | |
| 3 - Unit Maths[a] | 28.2 | 25.1 | 23.3 | 22.5 | 20.6 | 19.6 | 18.5 | 17.6 | 17.0 | 16.7 | | |
| 4 - Unit Maths[a] | 8.3 | 7.6 | 7.1 | 6.1 | 4.6 | 4.2 | 4.1 | 3.8 | 4.0 | 3.9 | | |
| Maths Extension | | | | | | | | | | | 20.7 | 20.5 |
| **Victoria** | | | | | | | | | | | | |
| Specialist Maths[b] | | | | 10.5 | 11.2 | 12.8 | 14.0 | 13.7 | 13.2 | 12.7 | 12.4 | 12.4 |
| **Queensland** | | | | | | | | | | | | |
| Maths 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 |
| **South Australia** | | | | | | | | | | | | |
| Maths 2 | 13.5 | 13.8 | 13.2 | 12.3 | 11.8 | 12.0 | 13.4 | 11.5 | 11.3 | 11.2 | 10.2 | 9.6 |
| **Western Australia** | | | | | | | | | | | | |
| Calculus[d] | | 13.9 | 13.6 | 12.7 | 12.5 | 11.4 | 10.9 | 10.5 | 10.9 | 10.2 | 9.2 | 8.4 |
| **Tasmania** | | | | | | | | | | | | |
| Maths Stage 2 | | | | 13.0 | 9.4 | 9.5 | 9.6 | 8.4 | 6.1 | 6.7 | 7.8 | 6.6 |
| Maths Stage 3 | | | | 5.6 | 5.1 | 5.3 | 5.2 | 4.7 | 4.0 | 3.6 | 5.1 | 4.8 |
| **Northern Territory** | | | | | | | | | | | | |
| Maths 2 | 7.6 | 9.5 | 9.3 | 7.7 | 6.2 | 6.5 | 6.1 | 6.9 | 6.6 | 5.6 | 6.4 | 6.2 |
| **Australian Capital Territory** | | | | | | | | | | | | |
| Advanced Maths Extended | | | | | | 10.8 | 11.1 | 11.8 | 11.5 | 10.7 | 10.8 | 10.7 |

[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] 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.

Source: DEST Statistical Collection as provided by state accreditation, curriculum, assessment and certification authorities.

## Participation in technology subjects in Year 12

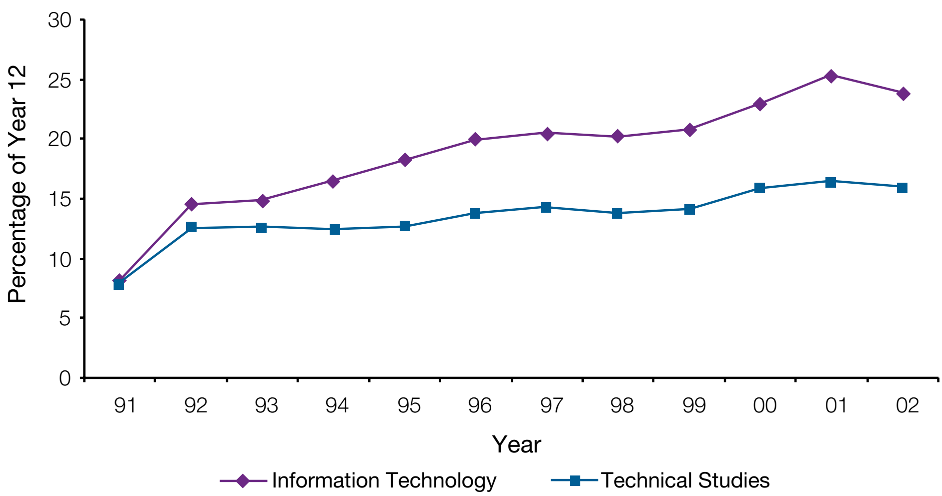
### Trends

Documenting trends in participation in technology subjects is made complex by the variety of subject labels that are used in the area. In order to simplify the representation of data for Table 5, participation in the variety of subjects concerned with information technology (or computer technology) and with technical studies has been combined in each of those two respective areas. Data are represented in Figure 6.

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 fairly well participation by individuals because few students take more than one subject in the area (Fullarton et al. 2003).[12]

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 6: Participation in information technology and technical studies subjects from 1991 to 2002**




[12] 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).

**Table 5: Percentage of Year 12 enrolments in technology subjects (1991 to 2002)**

| | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subject or area | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 |
| Information technology[a] | 8.1 | 14.5 | 14.7 | 16.3 | 18.2 | 19.9 | 20.4 | 20.2 | 20.7 | 22.9 | 25.2 | 23.7 |
| Technical studies[a] | 7.8 | 12.5 | 12.6 | 12.4 | 12.7 | 13.8 | 14.3 | 13.8 | 14.1 | 15.8 | 16.4 | 15.9 |
| Home science – Food | 0.2 | 0.1 | 0.1 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 4.3 | 4.2 |
| Home science – Home economics[b] | 4.7 | 4.6 | 4.4 | 5.8 | 5.9 | 1.9 | 1.9 | 1.6 | 1.6 | 3.0 | 3.1 | 3.0 |
| Agriculture | 1.8 | 2.0 | 1.9 | 2.1 | 2.0 | 1.9 | 2.6 | 1.7 | 1.9 | 1.9 | 2.2 | 2.2 |

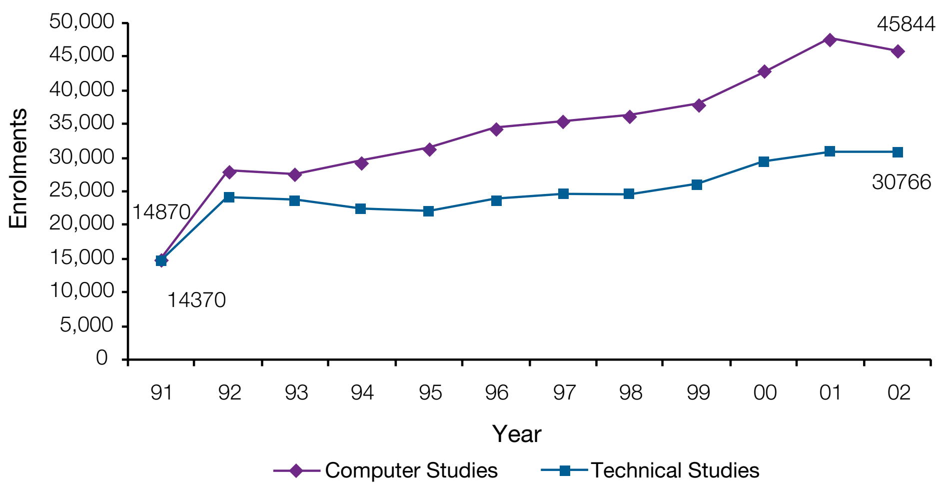
[a] Data refer to the combined participation rates across a number of subjects in an area.

[b] Home economics - Human development and society has not been included in this area.

Source: DEST Statistical Collection as provided by state accreditation, curriculum, assessment and certification authorities.

Notwithstanding caveats regarding the data that are available, there is evident a trend of increased participation in information technology subjects during the period from 1990 to 2001 followed by a downturn in 2002. In technical studies there was a general increase from 1990 to 2001 with a flattening in 2002. As shown in Figure 6, this growth in Year 12 participation rates between 1990 and 2001 was greater in information technology than in technical studies. Figure 7 shows a corresponding representation in terms of numbers of enrolments. Over the period from 1991 to 2002 enrolments in technical subjects more than doubled (increased by 16,396) and enrolments in information technology more than trebled (increased by 30,974).

**Figure 7: Numbers of enrolments in technology subjects from 1991 to 2002**



## Patterns of participation in technology

Fullarton et al. (2003) document some of the characteristics of participants in subjects from the technology area.[13] In 2001, participation in information technology was stronger amongst males than females (the ratio of enrolment indexes was 7.6 to 3.8). Participation was:

- a little lower among those of higher compared to lower socioeconomic status (the ratio of enrolment indexes for the highest and lowest quarters was 4.6 to 6.3);
- lower among students with higher levels of achievement in Year 9 (the ratio of enrolment ratios between the top and bottom quarters was 4.3 to 7.6);
- a little higher in government than independent schools (the ratio of enrolment indexes was 5.9 to 4.1); 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 of enrolment indexes was 6.5 to 1.5).[14] In addition participation was:

- less among students of higher compared to lower socioeconomic status (the ratio of the enrolment indexes was 4.4 compared to 2.6);
- higher among students of an English-speaking background compared with a language background other than English (the ratio of enrolment indexes was 4.1 to 2.7);
- lower among students with higher levels of achievement in Year 9 (the ratio of enrolment ratios between the top and bottom quarters was 2.5 to 6.5);
- higher in government than independent schools (the ratio of enrolment indexes was 4.5 to 2.3); and
- a little greater in rural than city locations.

Gender differences in home science-home economics are almost precisely the reverse of patterns in technical studies (the ratio of the male to female enrolment index is 1.5 to 6.6). However, the pattern in relation to socioeconomic background is almost the same (the ratio of enrolment indexes for highest quarter to lowest quarter is 2.1 to 5.5) as is the pattern relation to earlier school achievement, school sector and location.

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13 Because each area includes enrolments in subjects with different names, an enrolment index rather than a percentage participation rate has been used to compare levels of participation (see Fullarton et al. 2003). It represents a combined measure of curriculum share.

14 Fullarton et al (2003).

## Summary

A number of changes in enrolment patterns are evident from the analysis of national data from 1976 to 2002 presented in this section. In the sciences there has been a steady decline in the percentage of Year 12 students participating in biology, chemistry and physics that has been partly compensated by the emergence of participation in other science studies during the 1990s. Total Year 12 enrolments grew during the 1980s as a result of increases in school holding power. Consequently, when participation in biology, chemistry and physics is considered in relation to the full cohort (or as absolute numbers of students), the picture is one of a rise during the 1980s followed by a decline in 1990s. Although this decline is not dramatic there is also evidence of a decline in the numbers of students studying two or more science subjects. Whether this has consequences for participation in science studies beyond school is not yet clear.

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 levels in mathematics among Year 12 students are very high, following a substantial increase during the period from 1990 to 1999. At the turn of the century, more than four in five students included some form of mathematics in their course. However, during the 1990s the growth was in participation in "fundamental" mathematics and there was a decline in participation in "advanced" mathematics that is similar in magnitude to the declines in physics and chemistry.

During the 1990s there was an increase in participation in information technology and technical studies. By way of comparison, the increases in these subject areas were greater than the declines in physics and chemistry. In 2001, one quarter of Year 12 students included an information technology subject in their course and one sixth included a technical subject in their course. The implications of this growth for teacher education are not obvious because the articulation of studies of these subjects at school with post-school study and the backgrounds for teachers of information technology and technical subjects are not as clear as for the sciences.

In summary, a decline in numbers in the traditional sciences of biology, chemistry and physics (and in advanced mathematics) appears to be coincident with an increase in numbers in technology subjects and fundamental mathematics. Elsewhere it has been observed that, at school level, there is little connection between the traditional sciences and technology (Elsworth et al. 1999).

# 3. University Participation in the Sciences and Technology

In this section attention is paid to participation in university courses in mathematics, science and technology. The section begins by considering entry to science, mathematics and technology fields of education at university. It makes use of cross-sectional commencing student data from the Higher Education Statistics Collection (HESC) maintained by the Department of Education, Science and Training (DEST) 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 completion rates based on two sets of longitudinal data conducted by DEST and numbers of completions using the HESC data. There will always be an issue of defining the scope of a term such as the sciences and technology. In general, the section focuses on the major science-based broad fields of education: sciences, information technology, engineering, architecture, agriculture and health.

## Entry to science mathematics and technology studies in higher education

### Commencing student information

Table 6 records commencing enrolments for non-overseas students new to higher education for 1990 to 2002. The data refer to enrolments in bachelor honours, bachelor pass and diploma courses. Trends in numbers of commencements are shown in Figure 8. In 2002, approximately 11 per cent of these commencing enrolments were in the natural and physical sciences, 12 per cent were in health and 19 per cent were in various technology fields. Females provided a substantial majority of commencing enrolments in health but a substantial minority in information technology and engineering. Females provided just a little more than half of the commencing enrolments in the natural and physical sciences and less than half in agriculture and architecture.

**Table 6: Domestic undergraduate commencing students who are new to higher education by broad field of education from 1990 to 2002**

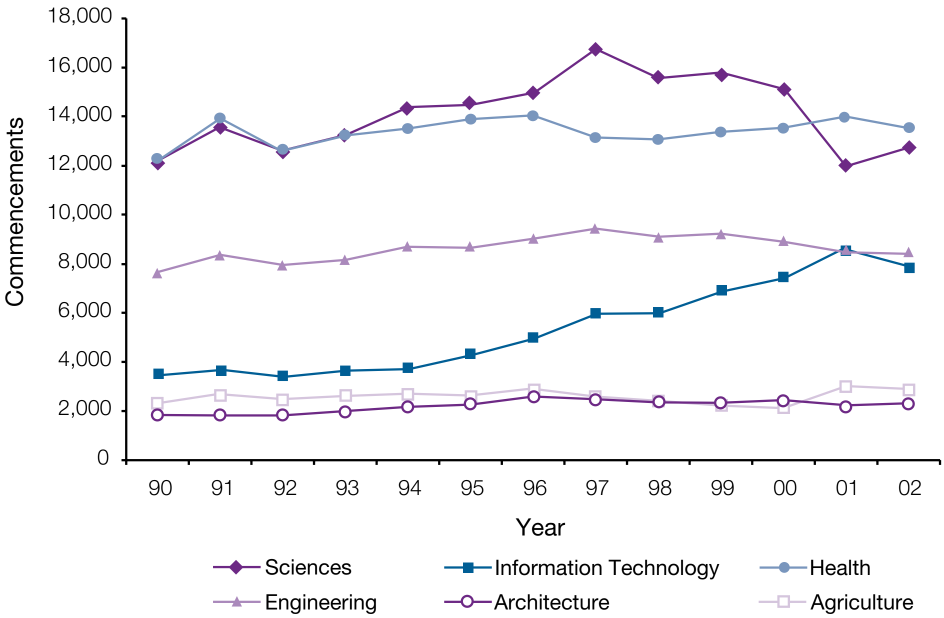
| Year | Sciences | | Information Technology | | Engineering | | Architecture | | Agriculture | | Health | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % |
| 1990 | 12,040 | 12.0 | 3,516 | 3.5 | 7,641 | 7.6 | 1,825 | 1.8 | 2,338 | 2.3 | 12,260 | 12.2 |
| 1991 | 13,604 | 12.8 | 3,691 | 3.5 | 8,325 | 7.8 | 1,829 | 1.7 | 2,684 | 2.5 | 13,925 | 13.1 |
| 1992 | 12,572 | 13.2 | 3,445 | 3.6 | 7,944 | 8.4 | 1,832 | 1.9 | 2,499 | 2.6 | 12,639 | 13.3 |
| 1993 | 13,192 | 12.9 | 3,598 | 3.5 | 8,127 | 8.0 | 1,968 | 1.9 | 2,639 | 2.6 | 13,238 | 13.0 |
| 1994 | 14,324 | 13.1 | 3,762 | 3.4 | 8,660 | 7.9 | 2,154 | 2.0 | 2,716 | 2.5 | 13,506 | 12.3 |
| 1995 | 14,495 | 12.4 | 4,336 | 3.7 | 8,675 | 7.4 | 2,228 | 1.9 | 2,654 | 2.3 | 13,883 | 11.9 |
| 1996 | 14,959 | 11.9 | 5,017 | 4.0 | 8,979 | 7.1 | 2,549 | 2.0 | 2,888 | 2.3 | 14,018 | 11.1 |
| 1997 | 16,719 | 13.5 | 6,015 | 4.9 | 9,407 | 7.6 | 2,451 | 2.0 | 2,614 | 2.1 | 13,133 | 10.6 |
| 1998 | 15,550 | 13.1 | 6,042 | 5.1 | 9,084 | 7.7 | 2,361 | 2.0 | 2,414 | 2.0 | 13,053 | 11.0 |
| 1999 | 15,720 | 13.0 | 6,927 | 5.7 | 9,161 | 7.6 | 2,326 | 1.9 | 2,251 | 1.9 | 13,357 | 11.0 |
| 2000 | 15,071 | 12.4 | 7,463 | 6.1 | 8,891 | 7.3 | 2,404 | 2.0 | 2,147 | 1.8 | 13,532 | 11.1 |
| 2001 | 11,981 | 10.0 | 8,522 | 7.1 | 8,479 | 7.1 | 2,181 | 1.8 | 3,029 | 2.5 | 13,977 | 11.7 |
| 2002 | 12,718 | 11.0 | 7,828 | 6.8 | 8,418 | 7.3 | 2,287 | 2.0 | 2,910 | 2.5 | 13,540 | 11.7 |

Note: Data from 1997 onwards were compiled in a different way to data for prior years to take into account the coding of Combined Courses to two fields of study. As a consequence, the total for some broad fields of study show larger increases than would be the case if data for only one field were to be counted. Counting both fields of study for Combined Courses means that the totals for each year may be less than the sum of all Broad Fields of Study.

Source: DEST Higher Education Statistics Collection: Commencing enrolments for non-overseas students new to higher education for 1990 to 2002.

Over the period from 1990 to 2002, there were 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. In the past two years there was a small decline in the sciences but, over the previous ten years, the percentage fluctuated between 12 and 13 per cent. Engineering has declined a little from approximately eight to approximately seven per cent of new commencing enrolments.

**Figure 8: Trends in commencing domestic enrolments new to higher eduction in bachelor degree courses from 1990 to 2002**




## Longitudinal data on transitions

Data from LSAY provide a perspective on the post school destinations of Year 12 students from 1998. The focus is on first 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 7 the general post-secondary destinations (in relation to further study) have been tabulated for two groups of students. The first 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. 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.

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 from 1998. Data are recorded in Table 8. Figure 9 represents the percentage of university entrants, with different Year 12 subject backgrounds, who studied in various fields of education at university.

Seventy-nine 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 field was science (33 per cent) followed by engineering (24 per cent) and then health (19 per cent). Seventy-one 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 field was also science (33 per cent) followed by health (22 per cent) and then engineering (14 per cent).

**Table 7: Percentage of students who completed Year 12 in 1998 in various educational destinations by extent of science studies in Year 12 up to two years after completing school**

| | Two physical science subjects in Year 12 | | Two science subjects in Year 12 | | All Year 12 students |
|---|---|---|---|---|---|
| | Yes | No | Yes | No | |
| 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) |

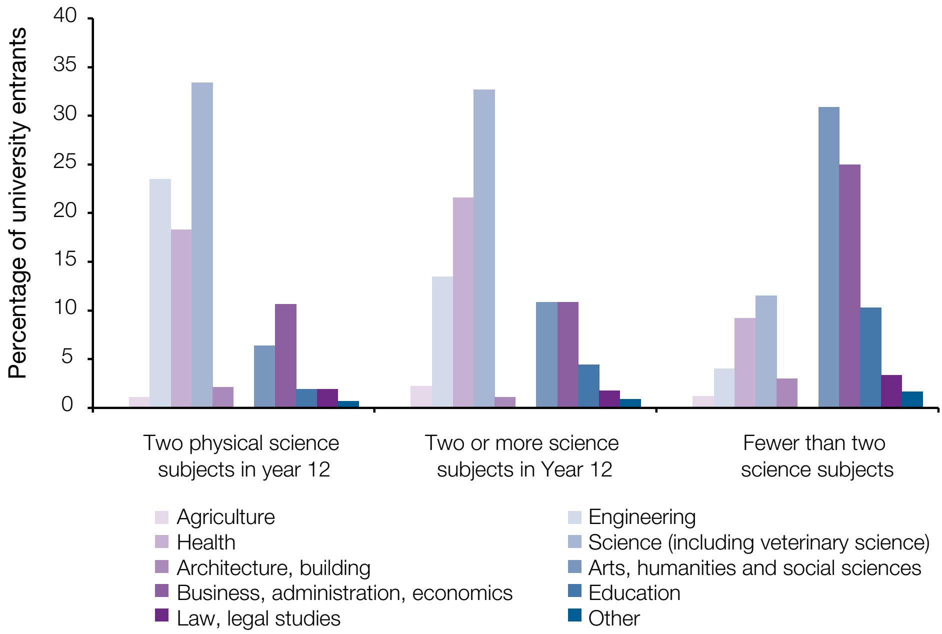
Note: Analyses by Julie McMillan.

Source: Longitudinal Surveys of Australian Youth.

For both groups of science specialists who entered university the most common non-science fields of study were business administration and commerce (11 per cent for each group) and the arts, humanities and social sciences (6 and 11 per cent respectively). Overall, more than 70 per cent of science specialists and 79 per cent of physical science specialists from Year 12 who enter university, study in a science-related field.

Those science specialists from Year 12 who pursued studies in TAFE were less likely to continue to study science than their peers who pursued their studies at university. Fifty-three per cent of those who specialised in physical science and then studied at TAFE studied in a science-related field and 56 per cent of the more general science specialists who studied at TAFE did so in a science-related field.

**Figure 9: Percentage distribution across fields of study at university by science background of students who completed Year 12 in 1998**



## Table 8: Percentage of students who completed Year 12 in 1998 in various fields of study by extent of science studies in Year 12

### (a) Classified by extent of physical science studies in Year 12

| | Two physical science subjects in Year 12 | | Fewer than two physical science subjects in Year 12 | |
|---|---|---|---|---|
| Field of study | University | TAFE | University | TAFE |
| **Science-related** | | | | |
| Agriculture | 1.1 | 4.6 | 1.6 | 3.5 |
| Engineering | 23.5 | 32.4 | 3.7 | 6.6 |
| Health | 18.5 | 0.0 | 12.2 | 12.5 |
| Science (including veterinary science) | 33.4 | 16.3 | 15.3 | 11.6 |
| Architecture, building | 2.1 | 1.9 | 2.4 | 3.7 |
| **Other** | | | | |
| Arts, humanities and social sciences | 6.4 | 5.1 | 28.0 | 11.2 |
| Business, administration, economics | 10.7 | 23.9 | 22.4 | 28.3 |
| Education | 1.9 | 0.0 | 9.7 | 1.1 |
| Law, legal studies | 1.9 | 2.4 | 3.6 | 1.9 |
| Other | 0.7 | 13.5 | 1.6 | 19.7 |
| Total | 100 | 100 | 100 | 100 |
| (n) | (444) | (16) | (2,136) | (1,139) |

Note 1: Excludes apprentices and trainees.
Note 2: Analyses by Julie McMillan.
Source: Longitudinal Surveys of Australian Youth

### (b) Classified by extent of any science studies in Year 12

| | Two physical science subjects in Year 12 | | Fewer than two physical science subjects in Year 12 | |
|---|---|---|---|---|
| Field of study | University | TAFE | University | TAFE |
| **Science-related** | | | | |
| Agriculture | 2.2 | 9.2 | 1.2 | 3.0 |
| Engineering | 13.5 | 14.3 | 4.0 | 6.2 |
| Health | 21.6 | 11.2 | 9.2 | 12.4 |
| Science (including veterinary science) | 32.7 | 21.4 | 11.5 | 10.7 |
| Architecture, building | 1.1 | 2.3 | 3.0 | 3.8 |
| **Other** | | | | |
| Arts, humanities and social sciences | 10.9 | 4.8 | 30.9 | 11.7 |
| Business, administration, economics | 10.9 | 17.9 | 25.0 | 29.2 |
| Education | 4.4 | 0.0 | 10.3 | 1.2 |
| Law, legal studies | 1.8 | 0.9 | 3.4 | 2.0 |
| Other | 0.9 | 18.0 | 1.7 | 19.8 |
| Total | 100 | 100 | 100 | 100 |
| (n) | (848) | (100) | (1,732) | (1,055) |

Note: Excludes apprentices and trainees.
Analyses by Julie McMillan.
Source: Longitudinal Surveys of Australian Youth.

## Victorian data on the transition from Year 12 to university

The Australian Council of Deans of Science has produced analyses of Victorian Tertiary Admissions Centre data on university entrants for 1998 (Dobson & Calderon 1999). Those analyses focus on the various combinations of science and mathematics subjects by Year 12 students in 1997 and the relationship of those combinations to entry to the science or engineering broad fields of study at university in 1998. For the present report the data have been reorganised and simplified to relate science studies in Year 12 to field of study at university. These data are presented in Table 9.

**Table 9: Percentages of students who completed Year 12 in 1997 with various science specialisations entering university fields of study (Victoria)**

| Year 12 science combination | Science | Engineering | Other | Total |
|---|---|---|---|---|
| Chemistry and physics | 36 | 20 | 44 | 100 |
| Any two science subjects | 33 | 15 | 52 | 100 |
| Any two science subjects (not counting psychology) | 35 | 18 | 47 | 100 |
| Two science subjects (not chemistry and physics) | 32 | 6 | 62 | 100 |

Source: ACDS (1999).

Among students who included both physics and chemistry in their Year 12 course and went to university the next year, 36 per cent studied in the sciences, 20 per cent studied in the engineering broad field of study and 44 per cent studied in another field of study. These figures are reasonably similar to the national data for 1999 reported in Table 8 from LSAY. However, the analysis of the VTAC does not provide information for some science-related fields of study such as health.

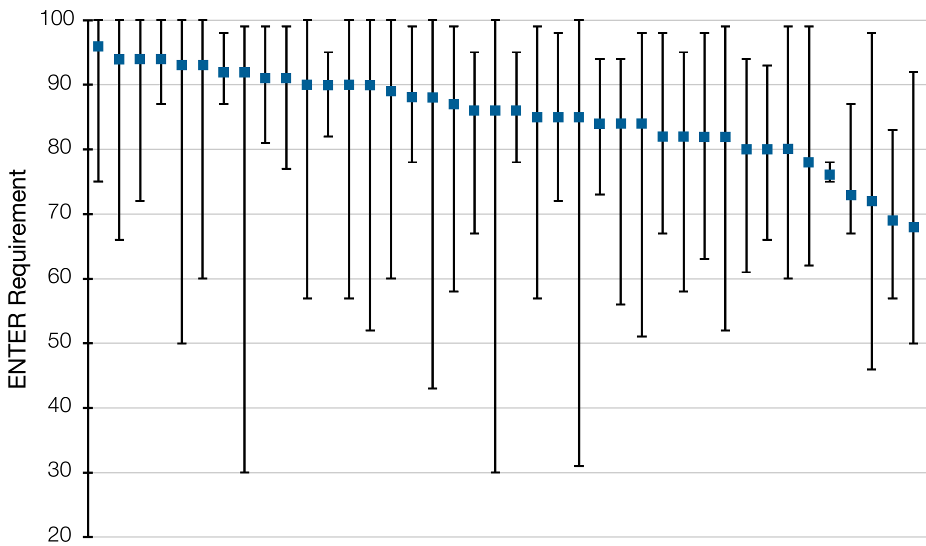
Among students who studied any two science subjects in Year 12 and went to university in the following year, 33 per cent studied in the science field of study, 15 per cent studied in engineering and 52 per cent studied in another field (which may have included health or another science-related field). Again these data are similar to those derived from LSAY and shown in Table 8.

Excluding psychology, because it is not studied as frequently in jurisdictions other than Victoria, makes only a small difference. However, if the group doing two science subjects but not the combination of physics and chemistry is considered, there is a much smaller percentage studying in engineering but little difference in the percentage studying in the science field of study.

## Entry requirements for science and engineering

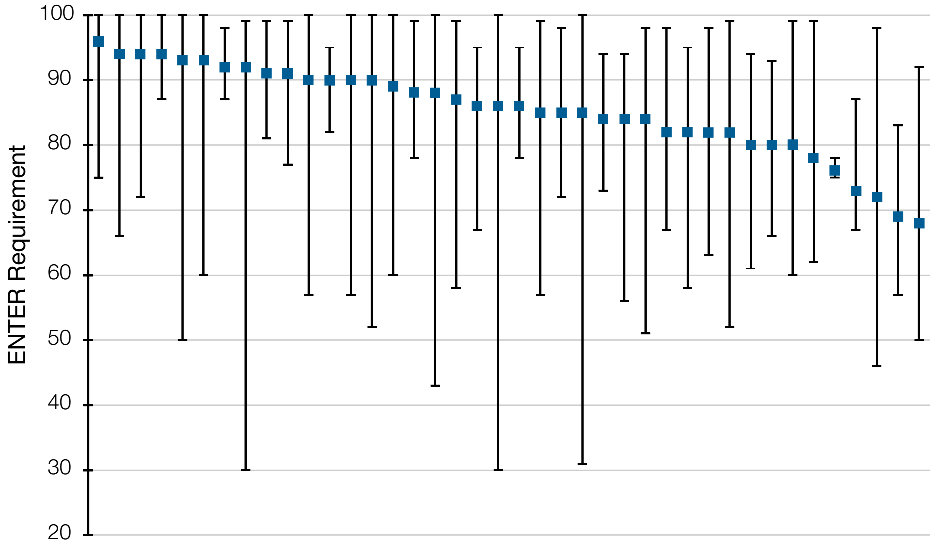
The equivalent national tertiary entrance rank (ENTER) can be interpreted as a measure of the relative academic background of students entering university courses. Overall, median ENTER requirement for fields of education within science and engineering has been stable from 1999 to 2002 and high at 88 but there is considerable variation. In general, the requirements for entry to engineering courses have been just a little higher than for science. Within detailed fields of study there is still considerable variation. Figure 10 shows the median ENTER requirement for each minor field of education in science for 2001. For each minor field it records the median (across institutions), the maximum and the minimum. It can be seen that median ENTER requirements ranged from 94 to 69. Corresponding data for engineering in 2001 are recorded in Figure 11. In engineering the range of medians is from 96 to 68. In both engineering and science there is a considerable range within minor fields.

**Figure 10: Distribution of median ENTER scores for minor fields of education within science for 2001**




Source: DEST Higher Education Statistics Collection: ENTER scores for minor fields of study within science for commencing domestic students (2001).

**Figure 11: Distribution of median enter scores for minor fields of education within engineering for 2001**




Source: DEST Higher Education Statistics Collection: ENTER scores for minor fields of study within engineering for commencing domestic students (2001).

**Table 10: Completion rates for university undergraduate courses by broad field of study for 1992 and 1993 entry cohorts**

| Field of study | Status of the 1992 entry cohort in 1997 | | | Predicted probabilities of completion | |
|---|---|---|---|---|---|
| | Completed | Not completed | | 1992 entry cohort | 1993 entry cohort |
| | | Not studying | Still studying | | |
| Agriculture | 54.5 | 41.1 | 4.4 | 61.7 | 62.4 |
| Architecture | 61.6 | 29.4 | 9.0 | 65.6 | 64.7 |
| Arts, humanities & social sciences | 55.0 | 39.2 | 5.9 | 59.4 | 58.4 |
| Business admin & economics | 56.4 | 36.2 | 7.4 | 63.0 | 62.5 |
| Education | 69.9 | 27.6 | 2.5 | 74.8 | 71.4 |
| Engineering | 55.8 | 34.2 | 10.1 | 59.4 | 58.8 |
| Health | 75.4 | 18.1 | 6.5 | 79.2 | 78.5 |
| Health (Nursing) | 73.1 | 25.6 | 1.3 | 76.9 | 75.2 |
| Law, legal studies | 63.4 | 28.3 | 8.3 | 70.9 | 72.0 |
| Science | 56.2 | 37.5 | 6.3 | 57.9 | 58.3 |
| Vet science | 90.2 | 6.9 | 2.4 | 89.8 | 89.8 |
| All | 60.4 | 33.8 | 5.8 | 65.3 | 64.3 |

Source: Urban et al. (1999); Martin et al. (2001).

## Completion rates for undergraduate courses

The best recent estimates of completion rates for undergraduate university courses are provided by two papers produced in the DEST Higher Education Group by Urban et al. (1999) and Martin et al. (2001). The first paper is based on a longitudinal database of just fewer than 130,000 domestic students who enrolled in an undergraduate course between January and March 1992. The paper by Urban et al. (1999) analyses the status of these students by the end of 1997. The second makes use of updated information on the 1992 cohort through to the end of 1999 and also makes use of corresponding data from the 1993 entry cohort (of just over 130,000 students). Table 10 presents a set of summary statistics derived from the analyses of those data.

At the end of 1997, 60 per cent of the 1992 cohort had completed their course and a further 6 per cent were still studying (Urban et al. 1999). By 1999, 64 per cent of the 1992 cohort had completed the course they commenced and three per cent were still studying (Martin et al. 2001). For the 1993 cohort, 63 per cent had completed a course by 1999 and four per cent were still studying.[15]

Using a logistic regression model to make allowance for the influence of correlated background factors, Martin et al. (2001) were able to identify the major influences on completion. Other things being equal, female students were more likely to have completed a course (by about six percentage points) than males, students of a language background other than English were more likely to have completed than other students (by two percentage points), and students of the most advantaged socioeconomic background were more likely to have completed than those of most disadvantaged socioeconomic backgrounds (by about four percentage points). There was a considerable influence of mode of study (full-time being favoured over part-time or external) and there was a considerable difference between fields of study.

In terms of field of study, completion rates for veterinary science (almost 90 per cent) and health (76 per cent for nursing and 79 per cent for other health) were substantially higher than those for arts, humanities and social science (58 per cent), science (58 per cent) and engineering (59 per cent). From these analyses it can 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, will have completed that course within seven years after commencement.

15 Of course there may be people who return to complete a course at a later time. Martin et al. (2001) estimate that including those later returns to study might yield a final completion rate of around 71 per cent.

Undergraduate science students, along with their peers in the arts, humanities and social sciences appear the least likely to complete their courses. These are the most general and superficially the least vocationally oriented fields of study. 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 out of study). It is also possible that employment options for these general courses may appear less clear to students during their course.

## Undergraduate course completions

Table 11 provides information regarding completions from undergraduate courses (bachelor honours, bachelor pass and diploma) from science-related fields of study over the years from 1997 to 2001 together with total completions over the same period. The change in the classification of field of study/education between the 2000 graduates and the 2001 graduates complicates comparisons (the main change is that information technology is shown separately from the sciences), but the general pattern is that the total number of graduates in science-related fields makes up approximately 40 per cent of all graduates, yielding just over 40,000 graduates in 2001 (and just less at around 37,000 graduates in the previous four years).

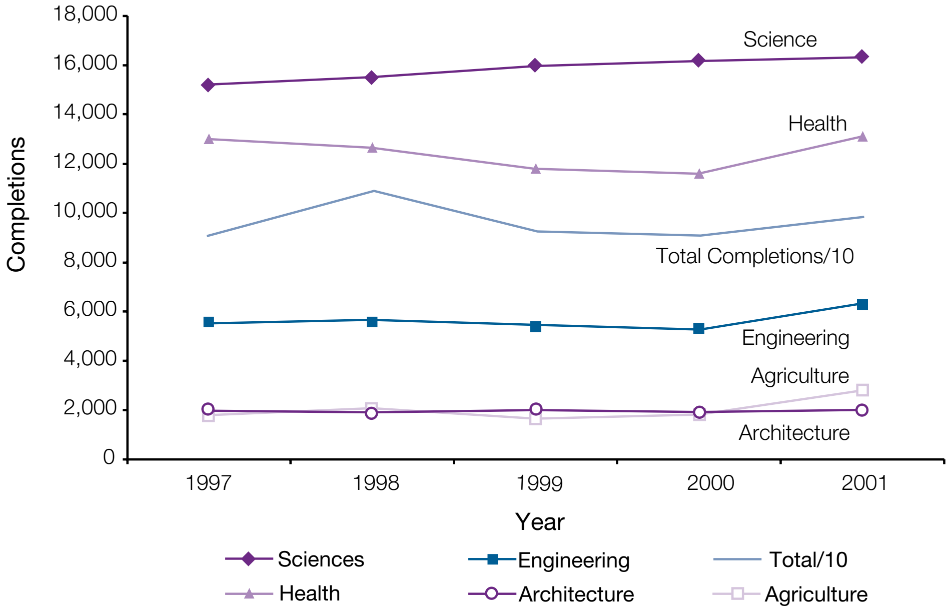
**Table 11: Completions from science-related undergraduate courses rates by non-overseas students from 1997 to 2001**

| Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | | Natural & Physical Sciences | Information Technology | Engineering & Related Technologies | Health | Agriculture, Environmental & Related Studies | Architecture & Building | Total completions |
| 2001 | Number | 10,904 | 5,418 | 6,276 | 13,054 | 2,802 | 2,018 | 97,632 |
| | % of total | 11.2 | 5.5 | 6.4 | 13.4 | 2.9 | 2.1 | |
| | | Science | | Engineering, Surveying | Health | Agriculture | Architecture, Building | |
| 2000 | Number | 16,165 | | 5,325 | 11,551 | 1,831 | 1,926 | 91,626 |
| | % of total | 17.6 | | 5.8 | 12.6 | 2.0 | 2.1 | |
| 1999 | Number | 15,975 | | 5,408 | 11,765 | 1,691 | 1,992 | 92,934 |
| | % of total | 17.2 | | 5.8 | 12.7 | 1.8 | 2.1 | |
| 1998 | Number | 15,464 | | 5,616 | 12,614 | 2,044 | 1,910 | 108,119 |
| | % of total | 14.3 | | 5.2 | 11.7 | 1.9 | 1.8 | |
| 1997 | Number | 15,182 | | 5,579 | 13,006 | 1,748 | 1,953 | 91392 |
| | % of total | 16.6 | | 6.1 | 14.2 | 1.9 | 2.1 | |

Note: Change of classification between 2000 and 2001.

Source: DEST Higher Education Statistics Collection: Undergraduate course completions by non-overseas students from 1997 to 2001.

**Figure 12: Trends in completions of science-related fields of education from 1997 to 2001**




Source: DEST Higher Education Statistics Collection: Undergraduate course completions by non-overseas students from 1997 to 2001.

The science field of study (included information technology in 2001) provided approximately 17 per cent of graduates over the five years considered, engineering provided approximately six per cent and health provided approximately 13 per cent of graduates. Trends, including a comparison with total completions, are shown in Figure 12.

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 2002 is compared with completions for 2001 (as is shown in Table 12), there does appear to be an indication of a small increase in engineering and information technology and a decline in health with an overall similarity in the patterns for both sets of data.

**Table 12: Percentage distributions of 2001 completions and 2002 commencements across science-related fields of education**

| | 2001 Completions | 2002 Commencements |
|---|---|---|
| Natural and Physical Sciences | 11.2 | 11.2 |
| Information Technology | 5.5 | 7.1 |
| Engineering and Related Technologies | 6.4 | 7.3 |
| Architecture and Building | 2.1 | 2.0 |
| Agriculture, Environmental & Related Studies | 2.9 | 2.5 |
| Health | 13.4 | 11.9 |
| Total | 41.5 | 42.0 |

Source: DEST Higher Education Statistics Collection: Undergraduate course commencements and completions by non-overseas students from 1997 to 2001.

## Summary

Commencing enrolments in undergraduate courses in science-related fields varied over the period from 1990 to 2002. The overall pattern appears to have been that a post-1997 decline in commencements in the physical and natural sciences, and to a smaller extent in engineering, has been accompanied by a rise in information technology. Health commencements fluctuated a little but in general remained at a constant level and a similar steady state was evident in architecture and agriculture. There is evidence of a fairly strong connection between specialising in science in the final year of secondary school and commencing science-related fields of education at university. For example, 86 per cent of those studying two physical science subjects in school continue to university and 79 per cent of those young people study in a science related field at university. Completions in science and engineering fields over the period from 1997 to 2001 apparently still reflect the growth in commencements from the first half of the decade. It might be expected that there would be a small decline in completions from 2002 onwards.

# 4. Teacher Education

## Initial teacher education courses in Australia

Two recent reports provide perspectives on initial teacher education courses in Australia. A report by Ballantyne et al. (2003) indicates that there was a wide variety of teacher education courses in Australia. This report was based on detailed follow-up by means of interview to map teacher education programs in Australia and to compile data on student completions for 1999, 2000 and 2001. According to this report, during 2001 there were 38 institutions that were recorded as offering 410 teacher education courses. However, one third of these programs (136) had no completions for 2001 and 114 had no completions for the past three years. Therefore there were 296 active programs in recent years or 263 with completions in 2001.

Courses vary in duration and entry requirements as shown below in Table 13. The data in this table refer to both courses and completions. They do not indicate the numbers of students who choose to leave a course "early" and thus take a three-year Bachelor of Teaching rather than a four-year Bachelor of Education or a one-year Diploma of Education or Bachelor of Teaching rather than a two-year Master of Teaching or Bachelor of Teaching. Analyses of the database developed as part of the study indicates that approximately eight per cent of the courses have provision for early exit (most frequently in two-year graduate entry and four-year undergraduate courses).

**Table 13: Characteristics of initial teacher education courses with completions in 2001**

| Entry Level | Duration | Number | % of courses | % of completions | Notes |
|---|---|---|---|---|---|
| Graduate | One year | 57 | 22% | 31% | NSW Vic WA have 30% or more of courses in this group. |
| | Two years | 46 | 18% | 12% | SA, Tas Qld NT and ACT have 30% or more of courses in this group |
| Undergraduate | Three years | 10 | 4% | 3% | |
| | Four years | 145 | 50% | 54% | Many of these courses provide for early exit and later upgrading |

Note: Excludes courses with no completions in 2001, three courses for which no duration was specified, and two for which no entry level was specified.

Source: Ballantyne et al. (2003).

The second report, by Lawrance and Palmer (2003), examined practices and innovations in initial teacher education for science, mathematics and technology (specifically design and technology rather than information technology) in 36 participating universities. The report was based on a survey of teacher education programs conducted by telephone interview, 13 case studies of innovative practice, an email survey of deans of science and professional bodies and a review of relevant literature including policy documents. It examines the course in those institutions in relation to content studies, links between content and pedagogical studies, integration of teaching theory and practice, aspects concerned with literacy and numeracy among school students, exposure to school projects and programs, and links with business and industry. Overall it examined differences in teacher preparation among different types of programs. The report provides considerable detail regarding the courses provided and includes estimates of the numbers of students in those programs.

As was noted by Ballantyne et al. (2003), most of the primary undergraduate programs were four-year concurrent degrees or double degree programs. Innovations at the whole-program level were relatively few and the majority of innovations related to particular courses within programs. Innovations included: the integration of mathematics and science units with each other or with other areas around authentic tasks; the use of problem-based learning; the combining of content and pedagogy through innovative themes; the creation of links between theory with school practice; and school visits that enabled students to practise innovative teaching techniques with small groups. Although there were both undergraduate and graduate programs for secondary teachers of science and mathematics, the majority of enrolments were in graduate programs. Again the innovations were more frequently at a course than a program level. In concurrent undergraduate programs there were approaches to tailoring science or mathematics content to the perceived needs of teacher education students and providing a wider range of major discipline studies. More generally in both graduate and undergraduate-entry programs there were provisions for modelling innovative teaching strategies, using school-based approaches to teaching methods courses, different organisational arrangements for teaching practice and uses of information technology. The report raised the issues of the appropriate range content studies in science and mathematics, and the appropriate balance of content and education studies.

## Commencements in initial teacher education: trends from 1990

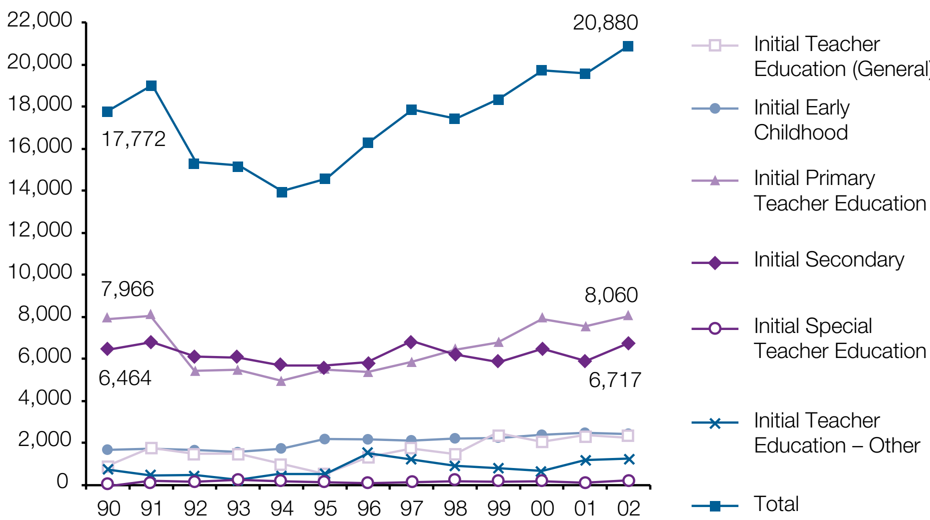
Patterns of commencements in initial teacher education courses (by non-overseas students) declined from the beginning of the 1990s to 1994. From 1995 onwards commencements generally increased. From 1994 to 2002, the number of domestic commencements in initial teacher education rose by nearly 7,000 from just under 14,000 to just under 21,000. The general trends are shown in Figure 13. In 2002, there were 8,060 commencements in primary teacher education, 2,420 commencements in early childhood and 6,717 commencements in secondary teacher education from a total of 20,880 commencements by domestic students in all initial teacher education courses. On this basis it could be expected that completions from teacher education courses will continue to increase in future years.

On the basis of the data in Figure 13, it would appear that growth in commencements since 1994 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 teacher education (general).

Figure 14 shows changes in commencements in graduate and undergraduate courses in initial primary and secondary teacher education. On the basis of those data it would appear that the growth in initial teacher education commencements since 1994 (as well as the decline from 1990 to 1994) was largely fuelled by increased commencements in undergraduate courses in primary teacher education. There was also a net rise over the period from 1990 to 2002 in commencements in graduate courses in initial secondary teacher education. Over the same period there was a small decline in commencements in undergraduate secondary teacher education courses. Commencements in graduate primary teacher education courses rose, but remain much lower than any other course type.

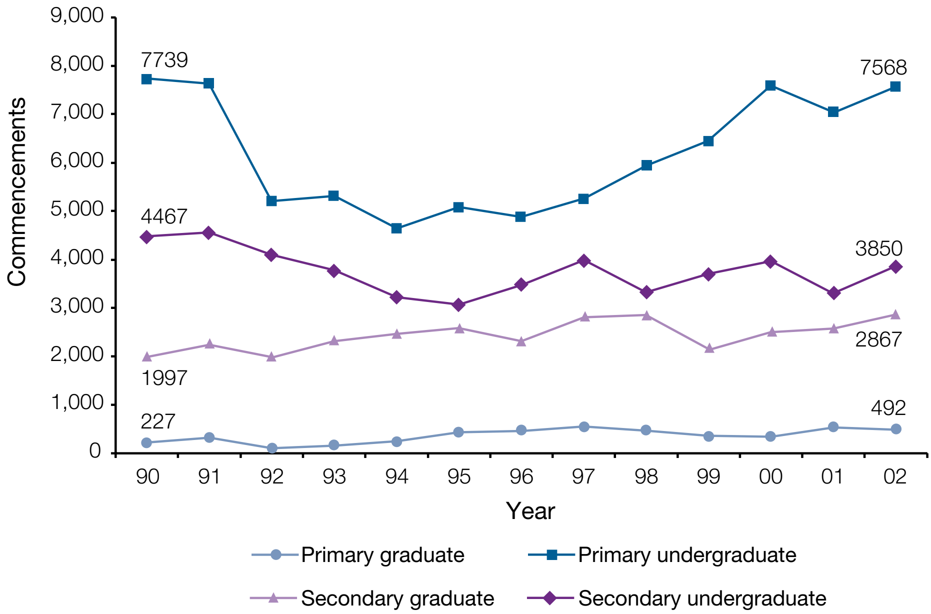
An important question is whether these trends in commencements are congruent with likely trends in school enrolments and differentiated demands for teachers.

**Figure 13: Commencing domestic students in various initial teacher education courses from 1990 to 2002**




Source: DEST Higher Education Statistics Collection: Commencing Students Enrolled in Teacher Education Courses by Citizenship and Gender 1990 to 2002.

**Figure 14: Commencing domestic students in initial teacher education courses from 1990 to 2002**




Source: DEST Higher Education Statistics Collection: Commencing Students Enrolled in Teacher Education Courses by Citizenship and Gender 1990 to 2002.

## Characteristics of teacher education students

An examination of the characteristics of students in teacher education courses was undertaken using data from the Longitudinal Surveys of Australian Youth (LSAY). These data were from the 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 1995. Those who continued uninterrupted through school completed Year 12 in 1998. Their progress has been followed each year since 1995. These analyses are based on the group of just fewer than 3,000 who had participated in university study and with whom contact had been maintained up to and including 2001. 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 14 the characteristics of those who had been in initial teacher education at any time since leaving school and up to 2001 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 14 presents a picture consistent with much of the conventional wisdom regarding the characteristics of those participating in initial teacher education programs. 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. The data in Table 14 indicate the preponderance of young women in these initial teacher education programs. Young women make up 83 per cent of those in these courses compared with 56 per cent of other university courses. The DEST Higher Education Statistics collection reflects this disparity and forms the basis for the report by Carrington and Pratt (2003) for the parliamentary library.[16]

According to data from the DEST Higher Education Statistics Collection, the preponderance of female enrolments in teacher education has increased since the 1980s.[17] Those data indicate that in 1988, females constituted 71 per cent of enrolments in all teacher education courses rising to 75 per cent in 1992 and remaining at 76 per cent from 1997 to 2001.

The data in Table 14 suggest that participants in initial teacher education programs (or at least undergraduate programs) are a little more drawn from the middle of the socioeconomic distribution than either the top or bottom, compared with other university students. Initial teacher education had slightly lower representation among those whose parents worked in professional occupations and semi or unskilled occupation, and slightly higher representation among those whose parents worked in clerical or skilled trades occupations.

Similarly, participants in initial teacher education were less likely than their peers in other fields of education to have come from families where their parents had themselves attended university (28 compared to 36 per cent) and were more likely to come from families where their parents had not completed secondary school (43 compared to 31 per cent). 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. There were relatively small differences in relation to the type of secondary school attended. Teacher education students were just a little more likely to have come from a government or Catholic school, and a little less likely to have come from an independent school than their peers in other university courses.

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[16] The data in this report also include graduate entry programs in initial teacher education where the preponderance of females is a little less than in undergraduate programs. That report suggests that, overall, 77 per cent of those in all teacher education programs are females.

[17] These are based on analysis for domestic students only, but for all teacher education courses.

**Table 14: Characteristics of students in initial teacher education and other university courses from 1999 to 2001**

| | | Percentage of students in category | |
|---|---|---|---|
| Characteristic | Category | Initial teacher education | Other university courses |
| Gender | Male | 17.1 | 43.9 |
| | Female | 82.9 | 56.1 |
| Parental Occupation | Professional | 48.6 | 55.5 |
| | Clerical | 19.3 | 15.2 |
| | Skilled | 19.5 | 13.5 |
| | Semi/unskilled | 12.6 | 15.7 |
| Parental Education | Higher Education | 27.7 | 35.6 |
| | Trade/Technical | 9.1 | 9.1 |
| | Complete secondary | 20.6 | 24.4 |
| | Not complete secondary | 42.6 | 31.0 |
| Parental Birthplace | Australia | 73.2 | 62.6 |
| | Other English speaking | 8.4 | 9.9 |
| | Non-English speaking | 18.4 | 27.5 |
| Location in Year 9 | State capital | 44.0 | 62.2 |
| | Urban region | 9.9 | 9.5 |
| | Large provincial city | 12.1 | 5.5 |
| | Small provincial city | 4.3 | 3.9 |
| | Other rural | 29.7 | 18.8 |
| School sector | Government | 58.5 | 56.5 |
| | Catholic | 27.6 | 25.0 |
| | Independent | 13.9 | 18.5 |
| Year 9 achievement | Highest ( >1 sd) | 14.8 | 27.2 |
| | High ( > mean) | 49.4 | 47.2 |
| | Low ( < mean) | 26.7 | 19.2 |
| | Lowest ( >1 sd) | 9.1 | 6.4 |
| Numbers | | 242 | 2829 |

Note: Analyses by Julie McMillan.

Source: Longitudinal Surveys of Australian Youth based on the cohort of students in Year 9 in 1995 who were followed through to the end of 2001.

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[18] (the difference is 15 compared to 27 per cent) and more likely to have been from the low or lowest groups[19] (the difference was 36 compared to 26 per cent).

[18] This group was defined as those scoring at least one standard deviation above the Year 9 mean.

[19] These were defined respectively as below the mean by one standard deviation or less and below the mean by at least one standard deviation.

## Course completions

### Overall completions from initial teacher education

Information from the DEST Higher Education Statistics Collection provides an indication of trends in completions from initial teacher education courses from 1990 to 2001. Summary data recorded in Table 15 show fluctuations in completions from year to year. A focus on initial primary and initial secondary teacher education shows a clearer trend than for all of initial teacher education. In those two key areas there appears to have been a decline in completions through to 1996, a plateau effect from 1996 to 1999 (even a small upturn) followed by an increase from 1999 to 2001.

**Table 15: Initial teacher education course completions by domestic students from 1990 to 2001**

| | Minor Field of Study | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Initial Teacher Education (General) | Initial Early Childhood Teacher Education | Initial Primary Teacher Education | Initial Secondary Teacher Education | Initial Special Teacher Education | Initial Teacher Education-Other | Total Initial Teacher Education | Total All Teacher Education |
| 1990 | 617 | 1,063 | 5,078 | 4,399 | 21 | 414 | 11,592 | 19,704 |
| 1991 | 993 | 1,115 | 5,459 | 4,541 | 82 | 366 | 12,556 | 21,166 |
| 1992 | 1,018 | 1,167 | 5,062 | 3,954 | 102 | 377 | 11,680 | 20,477 |
| 1993 | 735 | 1,102 | 5,014 | 4,744 | 111 | 206 | 11,912 | 20,771 |
| 1994 | 696 | 1,121 | 4,054 | 4,506 | 106 | 232 | 10,715 | 19,182 |
| 1995 | 487 | 1,010 | 3,670 | 4,315 | 65 | 224 | 9,771 | 18,195 |
| 1996 | 696 | 1,008 | 3,081 | 3,943 | 86 | 769 | 9,583 | 17,618 |
| 1997 | 554 | 1,224 | 3,333 | 4,397 | 108 | 822 | 10,438 | 17,632 |
| 1998 | 635 | 1,359 | 3,455 | 4,396 | 100 | 712 | 10,657 | 17,247 |
| 1999 | 1,148 | 1,153 | 3,208 | 3,541 | 73 | 365 | 9,488 | 13,407 |
| 2000 | 1,000 | 1,245 | 4,218 | 4,181 | 113 | 506 | 11,263 | 16,491 |
| 2001 | 2,510 | 1,618 | 4,933 | 4,365 | 52 | 1,012 | 14,490 | 17,642 |

Notes:

1. The classification used for field of study changed to field of education between the 2000 and 2001 completions data. The codes shown above for initial teacher education in 2001 are as follows: 070100 (Teacher Education), 070101 (Teacher Education: Early Childhood), 070103 (Teacher Education: Primary), 070105 (Teacher Education: Secondary), 070113 (Teacher Education: Special Education). The codes 070107 (Teacher-Librarianship) and 070115 (English as a Second Language Teaching) have been combined as Initial Teacher Education - Other.
2. The total figure of completions for 2001 would be 14,609 if the 757 completions in "other" were not included.
3. The figure for total initial teacher education completions for 2001 does not include 3,266 from the field 070199 teacher education – not elsewhere classified.

Source: Higher Education Statistics Collection.

The post-1999 increases appear to have been mainly associated with increases in primary and secondary initial teacher education and, within that, the increase has been greater for initial primary than initial secondary. However, that picture is complicated by uncertainty regarding the category designated as initial teacher education (general). It is possible that this includes courses (such as a graduate diploma of education) that could result in either a primary or secondary school teaching qualification. There was a sharp increase in the numbers from that category in 2001. There is also some lack of clarity in the way in which graduate diplomas of education are recorded at institution level. Ballantyne et al. (2003) identify two examples where completions from a graduate diploma of education were incorrectly classified as post-initial, rather than initial, teacher education completions. Notwithstanding those issues, it does appear that there has been an increase in initial teacher education completions since 1999 and that those increases have involved primary, secondary and general teacher education.

Data in the report by Ballantyne et al. (2003) indicate that there were 14,073 expected completions of initial teacher education courses in 2001. The report also notes that completions had increased over the three years from 1999 through 2000 to 2001: from 11,114 through 12,360 to 14,073. Hence, on these figures, the increase for each successive year is 11 per cent and 14 per cent respectively. These figures are a little higher than the DEST figure for 1999 (9,488) and 2000 (11,263), but lower than the DEST figure for 2001 (14,990). Possible reasons for the discrepancies could be the detailed checking conducted by Ballantyne et al. at institution level and because they needed to base their estimates on expected completions for 2001.[20] However, the general trend of increased completions in 2000 and 2001 is evident in both sets of data.

## Variation in completions

There is considerable variation in the numbers of completions among institutions and programs. In 2001, there were 38 institutions that provided teacher education courses through 410 listed teacher education courses. One third of programs (136) had no completions for 2001 and 114 had no completions for the past three years. Therefore there were 296 active programs in recent years or 263 with completions in 2001. Within the total provision, 44 courses had 100 or more completions during 2001. The average number of graduates per course was approximately 52.

Eight major institutions accounted for 43 per cent of all completions during 2001 (amounting to 6,381 completions). The eight largest providers are Queensland University of Technology, Melbourne University, Australian Catholic University, University of Western Sydney, Newcastle University, Charles Sturt University, Deakin University and Edith Cowan University.

[20] The method used by Ballantyne et al. (2003) involved detailed checking of data that were recorded by institutions..

## Patterns among levels of schooling in course completions for 2001

Data for course completions[21] in 2001 are recorded in Table 16. There were differences in graduation numbers among states but the total completions appear to match school population differences.

Three states (New South Wales, Victoria, Western Australia) tended to produce more secondary than primary teachers while other states produce more primary teachers than secondary. These differences appear to reflect differences in numbers of students in primary and secondary schools (e.g. in New South Wales, Victoria, Tasmania and the ACT, Year 7 is part of the secondary school structure). There was also a larger number of early childhood teachers in Tasmania and adult teachers in the Northern Territory (possibly associated with community programs at Bachelor College). Victoria has a notable number of combined primary and secondary or middle school level teachers (amounting to 13 per cent of all completions).

### Table 16: Numbers of teacher education course completions for 2001

| | Early Childhood | Primary | Primary & Secondary | Secondary | Adult | Total | ABS School Enrolments |
|---|---|---|---|---|---|---|---|
| NSW | 659 | 1722 | 25 | 2102 | 212 | 4720 | 1,099,169 |
| VIC | 238 | 1225 | 466 | 1548 | 147 | 3624 | 809,365 |
| QLD | 400 | 1365 | 44 | 1091 | 126 | 3026 | 610,810 |
| WA | 126 | 354 | 0 | 641 | 42 | 1163 | 318,895 |
| SA | 107 | 416 | 46 | 235 | 66 | 870 | 249,496 |
| TAS | 77 | 77 | 54 | 56 | 23 | 287 | 82,797 |
| ACT | 29 | 168 | 0 | 88 | 0 | 285 | 60,643 |
| NT | 8 | 40 | 0 | 25 | 25 | 98 | 36,966 |
| TOTAL | 1644 | 5367 | 635 | 5786 | 641 | 14073 | |

Source: Ballantyne et al. (2003) Table 6.

21 The individual graduate is the unit recorded for completions in this and related tables. In analyses of secondary subject specialisations graduates were recorded in multiple categories so the total specialisations does not necessarily match the number of graduates

## Completions from different course structures

Table 17 records the numbers of course completions from different types of initial teacher education courses and different levels of specialisation. From these data it is evident that just under half (48 per cent) of the completions were from undergraduate bachelor degree courses (of either three or four years duration), four out of ten (40 per cent) were from graduate entry programs and just 12 per cent were from double degree programs.

It is evident those undergraduate courses provide the majority of completions in primary and early childhood education (two-thirds of primary completions) and that graduate programs provide a majority of secondary education completions (63 per cent of all completions). Notwithstanding this pattern of traditional forms, these data suggest that one fifth (21 per cent) of secondary completions came from undergraduate programs and a further sixth (16 per cent) came from double degree courses. In addition, nearly one quarter (23 per cent) of primary teaching completions came from graduate programs and just over one tenth (11 per cent) came from double degree courses.

**Table 17: Structural characteristics of initial teacher education courses and completions for 2001**

| | Undergraduate | | | Graduate | | | Double degree | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Row% | Total% | N | Row% | Total% | N | Row% | Total% | N | % |
| Early childhood | 1365 | 83% | 10% | 180 | 11% | 1% | 99 | 6% | 1% | 1644 | 12% |
| Primary | 3526 | 66% | 25% | 1240 | 23% | 9% | 601 | 11% | 4% | 5367 | 38% |
| Prim/Sec or middle | 266 | 42% | 2% | 320 | 50% | 2% | 49 | 8% | 0% | 635 | 5% |
| Secondary | 1188 | 21% | 8% | 3674 | 63% | 26% | 924 | 16% | 7% | 5786 | 41% |
| Adult | 457 | 71% | 3% | 184 | 29% | 1% | 0 | 0% | 0% | 641 | 5% |
| Total | 6802 | 48% | | 5598 | 40% | | 1673 | 12% | | 14073 | |

Source: Ballantyne et al. (2003).

## Course completions by area of secondary specialisation

Ballantyne et al. (2003) provide information about the number of course completions in various specialisations for intending secondary teachers.[22] However, it cautions that there were difficulties in obtaining consistently accurate data. Data for completions in 2001 are shown in Table 18.

22 In these data each course completion can register as more than one specialisation. The unit is therefore the specialisation completed and not the individual who has completed a course.

These data indicate that just fewer than one in five (19 per cent) of the completions specialised in senior English. The proportion of English specialisations appears to match the share of curriculum time for English in both Years 7 to 10 and also Years 11 and 12 (Fullarton et al. 2003). Mathematics has a similar curriculum share to English in secondary schools (see Fullarton et al. 2003) but only 7.1 per cent of the secondary completions were in “senior mathematics”. In order to assess the adequacy of this output of mathematics specialists, other factors need to be considered. Those who specialise in physics and chemistry might also be expected to teach mathematics. If such people could be assumed to teach mathematics for half of their teaching time then an additional output of 4.5 per cent for mathematics could be estimated.[23] When this adjustment is made the result is an effective contribution from the completions of 11.6 per cent to mathematics teaching. In addition, it should be noted that the classification used by Ballantyne et al. (2003) was for “senior mathematics”. It is also possible that an allowance could be made for others teaching junior secondary mathematics. Physical science specialists have already been considered but it is possible to envisage less specialisation in the teaching of junior mathematics.

Only one in 20 (5.5 per cent or 318) of the completions involved chemistry and even fewer (3.6 per cent or 207) were in physics. It is difficult to estimate whether physics and chemistry completions correspond with curriculum share because graduates of each contribute to the teaching of science in Years 7/8 to 10 along with other science specialisations such as biology.

Four per cent (234) of completions included a specialisation in information and communication technologies. ICT specialisations may be a little lower than demand depending on assumptions made about ICT teaching in Years 7 to 10.

**Table 18: Numbers of course completions by secondary specialists by selected specialisations for 2001**

| | Physics | Chemistry | Maths | English | ICT | LOTE | Other | Total |
|---|---|---|---|---|---|---|---|---|
| ACT | 3 | 6 | 12 | 35 | 2 | 13 | 71 | 88 |
| NSW | 106 | 140 | 139 | 325 | 49 | 152 | 911 | 2102 |
| NT | 1 | 2 | 2 | 8 | 3 | 3 | 19 | 25 |
| QLD | 19 | 42 | 71 | 201 | 30 | 76 | 439 | 1091 |
| SA | 8 | 12 | 18 | 38 | 2 | 35 | 113 | 235 |
| TAS | 0 | 2 | 8 | 25 | 1 | 7 | 43 | 56 |
| VIC | 40 | 97 | 114 | 402 | 110 | 134 | 897 | 1548 |
| WA | 30 | 17 | 44 | 89 | 37 | 32 | 249 | 641 |
| TOTAL | 207 | 318 | 408 | 1123 | 234 | 452 | 2742 | 5786 |
| % of Total | 3.6% | 5.5% | 7.1% | 19.4% | 4.0% | 7.8% | 47.4% | 100.0% |

Source: Ballantyne et al. (2003).

23 Based on the chemistry share of 5.5 per cent and the physics share of 3.6 per cent being divided equally between mathematics and the science discipline.

Nearly eight per cent of completions included a specialisation in a language other than English (LOTE). The main LOTE completions were in order of frequency: Japanese (127), French (85), Chinese (60), Indonesian (55), German (47) and Italian (40). There were also LOTE completions in Modern Greek (13), Arabic (10) and Spanish (9). There would appear to be more specialisations in LOTE than is reflected in the curriculum share in schools. However, this data does not seem consistent with the anecdotal comments from education authorities regarding the shortage of teachers of LOTE. There are several possible explanations for this lack of congruence. First, those completing a LOTE specialisation in their course could practice as specialist teachers in another area (the specialisations coded are not mutually exclusive). Second, the experience of education authorities is based on current availability rather than an emerging source that has yet to flow into schools and school systems. Third, the shortage of LOTE teachers could be of such magnitude that it will take time to catch up. Fourth, requirements for LOTE are for specific languages and therefore it may be hard to fill those specific requirements even though the overall supply of LOTE teachers in general appears more adequate. The issue of staffing LOTE requirements in schools is a difficult matter because of the large number of specialisations within the area.

## Course structure and secondary specialisations

It has been noted that the majority of completions in secondary school teacher education courses were from graduate programs (graduate diplomas, graduate bachelor degrees and masters degrees). It was also possible to analyse the database produced by Ballantyne et al. (2003) to examine links between course structures and secondary school specialisations. The results of these analyses report both the distribution of courses resulting in various specialisations and the distributions of completions for selected specialisations. Results have been recorded in Table 19.

The data in Table 19 indicate that although a majority of secondary specialists in all fields came from graduate courses, this was more strongly the case for chemistry and physics. More than 80 per cent and probably around 90 per cent (depending on assumptions made about mixed and unspecified courses) of chemistry and physics specialists came from graduate programs. Not only were there more graduate entry than undergraduate courses that produced chemistry or physics specialists but also, on average, those courses each produced more completions.[24]

Approximately three quarters of senior mathematics specialists came from graduate or mixed entry programs. Those graduate entry programs each produced more mathematics completions than undergraduate programs.

Sixty-one per cent of specialist completions in English were from graduate programs and a further five per cent were from mixed entry programs. This matched the distribution of courses indicating that the average outputs of graduate and undergraduate programs for these specialisations are similar. Undergraduate programs (involving either single or double degrees) produced about one third of English specialisations.

Information technology specialisations are less frequently from graduate programs than was the case for other specialisations. Fewer than half of the specialisations in this field came from graduate programs. Forty-two per cent of information technology specialisations came from single undergraduate degree programs and nine per cent came from double degree programs. It is possible that future years may provide greater opportunities for recruiting information technology specialists into graduate initial teacher education programs.

24 This is reflected in the data in Table 19 which shows that graduate programs in these fields made up around 70 per cent of programs but produced more than 80 (and up to 90) per cent of completions.

### Table 19: Characteristics of courses and completions associated with various specialisations for 2001

| Specialisation and type of course | Courses | | Completions | |
|---|---|---|---|---|
| | Number | % | Number | % |
| **Senior mathematics specialisations** | | | | |
| Graduate entry program | 38 | 62.3 | 298 | 73.0 |
| Mixed graduate/undergraduate | 3 | 4.9 | 9 | 2.2 |
| Bachelors undergraduate double degree | 11 | 18.0 | 46 | 11.3 |
| Bachelors undergraduate | 8 | 13.1 | 43 | 10.5 |
| Not specified | 1 | 1.6 | 12 | 2.9 |
| Total | 61 | | 408 | |
| **Chemistry specialisations** | | | | |
| Graduate entry program | 36 | 73.5 | 264 | 83.0 |
| Mixed graduate/undergraduate | 1 | 2.0 | 4 | 1.3 |
| Bachelors undergraduate double degree | 7 | 14.3 | 18 | 5.7 |
| Bachelors undergraduate | 3 | 6.1 | 9 | 2.8 |
| Unspecified | 2 | 4.1 | 23 | 7.2 |
| Total | 49 | | 318 | |
| **Physics specialisations** | | | | |
| Graduate entry program | 30 | 69.8 | 169 | 81.6 |
| Mixed graduate/undergraduate | 1 | 2.3 | 10 | 4.8 |
| Bachelors undergraduate double degree | 6 | 14.0 | 11 | 5.3 |
| Bachelors undergraduate | 4 | 9.3 | 10 | 4.8 |
| Unspecified | 2 | 4.7 | 7 | 3.4 |
| Total | 43 | | 207 | |
| **English specialisations** | | | | |
| Graduate entry program | 39 | 60.9 | 654 | 61.0 |
| Mixed graduate/undergraduate | 3 | 4.7 | 48 | 4.6 |
| Bachelors undergraduate double degree | 12 | 18.8 | 190 | 17.7 |
| Bachelors undergraduate | 9 | 14.1 | 165 | 15.4 |
| Unspecified | 1 | 1.6 | 16 | 1.5 |
| Total | 64 | | 1073 | |
| **ICT specialisations** | | | | |
| Graduate entry program | 22 | 59.5 | 107 | 47.6 |
| Bachelors undergraduate double degree | 8 | 21.6 | 20 | 8.9 |
| Bachelors undergraduate | 6 | 16.2 | 95 | 42.2 |
| Unspecified | 1 | 2.7 | 3 | 1.3 |
| Total | 37 | | 225 | |

Source: Based on data provided by Ballantyne et al. (2003).

## Graduates from science-related fields of study

The previous section has focussed on overall commencements in initial teacher education courses. In this section attention is given to the numbers of graduates from science-related fields that enter teacher training or teaching. Table 20 provides an overview of these destinations and is based on material from the Graduate Destinations Survey conducted annually by the Graduate Careers Council of Australia (GCCA). It is based on material cited in the report entitled Demand and Supply of Primary and Secondary School Teachers in Australia (MCEETYA 2003). These data are based on a survey of graduates that has a response rate of approximately 60 per cent. For that reason the percentages obtained from the survey need to be applied to population data for completions in order to generate estimated numbers. Overall, around six per cent of mathematics graduates, six per cent of life sciences graduates and less than three per cent of physical science graduates entered teacher training or schools directly.

**Table 20: Percentages of engineering, science and mathematics bachelor degree graduates working full-time in schools or in teacher training for 2001**

| | Engineering/ Surveying | Computer Science | Maths | Gen/Life Science | Physical Science |
|---|---|---|---|---|---|
| % Female graduates in schools or teacher training | 0.0 | 0.8 | 7.7 | 6.0 | 2.9 |
| % Male graduates in schools or teacher training | 0.1 | 0.4 | 5.1 | 5.0 | 2.4 |

Source: These data are based on the Graduate Destination Survey conducted annually by the Graduate Careers Council of Australia and cited in MCEETYA (2003).

According to the DEST Higher Education Statistics Collection, there were 16,225 completions by domestic students from the science broad field of study in 2000. Based on the distribution of respondents across minor fields of study within science, it can be estimated that there were approximately 3,800 computer science graduates, 9,300 graduates in life sciences, 850 mathematics graduates, 980 chemistry graduates and 520 physics graduates. On the basis of the percentages of bachelor graduates in schools or teaching, it can be estimated that the immediate yields from the graduates of 2000 for teaching were approximately 23 from computer science, 600 from the life sciences, 50 from mathematics and 40 from the physical sciences. It needs to be stressed that these figures are approximations only, but the general conclusion is that there is a small number of graduates from science related fields entering teaching or teacher education immediately after completing a bachelor degree.

Data from earlier Graduate Destination Surveys suggest that there may have been a decline in the percentage of mathematics and science graduates entering teaching over the past 10 years. In the 1992 GDS of 1991 bachelor degree graduates, the percentage of mathematics graduates (made up of general, applied and pure mathematics) entering teacher training was 10 per cent with a further two per cent entering school education (Guthrie 1993). The percentage of chemistry graduates entering teacher training was four per cent and for physics graduates the percentage was nearly five per cent. For biology and life sciences the percentage of graduates entering teacher training was just under six per cent. In summary, between 1991 and 2001 there appear to have been declines in the percentages of mathematics and physical science graduates entering teacher training. However, over the same time span, the percentages of graduates in the life sciences and biological sciences entering teacher training have remained relatively stable.

The corresponding GDS, conducted in 1980 of 1979 graduates, indicates that 13 per cent of mathematics first-degree pass graduates entered teacher training.[25] The corresponding figures for the physical sciences and the life sciences were eight per cent and three per cent. These data, although incomplete, suggest a trend over a 20-year period towards a smaller percentage of graduates in mathematics and the physical sciences entering teacher training. The trend for graduates in biology and life sciences does not appear to be uniform. There was apparently an increase in the percentage entering teacher training in the 1980s and little change since 1992.

The trends above need to be considered in conjunction with the numbers of graduates in those fields. However, in a previous section of this report it was noted that from 1990 to 2002 there were fluctuations in the numbers of domestic enrolments in science-related fields rather than a large change. For example, domestic commencements in science grew from 12,040 in 1990 to 12,718 in 2002 having peaked at 16,719 in 1997. Only for information science was there a steady rise in domestic commencements (from 3,516 in 1990 to 7,828 in 2002) but this has not been a significant source of entrants to teacher education. Completions data, reported in a previous section of the report, do not show a major increase in numbers either. In 1997, there was a total of 15,182 domestic completions in science and in 2001 there was total of 16,322 completions in science and information technology combined. A general conclusion, albeit one that is limited in its certainty by the availability of appropriate data, could be that there has been a reduction in the flow of mathematics and science graduates into initial teacher education.

25 This figure includes university bachelor pass and bachelor honours graduates as well as bachelor degree graduates from colleges of advanced education. The overall percentages were computed from GCCA numbers for each group of graduates.

**Table 21: Percentages of graduates of teacher education courses from 2000 in various activities in April 2001**

| | Females | Males | Total |
|---|---|---|---|
| Total Education | 58 | 62 | 59 |
| Schools | 54 | 57 | 55 |
| Higher Education | 1 | 3 | 1 |
| Other Education | 2 | 3 | 2 |
| Teacher Training | 3 | 3 | 3 |
| Other Employment | 8 | 10 | 8 |
| Seeking Full-Time work | 10 | 12 | 10 |
| Other activities (including further study) | 21 | 13 | 19 |

Source: These data are based on the Graduate Destination Survey conducted annually by the Graduate Careers Council of Australia and cited in MCEETYA (2003).

## Destinations of graduates from initial teacher education courses

Data from the graduate destinations survey indicate that just fewer than 60 per cent of graduates from initial teacher education courses are working full-time in education in April of the year following completion of their course. More details for male and female education graduates are shown in Table 21. On that basis it can be estimated that approximately 60 per cent of these graduates are working in education (55 per cent in schools and the remainder in other institutions), eight per cent are working in other fields, 10 per cent are unemployed and 20 per cent are involved in other activities including further study.

## Summary

Through the first four years of the 1990s there were declining numbers of students commencing initial teacher education courses but since 1995 there has been an increase in commencement numbers. Both the post-1995 increase and the preceding decline were largely associated with changes in the numbers commencing initial primary teacher education courses. 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.

More recent years (from 1999 onwards) have seen an increase in the numbers of people completing initial teacher courses. The increases in both commencements and completions have been greater in initial primary teacher education than initial secondary teacher education courses. The majority of those completing initial primary teacher education programs do so through undergraduate programs of three or four years duration and the majority of those completing initial secondary teacher education courses do so through graduate entry programs of one or two years duration. More specifically, it appears that among those completing initial secondary teacher education the numbers of senior mathematics specialists (and less certainly specialists in chemistry and physics) do not match the numbers of specialists in senior English. The overwhelming majority of specialisations in chemistry and physics, and a substantial majority of specialists in senior mathematics complete graduate entry teacher education programs. Data reviewed in this section suggest that there has been a decline in the percentage of mathematics and science graduates entering initial teacher education courses. Approximately 60 per cent of those completing initial teacher education programs work full time in education in the year following the completion of their course.

# 5. Characteristics of the Teaching Workforce

This section of the report considers some general characteristics of the teaching workforce and some specific characteristics of teachers of mathematics, science and technology.

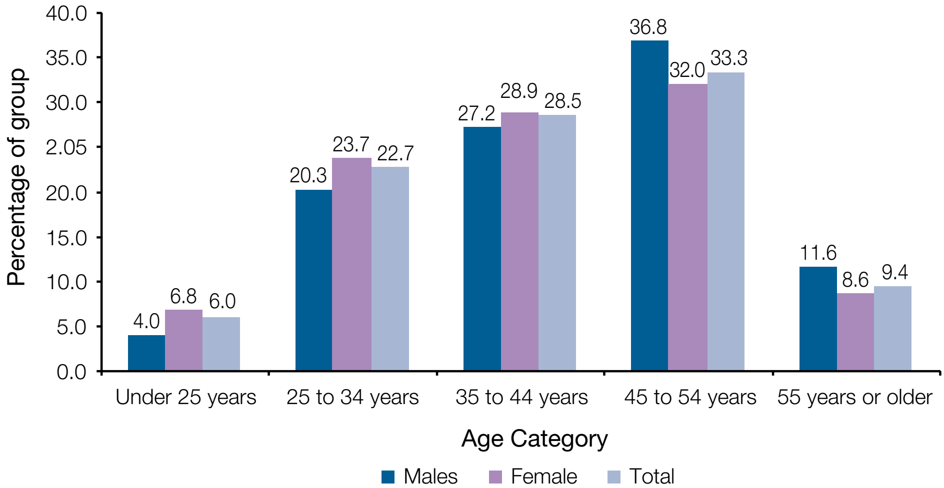
## General characteristics of the profession

### Age profile

Two of the major demographic changes in the teaching profession over recent years have been the increase in the average age and the increase in the percentage of teachers who are female.

A recent publication by the Australian Bureau of Statistics (2003: 102-103) notes that over the 15 years to 2001, the median age of the teaching population rose from 34 to 43 years and the percentage of teachers over the age of 45 years rose from 17 to 44 per cent. Australian Bureau of Statistics Census data shows differences in age profiles (ABS 2001). The age distribution for male teachers is more skewed to older ages (48 per cent were 45 years or older and 12 per cent were 55 years or older) than for females (41 per cent were 45 years or older and 9 per cent 55 years or older). Summary data are shown in Figure 15.

**Figure 15: Percentage of teachers employed by age and gender for 2001**

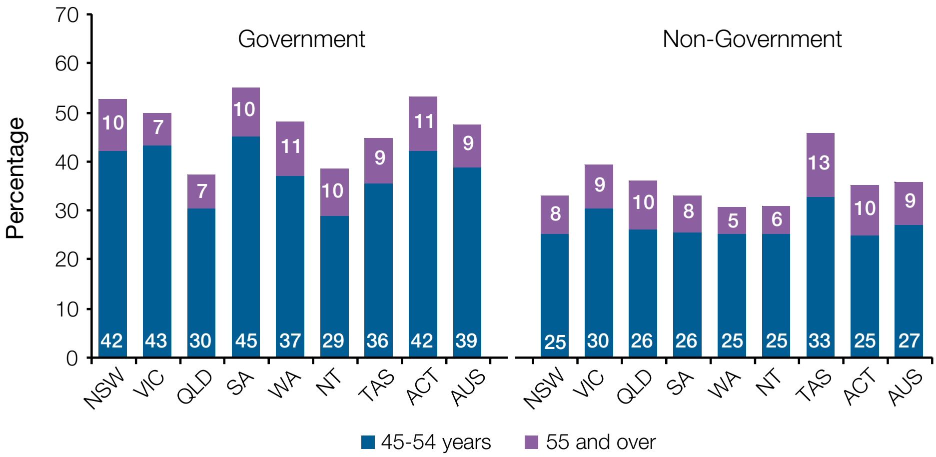



Source: Australian Bureau of Statistics, Census of Housing and Population (ABS 2001).

Figures 16 and 17 record greater detail about the age distribution of the teaching workforce for primary and secondary schools respectively. For each of these levels of schooling, the figures show for each state and for government and non-government schools, the percentages of teachers aged 45 to 54 years and aged 55 years or older. An overall comparison of Figure 16 with Figure 17 showed that there were slightly higher proportions of teachers in these age groups among secondary than among primary teachers.

In general, there were larger percentages of teachers in these age groups in government compared to non-government schools. The difference was 12 percentage points among secondary school teachers and 11 percentage points among primary school teachers.

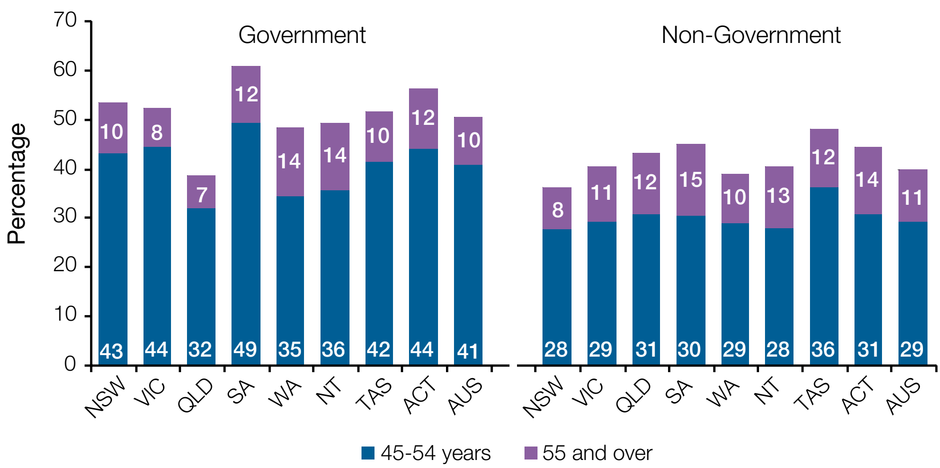
**Figure 16: Percentage of primary teachers aged 45 years and older by sector and State or Territory for 2001**




Source: Government and non-government schools staffing surveys (DEST 2002).

There were also differences among the States and Territories. Among the government school systems, South Australia had the highest percentage of teachers aged 45 years or older (55 per cent or primary teachers and 61 per cent of secondary teachers) and Queensland had the lowest percentage (37 per cent of primary teachers and 39 per cent of secondary teachers). In non-government schools, Tasmania had the highest percentage of teachers 45 years or older (46 and 48 per cent respectively for primary and secondary schools).

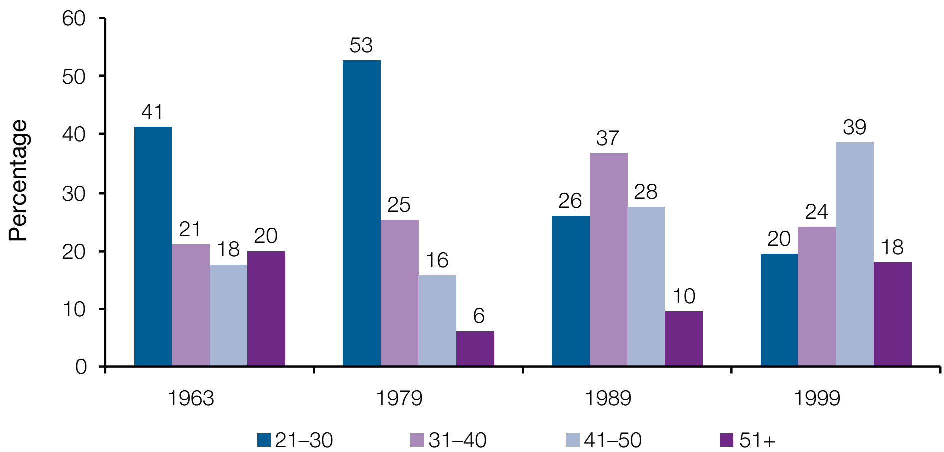
**Figure 17: Percentage of secondary teachers aged 45 years and older by sector and State or Territory for 2001**




Source: Government and non-government schools staffing surveys (DEST 2002).

Figure 18 shows the change in the age distribution of teachers in schools over a longer period since 1963. These data are based on the surveys of the teaching workforce (in schools) conducted on a periodic basis by the Australian College of Educators (ACE). The percentage of teachers over the age of 50 years provides one indictor of the age of the teaching profession. In 1963 the percentage was 20 per cent, in 1979 it was six per cent, in 1989 it was nine per cent and in 1999 the percentage was 18 per cent. However, representing the distribution of ages of teachers revealed by the ACE surveys shows that the pattern for 1999 is quite different from previous surveys. Compared to the surveys of 1963 and 1979, there was a far smaller percentage of teachers under the age of 30 years in 1999. Compared to 1989, there were rather larger percentages of teachers in the age range from 41 to 50 years.

**Figure 18: Age distribution of teachers for 1963, 1979, 1989 and 1999**




Sources: Australian College of Educators (2002); Dempster et al. (2000); Logan, Dempster, Berkeley, Chant, Howell and Warry (1990); Logan, Dempster, Chant and Warry (1990) Bassett (1980).

## Gender composition

In its commentary on social trends, the Australian Bureau of Statistics notes the steady increase in the percentage of teachers who are female over a 20-year period (ABS 2003b: 103). It notes that in 1982 the ratio of female to male teachers was 1.4 whereas in 2002 the ratio was 2.1. It 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). Table 22 shows the same trend using survey data gathered and reported by the Australian College of Educators in four surveys (1963, 1979, 1989 and 1999). From 1963 to 1999 the percentage of teachers who were female increased from 52 per cent to 65 per cent.

**Table 22: Percentage distributions showing gender of teachers for 1963, 1979, 1989 and 1999**

| Year | 1963 | 1979 | 1989 | 1999 |
|---|---|---|---|---|
| Male | 48 | 43 | 39 | 35 |
| Female | 52 | 56 | 61 | 65 |

Source: Australian College of Educators (2002); Dempster et al. (2000); Logan, Dempster, Chant & Warry (1990); Bassett (1980).

## Qualifications

The surveys conducted by the Australian College of Educators show that the teaching profession has become better qualified in education studies over the period since 1979. Summary data are contained in Table 23. In addition, the most recent of those surveys indicate high initial qualifications for all levels of schooling but with a number of primary school teachers having less than a three-year degree or diploma.

**Table 23: Percentages showing highest qualification in education held by Year 12 teachers for 1979 and 1999**

| Highest Qualification | 1979 % | 1999 % |
|---|---|---|
| Higher Degree (Doctoral or Masters) | 2 | 8 |
| Post Graduate Diploma or Certificate | 21 | 21 |
| Bachelor degree | 19 | 44 |
| Diploma or Teachers College Certificate | 32 | 21 |
| Associate/Certificate (not TC) | 6 | 4 |
| Other | 5 | 1 |
| No qualification | 16 | 0 |

Source: Dempster et al. (2000); Bassett (1980).

Table 24 shows the pattern of initial qualifications of teachers of different levels of schooling in 1999. Those data indicate a high level of qualification at all levels of schooling although there is a number (amounting to approximately one fifth) of teachers in primary schools with less than a diploma or three-year degree.

**Table 24: Percentage distributions showing initial qualifications of teachers for 1999**

| | Early childhood | Primary | Secondary | Special education | Other |
|---|---|---|---|---|---|
| Certificate | 7.4 | 20.5 | 9.2 | 2.9 | 79.1 |
| Diploma or three-year degree | 52.7 | 52.2 | 21.6 | 11.0 | 10.1 |
| Degree (four year) | 6.8 | 13.9 | 22.5 | 24.8 | 4.7 |
| Degree and diploma | 21.7 | 11.8 | 43.7 | 53.6 | 5.4 |
| Double degree | 11.4 | 1.6 | 2.9 | 7.8 | 0.8 |
| Number of respondents | 193 | 179 | 191 | 197 | 121 |

Source: Dempster et al. (2000).

## Income and earnings

In terms of average weekly earnings, data from the 2001 Census of Population and Housing conducted by the Australian Bureau of Statistics (ABS 2001) indicate that teachers earn substantially more (the average for all school teachers was $897) than the average for the workforce ($799). Within the teaching profession, secondary school teachers earn more than primary school teachers who earn more than pre-primary school teachers. Each of these groups of teachers earned less than university lecturers and tutors. For each group of teachers, males earned more than females. Relevant data are recorded in Table 25.

**Table 25: Estimated full-time average weekly ordinary time earnings ($) for educational professionals for 2001**

| | Males | Females | Persons |
|---|---|---|---|
| Primary school teachers | 969 | 805 | 841 |
| Secondary school teachers | 1,038 | 878 | 956 |
| Special education teachers | 971 | 816 | 850 |
| University lecturers and tutors | 1,179 | 717 | 1,059 |
| Vocational education teachers | 924 | 657 | 798 |

Source: ABS (2001).

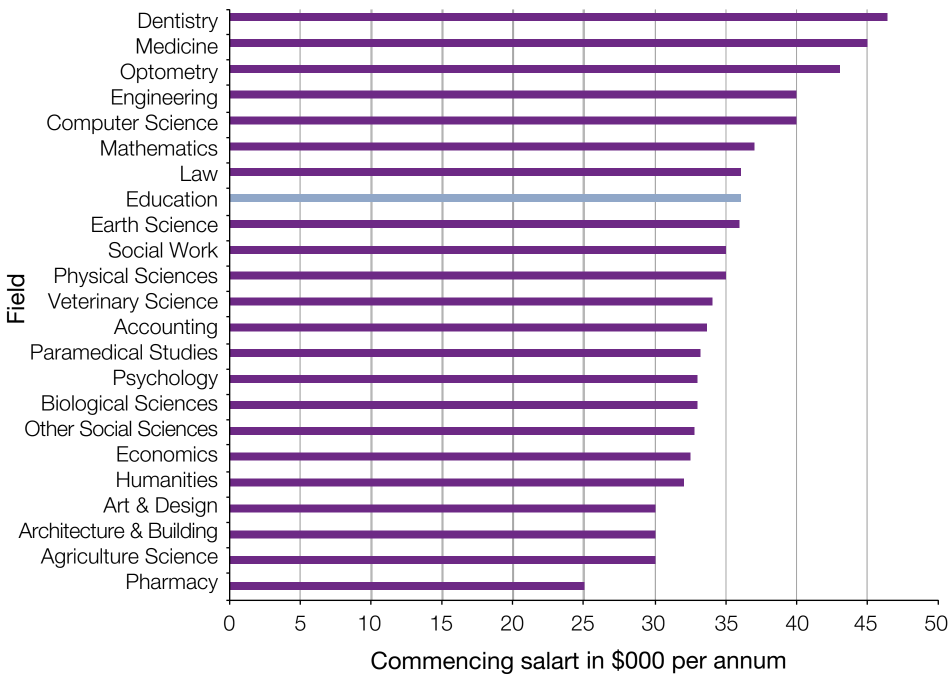
According to the commentary on social trends by the Australian Bureau of Statistics over the 15-year period to 2000, the average weekly ordinary full-time earnings for secondary teachers rose by 76 per cent and for primary teachers rose by 75 per cent (ABS 2003b: 104). One comparison suggested is with full-time adult non-managerial professionals for whom the rise over the corresponding period was 86 per cent.

Information from the GCCA (2002a) graduate destination survey for 2001 suggests that starting salaries for education graduates compare well with those from other fields of study. Teacher education graduates' commencing salaries are just above the all graduates' average of $35,150 per year. Dentistry, medicine, optometry, engineering, law, computer science and mathematics exceeded the average commencing salary of teacher education graduates.[27] Commencing salaries for those graduating in the earth sciences and physical sciences were marginally below those for teacher education graduates, with commencing salaries for graduates in the biological sciences slightly lower still. Relevant data are represented in Figure 19.

Limited information about salaries five years after graduation is also available from the Graduate Careers Council of Australia based on a follow-up study conducted in one large university (GCCA 2002a). These data show that salary growth for graduates over the first five years after graduation outstrips average weekly earnings.

On average, graduate salaries five years after graduation are 100 per cent greater than starting salaries compared to a 40 per cent growth in average weekly earnings. However, the growth is not uniform for all professions. For education graduates, salaries five years after graduation are only 55 per cent greater than starting salaries. In comparison, the change for law is 178 per cent, accounting is 167 per cent, medicine is 132 per cent and engineering is 121 per cent. On the other hand, the growth for physical science is 97 per cent, social sciences is 52 per cent and social work is 56 per cent.

**Figure 19: Commencing salaries for graduates by field of study for 2001**




Source: Graduate Careers Council of Australia (2002a).

27 Comparisons do not take account of differences in course length and do not represent return on investment because investments differ as a consequence of HECS charges, etc. For graduates in computer science, mathematics and the sciences, three rather than four years of study are generally required to obtain their qualification.

The OECD has expressed teachers' salaries in a number of countries as a ratio of GDP per capita (OECD 2002). On this basis, Australian teachers' salaries were above the mean of OECD countries, both in terms of commencing salaries and after 15 years of experience. However, in a number of developed countries, teaching salaries were higher than in Australia (e.g. Korea, Germany and Switzerland). Australia was one of the countries in which salaries for primary and secondary teachers were similar (e.g. Korea, Portugal, United States and England). In other OECD countries, upper secondary school teachers are paid significantly higher salaries than other teachers (e.g. Austria, Germany and Switzerland). Teachers in Australia tend to reach the highest level on the pay scale, equivalent to about 1.4 times the starting salary, after between 8 and 11 years of teaching. This is comparable to progression rates in, for example, New Zealand, England, Scotland and Denmark.

## Interstate mobility

Even though it is assumed that there is increased mobility in terms of moving from one State or Territory to another, analyses conducted by the Australian Bureau of Statistics of February 2002 Labour Mobility Survey suggest that teachers have relatively low rates of movement between States or Territories (ABS 2002). According to those analyses shown in Table 26, the mobility of teachers (from teaching in one State or Territory in 2001 to teaching in another State or Territory in 2002) of 1.7 per cent is low and lower than the mobility rate of 2.4 per cent for all other occupations over the same period.

**Table 26: Occupation at February 2002 by whether changed State/Territory of usual residence from February 2001 to February 2002 by occupation at February 2001**

| Occupation at February 2002 | Occupation at February 2001 | Did not change State from Feb 2001 to Feb 2002 '000 | Changed State from Feb 2001 to Feb 2002 '000 | Total Persons '000 |
|---|---|---|---|---|
| School Teachers (241) at Feb 2002 | School Teachers at Feb 2001 | 253.7 | 4.3 | 258.0 |
| School Teachers (241) at Feb 2002 | Other occupations/ not working at Feb 2001 | 17.0 | 2.1 | 19.1 |
| School Teachers (241) at Feb 2002 | Total at Feb 2001 | 270.7 | 6.4 | 277.1 |
| All Other Occupations Feb 2002 | School Teachers at Feb 2001 | 4.1 | – | 4.1 |
| All Other Occupations Feb 2002 | Other occupations/ not working at Feb 2001 | 8,566.3 | 213.2 | 8,779.5 |
| All Other Occupations Feb 2002 | Total at Feb 2001 | 8,570.3 | 213.3 | 8,783.6 |
| Total Employed at Feb 2002 | School Teachers at Feb 2001 | 257.8 | 4.3 | 262.1 |
| Total Employed at Feb 2002 | Other occupations/ not workingat Feb 2001 | 8,583.1 | 215.5 | 8,798.6 |
| Total Employed at Feb 2002 | Total at Feb 2001 | 8,841.0 | 219.7 | 9,060.7 |

Notes: – nil or rounded to zero (including null cells)
Other occupations / looking for work / not in the labour force (including students)
Estimates between 0.9 and 5.6 have a relative standard error between 25 per cent and 50 per cent and should be used with caution. Estimates less than 0.9 have a relative standard error of greater than 50 per cent and are considered too unreliable for general use.

Source: ABS (2002).

## Characteristics of science teachers

### Teachers of Year 8 mathematics and science

According to the surveys of nationally representative samples conducted for the International Association for the Evaluation of Educational Achievement (IEA) *Trends in Mathematics and Science Studies* of 1998-99, a teacher with a major area of study in mathematics taught approximately 60 per cent of Year 8 mathematics classes (Mullis et al. 2000: 282). This was less than in Japan or Singapore but a little higher than in England, New Zealand or the United States. The figure was considerably higher than in Canada where Year 8 is part of an elementary school structure in many provinces.[28] Relevant data are recorded in Table 27. In terms of the Australian data, the percentage of Year 8 teaching of mathematics taught by a teacher with either mathematics or mathematics education qualifications is 72 per cent.

**Table 27: Percentage of Australian Year 8 students whose teachers report having a major area of study in mathematics compared with selected other countries for 1998-99**

| Country | Mathematics % | Mathematics Education % | Science or Science Education % |
|---|---|---|---|
| Australia | 61 | 33 | 37 |
| Canada | 22 | 19 | 24 |
| England | 47 | 32 | 20 |
| Japan | 79 | 27 | 4 |
| New Zealand | 43 | 8 | 36 |
| Singapore | 78 | 32 | 38 |
| United States | 41 | 37 | 16 |

Note: Standard errors for countries are approximately three percentage points.

Source: Mullis et al. 2000.

Table 28 provides information, also based on the TIMSS 98 surveys, about qualifications of teachers of Year 8 science classes in 1998. Those data indicate that Year 8 science in Australia is most often taught by a teacher with a major study in biology but rather less often by a teacher with a major in physics. In this respect the pattern is similar to many other countries such as Singapore, New Zealand and the United States. In England and Japan there is a relatively stronger representation of physics and chemistry in the qualifications of those teaching Year 8 science.

28 It is interesting to note that this lower percentage of teachers with advanced mathematics qualifications in Canada was not reflected in lower performance on the TIMSS achievement tests.

**Table 28: Percentage of Australian Year 8 students whose teachers report having a major area of study in science compared with selected other countries for 1998-99**

| Country | Biology | Physics | Chemistry | Science |
|---|---|---|---|---|
| Australia | 58 | 23 | 40 | 52 |
| Canada | 36 | 8 | 17 | 28 |
| England | 49 | 47 | 54 | 54 |
| Japan | 31 | 30 | 37 | 44 |
| New Zealand | 48 | 15 | 31 | 7 |
| Singapore | 48 | 20 | 53 | 46 |
| United States of America | 47 | 13 | 21 | 43 |

Note: Standard errors for countries are approximately three or four percentage points.

Source: Mullis et al. 2000.

## Teachers of Year 12 science, mathematics and technology

Teachers of Year 12 mathematics and science subjects are generally better qualified in their subjects than those who teach at Year 8. As shown in Table 29, approximately 70 per cent of Year 12 mathematics teachers in 1999 had a three-year university study in mathematics or more and approximately 80 per cent of those teaching a science had a three-year university study or more in a science discipline.[29] Adding to these percentages those who had two years of mathematics or a science would bring the numbers to approximately 80 per cent and 90 per cent respectively.[30] The pattern is different for information technology, where just fewer than half of the Year 12 teachers held third-year or higher qualifications in the area, or technical subjects where fewer than 40 per cent hold third year university qualifications. Consistent with Table 29, there is a range of other qualifications held by Year 12 teachers of information technology and technical subjects although the percentage with a TAFE qualification is not as high as would be expected if the field were attracting people with experience of industry and with qualifications consistent with that.

[29] The figures for biological sciences and physical sciences were similar to each other.

[30] There are different views between professional organisations as to whether two or three years of mathematics should be defined as the standard requirement for mathematics teaching in senior secondary school.

**Table 29: Percentages showing highest qualification held by Year 12 science, mathematics and technology teachers by gender for 1999**

| | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| | Maths | Science | Info Tech | Tech | Maths | Science | Info Tech | Tech |
| Highest Qualification | % | % | % | % | % | % | % | % |
| ≥ 3rd Year university | 69 | 83 | 48 | 37 | 73 | 77 | 46 | 40 |
| ≥ 2nd Year university | 81 | 90 | 52 | 43 | 83 | 88 | 53 | 47 |
| Other post-school | 16 | 9 | 25 | 39 | 12 | 9 | 34 | 39 |
| School or none | 4 | 1 | 23 | 18 | 5 | 2 | 14 | 14 |
| Number | 406 | 597 | 92 | 90 | 219 | 310 | 80 | 57 |

Source: Dempster et al. (2000).

Compared to previous ACE surveys, the data from 1999 suggests that a higher percentage of teachers of mathematics and science in that year had three years or more of university study than had been the case in previous surveys. In mathematics, the percentages had been 59 per cent in 1989 and 73 per cent in 1979. In science, the percentages had been 51 per cent in 1989 and 70, 62 and 48 per cent in biology, chemistry and physics respectively in 1979. The data from the 1999 survey in Table 29 also indicate that 65 per cent of Year 12 mathematics teachers and 65 per cent of Year 12 science teachers were male. The percentage of mathematics teachers who were male had not changed from 1989 but in science the percentage of teachers who were male had increased a little from 59 per cent in 1989.

There are differences between government and non-government schools in the percentage of Year 12 teachers of mathematics and science that have two years or more of university study in their field. Relevant data are recorded in Table 30. In mathematics, 74 per cent of teachers in government schools had that qualification level compared to 86 per cent of those teaching mathematics in non-government schools. In science, the difference was not so large, being 87 per cent compared with 92 per cent. In Year 12 information technology, a higher percentage of teachers from Catholic schools had two or more years of university study (63 per cent) than either government (47 per cent) or independent schools (52 per cent). These differences might be expected to be exacerbated at times when the supply of qualified teachers was shorter.

**Table 30: Percentages showing highest qualification held by Year 12 science, mathematics and technology teachers by school sector for 1999**

| | Government | | | Catholic | | | Independent | | |
|---|---|---|---|---|---|---|---|---|---|
| Highest Qualification | Math | Sci | Info | Math | Sci | Info | Math | Sci | Info |
| ≥3rd Year university | 62 | 77 | 40 | 78 | 86 | 60 | 78 | 85 | 48 |
| ≥2nd Year university | 75 | 87 | 47 | 84 | 92 | 63 | 89 | 93 | 52 |
| Other post-school | 20 | 12 | 30 | 11 | 6 | 23 | 9 | 7 | 33 |
| School or none | 5 | 2 | 23 | 5 | 2 | 15 | 2 | 1 | 14 |

Source: 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. In science, there was a drop in 1999 to just below 80 per cent whereas the figure had been higher than 80 per cent for the 30 years prior to that.

## Summary

The Australian teaching workforce has changed in a number of important ways over the past two or more decades. First, there has been a shift in the age distribution so that there are now more teachers above the age of 45 years and fewer young teachers. This has significant implications, and opportunities, for change as those teachers approach retirement. Second, there has been a shift towards a greater percentage of females in the teaching workforce in both primary and secondary schools. In 2002, 79 per cent of the primary teaching workforce was female compared with 70 per cent in 1982. The corresponding figures for the secondary school teaching workforce were 55 and 44 per cent. The teaching workforce is well qualified in education. Specifically with respect to senior school mathematics and sciences there is a generally high level of formal qualifications but greater variability in the junior secondary years. Although commencing salaries for teachers appear to compare favourably with other fields and with other countries, the rate of advancement does not appear to be as rapid as for many other professions.

# 6. Some Issues Associated with Demand and Supply of Teachers

Balancing supply and demand in teaching is a difficult exercise because of uncertainties on both the supply and demand elements of the balance. Estimates of supply and demand necessarily involve assumptions about factors that impact on both of these sets of elements.

## Supply issues and assumptions

The supply of additional teachers comes from the following main sources:

- new graduates;
- teachers returning from leave;
- former teachers returning to teaching;
- the pool of relief and casual teachers;
- unemployed teachers and teachers marginally attached to the labour force; and
- overseas migration.

Information provided by State and Territory education authorities and cited by MCEETYA (2003) provides perspectives on these sources of supply. In 1999, the number of teachers going on leave exceeded those returning. While this pattern may vary from year to year, in the longer term the number of teachers who return from leave would be expected to be lower than the number going on leave, since some of the latter resign while on leave. In addition, the MCEETYA data indicate that there are large numbers of qualified teachers seeking employment as teachers, either in permanent positions or on a casual relief basis. In 2000, there were nearly 30,000 qualified teachers registered as relief or casual teachers (MCEETYA 2003), and perhaps a similar number seeking employment as teachers in 2002 (from data provided by States and Territories and cited by MCEETYA 2003). Of course, not all of these qualified teachers are immediately available to teach, available to teach in all locations, or qualified to teach in the subject areas needed.

In addition, there are large numbers of qualified teachers who are not seeking employment as teachers, some of whom might be attracted to teach if conditions in their own lives, the labour market or the profession itself changed. The relatively small number of teachers registered as unemployed (3,000 in August 2000), teachers who are not actively seeking employment but who would be available to teach if a suitable job arose, and contract teachers working fewer hours than they would prefer, are further potential sources of teachers (MCCETYA 2003). In 2000-01, the net intake of teachers from overseas (that is, the number of arrivals to Australia of teachers minus the number of teachers departing Australia) was 83, continuing an overall trend over recent years away from a substantial net intake of teachers (MCCETYA 2003).

New graduates are by far the biggest source, perhaps constituting around 70 per cent of the new supply of teachers (MCEETYA, 2003). For that reason the following discussion focuses on new graduates only.

## New graduates from initial teacher education courses

There are two main routes to qualification as a teacher: a four-year undergraduate teacher education degree (most commonly a Bachelor Education); and a one or two-year teacher education diploma or degree (most commonly a Graduate Diploma of Education), following completion of an undergraduate degree in a non-teaching area, such as science or arts.

It is possible to estimate the supply of new teachers by working from commencements in different types of course, and assuming completion rates for different courses based on previous patterns. Analysis cited previously in this report suggests that a 70 per cent completion rate from undergraduate initial teacher education courses is appropriate.[31] Some projections of teacher supply assume a completion rate of 90 per cent for graduate entry programs. It is also necessary to make assumptions regarding the percentages of those completing who will be available for teaching in schools (which depends among other things on the availability of other employment opportunities). Analyses cited previously in this report suggest that a figure of 60 per cent has been the pattern in recent years but this could be higher if graduates were to be attracted in greater numbers to teaching rather than postgraduate study.[32]

[31] Other projections of teacher supply assume a lower figure of 60 per cent. The difference appears to reflect the time span taken for completion.

[32] There are projections that assume 70 per cent based on those that are “available for work”. Use of the 70 per cent assumption appears to be based on some of those people not being able to obtain work in current circumstances who would obtain work in different circumstances. The figure of 60 per cent refers to those who actually enter teaching at present.

The analyses presented in this paper have indicated that there are differences in the numbers of completions from initial teacher education in primary and secondary schooling (with a small number of completions in middle schooling). Over the past decade there has been greater stability in completions from graduate than undergraduate programs (with graduate programs being the main source of secondary mathematics and science teachers).

Ballantyne et al. (2003) note that some States and Territories (New South Wales, Victoria, Western Australia) tended to produce more secondary than primary teachers while other States and Territories produce more primary teachers than secondary. Our interpretation was that these differences appear to reflect differences in numbers of students in primary and secondary schools.

## Demand issues and assumptions

Demand needs to take account of the changing numbers of students in schools and learning areas, policy targets such as pupil-teacher ratios and curriculum range, the age profile of the teaching profession (which has implications for separation rates) and employment opportunities outside of teaching. Demand can be seen as "growth demand" (associated with changing demography and school enrolment levels), "policy-driven demand" (associated with changes in targets such as student-teacher ratios or curriculum emphases) and "replacement demand" (associated with replacement of teachers who leave the profession either through retirement or other reasons).

The Australian Bureau of Statistics prepares estimates of future population growth that provide the basis for estimates and projections of overall changes in the school-age populations. Projections depend upon assumptions about the total fertility rate and net overseas migration. On the basis of these data, Hugo (2000) has argued that Australia's primary and secondary school-age population[33] is likely to remain relatively stable over the next half century. The projections by Hugo suggest a decline in primary school enrolments[34] of between 33,000 and 80,000 in the decade up to 2011 followed by increases (of similar but smaller magnitude) in the decade up to 2021. Similarly, Hugo (2000) projects increases in the secondary school-age population (of between 48,000 and 70,000) in the decade up to 2011 (but more in the period up to 2006) followed by a smaller decline (of about 19,000 to 35,000) in the decade up to 2021. For secondary enrolments most projections of demand assume that the holding power of schools will remain constant at approximately 75 per cent. In general terms, the shift of enrolments from primary to secondary school levels appears to be important and not consistent with trends in completions from initial teacher education programs.

33 Hugo (2000) defines these as the age groups from 5 to 12 years and from 13 to 18 years respectively. He bases his projections on three scenarios based on different assumptions about fertility and net overseas migration.

34 The base figure for 2001 was approximately 2,130,000 for the primary school-age and 1,610,000 for the secondary school-age population.

To assess the required distribution of teacher specialisations over key learning areas two approaches were used. First, in the compulsory school years where students follow a similar, if not common curriculum in each State or Territory, an attempt was made to estimate time allocations to key learning areas in schools. Of course, in the primary school years it is assumed that teaching will usually be by a classroom teacher with relatively little specialised teaching. In the secondary school up to Year 10 teaching is by specialists but within a framework where students have limited choice over the subjects that they study. Second, for Years 11 and 12, where students choose from a wide range of subjects, but where the time allocation to each subject is comparable, an attempt was made to estimate the enrolment share of each learning area on the basis that would reflect requirements for specialist teachers.

Table 31 records the average percentage allocations of time to each key learning area in Victorian government schools. Comparable data could not be obtained from other states. Those data show a comparison between the mean percentage of time allocated per week to each of the key learning areas at the primary and secondary school levels in Victoria in 2001. The data indicate that there is little variation across the different stages of primary school but there is a different pattern in the first two years of secondary school. At the primary level there is a clear focus on the key learning areas of English and mathematics. In contrast, at the secondary level, time is more equally dispersed across all eight key learning areas although slightly more time is allocated to the areas of English and mathematics. If it is assumed that a similar pattern applies in Years 9 and 10, one could conclude that the demand for secondary school teacher specialisations up to Year 10 would be similar to that distribution.

**Table 31: Average percentage of time allocated to each key learning area in Victorian government schools by selected year levels for 2001**

| | Primary School | | | | Secondary |
|---|---|---|---|---|---|
| Key Learning Area | Years P – 2 | Years 3 - 4 | Years 5 - 6 | All Years P - 6 | Years 7 - 8 |
| English | 41.2 | 39.6 | 38.2 | 39.7 | 15.4 |
| Mathematics | 20.6 | 20.8 | 20.9 | 20.8 | 14.7 |
| Science | 4.7 | 4.9 | 4.9 | 4.8 | 10.4 |
| Technology | 4.7 | 4.5 | 5.0 | 4.7 | 12.1 |
| The arts | 8.5 | 8.0 | 7.8 | 8.1 | 12.2 |
| Studies of society & environment | 7.8 | 7.8 | 7.9 | 7.8 | 11.8 |
| Health and physical education | 9.1 | 9.9 | 11.0 | 10.0 | 14.2 |
| Languages other than English | 3.3 | 4.2 | 4.4 | 4.0 | 9.1 |

Source: Benchmarks 2001 – School Management, produced by Standards and Accountability, Department of Education and Training, Victoria (2002).

Table 32 records the enrolment share of each key learning area at Year 12 in 1993, 1998 and 2001. Those data indicate different percentages of enrolments in each key learning area.[35] In 2001 these ranged from approximately 20 per cent in studies of society and environment and in English, through 17 per cent in mathematics, 14 per cent in each of science and technology, eight per cent in the arts, five per cent in health and physical education and two per cent in languages other than English. Analyses of enrolment share based on 1993 survey data indicated that the distribution across key learning areas was similar in Year 11 and Year 12. These data provide a broad indication of the extent to which students take up subjects from key learning areas in the senior secondary school and the extent to which various specialisations are required at that level of schooling. The data in Table 32 also reflect the effect of shifts in increased participation in technology subjects and declines in participation in the sciences over the period from 1993 to 2001. They do not show changes that have occurred within key learning areas such as the decline in the traditional humanities and the increase in business-oriented studies within studies of society and environment.

**Table 32: Average percentage of enrolments in Year 12 in each key learning area in Australian schools for 1993, 1998 and 2001**

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

Source: Subject Choice Survey for 1993 (Ainley et al. 1994); Longitudinal Surveys of Australian Youth for 1998 and 2001 (Fullarton et al. 2003).

Shifts in the distribution of enrolments across curriculum areas can influence demand at a micro level but these tend to operate in the final two years of secondary schools rather than more generally. The past decade has seen a decline in enrolments in the traditional humanities and the sciences and an increase in enrolments in vocationally oriented business studies, technical studies and information technology. The effects of these shifts in enrolment distributions on demand are small overall but important for micro level adjustments in particular schools.

35 The values shown are enrolment indices for Key Learning Areas (KLAs). These are the enrolments in an area expressed as a weighted percentage of all enrolments (in full-time equivalent subjects). Values of enrolment index are additive across areas and sum to 100 for any student or group of students. Another way of thinking about enrolment indices is to consider them as curriculum share; a concept that can be envisioned as applying to the program of an individual student or across a group of students.

The Australian Bureau of Statistics has noted that between 1982 and 2002 the student-teacher ratio in primary schools declined from 20.8 to 16.9 and in secondary schools declined from 13.1 to 12.4 (ABS 2003a: 101-102). Policy settings regarding these ratios have significant implications for estimates of demand. However, they reflect not just desired goals but achievable goals in the context of the availability of teachers and the finances available to employ those teachers. Most projections assume that student-teacher ratios will remain constant in the foreseeable future. Other sources of "policy-driven demand" would be changes to the school starting age, increases in the minimum school leaving age, or the introduction of new senior secondary school programs to encourage more students to remain at school.

Losses from the teaching workforce generate significant "replacement demand" and occur through resignations, retirements, periods of extended leave, deaths, dismissals and other reasons.

Extended leave, for at least a term, is commonly taken by teachers, especially in the government school sector, for child care and other reasons. It accounts for a large proportion of the annual separations from the teaching workforce (MCEETYA 2003). Relatively strong performance of the Australian economy, and the employment options that has created, have resulted in higher rates of resignation from teaching over recent years (MCEETYA 2003). Because of the age profile of the teaching workforce, the rate of retirements is rising sharply, with important implications for demand. In a previous section of this paper it was noted that there has been a shift in the age distribution of Australia's teaching workforce that also has important implications for demand. In that section, it was noted that the age distribution was more skewed to older age groups for males than females, for secondary compared to primary school teachers and for some jurisdictions compared to others. Data that indicate a relative ageing of the teaching workforce are important when considered in conjunction with the results of the ACE national survey conducted in 1999 (Dempster et al. 2000) which indicated approximately two thirds of the responding teachers intended to retire between 55 and 60 years (68 per cent) with just 17 per cent planning to retire at an age beyond 60 years and 15 per cent planning to retire before they reached 55 years.[36]

In addition to incorporating differences between levels of schooling and jurisdictions (since the interstate mobility of teachers is low), useful estimates of demand also need to relate to particular curriculum areas. There is too little information in the public domain that enable estimates of demand at this level of detail but there is some indication that impending age-related separations may be greater in secondary mathematics and science than in other areas. Demand also needs to take account of movement between sectors and the impact of demand in one sector on the availability of supply to other sectors.

[36] It is probably reasonable to assume that 55 years includes retirement immediately prior to 55 years.

## Approaches to projecting the balance of supply and demand

Two recent projections of teacher supply and demand are those by Preston (2000) and the MCEETYA Teacher Quality and Educational Leadership Taskforce (2003). For primary schools, Preston (2000) projected that, over the period from 2000 to 2005, there would be an underlying trend of supply increasingly not meeting demand in primary schools to a relatively small extent but with some annual fluctuations and variations between jurisdictions. Those estimates suggested that, through most of the period, supply would be around 90 per cent of demand (except in 2003 when it would exceed demand) but the difference would amount to less than one per cent of the national teaching workforce. In terms of secondary teachers, Preston projected supply and demand to be in balance up to 2003 but with the gap widening in subsequent years. By 2005, supply would be only 70 per cent of demand (which would amount to two per cent of the national teaching workforce). Thus supply would not meet demand to an increasing extent. The shortfalls are projected to be much greater in some jurisdictions than others and are noticeably projected to be a problem in Tasmania, Victoria and South Australia. The projections do not consider differences in specialisations.

The MCEETYA Taskforce projections extend to 2007 (MCEETYA 2003). Those projections estimate graduates from initial teacher education courses as shown in Table 33. In terms of supply, these aggregate data are somewhat less than those projected by Preston (2000). However, a major issue is the lack of available source data regarding specialisations, especially of secondary teachers.

**Table 33: Projected supply of teachers from 2000 to 2005**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Total graduates completing courses | 10,872 | 10,708 | 10,903 | 11,742 | 12,513 | 11,319 |
| Graduates available for teaching jobs (70%) | 7,610 | 7,496 | 7,632 | 8,219 | 8,759 | 7,923 |

Source: MCEETYA (2003).

Both of these sets of projections appear to understate the numbers of completions in 2001. The figures from Ballantyne et al. (2003) suggest that there were just over 14,000 completions in 2001 (a figure that is close to that in the Higher Education Statistics Collection) of which 641 were in adult education and 1644 in early childhood. On that basis there were between 13,400 and 15,000 completions relevant to primary and secondary schools (depending on how early childhood completions were apportioned).

The modelling in the MCEETYA projections assumes a 60 per cent completion rate[37] whereas the analysis by Martin et al. (2001) suggests that for education a 70 per cent completion rate might be appropriate. On the other hand, the assumption of 70 per cent of graduates being available for teaching jobs appears to reflect GCCA estimates of overall availability for employment but not the percentage actually commencing as teachers. The pattern of recent years has been for a little under 60 per cent of completions in initial education courses to actually enter teaching jobs. On that basis the yield from the 2001 completions into teaching positions would be between 8,000 and 9,000 (depending on the apportioning of early childhood completions). This is a little higher than that suggested in Table 33.

There is insufficient data matching teacher supply and demand in particular specialisations to enable the likely gap between teacher demand and supply for particular learning areas to be calculated with confidence. In particular, official data are not available on enrolments in, or completions from, particular subject specialisations in Graduate Diploma in Education programs, the main source of newly qualifying science and mathematics teachers.

The 2001 investigation by Ballantyne et al. (2003) included a survey of education faculties at Australia's universities which sought to calculate the supply of new graduates in a number of teaching areas. The study reported 408 expected completions of pre-service teacher education by those qualifying to teach senior advanced mathematics, and 207 and 318 expected completions, respectively, of those qualifying to teach senior physics and chemistry. It can be inferred from the analysis by Ballantyne et al. (2003) that there may be emerging shortages in the availability of mathematics and science teachers who are graduates with specialisation in those subject areas.

Lawrance and Palmer (2003) conducted a survey of teacher education programs across Australia, gathering indicative data on enrolments in the major undergraduate and graduate programs in all Australian universities offering teacher education in science, mathematics and technology in 2001. The data they gathered show approximate totals of 360 mathematics teacher education enrolments and 790 science teacher education enrolments in Graduate Diploma in Education programs in 2001. Assuming a completion rate of 90 per cent for each of those programs, it is possible to estimate that 324 graduates of mathematics teacher education and 711 graduates of science teacher education emerged from those courses at the end of 2001.[38]

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[37] The MCEETYA report deals with primary and secondary teachers and does not use Higher Education commencement/ completion figures for Special Education, Adult Education or "Other" teacher categories in its analysis or projections.

[38] In addition to these numbers there would have been some additional completions from initial teacher education courses in these learning areas from undergraduate and double-degree programs. It is hard to estimate those numbers from the available data. Ballantyne et al. (2003) estimate the total completions from all types of courses in mathematics education as 408.

In addition to these, there were approximately 73 mathematics education and 122 science education enrolments in other graduate entry initial teacher education programs. These enrolments would be spread over one and a half or two years that, on the basis of 90 per cent completion rates, would yield an additional 38 mathematics and 63 science completions respectively. On this basis the total completions from these courses would have been 362 in mathematics education and 774 in science education. Furthermore, assuming a 60 per cent rate of entry into teaching in the year after graduation, we can estimate that those programs would have yielded 217 new mathematics teachers and 464 new science teachers in 2002.

Although the evidence is again scant, it may be that enrolments in science and mathematics teacher education within Graduate Diploma in Education programs have increased over the last two years. The submission to the Review of Teaching and Teacher Education from The University of Melbourne, for example, indicates that enrolments in its Graduate Diploma in Education program in science and mathematics teacher education grew substantially from 2001 to 2002 (University of Melbourne 2003). According to data reported by Lawrance and Palmer, science and mathematics teacher education enrolments in The University of Melbourne's Graduate Diploma in Education program constituted over 15 per cent of both science and mathematics teacher education enrolments nationwide in Graduate Diploma in Education programs in 2001 (Lawrance & Palmer 2003). A similar growth in enrolments in science and mathematics teacher education has been reported at the Queensland University of Technology (Nason 2003).

The Department of Employment and Workplace Relations (DEWR) maintains an online list of national and State/Territory skills shortages.[39] The most recent assessment by DEWR of the teacher labour market is dated February 2003 and is based on information obtained from teacher employers in the second half of 2002. DEWR's assessment is that national shortages existed at the end of 2002 in the areas of secondary manual arts/technology studies, mathematics, physics/chemistry, and general science teaching. Information technology is listed as a shortage in Victoria and Queensland. DEWR does not quantify the extent of identified shortages.

To enable better teacher workforce planning, it is imperative that data relating to the supply of teachers generally, and the flows of newly qualifying teachers through teacher education (particularly graduate) programs specifically, are regularly, reliably and consistently gathered.

[39] See: http://www.workplace.gov.au/Workplace/WPDisplay/0,1132,a0%253D0%2526a1%253D517%2526a2%253D606,00.html).

Over the next few years, Australia will face increasing shortages of teachers due to age-based retirements. The extent of the shortfall will depend on the success of policy initiatives to attract and retain teachers, and other factors such as changes to policy settings affecting student-teacher ratios and general employment conditions in the wider economy. Depending on these factors, shortages of possibly up to 20,000 to 30,000 teachers are estimated later in the decade (MCEETYA 2003). The shortages seem likely to be particularly pronounced in the learning areas of science, mathematics and technology, as well as in remote and rural locations and certain disadvantaged metropolitan schools.

## Summary

Although there are a number of uncertainties involved in projections of both supply and demand for teachers, there appears to be some general conclusions that emerge from data concerned with the availability of teachers over the years to 2010. The deficit in supply is much more an issue for secondary than primary schools, is likely to be greatest in the mid to latter part of the decade and may be greater in mathematics, science and technology. However, it needs to be noted that projections are based on data at aggregate levels and these overall generalisations can mask areas of particular need in some jurisdictions. There is a need for better and more disaggregated data to support labour force projections in school education.

# 7. Conclusion

Participation in senior secondary school mathematics, science and technology has varied over the past 30 years, but for the period since the early 1990s the trends have been clearer. Since 1990, during a period when the holding power of schools was relatively steady, there was a small but steady decline in participation in biology, chemistry and physics (more in biology than in chemistry and physics and more in combinations of two sciences) and a small decline in participation in advanced levels of mathematics. At the same time there was an increase in participation in information technology and vocationally oriented technical subjects (as there was for other vocationally oriented subjects). University participation in science-related fields remained steady during the 1990s and into the 2000s except for an increase in information technology studies.

Commencements in initial teacher education declined during the first half of the 1990s but increased after 1995. Both the decline and the subsequent increase appeared to be driven by changes in initial primary teacher education to a greater extent than initial secondary teacher education. These trends in commencements were reflected in later trends in course completions. A large majority of completions in mathematics and the physical sciences came from graduate programs although this was not the case for technology studies. There appears to have been a decline in the propensity for graduates in mathematics and science to enter teacher education after graduation. Most completions in primary teacher education came from undergraduate programs. Students who participated in undergraduate teacher education programs were predominantly female and, compared to other university students, tended to come to a greater extent from middle rather than upper socioeconomic backgrounds, non-metropolitan rather than metropolitan locations, and less often from the highest achievement group in school.

Changes in enrolment levels in mathematics, science and technology and changes in patterns of completion of initial teacher education courses have taken place at a time when there are changes in the teaching workforce. Although the teaching workforce has become better qualified, it has undergone a shift in age distribution that seems likely to result in an increased rate of retirement in the immediate future. Although there is a number of uncertainties associated with projections of the balance of the supply and demand of teachers, several studies are consistent in recognising that deficits in the supply of secondary specialist teachers are likely in the immediate future. Although there are many difficulties in detailed projections for specified learning areas it does appear that mathematics, science and technology are three learning areas in which the gaps may be the greatest.

The magnitudes of the projected deficits do appear to be within the scope of policy responses. Moreover, given that they are most evident in areas that have been most frequently supplied through graduate programs, they may be amenable to changes directed to graduate programs from which the response time is shorter. There does appear to be scope for stronger recruitment of graduates from mathematics, science and technology into teacher education. These incentives might involve ways of recognising and offsetting the additional HECS charges that are incurred through a graduate teacher education program. Limiting those courses to one year would also contain HECS charges and limit the extent to which intending teachers are obliged to defer their income earning capacity.

Several studies have suggested that teachers are motivated to teach mostly by altruistic (e.g. perceiving teaching to be a socially important job) and intrinsic factors (e.g. an enjoyment of working with children) and that remuneration is not a significant factor in deciding to become a teacher. However, an OECD review suggests that salary may influence decisions about remaining in teaching or returning to teaching. It may be that developing career structures that provide more for growth and development, and that are linked to salaries and standards, could be important areas for retaining teachers of mathematics, science and technology and attracting prospective teachers from other professions. Changes linked to these areas provide the basis for the longer term development of teaching in mathematics, science and technology.

It appears that there is a lack of appropriate data that would provide a basis for projections of requirements for additional teachers in specialist areas, such as mathematics, science and technology, at secondary school level. Although there may be many uncertainties in the projection of demand for teachers, given the range of influences that operate, those projections would be assisted by more comprehensive data about teaching specialisations and allocations. In terms of supply of prospective teachers it should be possible to record information about those enrolled in initial teacher education programs and their teaching specialisations. Improved teacher workforce planning will depend on data relating to the supply of teachers generally, and the flows of newly qualifying teachers through teacher education (particularly graduate) programs specifically. It is essential that these data be regularly, reliably and consistently gathered. As those enrolled in initial teacher education programs typically include more than one specialisation, information based on unit-record data that lists all specialisations for each enrolment would be of greatest value.

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