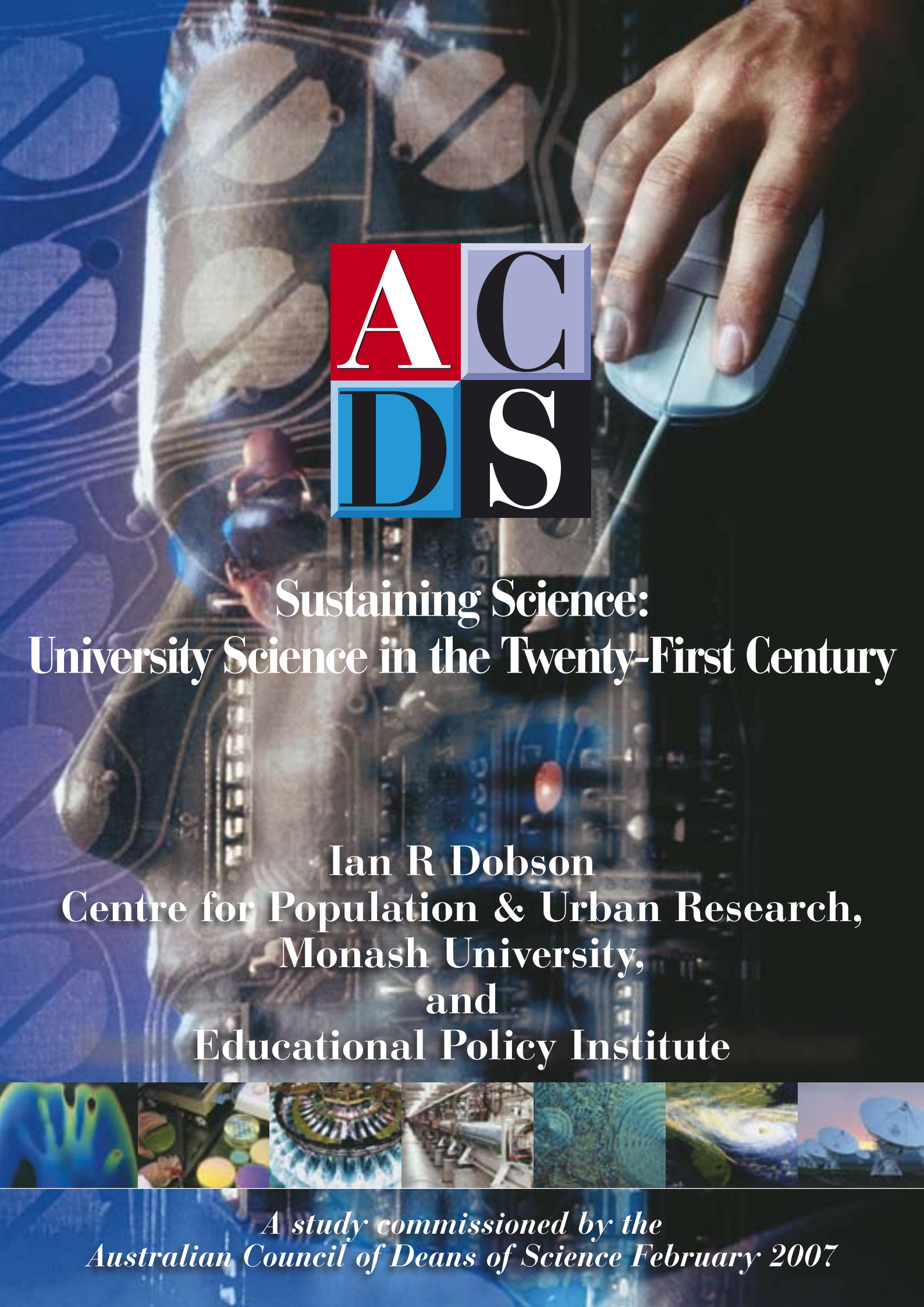

Sustaining Science: University Science in the Twenty-First Century

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and
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A study commissioned by the Australian Council of Deans of Science February 2007

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1. Introduction

Sustaining Science: University Science in the Twenty-first Century provides an analysis and commentary on trends in university enrolments in science based on the latest available statistics. The focus of this study is the period 2002 to 2005, the years during which DEST's[1] current methodologies for counting students and classifying courses and subjects have been in force. Although strict comparison over a longer time frame is no longer possible, the study considers some changes back to 1989.

The Australian Council of Deans of Science (ACDS) has been concerned about aspects of the trends shown by science enrolments for at least the past decade. In 1998, the Deans commissioned research into the numbers of science enrolments and the trends and patterns discernible from an analysis of higher education enrolments. The results were published as *Trends in Science Education: Learning Teaching and Outcomes 1989-1997* (Dobson & Calderon, 1999). The data showed that between 1989 and 1997, there had been an expansion of over 35,000 enrolments in science courses, which represented an increase over the period of about 58 per cent. On the surface, this seemed like a very positive outcome, because sector-wide growth had been more modest, at 49 per cent. Since science was expanding at a relatively fast rate, one could have been forgiven for thinking that all was well in Australia's science faculties. However, from the perspective of Australian universities' science faculties, much of this growth had been 'illusory'. The expansion in 'science' enrolments did not represent an expansion of teaching in the enabling sciences, but rather came from an expansion in the behavioural and biological sciences, and even in the 'non-sciences'. As such, much of the teaching provided to many of the new 'science' students was not being provided by traditional university enabling science departments. For example, the behavioural sciences are often taught by faculties of arts or medicine. Similarly, at some universities many of the biological sciences might be taught by medical or other health-related faculties.

It has also been the case that as time goes on, many more students now take 'science' as part of a combined course (eg science/arts or science/law), and although this is hardly a negative thing, some of the expansion in the 'non-science' component of 'science' degrees is due to the fact that non-core subjects are no longer taken from among the science disciplines, but from the course being studied in combination with the science degree. Computer Science had also been a strong growth area, but at some universities, much of the teaching in this discipline is provided by separate faculties of computing or business/commerce. The combined effect of these trends has meant declining enrolments in subjects taught by some departments, and severe financial constraints within faculties of science, including cutbacks in the numbers of academic and general staff in those departments.

The ACDS arranged for a second study to be undertaken in 2003. This resulted in the publication of *Science at the Crossroads? A study of trends in university science from Dawkins to now 1989 – 2002* (Dobson, 2003). It was necessary to take account of two fundamental changes in reporting brought in by DEST. The challenge for that study was to maintain the continuity of the time series established in the 1999 study, based on the definitions in place during the period 1989 to 2001.

The first fundamental change affected the course and subject classifications used to aggregate these into fields of education and academic disciplines respectively. This changed the apparent composition of science in terms of both reporting and publishing, from 2001. In particular, courses in information technology had been a sub-group of 'science' courses until 2001. From 2001, Information Technology became a broad Field of Education in its own right. A range of other sub-groups were redefined to either move in or out of the Field of Education which represented courses in science (called Natural and Physical Sciences). Details of these changes have been noted, as relevant, in the text, but more complete descriptions of the changes in the categorisation of science Fields of Study, Fields of Education and Discipline Groups can be found in the next chapter.

The second of these changes related to the introduction of a revised methodology for counting students. The methodology used before 2002 was based on the number of students enrolled on the first annual census date, 31 March, and the student load generated by those students for the whole year. DEST's revised methodology included **all** students enrolled at any stage during the year, including those not actually

1 DEST is the acronym used to describe the Department of Education, Science and Training, the current name of the department responsible for the Australian higher education sector. In the past it has been known as DEET (Department of Employment, Education & Training), DEETYA (Department of Employment, Education, Training & Youth Affairs) and DETYA (Department of Education, Training & Youth Affairs). For sake of simplicity in this report, the acronym DEST has been used in most places to describe the federal 'education department', irrespective of its actual name at various points in time.

enrolled at the 31 March census date. Perhaps this was done on the grounds that universities now teach for the whole year, rather than during the former traditional period between March and November.

Sustaining Science is the third study commissioned by ACDS to be the based on analyses of databases of higher education student statistics. Apart from time series back to 1989 which link this study with the previous two, the focus here is on DEST's contemporary definitions and enumeration methodologies. Therefore, the bulk of the analysis for this study relates to the years 2002 to 2005. However, all effort has been taken to ensure that the reader can readily appreciate the effects of the changes in higher education classification.

The earlier ACDS studies noted the 58 per cent growth in science enrolments between 1989 and 1997, and the 37 per cent growth between 1989 and 2002, respectively. Sector-wide growth had been 49 per cent over the first period, and 64.5 per cent over the period 1989 to 2002. This strong growth had been driven in part by the rapid expansion of information technology for which the rate of growth over the period had been 342.2 per cent. However, even information technology's fortunes have waned. In recent years, information technology numbers, (that is, students enrolled in a course classified within the Information Technology Field of Education) have declined by nearly 14,000 from around 73,400 in 2002 to fewer than 60,000 in 2005.

For *Trends in Science Education*, the years 1989, 1993, 1997 were the snapshot points used for the analysis. For *Science at the Crossroads*, these three years were used again as points of observation, and years 2001 and 2002 were added, with statistics 'redefined' to match the classification and enumeration methodologies which pertained in years prior to 2001. For *Sustaining Science*, all years 2002 – 2005 have been shown, using the current DEST methodologies.

Following this introduction, the report starts with a description of Australia's higher education statistics and the changes these have undergone in recent years in Chapter 2. The report then considers enrolments in the sector overall (Chapter 3), before examining the distribution of 'science' enrolments (Chapter 4). (That is, enrolments in courses described by universities as falling within the Natural and Physical Sciences Field of Education). This chapter also provides the link between the current methodologies and those used prior to 2001. In this chapter changes over time in science enrolments are noted against a range of variables such as Field of Education, sex, citizenship status, attendance mode and type, State/Territory and university. Subsequent chapters examine student load (these days known as EFTSL: Equivalent Full-time Student Load), and course completions (graduations).

Although the level of the courses in which Natural and Physical Sciences students are enrolled in are considered in several places, there is also a chapter (Chapter 7) concerned specifically with PhD enrolments and the Fields of Education they are being taken in. Course Completions have been analysed in a similar fashion in Chapter 6. However, it is Chapter 5, on student load, where the actual change in the content of a science degree is shown. This particular analysis produces a picture of what constituted a science course in 1989, and how it changed between then and 2005. HECS and science is considered briefly in Chapter 8, this having been the subject of both interest group and media attention in recent years.

Data for this exercise came from the Commonwealth education department, DEST. Since the 1980s, universities have been required to supply very detailed unit record files of their students and staff, initially to the Commonwealth Tertiary Education Commission (CTEC), then to the Commonwealth education department in its various guises. Much as the level of detail required seemed a little excessive at the time, the DEST data gathering system provides researchers with a rich set of statistics with which to work. This statistics system also provided Australia with the reporting infrastructure which underpins the Higher Education Contribution Scheme (HECS) and its successor HECS – HELP. The university data collections are not perfect, but they produce one of the most comprehensive sets of social statistics available in Australia. On the issue of nomenclature, every attempt has been made to avoid terminology which could be at odds with specific definitions used by DEST in its publications.

It is hoped that the data collected and analysed for this report will provide both the background for future monitoring and planning, and the starting point for extended analysis in Science and Information Technology at Australian universities**.**

'Science' is definitely on the agenda. One can find press coverage every week about aspects of science and science policy. Most reports seem to suggest the years have not been kind to university science.

A note on style

Reports based on statistical analysis can quickly become confusing if language and style are used inconsistently or ambiguously. All efforts have been taken in this report to avoid inconsistencies. Where appropriate, DEST terminology has been used, and Appendix 2 is a glossary of many of the terms used.

Style manuals for written English often recommend avoiding the use of upper case first letters for titles, and newspapers seem to be particularly allergic to capitalisation. However, in a work such as this, use of the upper case can assist the reader in understanding when a defined term is being referred to. Defined terms such as Field of Education and Discipline Group are used often, and if capitals have been used, it is an indication of the usage of the defined term.

2. Higher Education Statistics: A Description

A chapter on university statistics has been included for the sake of completeness. Higher education statistics are compiled by DEST staff from several unit record data files supplied by universities at various times during the year. Universities provide files which supply information on students and their courses, university departments, course enrolments, student load, past course completions and HECS liability status. From these returns, DEST compiles aggregated sets of data which are made available to universities and others, and which enable a wide range of analyses on universities and their students to be undertaken.

The history of the current system for collecting statistical material from universities really started with the Commonwealth Tertiary Education Commission (CTEC) and the uniform data collection methodology they introduced in the late 1980s. This system was intended for both halves of the then binary system of higher education. The system has been amended, and the collection software upgraded several times since the first collections were taken. CTEC was decommissioned in the 1980s, and elements of its role absorbed into the (then) Department of Employment, Education and Training. Data collection by universities is compulsory and was supported by provisions in the Higher Education Funding Act (HEFA). (Now the Higher Education Support Act – HESA).

The higher education system's data integrity relies on universities adhering strictly to the definitions. These are contained in a data element dictionary which assists university staff in understanding the scope of what has to be collected. Data elements defined for the student collection include matters relating to the students themselves, such as their sex, date of birth, permanent and semester residence information (collected in the form of postcodes or overseas country codes), and background information on country of birth, year of arrival in Australia, language spoken at home, and indigenous background. This information is provided to universities by students at enrolment time. Another set of information on students is generated by universities: students' basis of admission, type and mode of enrolment (full-time or part-time; internal or external or a mixture of the two), and their liability for, or exemption from paying fees of various types, including the Higher Education Contribution Scheme (HECS). (Known as HECS-HELP from 2005). Researchers can derive additional information from the material collectedly, for instance, by linking postcodes into indicators of location (Rural, Isolated or Urban), and socioeconomic status (High, Middle or Low). These latter two pieces of information are derived by using the Australian Bureau of Statistics' 'EdOcc' Index, which is based on information collected in the quinquennial Census of Population & Housing. The most recent Census was conducted in August 2006.

Still more information is provided by universities on the level, duration and name of the courses they offer, the subjects taught in those courses, and the teaching departments which teach those subjects. Since 2001, universities have coded their courses (such as BSc, etc) so they can be aggregated into *Fields of Education* (known as *Fields of Study* in earlier years), their subjects (i.e. the components of these courses, such as Chemistry 1 or Physics 2A) to *Discipline Groups* (also known as *Discipline Groups* in earlier years, but a different classification from the current one), and their teaching departments to *Academic Organisational Units* (AOUs). Aggregated files of university statistical data provide the opportunity for researchers and analysts to describe many aspects of the student body.

In terms of its reporting, DEST introduced one major change in the way statistics were collated in 2001 and another in 2002. Dealing with the second of these first, from 2002 there was a change in the way student enrolments were counted was introduced. For the purpose of reporting statistics, up until 2001, student enrolment counts were based on a **snapshot** taken as at the 31st March, much in the way the ABS' *Census of Population an Housing*. From 2002, students enrolled at any time during the year were counted. This 'whole of year' approach therefore counts students enrolled at any time from 1 September in *Year N-1* to 31 August in *Year N*. In 2002, this counting methodology produced an 'official' total university enrolment of over 896,000. Had the snapshot counting methodology been retained, in 2002 there would have been about 751,000 students. To fail to be aware of this quantum leap in university enrolments could lead to a misunderstanding of the real extent of increases and decreases from 2002.

The change which occurred from 2001 is more complex. It affected the way in which *courses and subjects*[2] are classified, meaning that the time series involving aggregations of courses and subjects in Australian

2 In brief, the terminology adopted here is that a 'course' is a study programme, such as BSc, BA, MBA or PhD. The components of courses are 'subjects'. For instance, a first year student enrolled in a BSc degree might be enrolled in Mathematics 1, Chemistry 1, Physics 1 and Biology A. Some courses, such as PhD may not have any classroom component, and therefore may not be comprised of subjects as such. Some students enrol in more than one course. The terminology adopted here is that the first course is the *primary* course, and the latter the *supplementary* course.

higher education statistics was broken with effect from 2001. Courses and subjects which had been classified into *Fields of Study* and *Discipline Groups* respectively up until year 2000 were re-classified into *Fields of Education* and *Discipline Groups* from 2001. Although both the old and new classifications included one 'Field' comprising mainly 'science' courses/subjects, some sub-groups changed from one Field of Study to another Field of Education. The next paragraphs summarise the changes relating to the manner in which *courses and subjects* were classified.

Before 2001, courses were coded to a Field of Study[3] classification for purposes of aggregation, and subjects to a Discipline Group/Branch of Learning classification. Both courses and subjects are now coded to a single classification, known as Field of Education for courses, but still referred to as Discipline Groups for subjects. Unfortunately, the mapping between the Field of Study and Field of Education classifications for courses is not exact. Neither do the 'old' Discipline Groups match exactly with 'new' Discipline Groups. The former Field of Study *09 Science* was in effect broken up, because the sub-field 'computer science' became its own Field of Education (*02 Information Technology*) under the new arrangements. Most of the rest of the former science Field of Study became Field of Education *01 Natural and Physical Sciences.* In addition, several sub-fields of study moved in and out of this new 'science' field of education. Some of these moves were unambiguous shifts, but in other cases, the new sub-Fields of Education do not exactly match the old sub-Fields of Study.

Figure 1 lists the Fields of Study and Fields of Education before and after 2001, and the major changes which occurred as a consequence.

Figure 1: Broad Fields of Study and Broad Fields of Education

Field of Study		Field of Education
01 Agriculture & Animal Husbandry	has largely become	05 Agriculture & Environmental Studies
02 Architecture & Building	has become	04 Architecture & Building
03 Arts, Humanities & Social Studies	has become either or	09 Society & Culture 10 Creative Arts
04 Business, Administration & Economics – Business & Administration	has become	08 Management and Commerce
04 Business, Administration & Economics –Economics	has become a subset of	09 Society & Culture
05 Education	has largely become	07 Education
06 Engineering & Surveying	has become	03 Engineering & Related Technologies
07 Health	has become	06 Health
08 Law & Legal Studies	has become a subset of	09 Society & Culture
09 Science	has been split between	01 Natural & Physical Science 02 Information Technology
10 Veterinary Science	has become a subset of	06 Health
No direct equivalent (and few enrolments)		11 Food, Hospitality & Personal Services
No direct equivalent (and few enrolments)		12 Mixed Field Programs

Source: Pre 2001: CTEC Field of Study Classification of Higher Education Courses. AGPS, April 1986: 6.
2001+ : ABS Appendices 6 & 7 Obtained in August 2003 from http://www.abs.gov.au

Apart from the creation of the new Field of Education *02 Information Technology*, the **major** changes insofar as 'science' is concerned have been –

- **Inclusion** in *01 Natural and Physical Sciences* of Soil Sciences, Medical Technology and Medical Science. None of these had been included in the former Field of Study *09 Science.*
- **Definite non-inclusion** in *01 Natural and Physical Sciences* of Human Movement Science/Sports Science, Nautical Science and Home Economics. Deans of Science might be dismayed by the removal of Home Economics from 'science', given the importance of physics and chemistry to cookery.
- **Likely/possible non-inclusion** in *01 Natural and Physical Sciences* of environmental science courses. Courses described under 'science' within the Field of Study classification as *090306 Environmental Science* prior to 2001, could be described under the current arrangements as either *010905 Ecology and Evolution* within the *01 Natural & Physical Sciences* Field of Education, or as *050999 Environmental*

3 The Field of Study classification (and the Field of Education one which has succeeded it) is a six-digit classification for universities to code the courses they teach into generic categories based on the likeness of the content and vocational orientation of those courses. The first two digits of the classification are referred to as the BROAD Field of Study (Education), the next two digits are referred to as the MAJOR Field of Study (Education) and the final two are referred to as the MINOR Field of Study (Education). The pre-2001 Discipline Group / Branches of Learning Classification was a four-digit classification which has been replaced by a new six-digit Discipline Group classification. The new Discipline Group classification is identical to the Field of Education classification.

Studies 'not elsewhere classified', within Broad Field of Education *05 Agriculture, Environmental & Related Studies*. On name alone, it seems more likely that universities would classify their BEnvSc degree within the latter.

It is necessary to accept that for the purposes of statistical comparisons which go back before 2001, there has been a re-definition of 'science', because the former Field of Study *09 Science* does not exactly match Field of Education *01 Natural & Physical Science* plus Field of Education *02 Information Technology*. Of course, such matters have no impact on university operations. Just because the course classification used by DEST now recognises Human Movement Studies/Sports Science courses as falling within the *Health* Field of Education does not mean that universities will have transferred their human movement studies department from the faculty of science (if that's where it had been located) to the faculty of lifestyle and leisure studies. It is important to appreciate that such changes occurred primarily because DEST's published statistics from 2001 report according to the *Field of Education* classification.

Just as there have been changes in the classification of courses, so have subjects been affected. Until 2000, subjects were classified according to a four-digit Discipline Group classification. Since 2001 however, although the term 'discipline' has been retained, subjects have been classified according to a new six-digit Discipline Group, which has the same entries as the Field of Education classification used to aggregate courses. In theory, the move from a four- to a six-digit classification increases the capacity to describe subjects to a greater level of detail. However, it will often be the case that subjects offered are more general in nature than the level of detail permitted by the new Discipline Group classification. As was the case with the old and new classifications for courses, the link between old and new for subjects is imperfect. However, so far as 'science' is concerned, the former discipline-based category *04 Sciences* largely falls within the new classification *01 Natural and Physical Sciences*. The former category *05 Mathematics, Computing* splits fairly cleanly between Disciplines *01 Natural and Physical Sciences* and *02 Information Technology*.

Figure 2: Discipline Groups: Old and New

Subject Grouping	Four-Digit Discipline Group Codes 1989 – 2000	Six-Digit Discipline Codes 2001 +
Biological Sciences	0401	010900 – 010900
Chemical Sciences	0405	010500 – 010599
Earth Sciences	0402	010700 – 010799
Mathematical Sciences	0500, 0501, 0599	010100 – 010199
Physical/Materials Sciences	0403	010300 – 010303
Other Sciences	0404, 0499	019900 – 019999
Information Technology	0502, 0503	020100 – 029999

A full list of correspondence between Fields of Study and Fields of Education, and old and new Discipline Groups appears as part of Appendix 1.

A word of caution

Although it is useful to aggregate courses according to their content, simply having a highly detailed classification does not ensure genuine comparability between universities unless identical coding practices are observed by all. Many university courses, particularly at the undergraduate level, are generalist degrees. The BSc is a good example of this. Some universities offer a higher proportion of generalist degrees than others. For example, one university might enrol all 'science' undergraduates in a single, generic BSc; another university might have tagged degrees with names such as BSc (Maths), BSc (Physics) and BSc (Chemistry) (etc.), based on students' opinions at the time they first enrol, as to the likely direction their studies might take.

Students enrolled in generalist BSc degrees across the country will specialise in one area of science or another, but even according to the most detailed Field of Education classification, the BSc course could only be described in a very general way. First year students often will not know at that stage whether they will major in mathematics, chemistry or zoology (for example). It is likely, therefore, that the BSc course will be classified by universities in some very 'general' way.

That this is true can be ascertained by examining DEST enrolment files over recent years. For example, Table 27 (on page 28) shows that in 2005, there were over 61,000 students enrolled in a bachelor-level primary course in *01 Natural and Physical Sciences*. There are 37 six-digit fields of education to which universities could classify the courses in which their students were enrolled, yet 15,035 (24.6 per cent) of the students were classified as being in *019999 Natural and Physical Sciences [courses] 'not elsewhere classified'*. A further 15,885 (26.0 per cent) students were classified as being enrolled in a field of education which in a strict sense doesn't exist, but if it did, would be: *010000 Natural and Physical Sciences [courses] – General*. Another 2,333 students were enrolled in courses classified as *019900 Other Natural and Physical Sciences* (3.8 per cent). This means, therefore, that according to universities, over 54 per cent of 'science' bachelor students in 2005 were enrolled in generalist degrees. The existence of a classification containing 37 detailed options does not help provide genuine detail. Of course, some students ARE enrolled in more specific courses. These include courses in fields such as medical science, forensic science, food science, and laboratory technology, but the great majority of 'BSc' students appear to have enrolled in a generalist degree.

These points are made in order to indicate that the Field of Education classification is not necessarily of much value at levels of detail beneath the 'Broad' Field of Education (the first two digit level). For these reasons, it is necessary to be wary when comparing patterns at different universities, or when Australia's performance is being compared internationally. Sometimes one should take statements about Australia's performance compared with other Organisation for Economic Cooperation and Developemnt(OECD) nations with a grain of salt, pending knowledge of what is being compared, and which information was supplied.

By way of example, according to a recent press report, "OECD figures show that 0.4 per cent of university students in Australia graduate with qualifications in maths or statistics, compared with the OECD average of 1 per cent" (Ferrari, 2007c). On the basis of the 2004 course completions used in this study, the 738 graduations in the Mathematical sciences represent 0.33 per cent of all courses completions in 2004. One must first inquire which information was supplied. If the Australian data supplied to satisfy the OECD request about mathematics and statistics graduates were drawn from the DEST statistics collected from universities, it seems unlikely that the proportion of 'maths and stats' graduates from the 54 per cent of generalist degrees would have been included.

Changes effective from 2005

More recent changes effective from 2005 have radically increased the statistical reporting burden on universities. This more recent set of changes was instituted primarily to meet the Government's desire for the capacity to track students over time across universities, it would seem. The so-called 'student learning entitlement' has been established to limit students' access to Government-subsidised university places.

Universities must now report student data to Government much more often than in the past, and universities (through the Australian Vice-Chancellors' Committee – the AVCC, now known as 'Universities Australia') have pointed out the increased financial and bureaucratic burden on them because of the changes from 2005. Reporting on a study commissioned by the AVCC, journalist Dorothy Illing (2006: 35) noted that "The [student learning] entitlement, which caps at seven years the amount of time a student can study full-time on a government subsidised place, has been blamed for much of the red tape engulfing universities. Research suggests few students stay at university more than seven years, raising questions about why the policy and its tedious administration were introduced". All in all, the radical increase in universities' reporting requirements bears the hallmarks of ideology-driven policy making. Before embarking on such a radical expansion of university reporting requirements, research to assess its need should have been a pre-requisite. Based on responses to this question put by the author to several DEST members of staff, such obviously necessary investigative research was never undertaken.

Fortunately, the changes which took effect from 2005 do not affect the student statistical time series from 2002. For this reason, there will be no further comment on them here.

Sod's Law

Australian higher education statistics are among the best (if not **the** best) available in the world. Although short of being perfect, the system documentation provides clear 'rules' for universities to follow. A set of data validation computer programs ensure that inconsistent reporting is kept to a minimum. However, a combination of circumstances has led to some universities having difficulties in producing correct statistics, particularly from 2005. It has been alleged that at least one student database system used by several universities is not particularly 'user friendly' when it comes to recording university courses and their associated Fields of Education. Further anecdotal evidence suggests that some errors arose because of the administrative burden associated with DEST's decision to introduce the reportedly excessively bureaucratic *student learning entitlement* system from 2005. This necessitated a change in structure of the files submitted by each university of their courses, and apparently this led to a number of errors. In addition, perhaps it could be argued that some universities spend less time than they should on ensuring data integrity.

The close analysis of DEST's aggregated data files necessitated by this study identified a number of data shortcomings. Although few of these data shortcomings are 'errors' in a strict sense, the interests of data consistency would have been served if many had been 'adjusted' before they were reported to DEST. In the main these have not affected data analysis at the broad level.

However, one data 'problem' had a significant impact on the preparation of this study, and in fact meant that a lot of work had to be repeated. This was because a considerable number of enrolments in several courses in the Field of Education *Health* had been miscoded by one university as though the students had been enrolled in courses in the *Natural and Physical Sciences*. Although it was possible for the university in question to unofficially 'review' and 'correct' its statistics in time for the preparation of this report, it does mean that the statistics in this study no longer match 'official' statistics (until DEST corrects those official statistics).

The coding errors in question are not noticeable when comparing course enrolments in *Health* and *Natural and Physical Sciences* overall, but the difference is stark when undertaking analysis by university. It is important that this coding error be acknowledged and recognised for this study, because the number of 'science' students would otherwise be over-stated. The extent of the problem is shown in Figure 3.

Figure 3: Adjustments to DEST Statistics to Account for Coding Errors

Enrolments reported by Field of Education (Primary)	2002	2003	2004	2005
Health	96,318	99,421	102,161	106,932
Natural and Physical Sciences	60,601	62,565	64,968	66,632
Correct figures (Figures supplied 13 February 2007)				
Health	96565	99882	103031	108915
Natural and Physical Sciences	60354	62104	64098	64649
Variation				
Health	247	461	870	1,983
Natural and Physical Sciences	-247	-461	-870	-1,983

The adjustments shown in Figure 3 have been made throughout this study, with appropriate adjustments for any sub-population examined.

It is to be hoped that the historical record for years 2002 to 2005 will be corrected by DEST.

University Enrolments: The Time Series Back to the Dawkins 'Reforms'

Previous sections sought to explain (among other things) the effects of the break in the time series on analyses of university enrolments and science enrolments by the change in classification of courses from Fields of Study to Fields of Education (in 2001), and by the change in counting methodology (in 2002). This point must be appreciated in order to understand properly what is being compared with what. In part, this section explains why there are variations in 'science' enrolments in *Trends in Science Education, Science at the Crossroads* and *Sustaining Science.*

The first study commissioned by the ACDS *Trends in Science Education,* (Dobson and Calderon, 1997) was based primarily on an analysis of enrolments in courses classified to the Field of Study *09 Science.* By the time of the second study, *Science at the Crossroads* (Dobson, 2003), the fundamental changes mentioned above had kicked in. A key criterion in undertaking the second analysis was that the ACDS required data for 2001 and years beyond to match the collection methodology used in the first study, notwithstanding the changes in statistical collections effective from 2001 and 2002, respectively. With the assistance of staff from DEST's Higher Education Group, data sets which matched the collection scope of earlier years were obtained for 2001 and 2002. It was then necessary to map the former Field of Study classification to the new Field of Education classification.

In order to come up with a consistent count for 'science' enrolments over time in *Science at the Crossroads*, it was necessary to adjust the 'official' published enrolment figures used in producing Trends in Science Education by matching them to the extent possible with the changed circumstances. According to the 2001 Field of Education classification, *soil science*, *medical science* and *medical technology* became part of the Field of Education *01 – Natural and Physical Sciences.* In producing *Science at the Crossroads,* enrolments in these three areas (which had not been part of the Broad Field of Study *09 – Science*) were added to 'science' enrolments in years 1989, 1993 and 1997, in order to maintain the 'science' time series. Similarly, enrolments in human movement and environmental studies (which had been classified with Field of Study *01 Science*, but were not included in the new Field of Education *01 Natural and Physical Sciences*) were added to 'science' enrolment figures for years 2001 and 2002.

For *Sustaining Science*, the third study, the ACDS recognised that it would be difficult to maintain an ongoing time series based on a now defunct collection methodology and classifications of courses and subjects, so the scope in this work is based on the definitions which pertain now. That is, 'science' courses and subjects are those which fall within Field of Education/Discipline Group *01 Natural and Physical Science.*

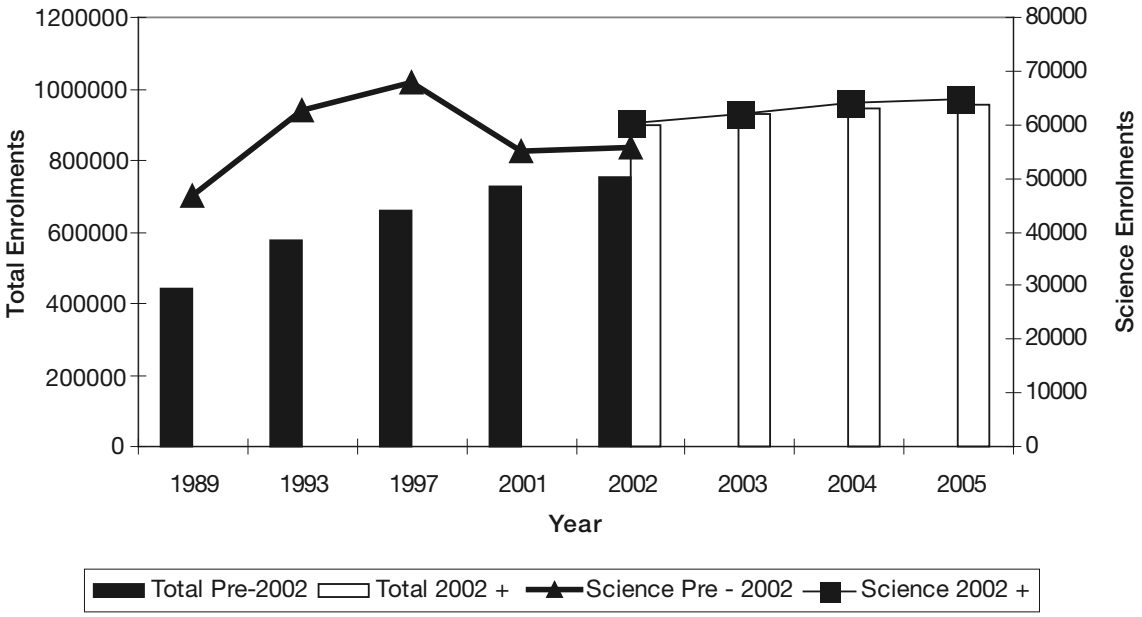
Table 1 and Figure 4 show the effect of changes in counting methodology and in the schema for classifying courses, and highlight the figures reported in *Trends in Science Education, Science at the Crossroads* and *Sustaining Science.*

Table 1: Higher Education Enrolments Pre and Post 2002 Counting Methodology and 2001 Course Classification Changes

	1989	1993	1997	2001	2002	2003	2004	2005
Enrolments – All Courses – Pre 2002 Methodology	441076	575617	658827	725099	750940			
Enrolments – All Courses – 2002+ Methodology					896621	929952	944977	957176
Science Enrolments – Pre 2002 Methodology (Primary Course Only)	48678	65772	71839	64758	55917			
Natural & Physical Science Enrolments – 2002+ Methodology (Primary Course Only)					60354	62104	64098	64649

Figure 4 summarises the effect these two changes have had on overall university Australian university enrolments and on 'science' enrolments. In the figure, the columns represent enrolments in the sector as a whole. The lines represent enrolments in 'science' courses.

Figure 4: University Enrolments – Effects of Changes in Counting Methodology and Course Classification



3. University Enrolments: The Sector 2002 – 2005

This chapter is a scene-setter. It looks at basic developments over the past few years in the sector over all in order to provide a context for changes which have occurred in the Natural and Physical Sciences. The first data year shown is 2002.

Looking at the higher education sector overall, Table 2 shows enrolments by all students according to course level. Overall the university student population increased by 6.8 per cent between 2002 and 2005. Both numerically and proportionately, enrolments in courses at the Other Postgraduate level increased the most (by 32,900, or 18 per cent). Undergraduate enrolments increased by over 23,000, or 3.6 per cent, and Higher Degree by Research enrolments by nearly 4,000, or 9.0 per cent. The proportion of total enrolments represented by each level changed little over the period.

Table 2: Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by Course Level

Course Level	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	2002
Higher Degree by Research	44209	45659	47309	48201	3992	9.0%
	4.9%	4.9%	5.0%	5.0%	6.6%	
Other Postgraduate	182403	201656	210460	215303	32900	18.0%
	20.3%	21.7%	22.3%	22.5%	54.3%	
Undergraduate	647732	657736	663407	671230	23498	3.6%
	72.2%	70.7%	70.2%	70.1%	38.8%	
Non-Award.	22277	24901	23801	22442	165	0.7%
	2.5%	2.7%	2.5%	2.3%	0.3%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 3 shows that proportionate growth between the sexes has been roughly equivalent. The female proportion of all students is now approaching 55 per cent, and more women than men are progressively entering tertiary study at university and equivalent private providers.

Table 3: Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by Sex

Sex	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	No.
Female	487988	505824	513420	521328	33340	6.8%
	54.4%	54.4%	54.3%	54.5%	55.1%	
Male	408633	424128	431557	435848	27215	6.7%
	45.6%	45.6%	45.7%	45.5%	44.9%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 4 looks at the sector according to students' citizenship status. The table indicates clearly that most of the growth in the sector has been in the number of international students, the number of which increased by 54,437, or 29.4 per cent between 2002 and 2005. The expansion of domestic student numbers was rather modest: just over 6,000, or less than 1 per cent. Overseas students are now a quarter of the enrolments in the sector, up from less than 21 per cent in 2002.

Table 4 Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by Citizenship Status

Citizenship Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	No.
Domestic Students	711563	719555	716422	717681	6118	0.9%
	79.4%	77.4%	75.8%	75.0%	10.1%	
Overseas Students	185058	210397	228555	239495	54437	29.4%
	20.6%	22.6%	24.2%	25.0%	89.9%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

The next two tables look at students' attendance at university. Table 5 looks at changes in attendance mode (internal, external or 'multi-modal'). Australian university students continue to be predominantly 'internal', and in fact there was a decline in enrolments by students enrolled externally. In proportionate terms, the number of 'multi-modal' students has increased strongly: by over 29,000, or 89.4 per cent.

Table 5 Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by Mode of Attendance

Attendance Mode	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	No.
Internal Mode of Attendance	724914	747421	754828	761969	37055	5.1%
	80.8%	80.4%	79.9%	79.6%	61.2%	
External Mode of Attendance	139228	140028	137465	133697	-5531	-4.0%
	15.5%	15.1%	14.5%	14.0%	-9.1%	
Multi-modal Mode of Attendance	32479	42503	52684	61510	29031	89.4%
	3.6%	4.6%	5.6%	6.4%	47.9%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 6 considers attendance type (full-time or part-time). Students have shown an increasing propensity to enrol 'full-time'. It is difficult to know from these broad data whether the apparent increasing popularity of full-time attendance is a result of students in the twenty-first century taking on higher study loads while working more hours than in the past. Research by others has certainly shown that students now spend more time working than in the past. See for example, Long and Hayden (2001). Another possible reason is that most of the growth in the sector was the product of increased overseas student enrolment, and on-shore overseas students are required to attend full-time. Over the period, the proportion of full-time students increased from 64.1 per cent to 66.5 per cent.

Table 6 Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by Type of Attendance

Attendance Type	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	No.
Full-time attendance	574580	605230	619696	636872	62292	10.8%
	64.1%	65.1%	65.6%	66.5%	102.9%	
Part-time attendance	322041	324722	325281	320304	-1737	-0.5%
	35.9%	34.9%	34.4%	33.5%	-2.9%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 7 examines student enrolments according to their Australian indigenous status. The table shows that there are few indigenous students at Australian universities. Based on the figures supplied by universities to DEST, the number of indigenous students declined by 501 over the period 2002 – 2005. People of Aboriginal and Torres Strait Islander descent made up about 2.5 per cent of the Australian population in 2001 (ABS, 2003, 4713.0), so ATSI representation at university is perhaps half what might be expected. However, the quality of some universities' reporting of Aboriginal and Torres Strait Islander numbers leaves a little to be desired. In 2005 universities reported on about 46,000 students (nearly 5 per cent) for whom there was 'no information'. This is almost six times the number of Aboriginal and Torres Strait Islander people reported. Although most of the 'no information' students are likely NOT to be indigenous, one wonders why some universities don't improve their reporting. Further analysis (not shown here) reveals that in 2005, about 43,000 of the 46,000 students for whom 'no information' was reported came from six universities, with nearly half (22,001) from just one university. Therefore the data quality problems identified are not widespread, but relate to relatively few universities.

Table 7 Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by Indigenous Status

Indigenous Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	No.
Non-Indigenous	841471	886018	908056	902619	61148	7.3%
	93.8%	95.3%	96.1%	94.3%	101.0%	
Indigenous	8871	8988	8895	8370	-501	-5.6%
	1.0%	1.0%	0.9%	0.9%	-0.8%	
No Information	46279	34946	28026	46187	-92	-0.2%
	5.2%	3.8%	3.0%	4.8%	-0.2%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 8 shows change by state/territory across the sector. Over the period 2002 to 2005, the number of enrolments at Queensland-based institutions increased the most (+15,042), followed by Victorian institutions (+14,390). Overall, states/territories' proportion of all enrolments changed little, with New South Wales and Victoria having over 56 per cent of total enrolments between them. States/territories tend to have university populations which match their overall population. The 2006 distribution of population by state/territory was as shown next to each state/territory in the table. This table provides an analysis of enrolments according to the state/territory of the institution, but some institutions have many enrolments in states other than their own. For instance, in recent years the Central Queensland University established city 'campuses' in Brisbane, Sydney, and Melbourne. (Birrell, 2006:55) A few other universities now also have large numbers of out-of-state enrolments, including New South Wales' Charles Sturt University which attracts considerable numbers of proximate Victorian students.

This leads logically to a consideration of which institutions are the largest and which have grown the most. Table 9 shows the growth in enrolments between 2002 and 2005, with institutions ranked according to the number of enrolments in 2005. The growth in enrolments at 'private' institutions is perhaps of interest. Institutions grouped as 'Other Private Providers' are those for which no enrolments were reported in 2002. These institutions comprise a number of theological colleges, business colleges and other specific industry institutions. Other 'private' institutions are shaded, for readers' information. Together these private sector's enrolments increased by 15,527, or nearly 482 per cent between 2002 and 2005. Several universities expanded their enrolments considerably, headed by Curtin University of Technology.

Table 8 Higher Education Enrolments 2002 – 2005: Students in all Fields of Education by State/Territory

State/Territory	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	No.
Australian Capital Territory (1.6% of Aust. population)	24283	26732	28244	27911	3628	14.9%
	2.7%	2.9%	3.0%	2.9%	6.0%	
New South Wales (33.1%)	289886	300234	296546	297191	7305	2.5%
	32.3%	32.3%	31.4%	31.0%	12.1%	
Northern Territory (1.0%)	6432	6276	6001	5917	-515	-8.0%
	0.7%	0.7%	0.6%	0.6%	-0.9%	
Queensland (19.7%)	170880	175747	182569	185922	15042	8.8%
	19.1%	18.9%	19.3%	19.4%	24.8%	
South Australia (7.5%)	60459	63035	65502	66486	6027	10.0%
	6.7%	6.8%	6.9%	6.9%	10.0%	
Tasmania (2.4%)	15706	16515	18068	18020	2314	14.7%
	1.8%	1.8%	1.9%	1.9%	3.8%	
Victoria (24.7%)	228561	236822	241755	242951	14390	6.3%
	25.5%	25.5%	25.6%	25.4%	23.8%	
Western Australia (10.0%)	88520	92580	93593	97180	8660	9.8%
	9.9%	10.0%	9.9%	10.2%	14.3%	
Multi State #	11894	12011	12699	15598	3704	31.1%
	1.3%	1.3%	1.3%	1.6%	6.1%	
Total (100.0%)	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Australian Catholic University 2002 – 2005; Australian College of Theology 2005 (2,336 enrolments)
Note: Australian population distribution by State/Territory. Source: ABS, 3101.0 Australian Demographic Statistics, June 2006

As Table 9 shows, some universities have been through a period of contraction. The most spectacular examples of 'down-sizing' occurred in New South Wales, at Charles Sturt University, and the Universities of New South Wales and Western Sydney, which between them had nearly 11,500 fewer enrolments in 2005 than they had had in 2002.

Several regional institutions had spectacular increases in their enrolments between 2002 and 2005. Central Queensland University, the University of Wollongong and the University of Ballarat all increased by between 3,000 and 4,000 enrolments over the period. As noted earlier, these impressive expansions of enrolments do not necessarily indicate that the institutions in question have acted as magnets for their regions. Some regional universities now have 'campuses' in major metropolitan centres. Other regional universities to increase in size by more than 1,000 enrolments over the period were James Cook University, the University of Newcastle, the University of the Sunshine Coast and Southern Cross University.

Finally in this chapter on system-wide statistics, Table 10 examines the situation according to primary enrolments by broad Field of Education. Over the period 2002 to 2005, Management and Commerce, the largest Field of Education increased in size the most, increasing its proportion of the total by 1.7 per cent. Of other Fields of Education, several increased their proportion of the total by small amounts. Natural and Physical Sciences, the 'home' of the courses which are the focus of this study, maintained its proportion of 6.8 per cent of primary enrolments. The only broad Fields of Education to decline markedly over the period were Agriculture, Environmental and Related Studies and Information Technology. In the case of the latter, it lost over 13,500 students (or 18.5 per cent) over the period, and Information Technology's proportion of the total declined by 2.0 per cent. A closer examination of Agriculture, Environmental and Related Studies reveals that although much of the decline in numbers was reflected across the system, the source of 289 of the decline was due to the decline in enrolments at the Australian Maritime College (See Table 9 for the overall pattern). So far as Information Technology is concerned, there have been some spectacular declines[4].

4 Although not shown in these tables, of the bigger players, the Queensland University of Technology's Information Technology numbers declined by over 36 per cent between 2002 and 2005, those of the University of Western Sydney and Monash University by 30 per cent each, and at the Central Queensland University by over 26 per cent. Of the more modestly-sized Information Technology players, Charles Darwin lost 51 per cent of its Information Technology enrolments over the period, and the University of New South Wales 44 per cent. By way of contrast, the number of Information Technology enrolments at the University of Ballarat increased by nearly 1,600 between 2002 and 2005.

Table 9 Higher Education Enrolments 2002 – 2005:
Students in all Fields of Education by University, Ranked by Enrolments 2005

University/Institution	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Monash University	52010	53610	55726	54950	2940	5.7%
University of Sydney	42305	45857	46250	45630	3325	7.9%
University of Melbourne	39378	40759	41901	41827	2449	6.2%
University of New South Wales	42333	42002	40421	39183	-3150	-7.4%
Queensland University of Technology	39192	39980	39921	38527	-665	-1.7%
Curtin University of Technology	33240	35656	36064	38506	5266	15.8%
RMIT University	38280	38200	38816	38214	-66	-0.2%
University of Queensland	37498	38161	38139	37177	-321	-0.9%
Griffith University	30969	32074	33189	34648	3679	11.9%
Charles Sturt University	39776	38365	35899	33560	-6216	-15.6%
University of Western Sydney	35361	36668	34399	33309	-2052	-5.8%
Deakin University	33033	32893	33106	33238	205	0.6%
University of South Australia	30627	31528	32611	31988	1361	4.4%
University of Technology, Sydney	29290	30585	31131	31602	2312	7.9%
Macquarie University	27239	29028	29868	29985	2746	10.1%
La Trobe University	24930	27975	27687	27208	2278	9.1%
Central Queensland University	21763	21352	22352	25569	3806	17.5%
University of Newcastle	23502	24323	24634	25114	1612	6.9%
University of Southern Queensland	24271	24956	25414	24694	423	1.7%
Edith Cowan University	23829	24110	23887	23585	-244	-1.0%
University of Wollongong	18764	20519	21131	22124	3360	17.9%
Victoria University	19475	20634	20024	20393	918	4.7%
University of Adelaide	16188	17355	18292	18943	2755	17.0%
University of New England	18202	18758	18529	18146	-56	-0.3%
University of Western Australia	15885	16546	16806	17082	1197	7.5%
University of Tasmania	13750	14682	16184	16760	3010	21.9%
Swinburne University of Technology	14404	14884	15068	16018	1614	11.2%
James Cook University	13189	13604	14395	14820	1631	12.4%
Flinders University of SA	13644	14113	14510	14660	1016	7.4%
Australian National University	11979	13384	14476	14317	2338	19.5%
Australian Catholic University	11894	12011	12699	13262	1368	11.5%
Murdoch University	12734	12724	12655	13201	467	3.7%
Southern Cross University	11961	12878	13079	13127	1166	9.7%
University of Canberra	10419	11270	11632	11498	1079	10.4%
University of Ballarat	6615	7319	9030	9782	3167	47.9%
Other Private Providers	0	174	798	8795	8795	
Charles Darwin University	5612	5519	5306	5324	-288	-5.1%
University of the Sunshine Coast	3947	4171	4630	5153	1206	30.6%
University of Notre Dame Australia	2832	3544	4181	4787	1955	69.0%
Bond University	51	1314	3820	4493	4442	8709.8%
Australian Defence Force Academy	1885	2078	2136	2079	194	10.3%
Australian Maritime College	1956	1833	1884	1260	-696	-35.6%
Avondale College	872	975	930	1072	200	22.9%
Melbourne College of Divinity	340	433	397	675	335	98.5%
Batchelor Institute	820	757	695	593	-227	-27.7%
National Institute of Dramatic Art	173	171	168	164	-9	-5.2%
Australian Film, Television and Rad	108	105	107	101	-7	-6.5%
Marcus Oldham College	96	115	0	33	-63	-65.6%
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**

Table 10 Higher Education Enrolments 2002 – 2005:
Students in all Fields of Education by Broad Field of Education (Primary Course#)

Broad Field of Education – No.	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Agriculture, Env. And Related Studies	18341	18300	18251	17003	-1338	-7.3%
	2.0%	2.0%	1.9%	1.8%	-2.2%	
Architecture And Building	17756	18591	18993	19697	1941	10.9%
	2.0%	2.0%	2.0%	2.1%	3.2%	
Creative Arts	53214	55705	57183	58324	5110	9.6%
	5.9%	6.0%	6.1%	6.1%	8.4%	
Education	85149	86222	87574	91275	6126	7.2%
	9.5%	9.3%	9.3%	9.5%	10.1%	
Engineering And Related Technologies	59863	63349	64223	64190	4327	7.2%
	6.7%	6.8%	6.8%	6.7%	7.1%	
Health	96565	99882	103031	108915	12350	12.8%
	10.8%	10.7%	10.9%	11.4%	20.4%	
Information Technology	73402	70986	67103	59819	-13583	-18.5%
	8.2%	7.6%	7.1%	6.2%	-22.4%	
Management And Commerce	228789	242988	253700	260742	31953	14.0%
	25.5%	26.1%	26.8%	27.2%	52.8%	
Natural And Physical Sciences	60354	62104	64098	64649	4295	7.1%
	6.7%	6.7%	6.8%	6.8%	7.1%	
Society And Culture	178868	184769	184868	188178	9310	5.2%
	19.9%	19.9%	19.6%	19.7%	15.4%	
Mixed Field Programmes	1893	2048	2082	1861	-32	-1.7%
	0.2%	0.2%	0.2%	0.2%	-0.1%	
Food, Hospitality And Personal Services	150	109	70	90	-60	-40.0%
	0.0%	0.0%	0.0%	0.0%	-0.1%	
Non Award	22277	24899	23801	22433	156	0.7%
	2.5%	2.7%	2.5%	2.3%	0.3%	
Total	**896621**	**929952**	**944977**	**957176**	**60555**	**6.8%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

As is outlined in the next chapter, some students enrol in more than one course of study. This table provides a distribution according to the 'primary' course in which students were enrolled. Subsequent enumerations of enrolments in courses classified as Natural and Physical Sciences show students enrolled in the Natural and Physical Sciences (as in this tables) PLUS students enrolled in a Natural and Physical Sciences course as a supplementary course.

On the basis of these broad figures, it can be observed that a numerical sense, 'science' has held its own this century. Primary enrolments in Natural and Physical Sciences courses expanded by nearly 4,300 enrolments, or 7.1 per cent, compared with a system-wide average of 6.8 per cent. The number of Science course enrolments as a proportion of all enrolments remained almost unchanged at 6.7 to 6.8 per cent.

4. How many ‘science’ students are there?

This chapter takes a closer look at science enrolments in the period since the counting methodology was changed, where ‘science’ relates to all those courses classified within the broad Field of Education *01 Natural and Physical Sciences*. The analysis starts with an examination of ALL students enrolled in a ‘science’ degree. Australian universities permit students to pursue two university degrees simultaneously so many students can be enrolled in more than one course. Therefore the total number of ‘science’ students is greater than was shown in Table 10, because of students being enrolled in more than one course.

Table 11 shows that in 2005, there were 74,018 science students. How was this figure derived? First, the 64,649 student enrolments in ‘science’ degrees as their primary course were included. These are the students shown in Natural and Physical Sciences courses in Table 10. Of these students, 58,804 students (about 91 per cent) were enrolled in a single course only, but 5,845 were enrolled in another course as well as in a science course. Second, there were 9,755 students enrolled in a ‘science’ course as a supplementary course. This latter figure includes 386 students who were enrolled in TWO courses in the Natural and Physical Sciences. To include these 386 students according to their secondary course could cause double counting, so these enrolments were deducted. Given the change in counting methodology from a snapshot to an ‘all of year’ approach from 2002, it is possible that these 386 students were **not** enrolled in two Natural and Physical Sciences courses simultaneously. However, it has been presumed here that they were. Thus the total number of (unique) persons enrolled in science courses in 2005 was derived as follows:

58,804 + 5845 + 9,755 - 386 = 74,018

All subsequent tables in this chapter are concerned with these 74,018 enrolments.

The growth in ‘science’ enrolments overall was 8.9 per cent, which should be compared with the growth in enrolments of ‘science’ primary enrolments of 7.1 per cent identified in the previous table.

The tables which follow identify changes in science enrolments according to a range of variables since 2002. Each table compares university-wide patterns with those in science.

Level of course

Table 12 examines enrolments according to the level of course. A considerably higher proportion of science students are enrolled in research degrees than is the situation in the sector overall. Table 2 showed that in 2005, 5.0 per cent of Australian university students were enrolled in research degrees, compared with 11.6 per cent of students enrolled in Natural and Physical Sciences courses. Sector-wide, the number of research students increased by nearly 4,000 over the period, and the proportion increased only negligibly. In contrast, there was strong growth in research degree enrolments in science. The table shows an increase of 958 enrolments in higher degrees by research, including an increase of 1,061 PhD students. Numbers of masters by research enrolments declined by 108 (or 10 per cent) over the period. Evident from a comparison of Tables 10 and 12 is the fact that Natural and Physical Sciences students represented 6.8 per cent of students at all course levels in 2005, but 18.9 per cent of all higher degree by research students in 2005. The Natural and Physical Sciences’ proportion of all research degree enrolments had been 17.3 per cent in 2002.

Table 11 Higher Education Enrolments 2002 – 2005: No. Students in Natural and Physical Sciences Courses

	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Primary Course Natural and Physical Sciences:						
Enrolled in a single Natural and Physical Sciences Course only	54540	56336	58191	58804	4264	7.8%
Supplementary Course in:						
Agriculture, Environmental And Related Studies	33	25	21	23	-10	-30.3%
Architecture And Building	0	0	0	0	0	
Creative Arts	22	20	27	29	7	31.8%
Education	382	446	545	625	243	63.6%
Engineering And Related Technologies	851	771	767	670	-181	-21.3%
Health	84	131	157	187	103	122.6%
Information Technology	334	354	373	327	-7	-2.1%
Management And Commerce	842	894	967	842	0	0.0%
Natural And Physical Sciences	376	386	243	386	10	2.7%
Society And Culture	2890	2741	2807	2756	-134	-4.6%
Sub total Secondary Courses	5814	5768	5907	5845	31	0.5%
Sub total: Primary Course Natural and Physical Sciences	**60354**	**62104**	**64098**	**64649**	**4295**	**7.1%**
Supplementary Course Natural and Physical Sciences:						
Primary course in:						
Agriculture, Environmental And Related Studies	68	63	50	52	-16	-23.5%
Architecture And Building	36	38	63	53	17	47.2%
Creative Arts	27	22	23	19	-8	-29.6%
Education	685	763	892	1051	366	53.4%
Engineering And Related Technologies	2941	2997	3103	2997	56	1.9%
Health	511	665	1400	1810	1299	254.2%
Information Technology	211	214	279	264	53	25.1%
Management And Commerce	1536	1693	1661	1647	111	7.2%
Natural and Physical Sciences	376	386	243	386	10	2.7%
Society And Culture	1572	1536	1548	1476	-96	-6.1%
Supplementary Course Sub total	7963	8377	9262	9755	1792	22.5%
Total No. Enrolments in Natural and Physical Sciences Courses	**68317**	**70481**	**73360**	**74404**	**6087**	**8.9%**
LESS: Enrolments in two Natural and Physical Sciences Courses	376	386	243	386	10	2.7%
Net No. Students Enrolled in Natural and Physical Sciences Courses	**67941**	**70095**	**73117**	**74018**	**6077**	**8.9%**

Science students do not feature in courses at the Other Postgraduate level to the extent they do in other Fields of Education. However, there was strong proportionate growth over the period (29 per cent), even though that represented a growth of only 948 students. Table 2 revealed that an additional 32,900 students enrolled in other postgraduate courses system-wide, an increase of 18 per cent.

As is the case at the research level, science students are over-represented among undergraduates. Overall, 70.1 per cent of university students were enrolled in undergraduate degrees in 2005 (Table 2), compared with 83.2 per cent of Natural and Physical Sciences students. Within undergraduate-level courses, students in Natural and Physical Sciences courses are enrolled predominantly in bachelor programmes. Natural and Physical Sciences students are also well represented in honours courses, and over 3,200 science students were enrolled in a bachelor (hons.) degree as their primary course in 2005. Analysis of DEST files indicates that this number represents 27.4 per cent of all bachelor degree honours students.

Field of Education *09 Society and Culture* (which incorporates students enrolled in arts and economics degrees) had more honours students, with 4,820 or 40.8 per cent of the total. Society and Culture is a much larger Field of Education, with 19.7 per cent of all students enrolled in its courses (see Table 10), compared with enrolments in the Natural and Physical Sciences, which represented 6.8 per cent.

Table 12 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by Level of Course

Course Type Group	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
HD by Research						
Doctorate by Research	6553	6884	7317	7619	1066	16.3%
Masters by Research	1081	1074	978	973	-108	-10.0%
HD by Research Total	**7634**	**7958**	**8295**	**8592**	**958**	**12.5%**
	11.2%	**11.4%**	**11.3%**	**11.6%**	**15.8%**	
Other Postgraduate						
Masters Coursework	1658	1818	2097	2102	444	26.8%
PG Qualifying	48	56	55	40	-8	-16.7%
Grad Dip – New Area	574	592	617	611	37	6.4%
Grad Dip – Extend	402	459	511	511	109	27.1%
Graduate Certificate	544	608	659	599	55	10.1%
Coursework Doctorate	7	5	6	10	3	42.9%
Other Postgraduate Total	**3233**	**3538**	**3945**	**3873**	**640**	**19.8%**
	4.8%	**5.0%**	**5.4%**	**5.2%**	**10.5%**	
Undergraduate						
Bachelors Graduate Entry	101	67	69	39	-62	-61.4%
Bachelors Honours	3230	3170	3172	3262	32	1.0%
Bachelors Pass	52908	54746	57043	57810	4902	9.3%
Associate Degree	15	8	8	18	3	20.0%
Associate Diploma	150	142	108	92	-58	-38.7%
Diploma	46	101	106	45	-1	-2.2%
Enabling	60	64	78	162	102	170.0%
Other Award Course	564	301	293	125	-439	-77.8%
Undergraduate Total	**57074**	**58599**	**60877**	**61553**	**4479**	**7.8%**
	84.0%	**83.6%**	**83.3%**	**83.2%**	**73.7%**	
Total	**67941**	**70095**	**73117**	**74018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Further analysis of bachelor degree students follows later in this chapter. (The bachelor degree is the majority course level in Australian higher education). A later chapter considers PhDs. These are important course levels to examine, as the PhD is the major barrier-to-entry qualification for many careers in academic and research science.

The gender distribution

Table 13 looks at enrolments by sex. Overall, there are more women than men in Australian higher education (see Table 3). This is also the case among Natural and Physical Sciences enrolments, but the proportion of female students has been around two per cent lower in the Natural and Physical Sciences than overall. The number and proportion of women studying science also increased more rapidly than for male students.

Table 13 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by Sex

Sex	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Female Students	35,539	36,883	38,481	38,916	3377	9.5%
	52.3%	52.6%	52.6%	52.6%	55.6%	
Male Students	32,402	33,212	34,636	35,102	2700	8.3%
	47.7%	47.4%	47.4%	47.4%	44.4%	
Total	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Citizenship Status

Table 14 (below) examines the distribution of students according to their citizenship status. Table 4 showed that 25.0 per cent of Australia's university students were overseas students, up from just over 20 per cent in 2002. Table 14 shows that overseas students are less prevalent in science, where there proportion increased from 10.1 per cent in 2002 to 13.9 per cent in 2005. However, the rate of growth is higher in science. The number of overseas students in the sector rose by 29.4 per cent between 2002 and 2005. This rise from a fairly low base should be compared with the 49.5 per cent rise of overseas student numbers in science. The growth in domestic 'science' students (so to speak) was more modest, at 4.4 per cent (an increase of 2,673 students), but this was a much greater rate than for the sector overall, which by comparison increased in number by about 6,000, a mere 0.9 per cent. Looking at the sector overall (Table 4), it can be seen that virtually all the growth could be attributed to overseas students, whereas enrolment growth between domestic and overseas students in the Natural and Physical Sciences was closer.

Mode of Attendance

In 2005, 88.7 per cent of science students attended internally, that is studied 'on campus' (see Table 15). This proportion was down slightly when compared with the situation a few years earlier. The equivalent figure for the sector as a whole was 79.6 per cent (Table 5). Perhaps this is to be expected. Science students are much more likely to require laboratory facilities in their studies, and 'off campus' attendance is unlikely to facilitate this. The proportion of science students studying externally stayed at about the same level over the period, but the 2005 figure of 6.5 per cent was less than half the sector average of 14.0 per cent.

Type of Attendance

Science students are more likely to attend full-time than students over all. Table 6 showed that in 2005, 66.5 per cent of students in courses in all Fields of Education attended full-time, compared with over 79 per cent of science students (Table 16). Perhaps this is because laboratory-based courses, which science courses are more likely to be than courses in most other Fields of Education, generally require a higher number of class contact hours.

Table 14 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by Citizenship Status

Citizenship Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Domestic Students	61,065	62,197	63,678	63,738	2673	4.4%
	89.9%	88.7%	87.1%	86.1%	44.0%	
Overseas Students	6,876	7,898	9,439	10,280	3404	49.5%
	10.1%	11.3%	12.9%	13.9%	56.0%	
Total	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 15 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by Mode of Attendance

Attendance Mode	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Internal Mode of Attendance	61,460	62,942	65,184	65,687	4227	6.9%
	90.5%	89.8%	89.2%	88.7%	69.6%	
External Mode of Attendance	4,627	4,741	4,917	4,796	169	3.7%
	6.8%	6.8%	6.7%	6.5%	2.8%	
Multi-modal Mode of Attendance	1,854	2,412	3,016	3,535	1681	90.7%
	2.7%	3.4%	4.1%	4.8%	27.7%	
Total	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 16 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by Type of Attendance

Attendance Type	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Full-time Attendance	52,653	55,210	57,575	58,570	5917	11.2%
	77.5%	78.8%	78.7%	79.1%	97.4%	
Part-time Attendance	15,288	14,885	15,542	15,448	160	1.0%
	22.5%	21.2%	21.3%	20.9%	2.6%	
Total	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Indigenous students

Table 17 considers science enrolments according to students' indigenous background. Most science students are NOT of Aboriginal or Torres Strait Island background, although the number has increased over the four years covered by this study. The rate of enrolment of indigenous students at 0.4 per cent is less than half the system-wide average enrolment rate for indigenous students of 0.9 per cent. As noted earlier, universities reported 'no information' for a large proportion of students.

Enrolments by state/territory

Table 18 shows the distribution of science students by state or territory. The figures in brackets next to the name of each state/territory are the proportion of all students enrolled in universities in that state/territory in 2005. Comparing the per cent distributions of students provides an indicator of relative over- or under-representation of science students state by state. The proportion of science students is higher than the proportion of all students in the Australian Capital Territory, Western Australia, Victoria and to a minor extent, Tasmania. Victoria was the largest-growing state so far as science was concerned in the period 2002 to 2005.

Table 17 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by Indigenous Status

Indigenous Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Non-Indigenous	63,443	66,780	71,680	71,552	8109	12.8%
	93.4%	95.3%	98.0%	96.7%	133.4%	
Indigenous	256	281	285	332	76	29.7%
	0.4%	0.4%	0.4%	0.4%	1.3%	
No Information	4,242	3,034	1,152	2,134	-2108	-49.7%
	6.2%	4.3%	1.6%	2.9%	-34.7%	
Total	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 18 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by State/Territory

State/Territory	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Australian Capital Territory (1.6% of Australian Population)	2909	3108	3283	3350	441	15.2%
	4.3%	4.4%	4.4%	4.4%	5.6%	
New South Wales (33.1%)	19693	20499	20998	20819	1126	5.7%
	28.9%	29.1%	28.4%	27.4%	14.4%	
Northern Territory (1.0%)	409	367	305	370	-39	-9.5%
	0.6%	0.5%	0.4%	0.5%	-0.5%	
Queensland (19.7%)	13287	13489	14169	14090	803	6.0%
	19.5%	19.1%	19.2%	18.5%	10.3%	
South Australia (7.5%)	4823	4904	5065	5227	404	8.4%
	7.1%	7.0%	6.8%	6.9%	5.2%	
Tasmania (2.4%)	1505	1511	1700	1619	114	7.6%
	2.2%	2.1%	2.3%	2.1%	1.5%	
Victoria (24.7%)	18,249	18,768	20,062	20,176	1927	10.6%
	26.9%	26.8%	27.4%	27.3%	31.7%	
Western Australia (10.0%)	7050	7449	7529	8367	1317	18.7%
	10.3%	10.6%	10.2%	11.0%	16.9%	
Multi State	16	0	6	0	-16	-100.0%
	0.0%	0.0%	0.0%	0.0%	-0.2%	
Total (100.0%)	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Note: Australian population distribution by State/Territory. Source: ABS, 3101.0 Australian Demographic Statistics, June 2006

Enrolments by university

Table 19 shows enrolment numbers in science courses, ranked in order of the number of science students in 2005. As one might expect, the largest universities overall are the ones most likely to have the most science students. The Group of Eight universities are also represented at the top of the ranked list of universities with the most science students. RMIT has wedged itself into the eighth position in terms of the number of science students it had in 2005, ahead of Group of Eight member the Australian National University.
In overall enrolment terms, however, the Australian National University is little more than one third of the size of RMIT. The Group of Eight enrolled a consistent 28 per cent of all students during the period 2002 to 2005, but a rather higher proportion of the nation's science students, which by 2005 was 47.4 per cent. Table 19 shows that the University of Melbourne has been the largest 'science' university in terms of enrolments since 2002.

Table 19 Higher Education Enrolments 2002 – 2005: Natural and Physical Sciences Students by University, Ranked by Enrolments 2005

University	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
University of Melbourne	6,156	6,135	6,910	7,156	1000	16.2%
University of Sydney	4,739	5,005	5,120	5,214	475	10.0%
Monash University	4,289	4,533	5,001	5,208	919	21.4%
University of Queensland	4,699	4,842	4,880	4,899	200	4.3%
University of New South Wales	4,059	4,212	4,295	4,243	184	4.5%
University of Western Australia	2,615	2,613	2,531	3,169	554	21.2%
University of Adelaide	2,584	2,681	2,768	2,822	238	9.2%
RMIT University	2,226	2,334	2,448	2,446	220	9.9%
Australian National University	2,097	2,183	2,304	2,376	279	13.3%
Murdoch University	1,836	2,033	2,120	2,363	527	28.7%
Queensland University of Technology	2,020	2,099	2,282	2,356	336	16.6%
University of Technology, Sydney	2,255	2,224	2,304	2,297	42	1.9%
La Trobe University	1,913	1,884	1,953	2,053	140	7.3%
Curtin University of Technology	1,919	2,023	1,930	1,953	34	1.8%
University of Western Sydney	1,676	1,775	1,866	1,944	268	16.0%
Griffith University	1,441	1,685	1,881	1,868	427	29.6%
James Cook University	2,102	1,811	1,932	1,826	-276	-13.1%
University of Southern Queensland	1,910	1,933	1,954	1,750	-160	-8.4%
Flinders University	1,580	1,588	1,637	1,724	144	9.1%
Deakin University	1,725	1,807	1,804	1,700	-25	-1.4%
University of Newcastle	1,635	1,669	1,668	1,673	38	2.3%
University of Tasmania	1,324	1,345	1,500	1,619	295	22.3%
University of Wollongong	1,911	1,846	1,789	1,599	-312	-16.3%
Macquarie University	1,326	1,361	1,448	1,525	199	15.0%
Charles Sturt University	1,146	1,427	1,495	1,224	78	6.8%
University of New England	827	860	892	1,041	214	25.9%
Edith Cowan University	680	755	888	806	126	18.5%
Central Queensland University	640	661	726	726	86	13.4%
Swinburne University of Technology	920	987	922	725	-195	-21.2%
University of South Australia	659	635	660	681	22	3.3%
Victoria University	773	819	759	663	-110	-14.2%
University of the Sunshine Coast	475	458	448	618	143	30.1%
University of Canberra	583	635	596	565	-18	-3.1%
Australian Defence Force Academy	229	290	383	409	180	78.6%
Charles Darwin University	409	367	305	341	-68	-16.6%
University of Ballarat	247	269	265	225	-22	-8.9%
University of Notre Dame Australia	0	25	60	76	76	
Avondale College	47	43	45	52	5	10.6%
Bond University	0	0	66	47	47	
Batchelor Institute	0	0	0	29	29	
Southern Cross University	72	77	76	7	-65	-90.3%
Australian Catholic University	16	0	6	0	-16	-100.0%
Australian Maritime College	181	166	200	0	-181	-100.0%
Other Institutions	0	0	0	0	0	
Total	**67,941**	**70,095**	**73,117**	**74,018**	**6077**	**8.9%**
Group of Eight Total	31,238	32,204	33,809	35,087	3849	
Group of Eight Per Cent of Total	46.0%	45.9%	46.2%	47.4%	63.3%	

Back to basics: a closer look at bachelor degrees

More students enrol in degrees at the bachelor level than at any other. Table 20 compares Natural and Physical Sciences bachelor degree student enrolments with those for all Fields of Education. The number of students includes those enrolled in 'science' as either a primary course or a supplementary course. In 2005, this comprised 51,742 students enrolled in a Natural and Physical Sciences primary course and 9,369 as a supplementary course, totalling 61,111 enrolments. It shows that the proportion of Natural and Physical Sciences to all Fields of Education increased slightly over the period, from 9 per cent in 2002, to 9.4 per cent in 2005. The table also shows that the growth in bachelor degree enrolments in science occurred at nearly twice the rate of growth in all Fields of Education.

Table 20 Higher Education Enrolments 2002 – 2005: Bachelor Students All Fields of Education and Natural and Physical Sciences.

Field of Education	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Bachelor Students – All Fields of Education #	623839	636133	644851	652731	28892	4.6%
Bachelor Students – Natural and Physical Sciences	56239	57983	60284	61111	4872	8.0%
Science Per Cent of All Fields of Education	9.0%	9.1%	9.3%	9.4%	16.9%	

Primary Course Bachelor Degree enrolments only

Bachelor degree students: the gender distribution

Table 21 looks at the gender distribution, comparing science bachelor degree students with those in all Fields of Education. Overall, female students have made up a consistent 56 per cent of all bachelor students. That proportion is in very slight relative decline, and women made up a more modest 51.7 per cent of the growth in bachelor student numbers between 2002 and 2005. Among science bachelor students, there were relatively fewer women, but they were nonetheless in the majority, at around 54 per cent in all years examined in this study. In 2005, female and male students in science bachelor degrees made up about 8.9 per cent and 9.9 per cent of all female and male bachelor degree students, respectively, calculated from Table 21.

Table 21 Higher Education Enrolments 2002 – 2005: Bachelor Students All Fields of Education and Natural and Physical Sciences by Sex.

Sex	2002	2003	2004	2005	Growth 2002 - 2005	
					No.	Per Cent
Bachelor Students – All Fields of Education						
Female	353357	359736	364307	368307	14950	4.2%
Male	270482	276397	280544	284424	13942	5.2%
Total	623839	636133	644851	652731	28892	4.6%
Female Per Cent of Total	56.6%	56.6%	56.5%	56.4%	51.7%	
Bachelor Students – Natural and Physical Sciences						
Female	30,295	31,483	32,695	32,907	2612	8.6%
Male	25,944	26,500	27,589	28,204	2260	8.7%
Total	**56,239**	**57,983**	**60,284**	**61,111**	**4872**	**8.7%**
Female Per Cent of Total	53.9%	54.3%	54.2%	53.8%	53.6%	

Citizenship Status

Table 22 looks at the composition of the bachelor student population in terms of their Citizenship status. Science bachelor students are much less likely to be overseas students than are bachelor students overall, and the growth over the 2002-2005 period was lower in the case of science bachelor students. In 2005, 20.5 per cent of bachelor students in all fields of education were overseas students; this was the case for only for 12.0 per cent of students in the Natural and Physical Sciences. Whereas slightly more than 10 per cent of domestic bachelor students were enrolled in science courses, the rate for overseas students was only about half of that, calculated from Table 22. However, there has been some expansion in overseas numbers in science bachelor courses. Over the period 2002 to 2005, the number of overseas science bachelor degree students increased from 4,477 to 7,345 (or by 64.1 per cent). Overall, the growth rate for overseas students in bachelor course enrolments was 23.8 per cent.

Table 22 Higher Education Enrolments 2002 – 2005: Bachelor Students All Fields of Education and Natural and Physical Sciences by Citizenship Status.

Citizenship Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Bachelor Students – All Fields of Education						
Domestic students	515820	515611	514002	518990	3170	0.6%
Overseas students	108019	120522	130849	133741	25722	23.8%
Total	**623839**	**636133**	**644851**	**652731**	**28892**	**4.6%**
Overseas Per Cent of Total	17.3%	18.9%	20.3%	20.5%	89.0%	
Bachelor Students – Natural and Physical Sciences						
Domestic students	51,762	52,500	53,529	53,766	2004	3.9%
Overseas students	4,477	5,483	6,755	7,345	2868	64.1%
Total	**56,239**	**57,983**	**60,284**	**61,111**	**4872**	**8.7%**
Overseas Per Cent of Total	8.0%	9.5%	11.2%	12.0%	58.9%	

Mode of Attendance

Table 23 examines enrolments according to mode of attendance, that is, whether students were enrolled on- or off-campus or a combination of the two. As noted earlier with respect to enrolments at all course levels, students enrolled in Natural and Physical Sciences courses have a lower propensity to study via distance education, with the most likely reason being that science degrees often involve laboratory work.

The number of students studying externally dropped between 2002 and 2005 for science bachelor degree students (a decline of 8.1 per cent), and bachelor degree students overall (a decline of 10.2 per cent). As can be seen from the table, science bachelor students made up over 10 per cent of all internal mode students in 2005, but only 5 per cent of all external mode students.

Type of Attendance

Table 24 looks at the propensity of students to attend full-time or part-time. As can be seen, the number and proportion of full-time students is increasing for all bachelor students and science bachelor students, but at a higher rate in the latter case. The number of bachelor degree students attending part-time decreased for both science and all bachelor students. Natural and Physical Sciences students are more likely to attend full-time, and in 2005, their rate of full-time attendance was nearly 84 per cent, compared with a rate of 77.4 per cent for bachelor students overall.

Table 23 Higher Education Enrolments 2002 – 2005: Bachelor Students
All Fields of Education and Natural and Physical Sciences by Mode of Attendance

Attendance Mode	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Bachelor Students – All Fields of Education						
Internal Mode of Attendance	530161	537565	540536	543215	13054	2.5%
External Mode of Attendance	68207	65014	62725	61275	-6932	-10.2%
Multi-modal Mode of Attendance	25471	33554	41590	48241	22770	89.4%
Total	**623839**	**636133**	**644851**	**652731**	**28892**	**4.6%**
External Per Cent of Total	10.9%	10.2%	9.7%	9.4%	-24.0%	
Bachelor Students – Natural and Physical Sciences						
Internal Mode of Attendance	51128	52443	54250	54800	3672	7.2%
External Mode of Attendance	3343	3317	3276	3072	-271	-8.1%
Multi-modal Mode of Attendance	1768	2223	2758	3239	1471	83.2%
Total	**56239**	**57983**	**60284**	**61111**	**4872**	**8.7%**
External Per Cent of Total	5.9%	5.7%	5.4%	5.0%	-5.6%	
Science Per Cent of All Fields of Education						
Internal Mode of Attendance	9.6%	9.8%	10.0%	10.1%	28.1%	
External Mode of Attendance	4.9%	5.1%	5.2%	5.0%	3.9%	
Multi-modal Mode of Attendance	6.9%	6.6%	6.6%	6.7%	6.5%	
Total	**9.0%**	**9.1%**	**9.3%**	**9.4%**	**16.9%**	

Table 24 Higher Education Enrolments 2002 – 2005: Bachelor Students
All Fields of Education and Natural and Physical Sciences by Type of Attendance

Attendance Type	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Bachelor Students – All Fields of Education						
Full-time attendance	469054	486314	495089	505475	36421	7.8%
Part-time attendance	154785	149819	149762	147256	-7529	-4.9%
Total	**623839**	**636133**	**644851**	**652731**	**28892**	**4.6%**
Full-time Per Cent of Total	75.2%	76.4%	76.8%	77.4%	126.1%	
Bachelor Students – Natural and Physical Sciences						
Full-time attendance	45551	47855	49951	51147	5596	12.3%
Part-time attendance	10688	10128	10333	9964	-724	-6.8%
Total	**56239**	**57983**	**60284**	**61111**	**4872**	**8.7%**
Full-time Per Cent of Total	81.0%	82.5%	82.9%	83.7%	114.9%	

Indigenous Students

Table 25 considers indigenous students enrolled in bachelor degrees in all Fields of Education and in Natural and Physical Sciences. As can be seen, indigenous students made up about 0.8 per cent of enrolments in all bachelor degrees, but only slightly more than half this amount in Natural and Physical Science bachelor courses.

At the time of the 2001 Census of Population and Housing, the experimental resident indigenous population was 458,00, or 2.5 per cent (ABS, 2003, 4713.0). This is a prima facie indicator of under-representation in the population of bachelor degree students.

Table 25 Higher Education Enrolments 2002 – 2005: Bachelor Students All Fields of Education and Natural and Physical Sciences by Indigenous Status.

Indigenous Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Bachelor Students – All Fields of Education						
Non-Indigenous	585368	604982	619666	617469	32101	5.5%
Indigenous	5209	5458	5570	5521	312	6.0%
No Information	33262	25693	19615	29741	-3521	-10.6%
Total	**623839**	**636133**	**644851**	**652731**	**28892**	**4.6%**
Indigenous Per Cent of Total	0.8%	0.9%	0.9%	0.8%		
Bachelor Students – Natural and Physical Sciences						
Non-Indigenous	52,001	54,898	59,080	59,168	7167	13.8%
Indigenous	222	241	248	294	72	32.4%
No Information	4,016	2,844	956	1,649	-2367	-58.9%
Total	**56,239**	**57,983**	**60,284**	**61,111**	**4872**	**8.7%**
Indigenous Per Cent of Total	0.4%	0.4%	0.4%	0.5%		

Field of Education

Tables 26 and 27 look at the specific Fields of Education science students enrol in. Table 26 summarises bachelor degree enrolments in Natural and Physical Sciences courses by Field of Education. Growth of any consequence, as can be seen, has been restricted to Biological Sciences courses and 'Other Natural and Physical Sciences' courses.

Table 26 Higher Education Enrolments 2002 – 2005: Bachelor Students Natural and Physical Sciences by Field of Education – Summary

Field of Education	2002	2003	2004	2005		Growth 2002 – 2005	
				No.	Per Cent	No.	Per Cent
Mathematical Sciences	2510	2502	2610	2516	4.1%	6	0.2%
Physical Sciences	889	952	1005	978	1.6%	89	10.0%
Chemical Sciences	1172	1160	1634	1217	2.0%	45	3.8%
Earth Sciences	878	809	796	707	1.2%	-171	-19.5%
Biological Sciences	11583	11806	12725	12284	20.1%	701	6.1%
Other Natural and Physical Sciences	39207	40754	41514	43409	71.0%	4202	10.7%
Total	**56239**	**57983**	**60284**	**61111**	**100.0%**	**4872**	**8.7%**

Table 27 is in more detail, and a brief examination confirms the observation made earlier, that many science students, and perhaps more specifically those enrolled at the bachelor level, are in generalist degrees. In 2005, nearly 31,000 science bachelor students (over half) were enrolled in courses coded to 'Natural and Physical Sciences', 'Natural and Physical Sciences nec', and 'Other Natural and Physical Sciences'. Next most populous were Biological Sciences courses, with nearly 9,000 enrolments in 2005. Over 6,600 students were enrolled in courses coded to the Medical Sciences Field of Education, and a further 2,571 in courses coded to Food Technology courses. The remaining enrolments were spread among a wide range of courses. It would require detailed analysis of universities' course information in order to establish just what universities policies for coding science courses to the Field of Education classification were. However, it does seem that MOST universities code MOST science courses to 'general' Fields of Education.

Table 27 Higher Education Enrolments 2002 – 2005: Bachelor Students Natural and Physical Sciences by Field of Education. Ranked by Enrolments 2005

Field of education	2002	2003	2004	2005		Growth 2002 – 2005	
				No.	Per Cent	No.	Per Cent
Natural and Physical Sciences	17382	14572	14428	15885	26.0%	-1497	-8.6%
Natural and Physical Sciences nec	13385	15633	15488	15035	24.6%	1650	12.3%
Medical Science	4184	4952	5870	6617	10.8%	2433	58.2%
Biological Sciences nec	4554	4610	4893	4922	8.1%	368	8.1%
Biological Sciences	3671	3602	4081	4191	6.9%	520	14.2%
Food Science and Biotechnology	2525	2705	2775	2571	4.2%	46	1.8%
Other Natural and Physical Sciences	1128	2110	2143	2333	3.8%	1205	106.8%
Biochemistry. and Cell Biology	930	1080	1153	1000	1.6%	70	7.5%
Mathematics	803	832	978	999	1.6%	196	24.4%
Mathematical Sciences	1153	1048	1028	916	1.5%	-237	-20.6%
Physics	718	811	905	890	1.5%	172	24.0%
Marine Science	706	765	765	686	1.1%	-20	-2.8%
Chemical Sciences	662	624	662	658	1.1%	-4	-0.6%
Human Biology	714	682	728	629	1.0%	-85	-11.9%
Forensic Science	252	351	475	613	1.0%	361	143.3%
Ecology and Evolution	533	552	584	572	0.9%	39	7.3%
Chemical Sciences nec	496	518	968	559	0.9%	63	12.7%
Mathematical Sciences nec	448	503	489	512	0.8%	64	14.3%
Pharmacology	325	420	331	354	0.6%	29	8.9%
Geology	359	330	323	312	0.5%	-47	-13.1%
Microbiology	239	256	281	227	0.4%	-12	-5.0%
Earth Sciences nec	323	348	320	209	0.3%	-114	-35.3%
Earth Sciences	125	81	54	90	0.1%	-35	-28.0%
Statistics	106	119	115	89	0.1%	-17	-16.0%
Geophysics	30	19	73	80	0.1%	50	166.7%
Physics and Astronomy	142	115	75	57	0.1%	-85	-59.9%
Zoology	150	163	155	43	0.1%	-107	-71.3%
Astronomy	29	26	25	31	0.1%	2	6.9%
Botany	52	50	43	12	0.0%	-40	-76.9%
Atmospheric Sciences	16	13	11	8	0.0%	-8	-50.0%
Hydrology	4	4	3	7	0.0%	3	75.0%
Genetics	34	46	42	2	0.0%	-32	-94.1%
Geochemistry	21	14	12	1	0.0%	-20	-95.2%
Laboratory Technology	26	11	4	1	0.0%	-25	-96.2%
Organic Chemistry	14	18	4	0	0.0%	-14	-100.0%
Total	**56239**	**57983**	**60284**	**61111**	**100.0%**	**4872**	**8.7%**

Nec = 'not elsewhere classified'

Science universities

Table 28 looks at Natural and Physical Sciences bachelor students and the universities they were enrolled at in 2002 to 2005, ranked by number of students in 2005. The University of Melbourne had the most bachelor students in Natural and Physical Sciences courses, and they represented 23 per cent of all of that university's bachelor degree enrolments, and 10.4 per cent of the nation's Natural and Physical Sciences bachelor degree students in 2005. A total of 2,191 of Melbourne's Natural and Physical Sciences enrolments were by students enrolled in 'science' as a supplementary course particularly with engineering and health courses as the primary course. Perhaps the introduction of the 'Melbourne Model' will change this. Monash University has the second-most science bachelor students but those students represent a much lower proportion of all Monash bachelor enrolments.

Seven of the Group of Eight universities occupy the first seven places in terms of rank order. The Group of Eight's proportion of bachelor degree students in the Natural and Physical Sciences is approaching half. Growth in Go8 science enrolments represented 62.0 per cent of the growth between 2002 and 2005.

Table 28 Higher Education Enrolments 2002 – 2005: Bachelor Students Natural and Physical Sciences by University Ranked by Enrolments 2005

University	2002	2003	2004	2005		Growth 2002 – 2005	
				No.	Per Cent	No.	Per Cent
University of Melbourne	5464	5421	6126	6332	10.4%	868	15.9%
Monash University	3906	4106	4507	4714	7.7%	808	20.7%
University of Sydney	4034	4248	4358	4456	7.3%	422	10.5%
University of Queensland	3759	3815	3768	3741	6.1%	-18	-0.5%
University of New South Wales	3317	3484	3542	3533	5.8%	216	6.5%
University of Western Australia	2126	2078	2010	2703	4.4%	577	27.1%
University of Adelaide	2152	2222	2278	2271	3.7%	119	5.5%
Murdoch University	1641	1756	1840	2094	3.4%	453	27.6%
Queensland University of Technology	1778	1814	1961	2012	3.3%	234	13.2%
University of Technology, Sydney	1980	1934	2012	2005	3.3%	25	1.3%
RMIT University	1775	1805	1865	1833	3.0%	58	3.3%
University of Western Sydney	1229	1341	1567	1768	2.9%	539	43.9%
La Trobe University	1635	1604	1668	1752	2.9%	117	7.2%
Griffith University	1289	1505	1686	1698	2.8%	409	31.7%
University of Southern Queensland	1859	1879	1881	1684	2.8%	-175	-9.4%
Curtin University of Technology	1632	1739	1663	1656	2.7%	24	1.5%
Australian National University	1489	1488	1496	1516	2.5%	27	1.8%
Deakin University	1534	1585	1572	1468	2.4%	-66	-4.3%
Flinders University of South Au	1397	1356	1380	1429	2.3%	32	2.3%
James Cook University	1385	1359	1406	1340	2.2%	-45	-3.2%
University of Newcastle	1310	1309	1268	1291	2.1%	-19	-1.5%
University of Wollongong	1512	1594	1498	1289	2.1%	-223	-14.7%
Macquarie University	1083	1065	1087	1098	1.8%	15	1.4%
University of Tasmania	970	996	1111	1084	1.8%	114	11.8%
Charles Sturt University	834	1093	1130	869	1.4%	35	4.2%
University of New England	687	710	728	734	1.2%	47	6.8%
Edith Cowan University	614	694	825	731	1.2%	117	19.1%
Central Queensland University	565	585	650	657	1.1%	92	16.3%
University of South Australia	564	549	568	598	1.0%	34	6.0%
Victoria University	613	663	615	565	0.9%	-48	-7.8%
University of the Sunshine Coast	465	445	434	541	0.9%	76	16.3%
University of Canberra	444	486	473	462	0.8%	18	4.1%
Swinburne University of Technology	495	499	468	310	0.5%	-185	-37.4%
Charles Darwin University	291	288	255	256	0.4%	-35	-12.0%
Australian Defence Force Academy	170	209	221	246	0.4%	76	44.7%
University of Ballarat	194	192	199	183	0.3%	-11	-5.7%
University of Notre Dame Australia	0	24	57	74	0.1%	74	
Avondale College	47	43	45	52	0.1%	5	10.6%
Bond University	0	0	66	42	0.1%	42	
Batchelor Institute	0	0	0	24	0.0%	24	
Total	**56239**	**57983**	**60284**	**61111**	**100.0%**	**4872**	**8.7%**
Group of Eight No.	26247	26862	28085	29266		3019	11.5%
Group of Eight Per Cent	46.7%	46.3%	46.6%	47.9%		62.0%	

5. Student Load: Teaching and Learning

So far this study has considered student enrolments in *courses*. This chapter looks at the *subjects* students take as part of their courses. University subjects are 'weighted' according to the proportion of a year's work that each represents, with the measure used being dubbed 'Equivalent Full-time Student Load' (EFTSL) (formerly 'Equivalent Full-time Student Units' (EFTSU)). A 'normal' full-time academic load for a year has been defined as 1.000 EFTSL, therefore a subject representing a quarter of a year's work will be weighted at 0.250 EFTSL. It is through this student load that HECS is calculated. A student taking more or more or less than a standard year's work load will usually generate more or more or less than 1.000 EFTSL. The terms EFTSU, EFTSL and 'equivalent full-time student' have been used interchangeably in this chapter.

Most people will be aware that educating Australia's student population involves a great deal of cross-discipline teaching and service teaching (provided by departments in one faculty to students of another). That is, the subjects students enrol in are neither necessarily restricted to a single discipline, nor to a single academic department or faculty. Table 29 shows just how much of the teaching provided in Australia's universities is in the humanities and social sciences, via the Society and Culture Discipline Group, and the large amount of service teaching that is provided to students enrolled in Management and Commerce courses. The point is that students enrolled in a course in any Field of Education might study subjects from any other Discipline Group. For example, students enrolled in courses classified as Engineering and Related Technologies will study not only subjects from the Engineering and Related Technologies discipline group, but might also study physics and mathematics, which are from the Natural and Physical Sciences discipline group.

In the sections which follow, tables consider the patterns of teaching and learning between 2002 and 2005, considering first the sector as a whole, followed by an examination of 'science' teaching, and then the pattern of study by students enrolled in Natural and Physical Sciences courses. It was noted earlier that incorrect data had been reported by a number of institutions and that in the case of one university, their incorrect statistical submissions had led to 'official' figures overstating of the number of Natural and Physical Sciences students by nearly 2,000 in 2005. Corrected data were obtained from the university in question, but it means that the figures in this report do not match 'official' figures as at February, 2007.

Student Load: the sector in the twenty-first century

Table 29 shows that in 2005, the 957,176 full and part-time students enrolled in courses at Australia's public and private universities and other institutions shown in Table 2 studied subjects equivalent to 674,092 full-time students. The table also shows the disciplines those subjects were part of. The incorrect information reported to DEST by one university which had mis-classified a number of Health courses as Natural and Physical Sciences has not affected the classification of subjects to the Natural and Physical Sciences Discipline Group (see pp10-11).

Table 29 highlights the changes in teaching/learning levels by discipline. Numerically speaking, the strongest growth occurred in Management and Commerce, the teaching of which increased by more than 18,000 equivalent full-time students. The disciplines of Society and Culture and Health also increased considerably, by 11,755 and 9,587 equivalent full-time students, respectively. The biggest loser was Information Technology, which was taught to 8,570 fewer equivalent full-time students in 2005 compared with 2002. Most disciplines maintained their relative proportion of total teaching, but the decline in Information Technology was off-set by growth in Health and Management and Commerce.

Table 29 Student Load 2002 – 2005: Distribution of All Teaching by Discipline Group

Discipline Group	2002	2003	2004	2005		Growth 2002 – 2005	
	No.	No.	No.	No.	%	No.	%
Agriculture, Environmental & Related Studies	8704	9007	9243	8675	1.3%	-29	-0.3%
Architecture and Building	11970	12477	12971	13476	2.0%	1506	12.6%
Creative Arts	46607	48305	48394	48896	7.3%	2288	4.9%
Education	51547	53170	54039	56065	8.3%	4518	8.8%
Engineering and Related Technologies	36874	39076	39564	39225	5.8%	2351	6.4%
Food, Hospitality and Personal Services	107	117	107	160	0.0%	53	49.2%
Health	57512	60803	63543	67099	10.0%	9587	16.7%
Information Technology	55237	52596	50741	46667	6.9%	-8570	-15.5%
Management and Commerce	114663	124229	127868	132784	19.7%	18121	15.8%
Mixed Field Programmes	384	415	480	585	0.1%	201	52.5%
Natural and Physical Sciences	73735	75597	77407	79297	11.8%	5562	7.5%
Society and Culture	169408	175068	176859	181163	26.9%	11755	6.9%
Total	**626749**	**650860**	**661216**	**674092**	**100.0%**	**47344**	**7.6%**

Whereas Table 29 shows the level of teaching in each broad discipline area, Table 30 shows the students to whom that teaching was provided according to students' primary course. The table shows that there was a decline in teaching to students enrolled in Agriculture, Environmental and Related Studies courses and in Information Technology courses. Obviously this was principally because there were fewer students enrolled in courses in those Fields of Education in 2005 than there had been in 2002 (see Table 10). The table also shows that the student load taught to students enrolled in Management and Commerce courses increased the most, by 26,634 equivalent full-time students, or 18.4 per cent. Table 10 showed that there had been an expansion in Management and Commerce enrolments of nearly 32,000.

Table 30 Student Load 2002 – 2005: Distribution of All Teaching by Field of Education

Field of Education	2002	2003	2004	2005		Growth 2002 – 2005	
	No.	No.	No.	No.	%	No.	%
Agriculture, Environmental & Related Studies	12852	12706	12604	11682	1.7%	-1169	-9.1%
Architecture and Building	13595	14282	14631	15143	2.2%	1547	11.4%
Creative Arts	42184	43880	44687	45644	6.8%	3459	8.2%
Education	60202	61684	62935	65582	9.7%	5380	8.9%
Engineering and Related Technologies	46895	49140	49664	49205	7.3%	2310	4.9%
Health	71738	74998	77828	83343	12.4%	11605	16.2%
Information Technology	51322	49066	45563	41151	6.1%	-10171	-19.8%
Management and Commerce	145127	155147	163737	171762	25.5%	26634	18.4%
Natural and Physical Sciences	47732	49288	50603	51106	7.6%	3374	7.1%
Society and Culture	125711	129886	128522	129672	19.2%	3962	3.2%
Mixed Field Programmes	1043	1240	1244	1212	0.2%	169	16.2%
Food, Hospitality and Personal Services	131	96	48	64	0.0%	-67	-51.1%
Non Award	8215	9447	9151	8525	1.3%	310	3.8%
Total	**626749**	**650859**	**661216**	**674092**	**100.0%**	**47344**	**7.6%**

A comparison of Tables 29 and 30 provides a rough indication of levels of service teaching. For example, Table 29 indicated that **teaching** in the Natural and Physical Sciences amounted to 79,297 equivalent full-time students in 2005. In the same year, Table 30 shows that 51,106 equivalent full-time students had been enrolled in **courses** in the Natural and Physical Sciences Field of Education. This is a rough indication of the fact that the Natural and Physical Sciences disciplines are taught to many more students than just 'science' students.

Table 31 summarises the distribution of teaching within in the Natural and Physical Sciences discipline. Table 32 provides an additional level of detail of the same. Overall, the period 2002 to 2005 saw an increase in teaching from the Natural and Physical Sciences disciplines, but there was a decline in the amount of teaching provided in both the Physical and Earth Sciences. However, some observers might see the result of the past four years as a relatively positive one. Of the so-called enabling sciences, both Mathematical and Chemical Sciences increased over the period, and there was strong growth in the Biological Sciences, and in Other Natural and Physical Sciences. More detail can be gleaned from Table 32.

Table 31 Student Load 2002 – 2005: Distribution of Teaching in the Natural and Physical Sciences Disciplines – Summary

Discipline	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	%
No.						
Mathematics and Statistics	20519	20906	21127	21285	766	3.7%
Physical Sciences	4994	4984	4970	4929	-65	-1.3%
Chemical Sciences	7621	7828	8060	8317	696	9.1%
Earth Sciences	3897	3864	3661	3747	-150	-3.8%
Biological Sciences	30512	31434	32030	33568	3056	10.0%
Other Natural and Physical Sciences #	6192	6580	7560	7452	1259	20.3%
Total	**73735**	**75597**	**77407**	**79297**	**5562**	**7.5%**
Per Cent						
Mathematics and Statistics	27.8%	27.7%	27.3%	26.8%	13.8%	
Physics and Astronomy	6.8%	6.6%	6.4%	6.2%	-1.2%	
Chemical Sciences	10.3%	10.4%	10.4%	10.5%	12.5%	
Earth Sciences	5.3%	5.1%	4.7%	4.7%	-2.7%	
Biological Sciences	41.4%	41.6%	41.4%	42.3%	54.9%	
Other Natural and Physical Sciences #	8.4%	8.7%	9.8%	9.4%	22.6%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Includes 'Natural and Physical Sciences nec'

The point made earlier with respect to courses (that a large range of options doesn't necessarily lead to more specific reported statistics) perhaps holds for the classification of subjects also. For example, Table 32 shows a substantial decline in the teaching in the sub-discipline of 'Mathematical Sciences' (-2,814 EFTSL or -60.1 per cent), but this decline was more than compensated for by increases in the sub-disciplines of 'Mathematics' and 'Statistics'. Although it is not visible in this table, changes of this type can occur because changes of coding practice within a university. In this case, some universities simply started to be more specific in their classification from 2003. This discipline 'name change' has occurred at several universities. It is clear then that the capacity within the classification for a greater level of detail does not necessarily provide this additional detail. DEST does not usually publish information at other than the least level of detail. Perhaps if they did, university statistics would be more consistent.

Table 32 Student Load 2002 – 2005: Distribution of Teaching in the Natural and Physical Sciences Disciplines – Detail

Discipline	2002	2003	2004	2005		Growth 2002 – 2005	
	No.	No.	No.	No.	%	No.	%
Mathematical Sciences							
Mathematical Sciences	4680	4739	2678	1866	2.4%	-2814	-60.1%
Mathematical Sciences nec	683	677	614	642	0.8%	-41	-6.0%
Mathematics	8587	8777	9911	9997	12.6%	1410	16.4%
Statistics	6569	6714	7924	8779	11.1%	2210	33.6%
Mathematical Sciences Total	**20519**	**20906**	**21127**	**21285**		**766**	**3.7%**
Physical Sciences							
Astronomy	267	286	323	342	0.4%	75	28.0%
Physics	3580	3592	4115	4284	5.4%	704	19.7%
Physics and Astronomy	1146	1105	531	303	0.4%	-843	-73.6%
Physical Sciences Total	**4994**	**4984**	**4970**	**4929**		**-65**	**-1.3%**
Chemical Sciences							
Chemical Sciences	4450	4589	4559	4477	5.6%	27	0.6%
Chemical Sciences nec	1994	2085	2186	2393	3.0%	399	20.0%
Inorganic Chemistry	280	328	392	422	0.5%	142	50.8%
Organic Chemistry	897	826	922	1025	1.3%	128	14.3%
Chemical Sciences Total	**7621**	**7828**	**8060**	**8317**		**697**	**9.1%**
Earth Sciences							
Atmospheric Sciences	119	132	135	167	0.2%	48	40.0%
Earth Sciences	1353	1419	1059	1048	1.3%	-305	-22.5%
Earth Sciences nec	831	756	694	819	1.0%	-13	-1.5%
Geology	937	855	1024	950	1.2%	13	1.4%
Geophysics	84	141	159	167	0.2%	83	98.1%
Hydrology	217	209	225	220	0.3%	3	1.2%
Soil Science	228	235	239	234	0.3%	6	2.6%
Oceanography	99	92	103	122	0.2%	23	23.2%
Geochemistry	29	24	22	21	0.0%	-7	-25.8%
Earth Sciences Total	**3897**	**3864**	**3661**	**3747**		**-150**	**-3.9%**
Biological Sciences							
Biochemistry and Cell Biology	3498	3727	4578	5182	6.5%	1684	48.1%
Biological Sciences	9490	9480	6868	5732	7.2%	-3758	-39.6%
Biological Sciences nec	2296	2660	2816	2782	3.5%	486	21.1%
Botany	813	765	868	883	1.1%	70	8.6%
Ecology and Evolution	1798	1886	1826	1676	2.1%	-121	-6.7%
Genetics	1183	1188	1604	1854	2.3%	672	56.8%
Human Biology	7766	7951	9180	10892	13.7%	3126	40.3%
Marine Science	590	621	688	690	0.9%	100	17.0%
Microbiology	1923	2005	2341	2561	3.2%	638	33.2%
Zoology	1155	1152	1260	1315	1.7%	160	13.9%
Biological Sciences Total	**30512**	**31434**	**32030**	**33568**		**3056**	**10.0%**
Other Natural & Physical Sciences							
Food Science and Biotechnology	1074	1236	1328	1069	1.3%	-5	-0.5%
Forensic Science	193	215	256	351	0.4%	158	81.5%
Laboratory Technology	182	193	220	226	0.3%	43	23.8%
Medical Science	1273	1329	1840	1809	2.3%	536	42.1%
Pharmacology	1515	1810	2080	2233	2.8%	718	47.4%
Other Natural and Physical Sciences	674	618	523	424	0.5%	-250	-37.1%
Other Natural & Physical Sciences Total	**6192**	**6580**	**7560**	**7452**		**1259**	**20.3%**
Total	**73735**	**75597**	**77407**	**79297**		**5562**	**7.5%**

Although not part of the formal classification Natural and Physical Sciences, teaching in the discipline areas of behavioural science and information technology are of interest to some Deans of Science. At some universities, these disciplines might be taught by departments in the science faculty. Both are shown in Table 33. Behavioural Sciences is a very popular discipline, and is taken by many more students than any grouping of 'sciences' from the Natural and Physical Sciences. It expanded by 1,092 EFTSL between 2002 and 2005, an increase of 4.7 per cent. As mentioned elsewhere, Information Technology is the area of university study which has declined the most. Between 2002 and 2005, Information Technology teaching declined by 8,570 EFTSL, or 15.5 per cent.

Table 33 Student Load 2002 – 2005: Behavioural Sciences and Information Technology

Discipline	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	%
Behavioural Sciences (From Society and Culture FoE)	23017	23688	24030	24109	1092	4.7%
Information Technology (IT FoE)	55237	52596	50741	46667	-8570	-15.5%

The next two tables examine the distribution of student load in the Natural and Physical Sciences disciplines according to the level of courses in which students were enrolled. Table 34 is sorted by course level. For students enrolled in Higher Degree by Research courses (PhDs and Masters by Research), the greatest proportion of enrolments had been in the Biological Sciences (3,410, or 47.1 per cent in 2005). The proportion of Biological Sciences PhDs increased slightly over the period. PhD teaching in the 'enabling sciences' (Chemical, Mathematical and Physical Sciences) between them was equivalent to 2,052 full-time students in 2005.

Teaching at the Other Postgraduate level is less common in the Natural and Physical Sciences disciplines than it is in many others. At this level, the Mathematical and Biological Sciences have the most students engaged at this level.

The Bachelor level of courses includes pass, honours and graduate entry bachelor degree students, and represented about 84.2 per cent of all teaching in the Natural and Physical Sciences disciplines in 2005, and the Biological Sciences was by far the largest proportion of this. In 2005, 43.3 per cent of all bachelor-level teaching was in the biological sciences, a slightly higher proportion than there had been in 2002. The Mathematical Sciences' number and proportion of equivalent full-time student load declined over the period, but were nonetheless considerable, with teaching to 18,334 equivalent full-time students in 2005 27.5 per cent of the total for bachelor degree students. The proportion of Bachelor degree teaching in both the Physical and Geological Sciences declined over the period.

Teaching to students enrolled in non-bachelor undergraduate courses represents a small proportion of overall teaching in the Natural and Physical Sciences.

Table 34 Student Load 2002 – 2005: Distribution of Teaching in the Natural and Physical Sciences Disciplines by Course Level and Discipline

Course Level and Discipline	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Higher Degrees by Research								
Mathematical Sciences	420	433	470	479	6.4%	6.4%	6.6%	6.6%
Physical Sciences	594	612	697	742	9.0%	9.0%	9.8%	10.3%
Chemical Sciences	772	786	817	831	11.7%	11.6%	11.5%	11.5%
Earth Sciences	803	809	759	750	12.2%	11.9%	10.7%	10.4%
Biological Sciences	3056	3192	3375	3410	46.4%	47.0%	47.5%	47.1%
Other Natural &Physical Sciences	942	951	991	1023	14.3%	14.0%	13.9%	14.1%
Total	**6587**	**6784**	**7109**	**7236**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Other Postgraduate								
Mathematical Sciences	797	903	1060	1274	36.7%	37.0%	40.2%	44.9%
Physical Sciences	190	160	171	170	8.7%	6.6%	6.5%	6.0%
Chemical Sciences	38	45	41	55	1.8%	1.8%	1.6%	1.9%
Earth Sciences	154	181	186	183	7.1%	7.4%	7.1%	6.5%
Biological Sciences	543	602	598	625	25.0%	24.7%	22.7%	22.0%
Other Natural &Physical Sciences	452	548	580	531	20.8%	22.5%	22.0%	18.7%
Total	**2174**	**2437**	**2637**	**2838**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Bachelor								
Mathematical Sciences	18388	18501	18556	18334	29.3%	29.0%	28.4%	27.5%
Physical Sciences	4069	4074	3967	3871	6.5%	6.4%	6.1%	5.8%
Chemical Sciences	6559	6705	6934	7169	10.5%	10.5%	10.6%	10.7%
Earth Sciences	2795	2725	2574	2685	4.5%	4.3%	3.9%	4.0%
Biological Sciences	26272	26976	27402	28893	41.9%	42.2%	42.0%	43.3%
Other Natural &Physical Sciences	4582	4923	5873	5792	7.3%	7.7%	9.0%	8.7%
Total	**62664**	**63904**	**65306**	**66744**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Other Undergraduate								
Mathematical Sciences	914	1069	1040	1198	39.6%	43.2%	44.2%	48.3%
Physical Sciences	141	138	134	145	6.1%	5.6%	5.7%	5.8%
Chemical Sciences	251	292	268	262	10.9%	11.8%	11.4%	10.6%
Earth Sciences	145	149	142	129	6.3%	6.0%	6.0%	5.2%
Biological Sciences	642	665	656	639	27.8%	26.9%	27.8%	25.8%
Other Natural &Physical Sciences	216	159	117	106	9.3%	6.4%	5.0%	4.3%
Total	**2309**	**2472**	**2356**	**2479**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
All Course Types								
Mathematical Sciences	20519	20906	21127	21285	27.8%	27.7%	27.3%	26.8%
Physical Sciences	4994	4984	4970	4929	6.8%	6.6%	6.4%	6.2%
Chemical Sciences	7621	7828	8060	8317	10.3%	10.4%	10.4%	10.5%
Earth Sciences	3897	3864	3661	3747	5.3%	5.1%	4.7%	4.7%
Biological Sciences	30512	31434	32030	33568	41.4%	41.6%	41.4%	42.3%
Other Natural &Physical Sciences	6192	6580	7560	7452	8.4%	8.7%	9.8%	9.4%
Total	**73735**	**75597**	**77407**	**79297**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 35 presents the same information as in the previous table, but it has been sorted in a different order.

Within the Biological and Chemical Sciences, teaching at the Bachelor degree level represented about 86 per cent during the period, and Higher Degrees by Research about 10 per cent. Teaching to Higher Degree by Research students represents a considerably higher proportion of total teaching in the Earth Sciences, and to a lesser extent, the Physical Sciences than it does in any other Natural and Physical Sciences disciplines. A relatively small proportion of teaching in the Mathematical Sciences is at the Higher Degree by Research level, but the proportion of teaching at the Bachelor level in 2005 was at the same level as in the Biological and Chemical Sciences.

Table 35 Student Load 2002 – 2005: Distribution of Teaching in the Natural and Physical Sciences Disciplines by Discipline and Course Level

Discipline and Course Level	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Mathematical Sciences								
Higher Degree by Research	420	433	470	479	2.0%	2.1%	2.2%	2.2%
Other Postgraduate	797	903	1060	1274	3.9%	4.3%	5.0%	6.0%
Bachelor	18388	18501	18556	18334	89.6%	88.5%	87.8%	86.1%
Other Undergraduate	914	1069	1040	1198	4.5%	5.1%	4.9%	5.6%
Total	**20519**	**20906**	**21127**	**21285**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Physical Sciences								
Higher Degree by Research	594	612	697	742	11.9%	12.3%	14.0%	15.1%
Other Postgraduate	190	160	171	170	3.8%	3.2%	3.4%	3.5%
Bachelor	4069	4074	3967	3871	81.5%	81.7%	79.8%	78.5%
Other Undergraduate	141	138	134	145	2.8%	2.8%	2.7%	2.9%
Total	**4994**	**4984**	**4970**	**4929**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Chemical Sciences								
Higher Degree by Research	772	786	817	831	10.1%	10.0%	10.1%	10.0%
Other Postgraduate	38	45	41	55	0.5%	0.6%	0.5%	0.7%
Bachelor	6559	6705	6934	7169	86.1%	85.7%	86.0%	86.2%
Other Undergraduate	251	292	268	262	3.3%	3.7%	3.3%	3.2%
Total	**7621**	**7828**	**8060**	**8317**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Earth Sciences								
Higher Degree by Research	803	809	759	750	20.6%	20.9%	20.7%	20.0%
Other Postgraduate	154	181	186	183	4.0%	4.7%	5.1%	4.9%
Bachelor	2795	2725	2574	2685	71.7%	70.5%	70.3%	71.7%
Other Undergraduate	145	149	142	129	3.7%	3.9%	3.9%	3.4%
Total	**3897**	**3864**	**3661**	**3747**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Biological Sciences								
Higher Degree by Research	3056	3192	3375	3410	10.0%	10.2%	10.5%	10.2%
Other Postgraduate	543	602	598	625	1.8%	1.9%	1.9%	1.9%
Bachelor	26272	26976	27402	28893	86.1%	85.8%	85.5%	86.1%
Other Undergraduate	642	665	656	639	2.1%	2.1%	2.0%	1.9%
Total	**30512**	**31434**	**32030**	**33568**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Other Natural and Physical Sciences								
Higher Degree by Research	942	951	991	1023	15.2%	14.4%	13.1%	13.7%
Other Postgraduate	452	548	580	531	7.3%	8.3%	7.7%	7.1%
Bachelor	4582	4923	5873	5792	74.0%	74.8%	77.7%	77.7%
Other Undergraduate	216	159	117	106	3.5%	2.4%	1.5%	1.4%
Total	**6192**	**6580**	**7560**	**7452**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
All Course Levels								
Higher Degree by Research	6587	6784	7109	7236	8.9%	9.0%	9.2%	9.1%
Other Postgraduate	2174	2437	2637	2838	2.9%	3.2%	3.4%	3.6%
Bachelor	62664	63904	65306	66744	85.0%	84.5%	84.4%	84.2%
Other Undergraduate	2309	2472	2356	2479	3.1%	3.3%	3.0%	3.1%
Total	**73735**	**75597**	**77407**	**79297**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 36 examines student load taught in subjects in the Natural and Physical Sciences disciplines, and shows which courses that student load is taught to. The table shows that in 2005, 48.4 per cent of teaching in the Natural and Physical Sciences went to students enrolled in Natural and Physical Sciences courses. It is also the case that the majority of the growth in Natural and Physical Sciences teaching was to these students. Between 2002 and 2005, the increase amounted to 3,619 equivalent full-time students, about 65

per cent of the growth. Students enrolled in courses in Fields of Education Health and Management and Commerce also increased considerably, by 1,461 and 1,404 equivalent full-time student load, respectively. In 2005 therefore, over half of university teaching in the Natural and Physical Sciences went to students NOT enrolled in a Natural and Physical Sciences course. Given the high proportions of service teaching provided from the Natural and Physical Sciences disciplines, teaching will decline if the Fields of Educationserviced decline. As was demonstrated in Table 10, enrolments in courses in both Agriculture and Information Technology declined over the period, by 1,338 and 13,583 primary course enrolments respectively. It is not surprising, therefore, that Table 36 shows that teaching in Natural and Physical Sciences subjects to students enrolled in Agriculture and Information Technology courses also declined. A brief examination of some of the effects on service teaching follows below.

Table 36 Student Load 2002 – 2005: Natural and Physical Sciences Teaching by Field of Education

Field of Education	2002	2003	2004	2005		Growth 2002 – 2005	
				No.	%	No.	%
Agriculture, Environmental and Related Studies	3763	3769	3666	3545	4.5%	-218	-5.8%
Architecture and Building	144	134	120	122	0.2%	-23	-15.7%
Creative Arts	266	286	267	242	0.3%	-23	-8.7%
Education	1727	1876	2026	2044	2.6%	317	18.4%
Engineering and Related Technologies	7645	7722	7741	7621	9.6%	-24	-0.3%
Health	12767	12752	13042	14228	17.9%	1461	11.4%
Information Technology	3167	2856	2369	1859	2.3%	-1308	-41.3%
Management and Commerce	4863	5248	5774	6267	7.9%	1404	28.9%
Natural and Physical Sciences	34722	36148	37394	38342	48.4%	3619	10.4%
Society and Culture	3403	3336	3549	3709	4.7%	307	9.0%
Mixed Field Programmes	236	364	382	302	0.4%	66	28.2%
Food, Hospitality and Personal Services	242	216	226	229	0.3%	-13	-5.5%
Non Award Courses	791	890	850	788	1.0%	-3	-0.3%
Total	**73735**	**75597**	**77407**	**79297**	**100.0%**	**5562**	**7.5%**

More on Service Teaching in the Natural and Physical Sciences

Given the importance of service teaching for faculties of science, the major providers of teaching in the Natural and Physical Sciences, this section examines the nature of that teaching, and looks at the declines in service teaching to those fields of education which receive the most service and cross-discipline teaching from the Natural and Physical Sciences. The Fields of Education in question are Information Technology, Agriculture, Environmental and Related Studies, and Engineering and Related Technologies Studies.

Table 37 looks specifically at Natural and Physical Sciences teaching to students enrolled in Information Technology courses. This teaching declined by 1,308 equivalent full-time students in the period 2002 to 2005. As can be seen, about 95 per cent of the decline was in the Mathematical Sciences. As shown in Tables 32 and 33, the Mathematical Sciences showed an overall increase of 766 equivalent full-time students over the period. Had it not been for this decline in the teaching of mathematics and statistics to Information Technology students, Mathematical Sciences might have grown by about 10 per cent, that is, about 2,000 equivalent full-time students.

The decline in the teaching of subjects in the Physical Sciences to Information Technology students was much lower, equivalent to 62 full-time students, but reference to Tables 31 and 32 above shows that in fact this was almost equivalent the entire decline in physics teaching to students in all Fields of Study over the period. The decline in the fortunes of Information Technology courses can therefore be seen as a major influence on the fortunes in both the Physical and Mathematical Sciences between 2002 and 2005.

Table 37 Student Load 2002 – 2005: Effect on Natural and Physical Sciences Disciplines due to changes in Information Technology Enrolments

Discipline Group	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	%
Mathematical Sciences	2881	2570	2127	1644	-1237	-42.9%
Physical Sciences	129	102	77	66	-62	-48.6%
Chemical Sciences	41	43	35	33	-8	-19.2%
Earth Sciences	16	16	19	24	8	49.0%
Biological Sciences	82	99	81	70	-12	-14.6%
Other Natural and Physical Sciences	18	25	29	21	3	17.6%
Total Natural and Physical Sciences	**3167**	**2856**	**2369**	**1859**	**-1308**	**-41.3%**

Table 38 replicates the analysis in Table 37 for students enrolled in courses in Agriculture, Environmental and Related Studies. The decline in teaching from the Natural and Physical Sciences disciplines to these students was more modest than was the case in teaching to Information Technology students, but still noteworthy. The reduction in teaching in the Chemical and Earth Sciences were the largest, at 88 and 60 equivalent full-time students, respectively.

Table 38 Student Load 2002 – 2005: Effect on Natural and Physical Sciences Disciplines due to changes in Agriculture, Environmental and Related Studies Enrolments

Discipline Group	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	%
Mathematical Sciences	417	422	428	410	-7	-1.7%
Physical Sciences	83	67	55	57	-27	-31.9%
Chemical Sciences	551	557	536	463	-88	-16.0%
Earth Sciences	736	733	699	676	-60	-8.2%
Biological Sciences	1809	1811	1774	1781	-28	-1.5%
Other Natural and Physical Sciences	166	180	174	158	-8	-4.9%
Total Natural and Physical Sciences	**3763**	**3769**	**3666**	**3545**	**-218**	**-5.8%**

Table 39 looks at service Natural and Physical Sciences teaching to Engineering students. The amount of this teaching also declined, but over all only by 24 equivalent full-time students. That there should have been a decline at could be seen as being unexpected; Table 30 in fact revealed that overall teaching to students enrolled in Engineering and Related Technologies courses increased by 2,310 equivalent full-time students between 2002 and 2005. However, an examination of teaching to engineering students reveals a substantial decline in the teaching of the Physical Sciences to engineering students. In fact, between 2002 and 2005, there was a decline of 224 EFTSL or 14.2 per cent, particularly in the period 2003 to 2005.

Table 39 Student Load 2002 – 2005: Effect on Natural and Physical Sciences Disciplines due to changes in Engineering and Related Technologies Enrolments

Discipline Group	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	%
Mathematical Sciences	4691	4719	4684	4628	-63	-1.3%
Physical Sciences	1575	1561	1491	1351	-224	-14.2%
Chemical Sciences	620	650	703	735	115	18.5%
Earth Sciences	365	358	364	407	42	11.5%
Biological Sciences	258	306	357	380	122	47.1%
Other Natural and Physical Sciences	136	128	142	120	-16	-12.0%
Sub total Natural and Physical Sciences	**7645**	**7722**	**7741**	**7621**	**-24**	**-0.3%**

There was also a decline in the teaching from the Mathematical Sciences disciplines equivalent to a reduction of 63 full-time equivalent students. Perhaps there has been a change of student preference within engineering. If not, perhaps this further decline in the teaching of the Physical Sciences should be further examined.

Gender Differences: do men and women study the same 'science'?

Women are in the majority in university enrolments. They represented 54.5 per cent of all enrolments in 2005 (see Table 3) and 52.6 per cent of enrolments in course in the Natural and Physical Sciences (see Table 13). The proportion of women enrolled varies between disciplines. Table 40 considers the patterns of subject enrolments by sex in the Natural and Physical Sciences. Women enjoy a considerable majority in both the Biological Sciences and the 'Other Natural and Physical Sciences' and in a slight majority in the Chemical Sciences. However, women represent a considerable minority in both the Physical and the Mathematical Sciences and to a lesser extent in the Earth Sciences. It is interesting that the number of equivalent full-time female students taking subjects from the Physical Sciences has declined. Calculating from Table 40, it can be seen that between 2002 and 2005 the number of equivalent full-time female students had declined by 130, or nearly 9 per cent. At the same time, the number of equivalent full-time male students increased by 66, nearly 2 per cent.

Table 40 Student Load 2002 – 2005: Natural and Physical Sciences Teaching to All Students by Discipline and Sex

Discipline and Sex	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Mathematical Sciences								
Female	7835	7986	8029	8246	38.2%	38.2%	38.0%	38.7%
Male	12684	12921	13098	13038	61.8%	61.8%	62.0%	61.3%
Total	**20519**	**20906**	**21127**	**21285**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Physical Sciences								
Female	1461	1367	1344	1331	29.3%	27.4%	27.0%	27.0%
Male	3532	3617	3626	3598	70.7%	72.6%	73.0%	73.0%
Total	**4994**	**4984**	**4970**	**4929**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Chemical Sciences								
Female	4056	4145	4225	4315	53.2%	52.9%	52.4%	51.9%
Male	3565	3683	3835	4003	46.8%	47.1%	47.6%	48.1%
Total	**7621**	**7828**	**8060**	**8317**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Earth Sciences								
Female	1623	1607	1502	1563	41.6%	41.6%	41.0%	41.7%
Male	2274	2258	2158	2184	58.4%	58.4%	59.0%	58.3%
Total	**3897**	**3864**	**3661**	**3747**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Biological Sciences								
Female	19478	20075	20440	21426	63.8%	63.9%	63.8%	63.8%
Male	11034	11359	11590	12142	36.2%	36.1%	36.2%	36.2%
Total	**30512**	**31434**	**32030**	**33568**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Other Natural and Physical Sciences								
Female	3757	4042	4663	4618	60.7%	61.4%	61.7%	62.0%
Male	2436	2539	2897	2834	39.3%	38.6%	38.3%	38.0%
Total	**6192**	**6580**	**7560**	**7452**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
All								
Female	38210	39221	40203	41498	51.8%	51.9%	51.9%	52.3%
Male	35526	36376	37204	37799	48.2%	48.1%	48.1%	47.7%
Total	**73735**	**75597**	**77407**	**79297**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Overseas students and science

Table 41 looks at the distribution between domestic and overseas students of the teaching of the Natural and Physical Sciences disciplines. The number of overseas students taking subjects in the Natural and Physical Sciences disciplines increased from 9,617 EFTSL in 2002 and 14,063 EFTSL in 2005. This was a proportionate increase from 13.0 per cent to 17.7 per cent. However, this proportion varied considerably between Natural and Physical Sciences disciplines.

Overseas students' proportion of Mathematical Sciences was 26.1 per cent in 2005, but was rather lower in the other disciplines, around 12 to 14 per cent in the Biological, Chemical and Physical Sciences. The number of full-time equivalent domestic students declined in several Natural and Physical Sciences disciplines: Mathematical, Physical and Earth Sciences. By contrast, numbers of equivalent full-time overseas students increased in all Natural and Physical Sciences disciplines.

Table 41 Student Load 2002 – 2005: Natural and Physical Sciences Teaching to All Students by Discipline and Citizenship Status

Citizenship Status	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Mathematical Sciences								
Domestic Students	16417	16211	16021	15737	80.0%	77.5%	75.8%	73.9%
Overseas Students	4102	4695	5106	5548	20.0%	22.5%	24.2%	26.1%
Total	**20519**	**20906**	**21127**	**21285**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Physical Sciences								
Domestic Students	4364	4296	4271	4215	87.4%	86.2%	85.9%	85.5%
Overseas Students	629	688	698	714	12.6%	13.8%	14.1%	14.5%
Total	**4994**	**4984**	**4970**	**4929**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Chemical Sciences								
Domestic Students	6822	6884	6997	7132	89.5%	87.9%	86.8%	85.7%
Overseas Students	799	944	1063	1185	10.5%	12.1%	13.2%	14.3%
Total	**7621**	**7828**	**8060**	**8317**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Earth Sciences								
Domestic Students	3539	3466	3259	3285	90.8%	89.7%	89.0%	87.7%
Overseas Students	358	398	402	462	9.2%	10.3%	11.0%	12.3%
Total	**3897**	**3864**	**3661**	**3747**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Biological Sciences								
Domestic Students	27607	28002	28092	28902	90.5%	89.1%	87.7%	86.1%
Overseas Students	2905	3432	3938	4666	9.5%	10.9%	12.3%	13.9%
Total	**30512**	**31434**	**32030**	**33568**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Other Natural and Physical Sciences								
Domestic Students	5368	5592	6146	5964	86.7%	85.0%	81.3%	80.0%
Overseas Students	824	988	1414	1488	13.3%	15.0%	18.7%	20.0%
Total	**6192**	**6580**	**7560**	**7452**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
All Disciplines								
Domestic Students	64119	64452	64787	65234	87.0%	85.3%	83.7%	82.3%
Overseas Students	9617	11145	12620	14063	13.0%	14.7%	16.3%	17.7%
Total	**73735**	**75597**	**77407**	**79297**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

What's in a Natural and Physical Sciences course?

The material above related to the teaching of subjects in Natural and Physical Sciences disciplines to all students. This section considers in more detail what goes into the average science course. It is now well known that the discipline content of a science course has changed over time. *Science at the Crossroads* showed that compared with 1989, students in 2002 were much less likely to pursue the enabling sciences of chemistry, mathematics and physics (Dobson, 2003:57). However, the pattern in the twenty-first century seems to have stabilised, as shown in Table 42. Among the sciences, in recent years only the Earth Sciences declined in terms of equivalent full-time student numbers. Perhaps this is unexpected, considering Australia's resources boom; presumably geologists are now in high demand. As noted in earlier studies, Biological Sciences remains the largest discipline by a considerable margin, and it demonstrated relatively strong growth over the period 2002 to 2005.

In terms of each discipline's proportions of the average total 'science' degree, Biological Sciences increased slightly, but in the main, the pattern was static. During the period 2002 to 2005, students enrolled in courses in the Natural and Physical Sciences increased slightly the proportion of the subjects they studied from within the Natural and Physical Sciences disciplines, from 72.7 per cent to 75.0 per cent.

Table 42 Student Load 2002 – 2005: Teaching to students enrolled in Natural and Physical Sciences Courses by Discipline Group

Discipline group	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Natural And Physical Sciences								
Mathematical Sciences	4731	4886	4996	4988	9.9%	9.9%	9.9%	9.8%
Physical Sciences	2593	2675	2745	2911	5.4%	5.4%	5.4%	5.7%
Chemical Sciences	5081	5229	5431	5617	10.6%	10.6%	10.7%	11.0%
Earth Sciences	2353	2313	2162	2195	4.9%	4.7%	4.3%	4.3%
Biological Sciences	16641	17326	17963	18624	34.9%	35.2%	35.5%	36.4%
Other Natural and & Physical Sciences	3324	3718	4097	4007	7.0%	7.5%	8.1%	7.8%
Sub total	**34722**	**36148**	**37394**	**38342**	**72.7%**	**73.3%**	**73.9%**	**75.0%**
Society & Culture – Behavioural Sciences	2220	2325	2354	2385	4.7%	4.7%	4.7%	4.7%
Society & Culture – Other	3422	3503	3598	3370	7.2%	7.1%	7.1%	6.6%
Agriculture, Environmental & Related Studies	1017	1099	1187	1273	2.1%	2.2%	2.3%	2.5%
Management & Commerce	1021	1069	1091	1043	2.1%	2.2%	2.2%	2.0%
Engineering & Related Technologies	1121	1031	953	898	2.3%	2.1%	1.9%	1.8%
Information Technology	1758	1596	1433	1205	3.7%	3.2%	2.8%	2.4%
Other Discipline Groups	2449	2517	2592	2590	5.1%	5.1%	5.1%	5.1%
Total	**47732**	**49288**	**50603**	**51106**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 43 looks at the gender distribution of teaching. Female students are more likely to enrol in courses in the Biological Sciences, and less likely to enrol in courses in Mathematical, Physical and Earth Sciences than their male counterparts. From Table 43 it is possible to calculate that women made up about 61 per cent of enrolments in the Biological Sciences disciplines, but only about 42 per cent of Mathematical Sciences subject enrolments and 29 per cent of enrolments in Physical Science subjects.

Table 43 Student Load 2002 – 2005: Natural and Physical Sciences Teaching to students enrolled in Natural and Physical Sciences Courses by Discipline Group and Sex

Sex	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Female Students								
Mathematical Sciences	2044	2081	2086	2101	7.9%	7.8%	7.6%	7.6%
Physical Sciences	891	853	832	851	3.4%	3.2%	3.0%	3.1%
Chemical Sciences	2757	2833	2932	2970	10.7%	10.6%	10.6%	10.7%
Earth Sciences	946	927	878	927	3.7%	3.5%	3.2%	3.4%
Biological Sciences	10254	10679	11067	11339	39.6%	39.8%	40.2%	41.0%
Other Natural and Physical Sciences	1987	2241	2462	2427	7.7%	8.4%	8.9%	8.8%
Other Disc	6982	7214	7303	7036	27.0%	26.9%	26.5%	25.4%
Sub total	25861	26827	27559	27651	100.0%	100.0%	100.0%	100.0%
Male Students								
Mathematical Sciences	2687	2805	2911	2887	12.3%	12.5%	12.6%	12.3%
Physical Sciences	1702	1822	1913	2060	7.8%	8.1%	8.3%	8.8%
Chemical Sciences	2324	2396	2500	2647	10.6%	10.7%	10.8%	11.3%
Earth Sciences	1407	1387	1283	1268	6.4%	6.2%	5.6%	5.4%
Biological Sciences	6387	6647	6896	7285	29.2%	29.6%	29.9%	31.1%
Other Natural and Physical Sciences	1336	1477	1635	1580	6.1%	6.6%	7.1%	6.7%
Other Disc	6028	5926	5906	5728	27.6%	26.4%	25.6%	24.4%
Sub total	21871	22461	23043	23456	100.0%	100.0%	100.0%	100.0%
Total	**47732**	**49288**	**50603**	**51106**				

Table 44 examines the difference in the course content of domestic and overseas students. All in all, the patterns of the two are similar, but with overseas students being more likely to enrol in 'Other Natural and Physical Sciences' subjects.

Table 44 Student Load: Natural and Physical Sciences Teaching (by discipline) to students enrolled in Natural and Physical Sciences Courses 2002 – 2005 by Discipline Group and Citizenship Status

Citizenship Status	2002	2003	2004	2005	2002	2003	2004	2005
	No.	No.	No.	No.	%	%	%	%
Domestic Students								
Mathematical Sciences	4263	4329	4374	4353	10.0%	10.0%	10.1%	10.0%
Physical Sciences	2304	2345	2381	2514	5.4%	5.4%	5.5%	5.8%
Chemical Sciences	4559	4603	4688	4780	10.7%	10.6%	10.8%	11.0%
Earth Sciences	2151	2101	1937	1951	5.0%	4.9%	4.5%	4.5%
Biological Sciences	14932	15216	15410	15584	35.0%	35.1%	35.5%	35.9%
Other Natural and Physical Sciences	2772	3027	3147	3048	6.5%	7.0%	7.2%	7.0%
Other Disciplines	11654	11681	11504	11220	27.3%	27.0%	26.5%	25.8%
Sub total	42634	43301	43439	43451	100.0%	100.0%	100.0%	100.0%
Overseas Students								
Mathematical Sciences	469	557	623	634	9.2%	9.3%	8.7%	8.3%
Physical Sciences	288	330	365	396	5.7%	5.5%	5.1%	5.2%
Chemical Sciences	523	626	744	837	10.2%	10.5%	10.4%	10.9%
Earth Sciences	203	212	225	245	4.0%	3.5%	3.1%	3.2%
Biological Sciences	1708	2111	2553	3040	33.5%	35.3%	35.6%	39.7%
Other Natural and Physical Sciences	552	691	950	959	10.8%	11.5%	13.3%	12.5%
Other Disciplines	1356	1459	1704	1544	26.6%	24.4%	23.8%	20.2%
Sub total	5099	5987	7163	7655	100.0%	100.0%	100.0%	100.0%
Total	**47732**	**49288**	**50603**	**51106**				

Table 45 compares the teaching to students enrolled in Natural and Physical Sciences courses at different universities. The bottom row shows the system-wide average of the discipline-based make up of a 'science' course, and each university can be compared with that set of figures. The input provided by non-Natural and Physical Sciences disciplines varies considerably across universities. Behavioural Sciences, Human Movement studies/science and Information Technology subjects are all included in non Natural and Physical Sciences. If a university offers science as a combined degree more than on average, this factor could also increase the apparent proportion of non-'science' teaching to Natural and Physical Sciences students. The average teaching supplied in 'Other Natural and Physical Sciences' disciplines is 7.8 per cent. Universities exceeding this average are likely to be those offering branded non-generalist degrees in areas such as food science, laboratory technology, forensic science or medical science, or they could be those universities with a higher than average proportion of their Natural and Physical Sciences courses classified as 'Natural and Physical Sciences nec'. Biological Sciences is by far the major discipline at most universities offering courses in the Natural and Physical Sciences.

Table 45 Student Load 2005: Natural and Physical Sciences Teaching to students enrolled in Natural and Physical Sciences Courses by Discipline and University Ranked by Student Load

University	Total EFTSL	Maths Sciences	Physical Sciences	Chem. Sciences	Earth Sciences	Biol. Sciences	Other N&PS	Non-N & PS Disc.	Total
University of Melbourne	4310	9.2%	6.7%	10.9%	3.6%	42.3%	4.5%	22.6%	100.0%
University of Sydney	4094	10.9%	7.5%	11.1%	2.9%	36.6%	4.5%	26.3%	100.0%
Monash University	3948	8.2%	4.7%	11.3%	4.7%	31.7%	14.1%	25.3%	100.0%
University of Queensland	3810	7.1%	4.0%	8.0%	2.5%	54.3%	5.0%	19.1%	100.0%
University of New South Wales	2974	10.7%	5.0%	7.8%	2.7%	27.1%	8.9%	37.7%	100.0%
University of Western Australia	2145	7.4%	3.7%	8.2%	4.8%	33.7%	5.6%	36.7%	100.0%
RMIT University	1819	11.5%	8.5%	13.9%	0.1%	22.5%	21.3%	22.2%	100.0%
University of Technology, Sydney	1775	16.8%	5.3%	9.7%	1.8%	28.3%	16.3%	21.8%	100.0%
The University of Adelaide	1760	8.6%	8.0%	9.7%	9.0%	40.4%	7.1%	17.2%	100.0%
Qld University of Technology	1634	13.1%	4.5%	13.9%	5.1%	40.2%	10.6%	12.7%	100.0%
La Trobe University	1634	10.4%	5.0%	11.6%	0.8%	56.8%	2.1%	13.3%	100.0%
Australian National University	1577	7.8%	14.1%	10.6%	7.0%	31.6%	8.5%	20.5%	100.0%
University of Western Sydney	1547	12.8%	3.8%	17.6%	1.2%	34.9%	8.5%	21.2%	100.0%
Curtin University of Technology	1470	13.7%	8.4%	16.1%	10.8%	23.5%	3.9%	23.6%	100.0%
Griffith University	1394	8.7%	4.4%	12.7%	1.7%	44.2%	13.5%	14.9%	100.0%
James Cook University	1273	7.1%	6.1%	5.8%	9.5%	44.0%	4.8%	22.8%	100.0%
Flinders University of SA	1250	7.5%	5.7%	16.1%	6.4%	35.9%	14.7%	13.6%	100.0%
University of Wollongong	1238	14.0%	8.3%	14.9%	6.8%	32.3%	0.3%	23.4%	100.0%
Murdoch University	1151	9.8%	4.3%	11.8%	2.5%	44.6%	4.6%	22.3%	100.0%
University of Newcastle	1097	10.3%	6.7%	11.6%	4.7%	37.5%	1.8%	27.4%	100.0%
Deakin University	1083	2.1%	1.3%	14.1%	0.6%	51.9%	7.1%	23.0%	100.0%
University of Tasmania	1065	6.5%	3.7%	9.9%	14.2%	39.0%	1.6%	25.0%	100.0%
Macquarie University	1020	13.0%	6.1%	11.2%	14.9%	31.1%	0.6%	23.2%	100.0%
University of Southern Qld	845	10.2%	2.7%	1.7%	0.9%	8.4%	1.8%	74.4%	100.0%
University of New England	697	10.4%	4.5%	10.1%	5.3%	35.2%	2.9%	31.5%	100.0%
Charles Sturt University	526	9.0%	2.4%	8.4%	0.7%	21.2%	26.7%	31.6%	100.0%
Edith Cowan University	525	6.4%	1.8%	5.1%	2.6%	36.9%	7.6%	39.6%	100.0%
University of South Australia	499	14.8%	1.9%	12.9%	2.1%	33.2%	5.0%	30.1%	100.0%
Victoria University	498	5.9%	0.8%	17.3%	0.0%	39.7%	15.1%	21.2%	100.0%
University of Canberra	419	7.4%	0.0%	9.7%	0.6%	34.9%	19.4%	27.9%	100.0%
Central Queensland University	418	8.5%	1.4%	12.5%	0.8%	37.3%	13.1%	26.5%	100.0%
Swinburne University of Tech.	418	13.0%	23.5%	14.6%	0.0%	13.2%	0.0%	35.7%	100.0%
University of the Sunshine Coast	362	15.1%	5.6%	13.4%	0.4%	38.1%	4.9%	22.4%	100.0%
Australian Defence Force Acad.	291	12.2%	10.1%	10.9%	14.3%	0.3%	0.0%	52.0%	100.0%
Charles Darwin University	182	2.3%	0.9%	7.2%	8.6%	40.4%	5.6%	35.0%	100.0%
University of Ballarat	177	5.4%	0.0%	5.6%	23.7%	10.0%	24.1%	31.1%	100.0%
University of Notre Dame	61	1.8%	0.0%	0.0%	1.2%	42.5%	8.0%	46.4%	100.0%
Bond University	53	0.0%	0.0%	0.0%	0.0%	17.2%	39.6%	43.2%	100.0%
Avondale College	42	15.3%	7.2%	12.3%	0.0%	17.1%	3.0%	45.2%	100.0%
Batchelor Institute	23	0.0%	0.0%	0.0%	11.6%	15.0%	3.3%	70.1%	100.0%
Southern Cross University	4	0.0%	0.0%	0.0%	0.0%	31.6%	0.0%	68.4%	100.0%
Total	**51106**	**9.8%**	**5.7%**	**11.0%**	**4.3%**	**36.4%**	**7.8%**	**25.0%**	**100.0%**

What does it all mean?

In one sense, these figures could lead one to the conclusion that all is well in the world of science. In the main, the distribution between the Natural and Physical Sciences disciplines has stabilised, and the proportion of the average science course taken from within Natural and Physical Sciences disciplines is slowly increasing. However, to become complacent on the basis of an examination of this century's statistics would overlook history.

Chapter 2 of this study examined the changes which occurred in the codification of courses and subjects, and in the methodology used to count the number of enrolments. As a result of these artificial quantum leaps, exact comparisons over time between the present and years prior to 2002 are not possible. However, the changes occasioned by the switch from Fields of Study to Fields of Education would not have affected some of the 'science' disciplines. Although DEST has changed both its counting methodology and the course and subject classifications, there are circumstances under the latter on which the classifications have had little impact. The new methodology for student enumeration has (of course) increased the number of students but in a general sense, if examining student enrolment in subjects in chemistry and physics, there is relatively little difference between 'old' and 'new' chemistry and physics. The differences in other Natural and Physical Sciences disciplines have been greater. It is not possible, for instance, to draw an exact comparison between 'old' and 'new' in the Mathematical Sciences (because pre-2001, computer science was included), Earth Sciences (to which the Soil Science discipline has been added), and 'Other Natural and Physical Sciences'.

In 1989, a total of 5,932 equivalent full-time students enrolled in 'science' courses were enrolled in 'chemistry' subjects. In 2005, even with an enrolment-counting methodology which increased the number of students, the total was only 5,617 EFTSL. In anyone's books this indicates a relative decline in the Chemical Sciences in 'science' degrees. In the Physical Sciences, the equivalent figures were 3,612 (1989) and 2,911 (2005). Again, this is a considerable decline, particularly when it is remembered that the counting methodology to produce the 2005 figure in each case includes students who would not have been counted in 1989. However, it is legitimate to compare the proportions of a 'science degree' made up by each discipline. Table 46 is an amalgam of a table published in *Science at the Crossroads* (Dobson, 2003: 57) and the more recent figures shown in Table 42.

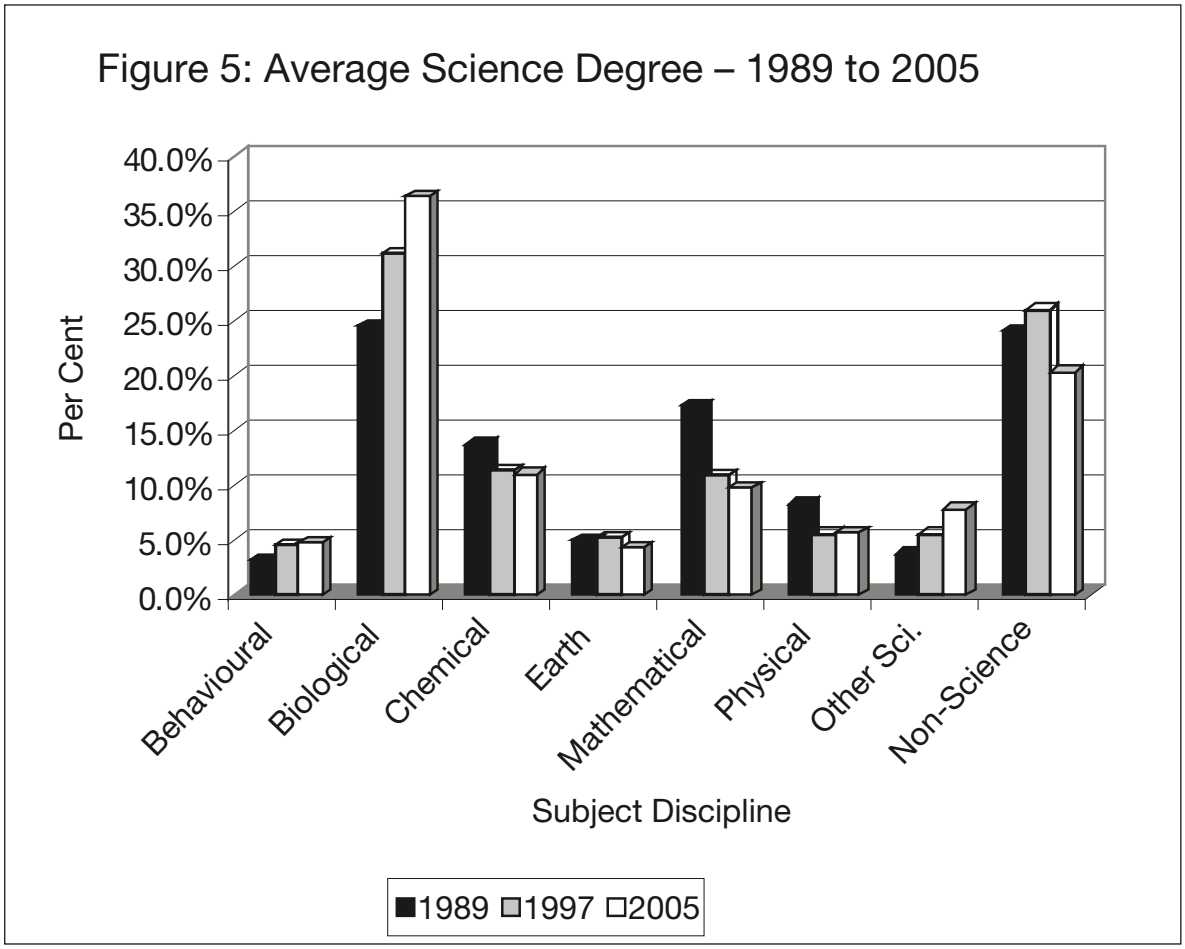
Table 46 Student Load 1989 – 2005: Teaching (by discipline) to students enrolled in Natural and Physical Sciences Courses – Per Cent

Discipline Group	1989	1993	1997	2001	2002	2003	2004	2005
Natural and Physical Sciences								
Mathematical Sciences	17.3%	14.2%	10.9%	9.0%	9.9%	9.9%	9.9%	9.8%
Physical Sciences #	8.3%	6.9%	5.6%	4.6%	5.4%	5.4%	5.4%	5.7%
Chemical Sciences	13.7%	12.3%	11.3%	9.7%	10.6%	10.6%	10.7%	11.0%
Earth Sciences	5.0%	5.7%	5.2%	5.3%	4.9%	4.7%	4.3%	4.3%
Biological Sciences	24.6%	27.2%	31.1%	32.5%	34.9%	35.2%	35.5%	36.4%
Other Sciences	3.7%	4.9%	5.6%	5.8%	7.0%	7.5%	8.1%	7.8%
Sub total	72.6%	71.2%	69.7%	66.9%	72.7%	73.3%	73.9%	75.0%
Behavioural Sciences	3.2%	3.9%	4.5%	4.4%	4.7%	4.7%	4.7%	4.7%
Non-'Science' Discipline Groups	24.1%	25.0%	26.0%	28.7%	22.6%	22.0%	21.4%	20.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

#Prior to 2002, known as 'Physical/Materials Sciences'

The figures indicate a decline of the proportion made up by the Mathematical Sciences from 17.3 per cent to 9.8 per cent. The other enabling sciences (Physical and Chemical Sciences) also declined as a proportion of an 'average' science degree. The Biological Sciences' proportion, on the other hand, has increased by nearly 12 per cent in the period 1989 to 2005, increasing from less than 25 per cent to over 36 per cent. It is clear that the enabling sciences' proportion has dropped considerably since 1989.

Figure 5 makes the same point as Table 46.



6. Science Graduates

The Sector

University course completions are examined in this chapter. Course completions are a so-called 'lagging indicator' and are reported in the year after the completion occurs. Just as there has been a major expansion in university enrolments since the start of the Dawkins era in 1989, so have the number of Australian graduates increased. Completions data for 2005 had not been released at the time this report was prepared.

DEST statistics reveal that just over 90,000 people completed a university course in 1989. As can be seen in Figure 6, in 2004, this number had expanded by about 150 per cent to over 225,000.

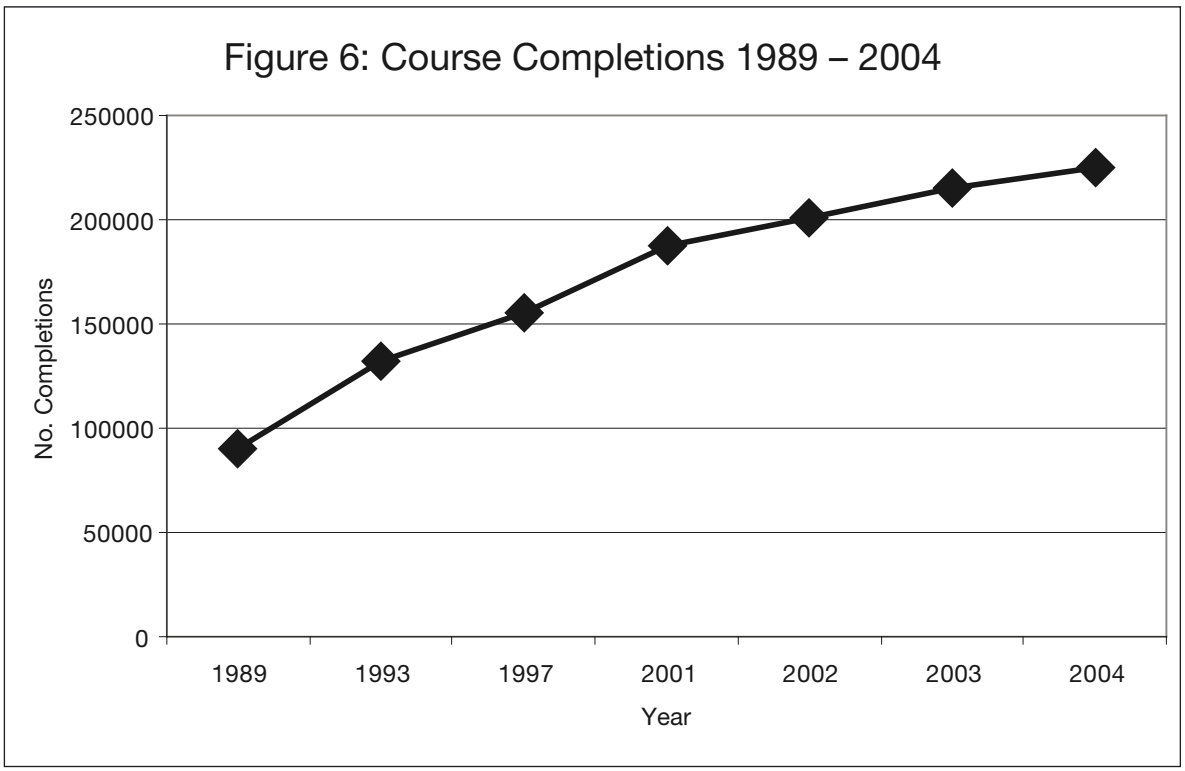


Table 47 examines the number of system-wide course completions for the period 2002 to 2004, by level of course. This period saw an increase of nearly 25,000 completions, of which nearly half were at the undergraduate level, and nearly half were at the Other Postgraduate level. The residual portion of the increase in completions (about 2.6 per cent) occurred in Higher Degrees by Research. Numerically, the largest growth occurred at the Bachelor Pass level (+11,736 completions), which represented a growth of 10.4 per cent. Growth in the number of Masters by Coursework completions was 10,510, a growth rate of 30.8 per cent. This is truly spectacular, because whereas Bachelor (Pass) enrolments represented over 55 per cent of all course completions in 2004, Masters by Coursework completions represented less than 20 per cent.

Table 47 Course Completions 2002 – 2004: by Course Level

Course Level	2002	2003	2004	Growth 2002 – 2004	
				No.	%
Higher Degrees by Research					
Doctorate Research	4290	4728	4900	610	14.2%
Higher Doctorate	26	35	31	5	19.2%
Masters Research	1551	1593	1570	19	1.2%
Higher Degrees by Research Total	5867	6356	6501	634	10.8%
Other Postgraduate					
Coursework Doctorate	103	134	203	100	97.1%
Grad Dip – Extend	4837	4955	4723	-114	-2.4%
Grad Dip – New Area	13992	13412	13529	-463	-3.3%
Graduate Certificate	9777	10998	11521	1744	17.8%
Masters Coursework	34153	40882	44663	10510	30.8%
PG Qualifying	155	134	99	-56	-36.1%
Other Postgraduate Total	63017	70515	74738	11721	18.6%
Undergraduate					
Associate Degree	443	444	337	-106	-23.9%
Associate Diploma	1862	2063	2057	195	10.5%
Bachelors Grad Entry	4355	4453	4232	-123	-2.8%
Bachelors Honours	9210	9297	10177	967	10.5%
Bachelors Pass	113268	119657	125004	11736	10.4%
Diploma	1217	1217	1088	-129	-10.6%
Other Award Course	1509	1113	1307	-202	-13.4%
Undergraduate Total	131864	138244	144202	12338	9.4%
Total	**200748**	**215115**	**225441**	**24693**	**12.3%**

Table 48 looks at course completions by sex. Just as there are more enrolments of female students than of male students, so do more women graduate. Not unexpectedly, the proportion of women is similar in both enrolments and completions, at 55 – 56 per cent.

Table 48 Course Completions 2002 – 2004: by Sex

Sex	2002	2003	2004	Growth 2002 – 2004	
				No.	%
Female	111434	119557	125540	14106	12.7%
Male	89314	95558	99901	10587	11.9%
Total	**200748**	**215115**	**225441**	**24693**	**12.3%**
Female Per Cent of Total	55.5%	55.6%	55.7%	57.1%	

Table 49 looks at course completions by domestic and overseas students in 2002, 2003 and 2004. Overseas students' proportion of total course completions exceeds the proportion overseas students make of total enrolments. Table 4 (above) showed that the proportion of overseas students increased from 20.6 per cent in 2002 to 25.0 per cent in 2005. These figures should be compared with the overseas proportion of course completions shown in Table 49, which show an increase from 24.5 per cent in 2002 to 28.3 per cent in 2004. This suggests that either overseas students complete their courses more expeditiously than domestic students, or that (on average) they tend to enrol in shorter courses.

Table 49 Course Completions 2002 – 2004: by Citizenship Status

Citizenship Status	2002	2003	2004	Growth 2002 – 2004	
				No.	%
Domestic Students	151555	157003	161622	10067	6.6%
Overseas Students	49193	58112	63819	14626	29.7%
Total	**200748**	**215115**	**225441**	**24693**	**12.3%**
Overseas Per Cent of Total	24.5%	27.0%	28.3%	59.2%	

Table 50 looks at course completions by university, ranked in descending order according to the number of completions in 2004. As might be expected, the rank order for course completions is similar to the ranking by enrolments. The spectacular proportionate growth for 'Other Institutions' is based mostly on the reporting by Bond University, which does not appear to have started reporting completions fully until 2004.

Table 50 Course Completions 2002 – 2004: by University, Ranked by Completions 2004.

University	2002	2003	2004	Growth 2002 – 2004	
				No.	%
Monash University	13166	13524	14473	1307	9.9%
The University of Sydney	8777	10383	12747	3970	45.2%
The University of Melbourne	11259	12340	12589	1330	11.8%
Queensland University of Technology	8819	9175	9669	850	9.6%
The University of New South Wales	9040	9883	9604	564	6.2%
The University of Queensland	8301	8644	9010	709	8.5%
University of Western Sydney	9607	9246	8937	-670	-7.0%
Curtin University of Technology	8084	8775	8840	756	9.4%
Charles Sturt University	7433	8190	8740	1307	17.6%
University of South Australia	6377	7644	8363	1986	31.1%
University of Technology, Sydney	7618	9617	8095	477	6.3%
La Trobe University	6189	7295	7581	1392	22.5%
RMIT University	7827	7008	7511	-316	-4.0%
Griffith University	6278	6945	7474	1196	19.1%
Deakin University	6697	7045	7224	527	7.9%
Macquarie University	5946	7122	6904	958	16.1%
Edith Cowan University	4950	5325	5613	663	13.4%
Victoria University	4099	4514	5293	1194	29.1%
The University of Newcastle	4533	5039	5187	654	14.4%
Central Queensland University	5802	5400	4817	-985	-17.0%
University of Wollongong	4063	4504	4575	512	12.6%
The University of Adelaide	4126	4594	4519	393	9.5%
The Australian National University	2655	3252	4079	1424	53.6%
The University of Western Australia	3957	4162	4061	104	2.6%
University of Southern Queensland	3637	4186	4000	363	10.0%
The Flinders University of South Au	3439	3299	3772	333	9.7%
University of Canberra	2822	3018	3410	588	20.8%
University of Tasmania	3104	3226	3393	289	9.3%
The University of New England	2858	3377	3345	487	17.0%
Australian Catholic University	2797	2743	3157	360	12.9%
Swinburne University of Technology	2944	2949	3103	159	5.4%
Southern Cross University	2657	2847	2808	151	5.7%
Murdoch University	2875	2820	2768	-107	-3.7%
James Cook University	2016	2198	2295	279	13.8%
University of Ballarat	2104	1292	2071	-33	-1.6%
Australian Maritime College	923	500	882	-41	-4.4%
Charles Darwin University	933	955	796	-137	-14.7%
University of the Sunshine Coast	634	543	664	30	4.7%
University of Notre Dame Australia	502	475	579	77	15.3%
Australian Defence Force Academy	428	493	497	69	16.1%
Other Institutions	472	568	1996	1524	322.9%
Total	**200748**	**215115**	**225441**	**24693**	**12.3%**

Table 51 considers the distribution of the sector's course completions for 2002-2004 by Field of Education. This table has been included to demonstrate the sector-wide breakdown of course completions, but it should be noted that the number of graduates is shown in the 'primary course' Broad Field of Education in those instances where a student was also completing a supplementary course.

The table shows that Management and Commerce produces the most graduates, followed by Society and Culture, Health and Education. About 6.6 per cent of all course completions were in the Natural and Physical Sciences. This proportion is consistent with the enrolments in Natural and Physical Sciences courses (as shown in Table 10, above).

Table 51 Course Completions 2002 – 2004: by Broad Field of Education (Primary Course Only)

Field of Education	2002	2003	2004		Growth 2002 – 2004	
	No.	No.	No.	%	No.	%
Agriculture, Environmental and Related Studies	3870	4082	4053	1.8%	183	4.7%
Architecture and Building	4168	4257	4179	1.9%	11	0.3%
Creative Arts	12070	13792	14417	6.4%	2347	19.4%
Education	22998	24301	25120	11.1%	2122	9.2%
Engineering and Related Technologies	10696	11788	12575	5.6%	1879	17.6%
Food, Hospitality and Personal Services	36	34	25	0.0%	-11	-30.6%
Health	23811	24274	26031	11.5%	2220	9.3%
Information Technology	18087	18538	17348	7.7%	-739	-4.1%
Management and Commerce	56035	61589	65267	29.0%	9232	16.5%
Natural and Physical Sciences	13155	13570	14790	6.6%	1635	12.4%
Society and Culture	35822	38890	41636	18.5%	5814	16.2%
Total	**200748**	**215115**	**225441**	**100.0%**	**24693**	**12.3%**

Course Completions in the Natural and Physical Sciences

As was noted above in relation to enrolments, some students are enrolled in more than one course. Such students, therefore, might complete more than one course. The last table showed that in 2004, there had been 14,790 course completions in PRIMARY courses classified within the Natural and Physical Sciences. In addition, in 2004, 908 students completed a Natural and Physical Sciences course as a SUPPLEMENTARY course. Of these, 19 completions were by students completing both a primary and a supplementary course in the Natural and Physical Sciences, and these students have need deducted in order to ensure that double counting is avoided. The total number of completions in 2004 therefore, was 14,790 + (908 – 19) = 15,679. Tables relating exclusively to Natural and Physical Sciences completions have been based on this figure.

Table 52 shows that the number of course completions in the Natural and Physical Sciences as a primary or a supplementary course increased by 1,709 or 12.2 per cent in the period 2002 to 2004. This rate was about the same as the sector average of 12.3 per cent: see Table 51. The largest single area of growth was at the Bachelor Pass level, but the strongest proportionate growth was in Graduate Diplomas and in Masters by Coursework. There were declines at a number of levels, including Masters by Research and several undergraduate course levels including fewer Bachelor (Hons.) graduations.

Table 52 Course Completions 2002 – 2004: Natural and Physical Sciences Students, by Course Level

Course Level	2002	2003	2004		Growth 2002 – 2004	
			No.	%	No.	%
Higher Degrees by Research						
Higher Doctorate	1047	1182	1180	7.5%	133	12.7%
PhD	8	9	9	0.1%	1	12.5%
Masters By Research	206	232	198	1.3%	-8	-3.9%
Higher Degrees by Research total	**1261**	**1423**	**1387**	**8.8%**	**126**	**10.0%**
Other Postgraduate						
Coursework Doctorate	0	1	1	0.0%	1	
Grad Dip – Extend	100	108	217	1.4%	117	117.0%
Grad Dip – New Area	189	189	197	1.3%	8	4.2%
Graduate Certificate	223	225	270	1.7%	47	21.1%
Masters Coursework	453	531	737	4.7%	284	62.7%
PG Qualifying	13	6	10	0.1%	-3	-23.1%
Other Postgraduate total	**978**	**1060**	**1432**	**9.1%**	**454**	**46.4%**
Undergraduate						
Associate Degree	5	1	3	0.0%	-2	-40.0%
Associate Diploma	32	28	29	0.2%	-3	-9.4%
Bachelors Grad Entry	38	31	21	0.1%	-17	-44.7%
Bachelors Honours	2431	2413	2369	15.1%	-62	-2.6%
Bachelors Pass	9117	9422	10311	65.8%	1194	13.1%
Diploma	4	24	22	0.1%	18	450.0%
Other Award Course	104	34	105	0.7%	1	1.0%
Undergraduate total	**11731**	**11953**	**12860**	**82.0%**	**1129**	**9.6%**
Total	**13970**	**14436**	**15679**	**100.0%**	**1709**	**12.2%**

The next two tables look at the distribution of graduates between the 'science' Fields of Education. Table 53 provides a summary of the more detailed information in Table 54. Although no Field of Education within the Natural and Physical Sciences showed a decline in the number of course completions in 2004 relative to 2002, Earth Sciences and Mathematical Sciences were both static. Over 58 per cent of course completions in the Natural and Physical Sciences were in 'Other Natural and physical Sciences', which is a rather high proportion for a category that should be residual. Comments were made in the chapters on enrolments and student load about the lack of relationship between the number of categories to which courses can be classified and the specificity of the statistics generated. The same pattern holds for universities' reporting on course completions.

Table 53 Course Completions 2002 – 2004: Natural and Physical Sciences Students, by Field of Education – Summary

Field of Education	2002	2003	2004		Growth 2002 – 2004	
			No.	%	No.	%
Mathematical Sciences	726	786	738	4.7%	12	1.7%
Physical Sciences	339	462	427	2.7%	88	26.0%
Chemical Sciences	519	512	574	3.7%	55	10.6%
Earth Sciences	521	440	531	3.4%	10	1.9%
Biological Sciences	3793	4071	4252	27.1%	459	12.1%
Other Natural and Physical Sciences	8072	8165	9157	58.4%	1085	13.4%
Total	**13970**	**14436**	**15679**	**100.0%**	**1709**	**12.2%**

Table 54 breaks down the entries in the last table into the component parts of each Field of Education. As noted, the residual category 'Other Natural and Physical Sciences' is by far the largest, with over 58 per cent of the total. It is clear that the majority of course completions are reported by universities as though they are generic degrees. Perhaps this is driven in part by the fact that bachelor-level degrees (which made up 81 per cent of Natural and Physical Sciences course completions in 2004), are by far the major group, and most of these WILL be generic degrees. The next largest category was Biological Sciences, with 4,252 completions in 2004, 27.1 per cent of the total. The number of course completions reported in the remaining Natural and Physical Sciences categories were modest indeed.

Table 54 Course Completions 2002 – 2004: Natural and Physical Sciences Students, by Field of Education – Summary – Detail

Field of Education	2002	2003	2004		Growth 2002 – 2004	
			No.	%	No.	%
Mathematical Sciences						
Mathematical Sciences	311	293	298	1.9%	-13	-4.2%
Mathematical Sciences nec	83	101	103	0.7%	20	24.1%
Mathematics	177	232	206	1.3%	29	16.4%
Statistics	155	160	131	0.8%	-24	-15.5%
Mathematical Sciences Total	726	786	738	4.7%	12	1.7%
Physical Sciences						
Astronomy	23	43	60	0.4%	37	160.9%
Physics	237	303	278	1.8%	41	17.3%
Physics and Astronomy	79	116	89	0.6%	10	12.7%
Physical Sciences Total	339	462	427	2.7%	88	26.0%
Chemical Sciences						
Chemical Sciences nec	193	202	283	1.8%	90	46.6%
Inorganic Chemistry	6	14	6	0.0%	0	0.0%
Chemical Sciences	307	285	279	1.8%	-28	-9.1%
Organic Chemistry	13	11	6	0.0%	-7	-53.8%
Chemical Sciences Total	519	512	574	3.7%	55	10.6%
Earth Sciences						
Atmospheric Sciences	4	8	6	0.0%	2	50.0%
Earth Sciences	60	60	71	0.5%	11	18.3%
Earth Sciences nec	232	155	243	1.5%	11	4.7%
Geochemistry	10	7	7	0.0%	-3	-30.0%
Geology	190	176	165	1.1%	-25	-13.2%
Geophysics	8	13	17	0.1%	9	112.5%
Hydrology	8	16	18	0.1%	10	125.0%
Oceanography	3	1	2	0.0%	-1	-33.3%
Soil Science	6	4	2	0.0%	-4	-66.7%
Earth Sciences Total	521	440	531	3.4%	10	1.9%
Biological Sciences						
Biochemistry and Cell Biology	334	387	413	2.6%	79	23.7%
Biological Sciences	877	1026	1143	7.3%	266	30.3%
Biological Sciences nec	1590	1598	1709	10.9%	119	7.5%
Botany	80	87	61	0.4%	-19	-23.8%
Ecology and Evolution	130	175	161	1.0%	31	23.8%
Genetics	48	54	56	0.4%	8	16.7%
Human Biology	219	238	234	1.5%	15	6.8%
Marine Science	164	215	201	1.3%	37	22.6%
Microbiology	155	127	136	0.9%	-19	-12.3%
Zoology	196	164	138	0.9%	-58	-29.6%
Biological Sciences Total	3793	4071	4252	27.1%	459	12.1%
Other Natural and Physical Sciences						
Food Science and Biotechnology	602	643	854	5.4%	252	41.9%
Forensic Science	85	51	114	0.7%	29	34.1%
Laboratory Technology	21	8	3	0.0%	-18	-85.7%
Medical Science	1067	1397	1587	10.1%	520	48.7%
Pharmacology	157	148	214	1.4%	57	36.3%
Natural and Physical Sciences	2562	2193	2419	15.4%	-143	-5.6%
Natural and Physical Sciences nec	3377	3217	3447	22.0%	70	2.1%
Other Natural and Physical Sciences	201	508	519	3.3%	318	158.2%
Other Natural and Physical Sciences Total	8072	8165	9157	58.4%	1085	13.4%
Total	**13970**	**14436**	**15679**	**100.0%**	**1709**	**12.2%**

Continuing the analysis of course completions in the Natural and Physical Sciences, Table 55 shows that in the Natural and Physical Sciences, women made up 55.5 per cent of course completions in 2004, not unexpectedly a similar proportion to the female proportion of enrolments. As with enrolments data, the proportion of women varies between the sub-Fields of Education. In 2004, women made up 61.2 per cent of course completions in the Biological Sciences and 57.6 per cent of course completions in Other Natural and Physical Sciences. Women were in the minority in the remaining Fields with their proportion of completions in Chemical, Earth, Mathematical and Physical Sciences being 45.6 per cent, 33.3 per cent, 37.6 per cent and 24.4 per cent respectively in 2004. These proportions have been calculated from Table 55.

Table 55 Course Completions 2002 – 2004: Natural and Physical Sciences by Field of Education and Sex

Field of Education and Sex	2002	2003	2004		Growth 2002 – 2004	
			No.	%	No.	%
Mathematical Sciences						
Female	285	303	278	1.8%	-7	-2.5%
Male	441	483	460	2.9%	19	4.3%
Mathematical Sciences Total	726	786	738	4.7%	12	1.7%
Physical Sciences						
Female	86	118	104	0.7%	18	20.9%
Male	253	344	323	2.1%	70	27.7%
Physical Sciences Total	339	462	427	2.7%	88	26.0%
Chemical Sciences						
Female	217	210	262	1.7%	45	20.7%
Male	302	302	312	2.0%	10	3.3%
Chemical Sciences Total	519	512	574	3.7%	55	10.6%
Earth Sciences						
Female	188	148	177	1.1%	-11	-5.9%
Male	333	292	354	2.3%	21	6.3%
Earth Sciences Total	521	440	531	3.4%	10	1.9%
Biological Sciences						
Female	2317	2479	2603	16.6%	286	12.3%
Male	1476	1592	1649	10.5%	173	11.7%
Biological Sciences Total	3793	4071	4252	27.1%	459	12.1%
Other Natural and Physical Sciences						
Female	4554	4620	5278	33.7%	724	15.9%
Male	3518	3545	3879	24.7%	361	10.3%
Other Natural and Physical Sciences Total	8072	8165	9157	58.4%	1085	13.4%
All Natural and Physical Sciences Fields						
Female	7647	7878	8702	55.5%	1055	13.8%
Male	6323	6558	6977	44.5%	654	10.3%
Total	**13970**	**14436**	**15679**	**100.0%**	**1709**	**12.2%**

Table 56 looks at domestic and overseas students. Overall, domestic students made up over 85 per cent of all course completions in the Natural and Physical Sciences in 2004. However, the increase in the number of completions by overseas students between 2002 and 2004 exceeded that of domestic students. This was particularly the case in Other Natural and Physical Sciences.

Table 56 Course Completions 2002 – 2004: Natural and Physical Sciences Students by Field of Education and Citizenship Status

Citizenship Status	2002	2003	2004		Growth 2002 – 2004	
			No.	%	No.	%
Mathematical Sciences						
Domestic Students	648	694	638	4.1%	-10	-1.5%
Overseas Students	78	92	100	0.6%	22	28.2%
Mathematical Sciences Total	726	786	738	4.7%	12	1.7%
Physical Sciences						
Domestic Students	279	377	341	2.2%	62	22.2%
Overseas Students	60	85	86	0.5%	26	43.3%
Physical Sciences Total	339	462	427	2.7%	88	26.0%
Chemical Sciences						
Domestic Students	463	449	515	3.3%	52	11.2%
Overseas Students	56	63	59	0.4%	3	5.4%
Chemical Sciences Total	519	512	574	3.7%	55	10.6%
Earth Sciences						
Domestic Students	481	392	475	3.0%	-6	-1.2%
Overseas Students	40	48	56	0.4%	16	40.0%
Earth Sciences Total	521	440	531	3.4%	10	1.9%
Biological Sciences						
Domestic Students	3413	3621	3696	23.6%	283	8.3%
Overseas Students	380	450	556	3.5%	176	46.3%
Biological Sciences Total	3793	4071	4252	27.1%	459	12.1%
Other Natural and Physical Sciences						
Domestic Students	7274	7213	7694	49.1%	420	5.8%
Overseas Students	798	952	1463	9.3%	665	83.3%
Other Natural and Physical Sciences Total	8072	8165	9157	58.4%	1085	13.4%
All Natural and Physical Sciences Fields						
Domestic Students	12558	12746	13359	85.2%	801	6.4%
Overseas Students	1412	1690	2320	14.8%	908	64.3%
Total	**13970**	**14436**	**15679**	**100.0%**	**1709**	**12.2%**

7. A closer look at PhDs

The PhD represents a 'barrier to entry' to many of those wishing to work in Australia's science professions. In the academic world, most careers cannot progress without this qualification. The PhD has had a short life in Australia, having been first introduced in the mid 1940s. In a report entitled *The Future Education of Scientists* it was noted that "The establishment and expansion of doctorate education has been one of the unique features of Australian university education since World War 2 (Hill, Fensham and Howden, 1973:5). As noted by the AVCC, "The introduction of PhD courses in Australia resulted from discussions in the Faculty of Science of the University of Melbourne. The Dean had approached the Vice-Chancellor in October 1944 and had informed him that most faculties supported its introduction…..By 1946 Melbourne had published its rules and three of its candidates (including two women) were awarded the degree in 1948. By 1949 all Australian universities were offering the degree" (AVCC, 1990:8). In those days, the PhD was particularly focussed on 'science'. In 1950, 11 PhDs were awarded in Australia, nine in 'science' (and one each in medicine/surgery and agricultural science). By 1960 79 of the 137 PhDs awarded had been in 'science', and a further 23 in medicine, engineering, etc. (AVCC, 1990:8).

Academic careers in most disciplines require a PhD, but this is now also often the case for many careers in science outside the university sector. It is not surprising, therefore, that students enrolled in PhD-level courses are over-represented in the Natural and Physical Sciences. Whereas PhD enrolments represented 4.1 per cent of all enrolments at Australian universities in 2005, in the Natural and Physical Sciences they represented 10.7 per cent. Table 57 shows that in 2005, 19.6 per cent of all PhD enrolments were in science, and that nearly 22 per cent of the growth in PhD enrolments between 2002 and 2005 had been in science. According to amended DEST statistics, the number of enrolments in science PhDs increased by 1,066, or 16.3 per cent.

Table 57 Higher Education Enrolments 2002 – 2005:
PhD Student Enrolments: All Fields of Education and Natural and Physical Sciences

Ph D Enrolments	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
PhD Enrolments – All Fields of Education	34040	35875	37685	38953	4913	14.4%
PhD Enrolments – Natural and Physical Sciences	6553	6884	7317	7619	1066	16.3%
Natural and Physical Sciences Per Cent of All	**19.3%**	**19.2%**	**19.4%**	**19.6%**	**21.7%**	

The proportion of women enrolled in science PhDs is increasing. From Table 58, it can be seen that the female proportion of PhD enrolments in the Natural and Physical Sciences increased from 45.0 per cent to 46.1 per cent. Nearly 53 per cent of the growth in the enrolments was by women.

Table 58 Higher Education Enrolments 2002 – 2005:
PhD Student Enrolments: Natural and Physical Sciences by Sex

Sex	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Female	2950	3137	3338	3514	564	19.1%
	45.0%	45.6%	45.6%	46.1%	52.9%	
Male	3603	3747	3979	4105	502	13.9%
	55.0%	54.4%	54.4%	53.9%	47.1%	
Total	6553	6884	7317	7619	1066	16.3%
	100.0%	100.0%	100.0%	100.0%	100.0%	

Tables 59 and 60 consider attendance at university for science PhD students. Table 59 shows that science PhD students are predominantly on-campus students. Table 60 shows that a declining proportion of science PhDs attend full-time, but that the proportion remains high, having been over 72 per cent in 2005.

Table 59 Higher Education Enrolments 2002 – 2005: PhD Student Enrolments: Natural and Physical Sciences by Attendance Mode

Attendance Mode	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Internal Mode of Attendance	6378	6665	7042	7298	920	14.4%
	97.3%	96.8%	96.2%	95.8%	86.3%	
External Mode of Attendance	163	186	207	250	87	53.4%
	2.5%	2.7%	2.8%	3.3%	8.2%	
Multi-modal Mode of Attendance	12	33	68	71	59	491.7%
	0.2%	0.5%	0.9%	0.9%	5.5%	
Total	**6553**	**6884**	**7317**	**7619**	**1066**	**16.3%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 60 Higher Education Enrolments 2002 – 2005: PhD Student Enrolments: Natural and Physical Sciences by Attendance Type

By Attendance Type	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Full-time Attendance	5140	5401	5629	5505	365	7.1%
	78.4%	78.5%	76.9%	72.3%	34.2%	
Part-time Attendance	1413	1483	1688	2114	701	49.6%
	21.6%	21.5%	23.1%	27.7%	65.8%	
Total	**6553**	**6884**	**7317**	**7619**	**1066**	**16.3%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 61 shows the distribution of PhD enrolments in the Natural and Physical Sciences according to whether students are domestic or overseas students. Whereas about 75 per cent of students enrolled in all levels of courses in 2005 were domestic students, the equivalent figure for Natural and Physical Sciences PhDs was 82.5 per cent. The number of overseas PhD students in the Natural and Physical Sciences increased strongly over the period. Between 2002 and 2005 there were 389 more overseas students, an increase of 41.2 per cent.

Table 61 Higher Education Enrolments 2002 – 2005: PhD Student Enrolments: Natural and Physical Sciences by Citizenship Status

Citizenship Status	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per cent
Domestic students	5608	5814	6108	6285	677	12.1%
	85.6%	84.5%	83.5%	82.5%	63.5%	
Overseas students	945	1070	1209	1333	389	41.2%
	14.4%	15.5%	16.5%	17.5%	36.5%	
Total	**6553**	**6884**	**7317**	**7619**	**1066**	**16.3%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 62 shows the distribution of PhD students by State/Territory. The Australian Capital Territory, which has only 1.6 per cent of Australia's population and less than 3 per cent of students overall has an over-representation of PhD students, with over 10 per cent of PhD enrolments in the Natural and Physical Sciences in 2005. In fact, Table 63 (below) reveals that the Australian National University has a particularly large number of PhD students in the Natural and Physical Sciences, considering that university's overall size.

Table 62 Higher Education Enrolments 2002 – 2005:
PhD Student Enrolments: Natural and Physical Sciences by State/Territory

By State/Territory	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Australian Capital Territory (1.6% of Australian Population)	611	675	761	778	167	27.3%
	9.3%	9.8%	10.4%	10.2%	12.8%	
New South Wales (33.1%)	1784	1807	1932	2058	274	15.4%
	27.2%	26.2%	26.4%	27.0%	30.3%	
Northern Territory (1.0%)	28	28	28	63	35	125.0%
	0.4%	0.4%	0.4%	0.8%	0.8%	
Queensland (19.7%)	1206	1274	1374	1423	217	18.0%
	18.4%	18.5%	18.8%	18.7%	11.0%	
South Australia (7.5%)	486	530	572	619	133	27.4%
	7.4%	7.7%	7.8%	8.1%	6.6%	
Tasmania (2.4%)	244	234	242	281	37	15.2%
	3.7%	3.4%	3.3%	3.7%	3.1%	
Victoria (24.7%)	1497	1601	1685	1727	230	15.4%
	22.8%	23.3%	23.0%	22.7%	27.6%	
Western Australia (10.0%)	697	735	723	670	-27	-3.9%
	10.6%	10.7%	9.9%	8.8%	6.6%	
Multi State						
	0.0%	0.0%	0.0%	0.0%	1.4%	
Total	**6553**	**6884**	**7317**	**7619**	**1066**	**16.3%**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 63 (next page) shows the number of PhD students in the Natural and Physical Sciences by university. The table shows universities ranked according to their number of Natural and Physical Sciences PhDs in 2005. The table shows that Group of Eight universities have the most enrolments, and that most had shown reasonable growth in the years 2002 to 2005. Only the University of Western Australia had fewer Natural and Physical Sciences PhDs in 2005 than they had had in 2002. In 2005, the Group of Eight institutions had almost 55 per cent of all PhD enrolments in the Natural and Physical Sciences and around 48 per cent of all Natural and Physical Sciences students.

Table 63 Higher Education Enrolments 2002 – 2005:
PhD Student Enrolments: Natural and Physical Sciences by University

University	2002	2003	2004	2005		Growth 2002 – 2005	
				No.	Per Cent	No.	Per Cent
University of Queensland	672	682	728	794	10.4%	122	18.2%
University of Melbourne	595	616	687	713	9.4%	118	19.8%
Australian National University	534	598	679	702	9.2%	168	31.5%
University of Sydney	511	506	526	530	7.0%	19	3.7%
University of New South Wales	402	418	446	438	5.7%	36	9.0%
University of Adelaide	310	342	375	404	5.3%	94	30.3%
University of Western Australia	357	372	368	299	3.9%	-58	-16.2%
Monash University	244	270	274	285	3.7%	41	16.8%
University of Tasmania	244	234	242	281	3.7%	37	15.2%
James Cook University	205	226	262	255	3.3%	50	24.4%
Macquarie University	125	154	191	227	3.0%	102	81.6%
University of New England	86	82	90	222	2.9%	136	158.1%
La Trobe University	192	190	199	208	2.7%	16	8.3%
Curtin University of Technology	179	189	187	202	2.7%	23	12.8%
University of Wollongong	162	163	172	196	2.6%	34	21.0%
University of Newcastle	167	169	194	196	2.6%	29	17.4%
University of Technology, Sydney	164	159	179	188	2.5%	24	14.6%
Queensland University of Technology	167	188	188	185	2.4%	18	10.8%
RMIT University	180	185	173	179	2.3%	-1	-0.6%
Deakin University	118	162	179	170	2.2%	52	44.1%
Flinders University of South Au	134	145	147	159	2.1%	25	18.7%
Murdoch University	121	142	138	139	1.8%	18	14.9%
Griffith University	83	92	105	100	1.3%	17	20.5%
Swinburne University of Technology	65	76	82	83	1.1%	18	27.7%
Victoria University	83	75	68	68	0.9%	-15	-18.1%
Charles Darwin University	28	28	28	63	0.8%	35	125.0%
University of Canberra	56	55	59	58	0.8%	2	3.6%
University of Western Sydney	111	98	80	57	0.7%	-54	-48.6%
University of South Australia	42	43	50	56	0.7%	14	33.3%
Central Queensland University	44	49	49	49	0.6%	5	11.4%
Edith Cowan University	40	32	30	30	0.4%	-10	-25.0%
University of Southern Queensland	28	27	32	25	0.3%	-3	-10.7%
University of Ballarat	20	27	23	21	0.3%	1	5.0%
Australian Defence Force Academy	21	22	23	18	0.2%	-3	-14.3%
University of the Sunshine Coast	7	10	10	15	0.2%	8	114.3%
Southern Cross University	56	58	54	4	0.1%	-52	-92.9%
Total	**6553**	**6884**	**7317**	**7619**	**100.0%**	**1066**	**16.3%**

There are no Natural and Physical Sciences PhD enrolments at ACU, CSU, NDA, Bond or AMC

At this point, perhaps it is appropriate to examine the distribution of PhD enrolments in the Natural and Physical Sciences in more detail. In doing so, it is necessary to consider again how Australian higher education statistics might be misleading unless they are interpreted appropriately. Table 64, which shows the four-year distribution of PhD enrolments by Field of Education, also reveals a reporting anomaly. The table shows increases in PhD enrolments in most science groupings except Earth Sciences over the period 2002 to 2005. What is perhaps disconcerting is that the grouping 'Other Natural and Physical Sciences' increased the most. This category also includes PhDs for which universities were unable or unwilling to classify to any Field of Education more specific than 'Natural and Physical Sciences - general'. Between 2002 and 2005, the number of PhD enrolments in this category increased by 752, or 65.2 per cent. PhD enrolment growth

elsewhere was rather more modest: Mathematics and statistics, +66, or 15.9 per cent; Physical Sciences, +156 or 22.2 per cent; Chemical Sciences, +51 or 6.0 per cent; Biological Sciences, +143 or 5.1 per cent. The Earth Sciences Field of Education was the only area of the Natural and Physical Sciences to suffer a decline. Between 2002 and 2005, the number of PhD enrolments in Earth Sciences declined by 102, or 16.2 per cent.

Table 64 Higher Education Enrolments 2002 – 2005: PhD Student Enrolments: Natural and Physical Sciences by Field of Education

Field of Education	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Mathematics Sciences	414	441	475	480	66	15.9%
Physical Sciences	702	751	824	858	156	22.2%
Chemical Sciences	853	882	926	904	51	6.0%
Earth Sciences	629	618	609	527	-102	-16.2%
Biological Sciences	2802	2973	3169	2945	143	5.1%
Other Natural and Physical Sciences #	1153	1219	1314	1905	752	65.2%
Total	**6553**	**6884**	**7317**	**7619**	**1066**	**16.3%**
Mathematics Sciences	6.3%	6.4%	6.5%	6.3%	6.2%	
Physical Sciences	10.7%	10.9%	11.3%	11.3%	14.6%	
Chemical Sciences	13.0%	12.8%	12.7%	11.9%	4.8%	
Earth Sciences	9.6%	9.0%	8.3%	6.9%	-9.6%	
Biological Sciences	42.8%	43.2%	43.3%	38.7%	13.4%	
Other Natural and Physical Sciences #	17.6%	17.7%	18.0%	25.0%	70.5%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Incl. Natural and Physical Sciences nec

Table 65 reveals considerable change in a few Fields of Education, and in some cases, these changes can be explained by changes in classification instigated by a few universities. For example, in 'Chemical Sciences nec', there was a decline in enrolments from 327 to 264 between 2004 and 2005, offset to some extent by an increase in 'Chemical Sciences'. A closer examination of PhD enrolments reveals that a number of universities changed the way they coded courses to Fields of Education between 2004 and 2005. Perhaps the reason for these changes between 2004 and 2005 was related the introduction of Education Minister Nelson's 'student learning entitlement' scheme, which required universities to greatly increase the detail and frequency of their reporting to the Department of Education, Science and Training. However, perhaps unwarranted classification changes might not have arisen had universities considered an additional level of quality control in their reporting. Perhaps the Department of Education, Science and Training ought to consider its position also.

Table 65 Higher Education Enrolments 2002 – 2005: PhD Student Enrolments: Natural and Physical Sciences by Field of Education

Field of education	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Mathematical Sciences	119	109	106	100	-19	-16.0%
Mathematics	196	225	228	219	23	11.7%
Statistics	31	30	32	42	11	35.5%
Mathematical Sciences nec	68	77	109	119	51	75.0%
Mathematical Sciences Total	414	441	475	480	66	15.9%
Physics and Astronomy	73	85	95	96	23	31.5%
Physics	604	628	658	684	80	13.2%
Astronomy	25	38	71	78	53	212.0%
Physical Sciences Total	702	751	824	858	156	22.2%
Chemical Sciences	503	516	569	616	113	22.5%
Organic Chemistry	30	27	24	19	-11	-36.7%
Inorganic Chemistry	13	65	6	5	-8	-61.5%
Chemical Sciences nec	307	274	327	264	-43	-14.0%
Chemical Sciences Total	853	882	926	904	51	6.0%
Earth Sciences	161	184	184	214	53	32.9%
Atmospheric Sciences	8	9	7	5	-3	-37.5%
Geology	256	233	245	152	-104	-40.6%
Geophysics	6	5	5	5	-1	-16.7%
Geochemistry	10	5	5	0	-10	100.0%
Soil Science	23	5	7	1	-22	-95.7%
Hydrology	2	2	0	0	-2	100.0%
Oceanography	8	10	13	0	-8	100.0%
Earth Sciences nec	155	165	143	150	-5	-3.2%
Earth Sciences Total	629	618	609	527	-102	-16.2%
Biological Sciences	637	707	754	818	181	28.4%
Biochemistry and Cell Biology	447	482	472	431	-16	-3.6%
Botany	186	170	179	151	-35	-18.8%
Ecology and Evolution	125	143	152	125	0	0.0%
Marine Science	90	110	118	133	43	47.8%
Genetics	95	87	102	102	7	7.4%
Microbiology	238	224	248	223	-15	-6.3%
Human Biology	252	254	285	237	-15	-6.0%
Zoology	299	296	274	187	-112	-37.5%
Biological Sciences nec	433	500	585	538	105	24.2%
Biological Sciences Total	2802	2973	3169	2945	143	5.1%
Other Natural and Physical Sciences	162	153	156	440	278	171.6%
Medical Science	126	137	190	264	138	109.5%
Forensic Science	0	0	0	18	18	
Food Science and Biotechnology	97	113	130	117	20	20.6%
Pharmacology	161	148	157	119	-42	-26.1%
Laboratory Technology	1	1	1	0	-1	100.0%
Natural and Physical Sciences general	69	71	73	63	-6	-8.7%
Natural and Physical Sciences nec	537	596	607	884	347	64.6%
Natural and Physical Sciences Total	1153	1219	1314	1905	752	65.2%
Total	**6553**	**6884**	**7317**	**7619**	**1066**	**16.3%**

Course completions in the Natural and Physical Sciences

The PhD is the predominant level of research in the Natural and Physical Sciences (see Table 66). Just as the number of Masters by Research enrolments in the Natural and Physical Sciences has declined (by 10.0 per cent between 2002 and 2005 – see Table 12, above), so the number of graduations has declined. The number of PhD graduations increased by 133, or 12.7 per cent.

Table 66 Course Completions 2002 to 2004: Higher Degrees by Research - Natural and Physical Sciences

Course type	2002	2003	2004		Growth 2002 – 2005	
	No.	No.	No.	%	No.	%
Higher Doctorate	8	9	9	0.1%	1	12.5%
PhD	1047	1182	1180	7.5%	133	12.7%
Masters by Research	206	232	198	1.3%	-8	-3.9%
Total	**1261**	**1423**	**1387**	**8.8%**	**126**	**10.0%**

Table 67 shows that the Natural and Physical Sciences proportion of PhD course completions has stayed at about 24 per cent. The rate of growth in PhD completions was slightly lower than the overall rate (12.7 per cent compared with 14.2 per cent).

Table 67 Course Completions 2002 to 2004: PhDs Natural and Physical Sciences, Other Fields of Education and All Fields of Education

Field of Education Broad	2002	2003	2004	Growth 2002 – 2005	
	No.	No.	No.	%	No.
Natural And Physical Sciences	1047	1182	1180	133	12.7%
Other Fields of Education	3243	3546	3720	477	14.7%
All Fields of Education	4290	4728	4900	610	14.2%
Natural And Physical Sciences % of All	**24.4%**	**25.0%**	**24.1%**	**21.8%**	

The next tables split PhD course completions in the Natural and Physical Sciences into sub-Fields of Education. Whereas enrolments and course completions at the bachelor degree level might reasonably be in a generalist degree, one would not have thought that this would still be the case with PhDs. Surely by this time the specifics of students' PhDs would be known in detail. To some extent this is the case, but as noted elsewhere, the residual category 'Other Natural and Physical Sciences' is a relatively large category. Table 68 indicates that 249 or 21.1 per cent of PhD course completions in 2004 were in 'Other Natural and Physical Sciences', and by referring to Table 69, it can be seen that two-thirds of these were in non-specific categories.

Table 68 Course Completions 2002 to 2004: PhDs Natural and Physical Sciences by Field of Education – Summary

Field of Education	2002	2003	2004	Growth 2002 – 2005	
				%	No.
Mathematical Sciences	66	85	71	5	7.6%
Physical Sciences	110	139	121	11	10.0%
Chemical Sciences	170	162	151	-19	-11.2%
Earth Sciences	77	82	105	28	36.4%
Biological Sciences	456	527	483	27	5.9%
Other Natural and Physical Sciences	168	187	249	81	48.2%
Total	**1047**	**1182**	**1180**	**133**	**12.7%**
Mathematical Sciences	6.3%	7.2%	6.0%	3.8%	
Physical Sciences	10.5%	11.8%	10.3%	8.3%	
Chemical Sciences	16.2%	13.7%	12.8%	-14.3%	
Earth Sciences	7.4%	6.9%	8.9%	21.1%	
Biological Sciences	43.6%	44.6%	40.9%	20.3%	
Other Natural and Physical Sciences	16.0%	15.8%	21.1%	60.9%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

By far the largest Field of Education in terms of PhD course completions was Biological Sciences. These completions represented nearly 41 per cent of all PhD completions in the Natural and Physical Sciences. PhD completions in the Chemical Sciences declined between 2002 and 2004, the only field to do so. In the Earth Sciences, it would appear that there had been a backlog of PhD students waiting to complete.

Table 69 provides more detail of Fields of Education of PhD completions in the Natural and Physical Sciences. In several sub-Fields within Natural and Physical Sciences, the numbers reported as 'not elsewhere classified' (nec) seem quite large.

One might reasonably wonder how many more categories would be needed to encompass 'knowledge': what could the PhDs described as Biological Sciences nec be if not one of the several categories available?

Table 69 Course Completions 2002 to 2004: PhDs Natural and Physical Sciences by Field of Education – Detail

Field of Education	2002	2003	2004		Growth 2002 – 2005	
	No.	No.	No.	%	No.	%
Mathematical Sciences						
Statistics	5	3	5	0.4%	0	0.0%
Mathematics	33	44	34	2.9%	1	3.0%
Mathematical Sciences	16	20	17	1.4%	1	6.3%
Mathematical Sciences nec	12	18	15	1.3%	3	25.0%
Mathematical Sciences Total	66	85	71	6.0%	5	7.6%
Physical Sciences						
Physics	93	116	108	9.2%	15	16.1%
Physics and Astronomy	15	19	10	0.8%	-5	-33.3%
Astronomy	2	4	3	0.3%	1	50.0%
Physics and Astronomy Total	110	139	121	10.3%	11	10.0%
Chemical Sciences						
Chemical Sciences nec	69	48	45	3.8%	-24	-34.8%
Inorganic Chemistry	6	14	6	0.5%	0	0.0%
Chemical Sciences	83	91	95	8.1%	12	14.5%
Organic Chemistry	12	9	5	0.4%	-7	-58.3%
Chemical Sciences Total	170	162	151	12.8%	-19	-11.2%
Earth Sciences						
Earth Sciences nec	26	19	20	1.7%	-6	-23.1%
Soil Science	2	0	1	0.1%	-1	-50.0%
Geology	29	33	53	4.5%	24	82.8%
Earth Sciences	14	25	25	2.1%	11	78.6%
Geophysics	2	1	0	0.0%	-2	-100.0%
Geochemistry	0	2	2	0.2%	2	
Hydrology	1	1	1	0.1%	0	0.0%
Atmospheric Sciences	0	0	1	0.1%	1	
Oceanography	3	1	2	0.2%	-1	-33.3%
Earth Sciences Total	77	82	105	8.9%	28	36.4%
Biological Sciences						
Biochemistry and Cell Biology	82	92	91	7.7%	9	11.0%
Biological Sciences nec	51	75	64	5.4%	13	25.5%
Botany	47	41	34	2.9%	-13	-27.7%
Zoology	51	42	53	4.5%	2	3.9%
Microbiology	49	31	38	3.2%	-11	-22.4%
Human Biology	40	57	32	2.7%	-8	-20.0%
Ecology and Evolution	10	14	12	1.0%	2	20.0%
Marine Science	15	20	16	1.4%	1	6.7%
Biological Sciences	95	139	126	10.7%	31	32.6%
Genetics	16	16	17	1.4%	1	6.3%
Biological Sciences Total	456	527	483	40.9%	27	5.9%
Other Natural and Physical Sciences						
Natural and Physical Sciences nec	62	85	131	11.1%	69	111.3%
Natural and Physical Sciences	9	11	8	0.7%	-1	-11.1%
Medical Science	20	26	30	2.5%	10	50.0%
Pharmacology	33	28	36	3.1%	3	9.1%
Food Science and Biotechnology	18	20	19	1.6%	1	5.6%
Laboratory Technology	0	0	0	0.0%	0	
Other Natural and Physical Sciences	26	17	25	2.1%	-1	-3.8%
Other Natural and Physical Sciences Total	168	187	249	21.1%	81	48.2%
Total	1047	1182	1180	100.0%	133	12.7%

Table 70 shows the gender distribution for PhD completers by Field of Education. Female students are in the majority on PhD course completions in the Biological Sciences, but not in the other sub-Fields of Education. It was noted earlier that there had been a decline in the number of PhDs awarded in the Chemical Sciences. Table 70 reveals that the drop in the number of male graduates explained most of the decline.

Table 70 Course Completions 2002 to 2004: PhDs Natural and Physical Sciences by Field of Education – Summary, by Sex

Field of Education	2002	2003	2004	Growth 2002 – 2005	
				No.	%
Female					
Mathematical Sciences	17	23	23	6	35.3%
Physical Sciences	24	47	38	14	58.3%
Chemical Sciences	65	58	64	-1	-1.5%
Earth Sciences	24	28	33	9	37.5%
Biological Sciences	228	284	253	25	11.0%
Other Natural and Physical Sciences	79	93	107	28	35.4%
Female Total	437	533	518	81	18.5%
Male					
Mathematical Sciences	49	62	48	-1	-2.0%
Physical Sciences	86	92	83	-3	-3.5%
Chemical Sciences	105	104	87	-18	-17.1%
Earth Sciences	53	54	72	19	35.8%
Biological Sciences	228	243	230	2	0.9%
Other Natural and Physical Sciences	89	94	142	53	59.6%
Male Total	610	649	662	52	8.5%
Female Per cent of All					
Mathematical Sciences	25.8%	27.1%	32.4%	120.0%	
Physical Sciences	21.8%	33.8%	31.4%	127.3%	
Chemical Sciences	38.2%	35.8%	42.4%	5.3%	
Earth Sciences	31.2%	34.1%	31.4%	32.1%	
Biological Sciences	50.0%	53.9%	52.4%	92.6%	
Other Natural and Physical Sciences	47.0%	49.7%	43.0%	34.6%	
Total	**41.7%**	**45.1%**	**43.9%**	**60.9%**	

The format used in Table 70 is repeated in Table 71. In 2004, 18.4 per cent of PhDs in the Natural and Physical Sciences were awarded to overseas students. Overseas students comprised about one-third of Mathematical Sciences PhD graduates, and about one-sixth of other sub-Fields of Education.

Table 71 Course Completions 2002 to 2004: PhDs Natural and Physical Sciences by Field of Education and Citizenship Status Students

Field of Education	2002	2003	2004	Growth 2002 – 2005	
				No.	
Domestic Students					
Mathematical Sciences	53	69	47	-6	-11.3%
Physical Sciences	91	121	101	10	11.0%
Chemical Sciences	152	139	132	-20	-13.2%
Earth Sciences	59	68	87	28	47.5%
Biological Sciences	385	446	401	16	4.2%
Other Natural and Physical Sciences	141	156	195	54	38.3%
Domestic students Total	**881**	**999**	**963**	**82**	**9.3%**
Overseas Students					
Mathematical Sciences	13	16	24	11	84.6%
Physical Sciences	19	18	20	1	5.3%
Chemical Sciences	18	23	19	1	5.6%
Earth Sciences	18	14	18	0	0.0%
Biological Sciences	71	81	82	11	15.5%
Other Natural and Physical Sciences	27	31	54	27	100.0%
Overseas students Total	**166**	**183**	**217**	**51**	**30.7%**
Overseas Per cent of All					
Mathematical Sciences	19.7%	18.8%	33.8%	220.0%	
Physical Sciences	17.3%	12.9%	16.5%	9.1%	
Chemical Sciences	10.6%	14.2%	12.6%	-5.3%	
Earth Sciences	23.4%	17.1%	17.1%	0.0%	
Biological Sciences	15.6%	15.4%	17.0%	40.7%	
Other Natural and Physical Sciences	**16.1%**	**16.6%**	**21.7%**	**33.3%**	
Total	**15.9%**	**15.5%**	**18.4%**	**38.3%**	

Student Load

Student Load is a better way to discern in detail what students are actually studying, although it is more useful at the Bachelor degree level than for PhD students, who are much more likely to be studying a single discrete discipline. The tables below show the disciplines being undertaken by students enrolled in PhD degrees in the Natural and Physical Sciences. Note that not all Natural and Physical Sciences PhD students are enrolled in Natural and Physical Sciences disciplines. Table 72 shows that in 2005, 569 equivalent full-time students were enrolled in non-Natural and Physical Sciences Disciplines (6,102 EFTSL – 5,533 EFTSL = 569). Over the period under examination, the Natural and Physical Sciences component declined from 93.6 per cent to 90.7 per cent of the total. Two pieces of information not observable from the table are that nearly half of the Natural and Physical Sciences PhDs taken in Agriculture, Environmental and Related Studies disciplines are in environmental studies, and that most of the student load showing in Society and Culture is in the Behavioural Sciences.

Table 72 Student Load 2002 – 2005: PhD Students Enrolled in Natural and Physical Sciences Courses, All Disciplines

Discipline	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Agriculture, Environmental and Related Studies	96	107	120	183	86	89.4%
Architecture and Building	18	0	1	0	-18	-100.0%
Creative Arts	7	8	9	0	-7	-100.0%
Education	0	0	0	1	1	
Engineering and Related Technologies	41	50	61	60	19	44.8%
Health	80	81	57	143	62	77.7%
Information Technology	12	13	20	31	20	165.6%
Management and Commerce	1	2	5	7	6	395.5%
Natural and Physical Sciences	4957	5204	5574	5533	575	11.6%
Society and Culture	80	96	114	144	64	80.4%
Total	**5294**	**5560**	**5961**	**6102**	**808**	**15.3%**
Agriculture, Environmental and Related Studies	1.8%	1.9%	2.0%	3.0%	10.7%	
Architecture and Building	0.3%	0.0%	0.0%	0.0%	-2.2%	
Creative Arts	0.1%	0.1%	0.2%	0.0%	-0.9%	
Education	0.0%	0.0%	0.0%	0.0%	0.1%	
Engineering and Related Technologies	0.8%	0.9%	1.0%	1.0%	2.3%	
Health	1.5%	1.5%	0.9%	2.3%	7.7%	
Information Technology	0.2%	0.2%	0.3%	0.5%	2.4%	
Management and Commerce	0.0%	0.0%	0.1%	0.1%	0.7%	
Natural and Physical Sciences	93.6%	93.6%	93.5%	90.7%	71.2%	
Society and Culture	1.5%	1.7%	1.9%	2.4%	8.0%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

The remaining tables in this section focus exclusively on the Natural and Physical Sciences Disciplines. Tables 73 and 74 provide the same information, the latter in greater detail. The figures shown in these tables have been corrected to compensate for the incorrect data supplied to DEST by one university. Table 73 shows the decline in PhD enrolments in Earth Sciences disciplines, and how the extent of study in these disciplines has declined from 12.5 per cent of all PhD studies by Natural and Physical Sciences students, to 9.7 per cent. Biological Sciences is the most popular area of the Natural and Physical Sciences for PhD students as it is for students enrolled in courses at other levels.

Table 73 Student Load 2002 – 2005: PhD Students Enrolled in Natural and Physical Sciences Courses, Natural and Physical Sciences Disciplines Only – Summary

Discipline	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Mathematical Sciences	308	340	374	374	66	21.5%
Physical Sciences	512	530	609	646	133	26.0%
Chemical Sciences	665	700	733	735	71	10.6%
Earth Sciences	619	631	592	535	-84	-13.5%
Biological Sciences	2226	2378	2589	2592	366	16.4%
Other Natural and Physical Sciences	628	625	677	650	23	3.6%
Total	**4957**	**5204**	**5574**	**5533**	**575**	**11.6%**
Mathematical Sciences	6.2%	6.5%	6.7%	6.8%	11.5%	
Physical Sciences	10.3%	10.2%	10.9%	11.7%	23.2%	
Chemical Sciences	13.4%	13.4%	13.2%	13.3%	12.3%	
Earth Sciences	12.5%	12.1%	10.6%	9.7%	-14.6%	
Biological Sciences	44.9%	45.7%	46.4%	46.8%	63.6%	
Other Natural and Physical Sciences	12.7%	12.0%	12.1%	11.8%	4.0%	
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	

Table 74 provides more detailed information. It is hard to know if these figures provide concrete information about changes of preference among students enrolled in PhDs in the Natural and Physical Sciences. For example, should anything be read into the decline in 'Biological Sciences' over the period, particularly

as 'Biological Sciences nec' increased strongly? It should also be noted that even at the PhD level, 276 equivalent full-time students have been classified by their universities as studying Other Natural and Physical Sciences or Natural and Physical Sciences nec. Some might expect that it would be possible to be more specific than this, given the existence of over thirty categories of Natural and Physical Sciences, not to mention a plethora of options within health, engineering and the behavioural sciences.

Table 74 Student Load 2002 – 2005: PhD Students Enrolled in Natural and Physical Sciences Courses, Natural and Physical Sciences Disciplines Only – Detail

Discipline	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Mathematical Sciences						
Mathematical Sciences	79	91	105	95	16	20.8%
Mathematical Sciences nec	16	8	8	24	8	48.6%
Mathematics	181	215	231	225	43	23.8%
Statistics	31	26	30	30	-1	-4.3%
Mathematical Sciences Total	308	340	374	374	66	21.5%
Physical Sciences						
Astronomy	23	29	49	58	35	150.4%
Physics	357	376	490	441	84	23.5%
Physics and Astronomy	132	125	70	147	15	11.1%
Physical Sciences Total	512	530	609	646	133	26.0%
Chemical Sciences						
Chemical Sciences	318	343	386	398	79	24.9%
Chemical Sciences nec	238	242	242	248	11	4.5%
Inorganic Chemistry	15	58	59	49	34	222.7%
Organic Chemistry	94	57	46	40	-53	-56.8%
Chemical Sciences Total	665	700	733	735	71	10.6%
Earth Sciences						
Earth Sciences	206	209	146	189	-18	-8.5%
Earth Sciences nec	185	156	166	179	-6	-3.2%
Geochemistry	12	8	6	5	-7	-56.6%
Geology	186	189	202	111	-75	-40.4%
Geophysics	20	57	57	49	29	143.0%
Hydrology	2	1	3	2	0	0.2%
Oceanography	3	6	8	0	-3	-100.0%
Soil Science	5	5	4	1	-4	-86.5%
Earth Sciences Total	619	631	592	535	-84	-13.5%
Biological Sciences						
Biochemistry and Cell Biology	365	341	475	349	-15	-4.2%
Biological Sciences	823	877	653	717	-106	-12.8%
Biological Sciences nec	242	303	368	517	275	113.8%
Botany	104	102	109	88	-17	-16.3%
Ecology and Evolution	89	119	119	108	19	21.0%
Genetics	76	56	69	73	-3	-4.5%
Human Biology	150	183	313	270	120	80.4%
Marine Science	71	85	111	93	22	31.6%
Microbiology	134	146	228	241	107	79.7%
Zoology	172	167	145	136	-36	-20.9%
Biological Sciences Total	2226	2378	2589	2592	366	16.4%
Other Natural and Physical Sciences						
Food Science and Biotechnology	113	113	112	87	-25	-22.5%
Forensic Science	9	3	4	4	-5	-54.2%
Laboratory Technology	1	1	1	0	-1	-100.0%
Medical Science	114	134	188	213	99	86.6%
Natural and Physical Sciences nec	80	64	80	87	7	8.2%
Other Natural and Physical Sciences	195	202	186	189	-7	-3.4%
Pharmacology	115	108	107	70	-45	-38.8%
Other Natural and Physical Sciences Total	628	625	677	651	23	3.7%
Total	**4957**	**5204**	**5574**	**5533**	**576**	**11.6%**

Table 75 shows the areas which are more popular with women. Women are in the majority in the Biological Sciences and in Other Natural and Physical Sciences, and increasingly represented in the Chemical Sciences. Although women have made inroads in the Mathematical Sciences, their inclination to take PhDs in the Physical Sciences has actually declined.

Table 75 Student Load 2002 – 2005: PhD Students Enrolled in Natural and Physical Sciences Courses – Female Students Only

Female Students	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Mathematical Sciences	82	100	110	120	38	46.3%
Physical Sciences	141	142	147	140	-1	-0.7%
Chemical Sciences	278	318	326	328	49	17.7%
Earth Sciences	213	222	201	187	-26	-12.0%
Biological Sciences	1192	1289	1405	1413	222	18.6%
Other Natural and Physical Sciences	318	324	346	349	30	9.5%
Total	**2225**	**2395**	**2536**	**2538**	**313**	**14.1%**
Mathematical Sciences	26.7%	29.5%	29.3%	32.2%	57.5%	
Physical Sciences	27.6%	26.9%	24.1%	21.7%	-0.8%	
Chemical Sciences	41.9%	45.4%	44.5%	44.6%	69.9%	
Earth Sciences	34.4%	35.2%	34.0%	35.0%	30.5%	
Biological Sciences	53.5%	54.2%	54.3%	54.5%	60.6%	
Other Natural and Physical Sciences	50.7%	51.8%	51.1%	53.6%	133.6%	
Total	**44.9%**	**46.0%**	**45.5%**	**45.9%**	**54.4%**	

Table 76 looks at the presence of overseas students in PhDs in the Natural and Physical Sciences.
The relative presence of overseas students is greater in the Mathematical and Physical Sciences, with growth in Physical Sciences having been quite strong in the period 2002 to 2005. The presence of Overseas students in Physical Sciences and Earth Sciences is approaching 25 per cent.

Table 76 Student Load 2002 – 2005: PhD Students Enrolled in Natural and Physical Sciences Courses – Overseas Students Only

Overseas Students	2002	2003	2004	2005	Growth 2002 – 2005	
					No.	Per Cent
Mathematical Sciences	60	69	73	73	12	20.5%
Physical Sciences	78	96	131	150	73	93.5%
Chemical Sciences	101	103	117	133	32	31.9%
Earth Sciences	112	113	122	132	20	17.6%
Biological Sciences	306	378	421	440	134	43.6%
Other Natural and Physical Sciences	112	112	123	124	12	10.6%
Total	**769**	**871**	**987**	**1051**	**282**	**36.7%**
Mathematical Sciences	19.6%	20.2%	19.4%	19.4%	18.6%	
Physical Sciences	15.1%	18.1%	21.5%	23.2%	54.3%	
Chemical Sciences	15.2%	14.8%	16.0%	18.1%	45.6%	
Earth Sciences	18.1%	17.9%	20.6%	24.7%	-23.6%	
Biological Sciences	13.8%	15.9%	16.2%	17.0%	36.5%	
Other Natural and Physical Sciences	17.8%	17.9%	18.2%	19.0%	51.9%	
Total	**15.5%**	**16.7%**	**17.7%**	**19.0%**	**49.0%**	

8. Science and HECS

Now almost a piece of ancient social history, the introduction of HECS – the Higher Education Contribution Scheme – occurred in 1989. Expansion in the size of the higher education sector in order to raise participation was one of the desired outcomes of the so-called Dawkins Reforms of the higher education system. The Government of the day was "committed to improving access to and success in the higher education system….Improvements in access and equity are heavily dependent on growth in the system. Without new places in the system, it will be difficult to change the balance of the student body to reflect more closely the structure and composition of society as a whole" (Dawkins, 1988:20-21).

However, new sources of funding were required, and one major source was the 'contribution scheme' recommended by the *Committee on Higher Education Funding* (Wran, 1988). The Wran Committee recommended a three-tiered scheme, with the highest contributions ($3,000 per annum) to be required from students in medicine, dentistry, agriculture, forestry and veterinary science. Students enrolled in engineering, surveying, science, applied science and health sciences (except nursing) were to pay an intermediate fee ($2,500 per annum). Students in most courses were to pay $1,500 per annum (Wran 1988). The 'simplified' system of HECS which was introduceed in required a contribution of $1,800 from all equivalent full-time students. It was stated at the time that HECS had been set to cover 20 per cent of the average course cost.

The 'one fee fits all' system persisted until 1997, when a three-tier system was in fact introduced, although the components of each tier were different from those intended by Wran, and the base rate of HECS was increased substantially. From the beginning HECS debts have been interest-free, but the HECS levels are adjusted annually according to inflation, as measured by the Consumer Price Index.

Discussions arise from time to time about whether HECS has a deterrent effect on students' attendance at university, or whether HECS is discriminatory. Many think that HECS does not create a deterrent to university access, including Bruce Chapman, who is often described as the architect of HECS. Chapman said in a recent newspaper opinion piece "In general there was very little change in the composition by course of commencements even after the radical price changes of 1997" (Chapman, 2007). Chapman was speaking in the context of a proposal to address the alleged shortage of maths/science teachers by cutting accumulated HECS debts. Others have contemplated the effects of HECS reductions on the possibility of boosting science teacher numbers. The Australian Academy of Science (AAS) recommended in 2003 that proportions of HECS debt be 'forgiven' for years in the teaching service (AAS, 2003:9).

It could, of course, be argued that science teachers are the subject of discrimination, because a new three-year BSc plus DipEd student is likely to enter the work force with a HECS debt around $5,000 higher than an equivalent BA plus DipEd graduate. This, of course, is a direct result of differential HECS, introduced from 1997.

Table 77 has been adapted from DEST's 2005 publication on student statistics. It shows the distribution of student load in 2005 by DISCIPLINE. This point is made, because not only students enrolled in Natural and Physical Sciences courses are shown in the first data column. The column shows the student load for enrolments in ALL courses. It was revealed in Table 36 that about half of the total teaching in the Natural and Physical Sciences *Discipline* is provided to students in courses classified within the Natural and Physical Sciences *Field of Education*.

Table 77 shows that students studying subjects in the Natural and Physical Sciences disciplines are more likely to be HECS-liable than students in several other disciplines, with almost 70 per cent of students 'paying' in this way. Fee-paying cverseas students feature much more in teaching in disciplines such as Engineering and Information Technology, and as a consequence the proportion of student fees met through HECS (which is for domestic students) is lower. The Natural and Physical Sciences disciplines also attract fewer Domestic Fee-paying students than other disciplines. In 2005, 3.4 per cent of students studying Natural and Physical Sciences subjects were enrolled as domestic fee-payers. Health (12 per cent) and Society and Culture (12.2 per cent) are much bigger players in the domestic fee-paying market. The former includes students paying fees in courses such as medicine and other health therapies, whereas Society and Culture includes Law, which is similarly 'popular' with domestic fee-paying students.

Table 77 Student Load by Discipline by HECS Exemption Status, 2005

	Natural & Physical Sciences	Agric, Environ. & Related Studies	Eng. and Related Tech.	Health	Info. Tech.	Society & Culture	Other Disc's	TOTAL
HECS Liable: Paid Up-Front	12,270	1,274	5,557	10,734	4,011	26,143	31,660	91,647
HECS Liable: Deferred	43,200	4,607	16,471	35,781	14,375	92,784	109,002	316,221
Sub total	**55,470**	**5,881**	**22,028**	**46,515**	**18,386**	**118,927**	**140,662**	**407,868**
HECS Exempt	1,366	33	182	106	300	1,097	2,020	5,105
Domestic Fee Paying	2,742	550	1,610	8,036	3,191	22,328	26,965	65,416
Tuition Fee Exempt	485	67	326	226	170	781	818	2,873
Non Award Domestic	244	21	46	163	85	909	931	2,398
Research Training Scheme	5,158	921	2,390	2,987	967	5,689	4,196	22,311
Overseas fee paying	14,068	1,204	12,365	9,098	23,939	33,394	78,374	172,442
Other	13	5	280	11	1	7	31	347
Total	**79,546**	**8,682**	**39,227**	**67,142**	**47,039**	**183,132**	**253,997**	**678,760**
HECS Liable: Paid Up-Front	15.4%	14.7%	14.2%	16.0%	8.5%	14.3%	12.5%	13.5%
HECS Liable: Deferred	54.3%	53.1%	42.0%	53.3%	30.6%	50.7%	42.9%	46.6%
Sub total	**69.7%**	**67.7%**	**56.2%**	**69.3%**	**39.1%**	**64.9%**	**55.4%**	**60.1%**
HECS Exempt	1.7%	0.4%	0.5%	0.2%	0.6%	0.6%	0.8%	0.8%
Domestic Fee Paying	3.4%	6.3%	4.1%	12.0%	6.8%	12.2%	10.6%	9.6%
Tuition Fee Exempt	0.6%	0.8%	0.8%	0.3%	0.4%	0.4%	0.3%	0.4%
Non Award Domestic	0.3%	0.2%	0.1%	0.2%	0.2%	0.5%	0.4%	0.4%
Research Training Scheme	6.5%	10.6%	6.1%	4.4%	2.1%	3.1%	1.7%	3.3%
Overseas fee paying	17.7%	13.9%	31.5%	13.6%	50.9%	18.2%	30.9%	25.4%
Other	0.0%	0.1%	0.7%	0.0%	0.0%	0.0%	0.0%	0.1%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Modified from DEST (2006) Selected Higher Education Student Statistics 2005: Table 3.5.3

9. Conclusion

Sustaining Science has examined enrolments, course completions and student load in the period 2002 to 2005, during which time the definition of 'science' and the way students are counted have remained constant. By confining attention only to this short period, enrolments in Natural and Physical Sciences courses might seem to pose no cause for concern. In fact there was growth in those years. Net 'science' enrolments grew by 6,077 or 8.9 per cent (see Table 11), the teaching of subjects in the 'science' disciplines to students in 'science' courses increased by 3,374 equivalent full-time students (+ 7.1 per cent) (see Table 30), and teaching to students in 'all' courses increased by 5,562 EFTS (+ 7.5 per cent) (see Table 29). Further, the proportion of non-science taught to students enrolled in Natural and Physical Sciences courses declined slightly. Table 42 shows that the proportion of 'non-science' subjects declined from 27.3 per cent to 25 per cent.

The major concern, however, ought to be with the longer term and with the patterns discernable over the past 15 – 20 years. As shown in Table 78 when examining the pattern back to 1989, the long-term absolute decline in chemistry, physics and mathematics ought to ring alarm bells. The 'steady as she goes' pattern of 2002-5 hides the fact that the 1990s saw sharp declines in enabling sciences participation by students enrolled in courses in the Natural and Physical Sciences. The number of enrolments has roughly doubled since 1989, with some uncertainty due to the changes in counting methodology, yet during such spectacular growth in the system the number of equivalent full-time science students taking chemistry declined by 315 or 5.3 per cent. For physics the decline was 701 about 19 per cent. In 1989 there were 7,520 equivalent full-time science students enrolled in mathematics; in 2005 this number had dropped to 4,988. This is a decline of 2,532 equivalent full-time students, or about one-third. Certainly there was strong growth in the biological sciences, with 7,976 equivalent full-time students studying in 2005 compared with 1989. However, although a useful addition to Australia's knowledge base, this ready and growing supply of biologically literate graduates will not help meet the current skills shortages for physical, chemical and mathematical scientists.

Table 78 Student Load 1989 - 2005: Teaching to students enrolled in Natural and Physical Sciences Courses by Discipline Group

All Students	1989	1997	2005	Variation 2005 – 1989	
				No.	Per Cent
Mathematical Sciences	7520	6512	4988	-2532	-33.7%
Physical Sciences	3612	3351	2911	-701	-19.4%
Chemical Sciences	5932	6753	5617	-315	-5.3%
Earth Sciences	2173	3106	2195	22	1.0%
Biological Sciences	10648	18658	18624	7976	74.9%
Other Sciences	1617	3375	4007	2390	147.8%
Total Science Disciplines	**31502**	**41755**	**38342**	**6840**	**21.7%**

'Science' is clearly on the agenda, or at last it is much discussed. Recently the Government awarded a research contract to examine aspects of careers in science (*Understanding Science, Engineering and Technology (SET) Research Postgraduate Career Pathways* DEST, 2006). Delivery on this should be in the second half
of 2007. Various other government reports have been released over recent years.

Another indicator of the 'currency' of the science issue is the daily press. In recent times, the press has been replete with stories about science and mathematics, mostly about their decline. In the period since the start of the research to produce this report, at least the following stories have appeared in the Australian press.

On science and school

No Change five years after school science 'crisis' alert: "A report that described as disappointing the teaching of science in Australian schools and recommended moves towards a national curriculum is yet to be implemented, five years after it was handed to the federal Government. Instead the federal Education Department has commissioned a second report by the same academics to identify how to improve the teaching of schools in sciences" (Ferrari, 2007a).

Our maths teaching below India's: "The quality of maths and science education in Australia has been ranked below countries such as India, where 40 per cent of the population cannot read or write". (Ferrari, 2007d).

Running out of teachers: The 700-page draft report on innovation released by the Productivity Commission last November cites 'barriers to future growth of human capital', and comments that 'there is a recognised shortage of engineers and secondary school teachers in science and mathematics'. Time and again Education Minister Julie Bishop and her predecessor Brendan Nelson have referred to this shortage" (Reisner, 2007).

Out of date science in classrooms: "…Professor John Rice, president of the Australian Council of Deans of Science, said that unless professional learning was better funded and teachers were required to take part, 'you're always going to have the workforce going out of date'" (Leung, 2007a).

Employers warn on VCE maths drop-off: "VCE enrolments in higher-level mathematics have fallen by up to 14 per cent over the past five years, prompting industry to predict a worsening of the skills shortage in fields such as science and engineering" (Leung, 2007b).

Rudd to lure ex-maths, science teachers back: "Former science and maths teachers may receive bonus payments to lure them back to the classroom…" (Lewis, 2007).

On science and the transition to university

Science scores mock clever country: "Studying traditional Chinese medicine, fashion design or sports management at university requires a higher score than undertaking a science degree, fuelling concerns among leading scientists that Australia risks losing its 'clever country' status" (Ferrari, 2 January 2007).

Reduce HECS to save science: Science students at university should have their HECS debt reduced and greater resources should be invested in school science to boost the appeal of the subject" (Ferrari and Gridneff, 2007)

Maths, science figure low in student plans: "The number of school students studying science across the nation has dropped by one-third in five years, and the proportion of university students with a maths qualification is less than half the OECD average". (Ferrari, 4 January 2007c).

20 years to fix science: "Australia has already lost its scientific knowledge base, creating a problem that will take two decades for the education system to redress" (Ferrari, 17 January 2007e).

Advisers fail to sell sciences: medallist : "Maths and other sciences suffer from poor marketing with school students simply unaware of the variety of careers available with a science degree" (Ferrari, 2007f).

The Federal Government needs to urgently plug the brain drain in maths and science: "The International Council for Industrial and Applied Mathematics…warned that there was an acute shortage of qualified maths teachers, university lecturers and professionals" (The Age, Editorial, 9 February 2007).

And in a press item which otherwise expressed views contrary to the mainstream, Moodie said recently that "The basic problem for the science boosters is that Australian higher education enrolments respond markedly to student demand which in turn is strongly influenced by prospective students' perception of career prospects. While science graduates have far better career prospects than non-graduates, recently they have not been as good as the prospects for graduates in other fields" (Moodie, 2007).

The employment and prospects issue was also mentioned by Cribb:

Silent shortcut to death: "Thousands of Australian scientists now live on 'sudden death' contracts, a disgraceful squandering of the nation's intellectual capital and educational investment. Why are we surprised that our children shun science courses?" (Cribb, 2006).

So, more than one of these press items related to the career structure for science and scientists. Perhaps there is something in this. Scientists often occupy short-term contracts. Science teachers enter their profession with a higher HECS debt that their humanities counterparts but have no way to command a higher salary. Many public sector salaries are considered to be below 'market rates'. Resources booms come and go, leading to precarious employment for earth scientists and others. An alleged brain drain is said to lure some of Australia's brightest to greener pastures abroad, but those alleging a brain DRAIN never acknowledge the brain GAIN through immigration.

A final issue for the author at least, which has arisen from this study is the importance of accurate and consistent statistics. The analysis necessary to produce this report revealed a range of inconsistencies, especially 2005 compared with earlier years. Fortunately, the statistics contained only one critical data error, which had it not been noticed would have produced a report that described the Natural and Physical Sciences as being in a much healthier state than is really the case. If the historical integrity of the DEST data collection is to be maintained, corrected files must be resubmitted, and published figures updated. Good policy cannot be developed without a reasonable knowledge of the present and the past.

10. References

AAS (Australian Academy of Science) *Policy statement on research and innovation in Australia* September (2003).

ABS 2001 Population Characteristics, Aboriginal and Torres Strait Islander Australians, 2001. Catalogue No. 4713.0

AVCC (Australian Vice-Chancellors' Committee) (1990). The Progress of Higher Degree Students. 1983 University Cohort. Canberra.

Birrell, Bob (2006). Implications of Low English Standards Among Overseas Students at Australian Universities. People and Place 14(4):53 - 64).

Chapman, Bruce (2007). Tinkering with HECS won't change students' choices. The Age February 22. Accessed on 23 February 2007 at **http://www.theage.com.au?opinion/tinkering-with-hecs-**.....

Cribb, Julian (2006). *Silent shortcut to sudden death.* The Australian 20 December.
http://www.theaustralian.news.com.au/0,5942,20953265,00.html
Accessed 23 December 2006.

Dawkins, The Hon. JS (1988). Higher Education: a policy statement. AGPS. Canberra.

DEST (Department of Education, Science and Training) (2006). *Understanding Science, Engineering and Technology (SET) Research Postgraduate Career Pathways*.
http://www.dest.gov.au/portfolio_department/dest_information/tenders_business_opportunities/tenders2005/prn_11498.htm
Accessed on 2 January 2007

Dobson, Ian R & A J Calderon (1999). *Trends in Science Education: Learning Teaching and Outcomes 1989-1997.* ACDS ISBN: 0-7326-2104-6

Dobson, Ian R (2003). Science at the Crossroads? A study of trends in university Science from Dawkins to now 1989 – 2002. ISBN: 0-7326-2250-6

Ferrari, Justine (2007a) *No Change five years after school science 'crisis' alert.* The Australian.
http://www.theaustralian.news.com.au/printpage/0,5942,20930487,00.html
Accessed 3 June 2007.

Ferrari, Justine (2007b) *Science scores mock clever country.* The Australian, 2 January.
http://www.theaustralian.news.com.au/printpage/0,20867,21065496-123.html
Accessed 15 January 2007

Ferrari, Justine (2007c). *Maths, science figure low in student plans*. The Australian, 4 January.
http://www.theaustralian.news.com.au/printpage/0,5942,21008392,00.html
Accessed 6 January 2007.

Ferrari, Justine (2007d) *Our maths teaching below India's.* The Australian, 16 January.
http://www.theaustralian.news.com.au/printpage/0,5942,209996,00.html
Accessed 15 January 2007

Ferrari, Justine (2007e) *20 years to fix Science*. The Australian, 17 January.
http://www.theaustralian.news.com.au/printpage/0,5942,21072128,00.html
Accessed 17 January 2007.

Ferrari, Justine (2007f) *Advisers fail to sell Science*. The Australian, 20 January.
http://www.theaustralian.news.com.au/printpage/0,5942,21088006,00.html
Accessed 20 January 2007.

Ferrari, Justine and Gridneff, Ilya (2007,) *Reduce HECS to save science*.
The Australian, 2 January. **http://www.theaustralian.com.news.au/printpage/0,5942,21004462,00.html**
Accessed 6 January 2007.

Hill SC, Fensham AJ and Howden IB, 1973. *The Education of PhD Scientists in Australia and its Implications for their Employment.* In The Future Education of Scientists. Australian Academy of Science and Industry Forum. Report Number 8, August 1973. Pp 5 – 10.

Illing, Dorothy (2006) *Bishop loosens red tape*. The Australian (newspaper). 7 June, p 35.

Leung, Chee Chee (2007a). *'Out of date' science in classrooms.* The Age, 5 March.

Leung, Chee Chee (2007b). *Employers warn on maths drop-off.* The Age, 12 March, p3.

Lewis, Steve (2007). *Rudd to lure ex-maths, science teachers back*.

The Australian, 6 January. **http://www.theaustralian.com.news.au/printpage/0,5942,21017919,00.html**
Accessed 11 January 2007.

Moodie, Gavin (2007). Science Enrolments. The Australian, 31 January.

Long, Michael and Hayden, Martin (2001). Paying their way. A survey of Australian Undergraduate University Student Finances, 2000. AVCC, Canberra.

Reisner, Alex (2007). *Running out of teachers.* The Australian, 17 January.
http://www.theaustralian.news.com.au/printpage/0,5942,21070726,00
Accessed 18 January 2007

The Age, (2007) *The Federal Government needs to urgently plug the brain drain in maths and science*.
Editorial 9 February.

Wran, Neville. (1988) Report of the Committee on Higher Education Funding. Overview and recommendations.

11. Appendices

Appendix 1: Classification of Courses and Subjects

Part A: Field of Study to Field of Education: 09 Science to 01 Natural and Physical Sciences

Field of Study Classification (Pre 2001)		Field of Education (2001+)	
090101	Science – General	010000	Natural and Physical Sciences, n.f.d.
090301	Life, General Sciences – General	00	No correspondence
90302	Anatomy	010903	Botany
		010913	Human Biology
		010915	Zoology
090303	Biochemistry	010901	Biochemistry and Cell Biology
090304	Biology	010901	Biochemistry and Cell Biology
		010905	Ecology and Evolution
		010907	Marine Science
		010909	Genetics
		010913	Human Biology
		010999	Biological Sciences, n.e.c.
090305	Botany	010903	Botany
090306	Environmental Science	010905	Ecology and Evolution
		050999	Environmental Studies, n.e.c.
090307	Food Science and Technology	019905	Food Science and Biotechnology
		030307	Food Processing Technology
		110111	Food Hygiene
		110199	Food and Hospitality, n.e.c.
090308	Home Economics	099901	Family and Consumer Studies
090309	Human Movement Science/Sports Science	069903	Human Movement
090310	Laboratory Techniques (not Medical Technology)	019909	Laboratory Technology
090311	Microbiology	010911	Microbiology
090312	Pharmacology	019907	Pharmacology
090313	Physiology	010903	Botany
		010913	Human Biology
		010915	Zoology
090314	Zoology	010915	Zoology
090399	Life, General Sciences – Other	010713	Oceanography
		010907	Marine Science
		010999	Biological Sciences, n.e.c.
		019903	Forensic Science
		019999	Natural and Physical Sciences, n.e.c.
090401	Mathematics – General	010100	Mathematical Sciences, n.f.d.
090402	Applied Mathematics	010101	Mathematics
090403	Pure Mathematics	010101	Mathematics
090404	Statistics and Operations Research	010103	Statistics
		091903	Econometrics
090499	Mathematics – Other	010101	Mathematics
		010199	Mathematical Sciences, n.e.c.
090501	Physical Sciences – General	010000	Natural and Physical Sciences, n.f.d.
090502	Chemistry	010501	Organic Chemistry
		010503	Inorganic Chemistry
		010599	Chemical Sciences, n.e.c.
090503	Geology	010703	Geology
		010705	Geophysics
		010707	Geochemistry
		010709	Soil Science
		010711	Hydrology
		010799	Earth Sciences, n.e.c.
090504	Nautical Science	031705	Marine Craft Operation
090505	Physics	010301	Physics
090599	Physical Sciences – Other	010303	Astronomy
		010701	Atmospheric Sciences
		019999	Natural and Physical Sciences, n.e.c.
	Fields added to Science from other FoS		
010204	Soil Sciences	010709	Soil Science
070405	Medical Technology	019901	Medical Science
		019909	Laboratory Technology
070501	Medical Science	019901	Medical Science

n.f.d = 'not further defined' n.e.c = 'not elsewhere classified'

Part B: Field of Education to Field of Study : 01 Natural and Physical Sciences to 09 Science

Field of Education Classification (2001+)		Field of Study Classification (Pre 2001)	
010101	Mathematics	090402	Applied Mathematics
		090403	Pure Mathematics
		090499	Mathematics – Other
010103	Statistics	090404	Statistics and Operations Research
010199	Mathematical Sciences, n.e.c.	090499	Mathematics – Other
010301	Physics	090505	Physics
010303	Astronomy	090599	Physical Sciences – Other
010501	Organic Chemistry	090502	Chemistry
010503	Inorganic Chemistry	090502	Chemistry
010599	Chemical Sciences, n.e.c.	090502	Chemistry
010701	Atmospheric Sciences	090599	Physical Sciences – Other
010703	Geology	090503	Geology
010705	Geophysics	090503	Geology
010707	Geochemistry	090503	Geology
010709	Soil Science	010204	Soil Sciences
		090503	Geology
010711	Hydrology	090503	Geology
010713	Oceanography	090399	Life, General Sciences – Other
010799	Earth Sciences, n.e.c.	030208	Geography
		090503	Geology
010901	Biochemistry and Cell Biology	090303	Biochemistry
		090304	Biology
010903	Botany	090302	Anatomy
		090305	Botany
		090313	Physiology
010905	Ecology and Evolution	090304	Biology
		090306	Environmental Science
010907	Marine Science	090304	Biology
		090399	Life, General Sciences – Other
010909	Genetics	090304	Biology
010911	Microbiology	090311	Microbiology
010913	Human Biology	090302	Anatomy
		090304	Biology
		090313	Physiology
010915	Zoology	090302	Anatomy
		090313	Physiology
		090314	Zoology
010999	Biological Sciences, n.e.c.	030208	Geography
		090304	Biology
		090399	Life, General Sciences – Other
019901	Medical Science	070405	Medical Technology
		070501	Medical Science
019903	Forensic Science	090399	Life, General Sciences – Other
019905	Food Science and Biotechnology	010206	Viticulture and Oenology
		090307	Food Science and Technology
019907	Pharmacology	090312	Pharmacology
019909	Laboratory Technology	070405	Medical Technology
		090310	Laboratory Techniques (not Medical Technology)
019999	Natural and Physical Sciences, n.e.c.	090399	Life, General Sciences – Other
		090599	Physical Sciences – Other

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Part C: Discipline Groups to Field of Education – Science only

Higher Education Discipline Groups (pre 2001)		Field of Education (2001+)	
04	**SCIENCES**		
0401	Biological Sciences	010901	Biochemistry and Cell Biology
		010903	Botany
		010905	Ecology and Evolution
		010909	Genetics
		010911	Microbiology
		010913	Human Biology
		010915	Zoology
		010999	Biological Sciences, n.e.c.
0402	Earth Sciences	010701	Atmospheric Sciences
		010703	Geology
		010705	Geophysics
		010707	Geochemistry
		010713	Oceanography
		010799	Earth Sciences, n.e.c.
		010907	Marine Science
0403	Physical/Materials Sciences	010301	Physics
		030305	Materials Engineering
0404	Pharmacology	019907	Pharmacology
		060501	Pharmacy
0405	Chemical Sciences	010501	Organic Chemistry
		010503	Inorganic Chemistry
		010599	Chemical Sciences, n.e.c.
0499	Other Sciences	010303	Astronomy
		019903	Forensic Science
		019905	Food Science and Biotechnology
		019909	Laboratory Technology
		019999	Natural and Physical Sciences, n.e.c.
05	**MATHEMATICS, COMPUTING (EXCL. Computing)**		
0501	Mathematics, Statistics	010101	Mathematics
		010103	Statistics
		081103	Insurance and Actuarial Studies
0599	Other Mathematics, Computing	010199	Mathematical Sciences, n.e.c.

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Part D: Field of Education to Discipline Group – Science & Information Technology only

Field of Education (2001+)		Higher Education Discipline Groups (pre 2001)	
01	**NATURAL AND PHYSICAL SCIENCES**		
010101	Mathematics	0501	Mathematics, Statistics
010103	Statistics	0501	Mathematics, Statistics
010199	Mathematical Sciences, n.e.c.	0599	Other Mathematics, Computing
010301	Physics	0403	Physical/Materials Sciences
010303	Astronomy	0499	Other Sciences
010501	Organic Chemistry	0405	Chemical Sciences
010503	Inorganic Chemistry	0405	Chemical Sciences
010599	Chemical Sciences, n.e.c.	0405	Chemical Sciences
010701	Atmospheric Sciences	0402	Earth Sciences
010703	Geology	0402	Earth Sciences
010705	Geophysics	0402	Earth Sciences
010707	Geochemistry	0402	Earth Sciences
010709	Soil Science	1101	Agriculture
010711	Hydrology	0702	Civil, Structural
		1101	Agriculture
010713	Oceanography	0402	Earth Sciences
010799	Earth Sciences, n.e.c.	0202	Geography
		0402	Earth Sciences
010901	Biochemistry and Cell Biology	0401	Biological Sciences
010903	Botany	0401	Biological Sciences
		1101	Agriculture
010905	Ecology and Evolution	0401	Biological Sciences
010907	Marine Science	0402	Earth Sciences
010909	Genetics	0401	Biological Sciences
010911	Microbiology	0401	Biological Sciences
010913	Human Biology	0401	Biological Sciences
010915	Zoology	0401	Biological Sciences
010999	Biological Sciences, n.e.c.	0202	Geography
		0401	Biological Sciences
019901	Medical Science	0806	Medicine, Medical Science
019903	Forensic Science	0499	Other Sciences
019905	Food Science and Biotechnology	0499	Other Sciences
		1101	Agriculture
019907	Pharmacology	0404	Pharmacology
019909	Laboratory Technology	0499	Other Sciences
019999	Natural and Physical Sciences, n.e.c.	0499	Other Sciences

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Appendix 2: Glossary of Higher Education Terms

The Glossary provides definitions of terms referred to in the text. Most of the definitions have been extracted directly from DEST's user manuals.

ABORIGINAL AND TORRES STRAIT ISLANDERS (See also INDIGENOUS STUDENTS)

Persons who identify themselves as being of Australian Aboriginal and Torres Strait Islander descent.

ACADEMIC ORGANISATIONAL UNIT (AOU)

The DEST name for what universities commonly refer to as "schools" or "departments". The concept of 'Faculty' as an aggregation of 'schools' or 'departments' does not exist in formal reporting to DEST.

ATTENDANCE MODE

A classification of the manner in which a student is undertaking a subject:

Internal Mode of Attendance: unit of study for which the student is enrolled and is undertaken through attendance at university on a regular basis; **or**

External Mode of Attendance: unit of study for which the student is enrolled involves special arrangements whereby lesson materials, assignments, etc. are delivered to the student, and any associated attendance at the institution is of an incidental, irregular, special or voluntary nature.

Multi-modal Mode of Attendance: a unit of study is undertaken partially on an internal mode of attendance and partially on an external mode of attendance.

ATTENDANCE TYPE

Attendance is classified as being full-time or part-time, based on the student load for the student:

Full-time	student load aggregated for all the courses being undertaken by the student in the Collection Year is 0.75 or more.
Part-time	student load aggregated for all the courses being undertaken by the student in the Collection Year is less than 0.75.

COMBINED COURSE

A course which has been specifically designed to lead to a single combined award (eg. BSc/DipEd or BSc/LLb) or to meet the requirements of more than one award (eg. BSc and BEng).

COMMENCING STUDENT

A student is a commencing student if she/he has enrolled in the course for the first time at the institution between 1 April of the year prior to the Collection Year and 31 March of the Collection Year. A Bachelor of Science student who move into Bachelor of Science (Honours) at the same university is NOT considered to be a commencing student.

COURSE

An award course, non-award course, enabling course, or cross-institution program undertaken at a higher education institution.

An award course is a program of study formally approved/accredited by the institution or any other relevant accreditation authority and which leads to an academic award granted by the institution or which qualifies a student to enter a course at a level higher than a bachelor's degree.

COURSE COMPLETION

The successful completion of all the academic requirements of a course which includes any required attendance, assignments, examinations, assessments, dissertations, practical experience and work experience in industry.

DISCIPLINE GROUP

A discipline group is a means of classifying subjects in terms of the subject matter being taught and/or researched in them.

EFTSL/EFTSU (EQUIVALENT FULL-TIME STUDENT LOAD/UNIT)

A measure of the student load attributable to a subject or to a set of subjects. The measure indicates the notional proportion of the workload which would be applicable to a student undertaking a full year of study in a particular year, of a particular course.

FEE-PAYING STUDENT

A student for whom a fee is paid to the institution for tuition.

FIELD OF STUDY/FIELD OF EDUCATION CLASSIFICATION

A classification of courses based on similarity in terms of the vocational field of specialisation or the principal subject matter of the course.

INDIGENOUS STUDENTS

Persons who identify themselves as being of Australian Aboriginal and Torres Strait Islander descent.

OVERSEAS STUDENT

A student who is NOT one of the following:

an Australian citizen; or

a New Zealand citizen, or a diplomatic or consular representative of New Zealand, a member of the staff of such a representative or the spouse or dependent relative of such a representative; or

a person entitled to stay in Australia, or to enter and stay in Australia, without any limitation as to time and resides in Australia during the semester.

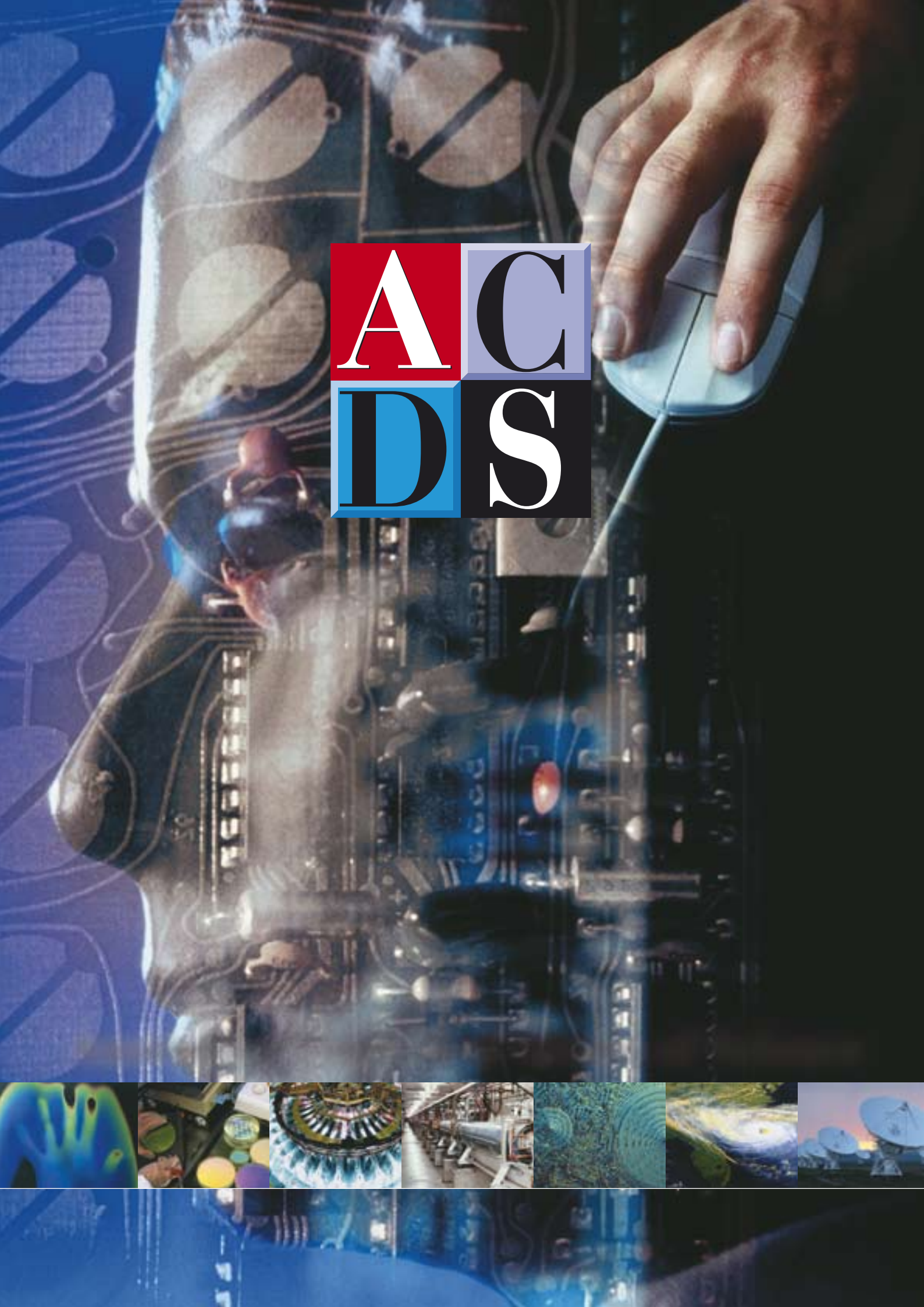
STUDENT LOAD See EFTSL/EFTSU.

SUBJECT

The basic component of a course or program, which a student may undertake and on successful completion of the unit's requirements, gain credit towards completion of the course. In this study, the this term has been used interchangeably with 'unit'.

UNIT

See 'Subject'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