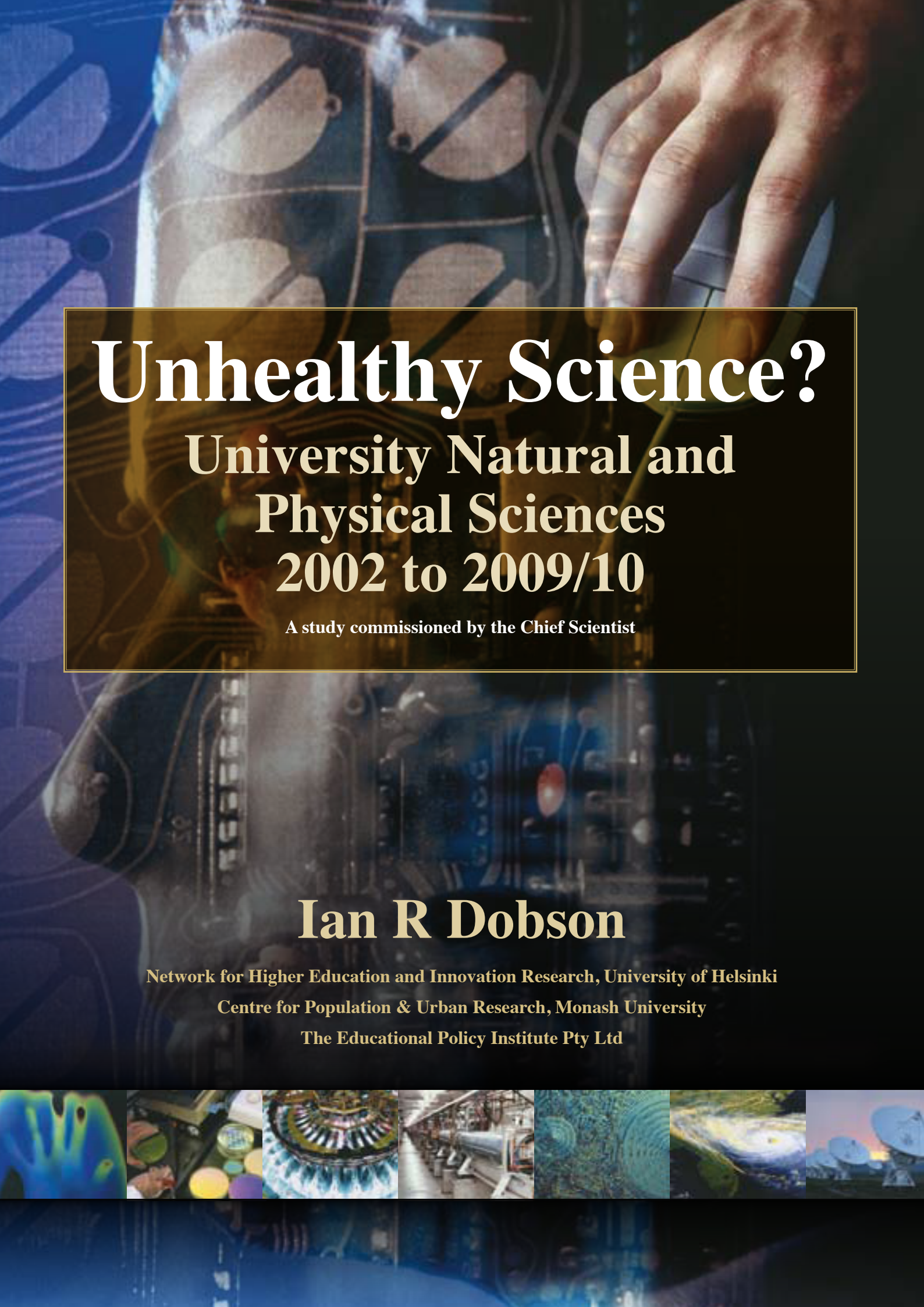

Unhealthy Science?

University Natural and Physical Sciences 2002 to 2009/10

A study commissioned by the Chief Scientist

Ian R Dobson

Network for Higher Education and Innovation Research, University of Helsinki

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Chapter 1

Introduction

Unhealthy Science? University Natural and Physical sciences 2002 to 2009-10 is a study undertaken at the behest of the Office of the Chief Scientist, Department of Innovation, Industry, Science, Research and Tertiary Education. It examines university statistical data in detail for the years 2002 – 2009, the latter year being the most recent for which detailed data were available from aggregated data sets. Some additional information was also obtained from tables of 2010 data produced on request for staff from the Office of the Chief Scientist by staff from the Department of Education, Employment and Workplace Relations. In some ways, this study extends three earlier studies undertaken on behalf of the Australian Council of Deans of Science (ACDS), and in introducing Unhealthy Science?, it is appropriate to start by considering the studies done for the ACDS.

In 1998, the ACDS commissioned research into the numbers of science enrolments and the trends and patterns discernible from an analysis of higher education statistics. The resulting *Trends in Science Education: Learning Teaching and Outcomes 1989-1997* (Dobson & Calderon, 1999) presented data that 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, compared with the sector-wide growth of 49 per cent. Superficially, therefore, this seemed like a very positive outcome, but the reality was that this apparently positive state of affairs masked a long-term decline in uptake of what are generally known as 'the enabling sciences' of chemistry, mathematics and physics. The apparent expansion in 'science' 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 no longer provided by traditional university enabling science departments. For example, at some universities some biological sciences teaching is provided by medical or other health-related faculties and departments.

It is also true that more students started to take 'science' as part of a combined course (e.g. science / law) than in the past. Although this is hardly a negative thing, some of the expansion in the 'non-science' component of 'science' degrees reflected the growth of subjects that were not science disciplines, but were from the course being studied in combination with the science degree.

A second study was undertaken in 2003 (*Science at the Crossroads? A study of trends in university science from Dawkins to now, 1989 – 2002* (Dobson, 2003)), and a third in 2007, *Sustaining Science: University Science in the Twenty-first Century* (Dobson, 2007).

That second study had to make allowances for two substantial shifts of definition in the data collection methodology. First, from 2001 different Field of Study and Discipline Group classifications were replaced by a common classification of Fields of Education and Discipline Groups. (These groupings are attached, as Appendix1). Second, from 2002, the enumeration methodology was changed. Until 2001, the number of students enrolled at Australian universities had been compiled according to a census methodology based on the number of students enrolled as at 31 March each year. The revised methodology counted students enrolled at any stage of the year, rather than on a single date. The impact of this was to increase the apparent number of university enrolments in 2002 by 19 per cent. The official enrolment count for 2002 was about 897,000. However, according to the methodology current in 2001 and earlier years, there would have been 751,000 in 2002. The methodology change increased the number of Natural and Physical Sciences students by about 8 per cent, from 56,000 to more than 60,000. The 2002 enumeration methodology is based on counting every student enrolled at some time during the year, whereas the previous methodology was based on a single annual census date. In some ways, perhaps the post-2001 methodology is more accurate, but census date methodologies are more familiar, and easier to comprehend.

It is important to appreciate that these two changes (of classification groups and counting methodology) mean that accurate and detailed longitudinal comparisons before 2001/2002 are no longer possible.

Most of the data for this study came from data files that have been posted on the Commonwealth education department's website for many years. Since the 1980s, universities have been required to supply 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. Even if the level of detail required seemed a little excessive at the time, the DEEWR[1] data gathering system provided 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 fee-charging schemes. The university data collections are not perfect, but they produce a comprehensive sets of social statistics.

Works such as this one require readers to be aware of a range of definitions in order to appreciate and understand the scope of the phenomena being described. These definitions have changed little over the past few years, so readers will understand that a modicum of self-plagiarism in the introductory sections has been unavoidable.

The focus of *Unhealthy Science?* is the period 2002 to 2009/2010, the years during which DEEWR's current methodologies for counting students and classifying courses and subjects have been in force. By adopting 2002 as the first year analysed in this study, the consistency problems created by the change in counting methodology are avoided.

A note on style

As noted in earlier reports for the ACDS, reports based on statistical analysis can quickly become confusing if language and style are used inconsistently or ambiguously. As with previous studies, all efforts have been taken in this report to avoid inconsistancies. Where appropriate, DEEWR terminology has been used, and Appendix 2 is a glossary of many of the terms used.

1 DEEWR is the acronym for the Department of Education, Employment and Workplace Relations. At time of writing, this was the 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), DETYA (Department of Education, Training & Youth Affairs), and DEST, the Department of Education, Science and Training. For sake of simplicity in this report, the acronym **DEEWR** has been used in most places to describe the federal 'education department', irrespective of its actual name at various points in time. Since 15 December, 2011, the department responsible for universities has become part of the expanded ministry: the Department of Innovation, Industry, Science, Research and Tertiary Education (DIISRTE).

Chapter 2

Higher Education Statistics: A Description

This chapter on university statistics has been included for the sake of completeness, and much of it is self-plagiarised from *Sustaining Science: University Science in the Twenty-First Century* (Dobson, 2007). Higher education statistics are compiled by DEEWR staff from several unit record data files supplied by universities at various times during the year. Universities submit files according to an annual schedule. The files include information on students and the courses they are enrolled in, university departments, subjects and student load, past course completions and various matters relating to tuition fees. Until 2011, DEEWR staff used to compile aggregated data sets which were available to staff and researchers from universities and others. These data sets enabled a wide range of analyses on universities and their students to be undertaken. Unfortunately, this system has been abandoned, and replaced with an on-line 'data cube' system that does not permit statistical analysis in the same detail. It would seem that there have been concerns about privacy, although I am unaware of any instances of when university students' privacy has been violated because of the availability of these aggregated data sets. This should be the subject of future investigation!

DEEWR staff continue to provide a large number of summary tables at a range of levels of detail.

The history of the current system for collecting statistical material from universities 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 hen binary system of higher education[2]. The system has been amended, and the collection software upgraded several times since the first collections were taken. CTEC was a body established to provide the government of the day with independent advice on higher education, but it was decommissioned in the 1980s, and elements of its role absorbed into the federal education ministry, currently DEEWR. Data collection by universities is compulsory under provisions in the Higher Education Support Act. (The previous Act was the Higher Education Funding Act).

The higher education system's data integrity relies on universities adhering strictly to the definitions. These are contained in data element dictionaries and glossaries that assist 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 students' country of birth, year of arrival in Australia, language spoken at home, and Indigenous status. Students provide this information to universities at the time of enrolment. Another set of information on students is generated by universities: students' basis of admission, attendance mode (internal or external or a mixture of the two), attendance type (full-time or part-time), and their liability for, or exemption from, paying fees of various types.

Still more information is provided by universities about the level, duration and name of the courses they offer, the subjects taught in those courses[3], and the teaching departments which teach those

2 Until the so-called Dawkins reforms of the late 1980s / early 1990s, Australia had research-oriented universities and teaching-oriented institutions known as colleges of advanced education or institutes of technology. Among Dawkins' reforms was the creation of a unitary system (of universities) effected by a mixture of mergers and institutional redesignations.

3 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 a 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.

subjects. Since 2001, universities have coded the courses they offered so they can be aggregated into *fields of education*. The subjects that students study within those courses can similarly be coded into *discipline groups*. Quoting from DEEWR documentation 'the main purpose of the classification is to ensure courses, specialisations and units of study [referred to as "subjects" in this study] with the same or similar vocational emphasis are reliably classified to the same "field of education". It is intended also to aid people who design data collections, respond to requests for data, and compile, verify and analyse data. As such, the classification may be viewed as a dictionary clarifying where particular courses, specialisations and units of study data should be categorised' (Curtin University n.d.).

The situation that existed in coding courses and subjects before 2001 falls outside the coverage of this document, but a description of these earlier aggregations can be found in *Sustaining Science* (Dobson, 2007).

The field of education classification is divided into 12 *broad* fields of education and sub-divided into 83 *narrow* fields of education and 439 *detailed* fields of education. These are expressed with a two-, four- and six-digit code, respectively. Programmes of study that do not lead to an award but comprises subjects that are part of an award course are described as *non-award courses*. Figure 1 provides a list of broad fields of education, and Appendix 1 is a list of the *field of education / discipline group* classification, down to the detailed level for the areas covered in this study.

Figure 1: Broad Fields of Education / Broad Discipline Groups: full descriptions and abbreviated forms used in the text and tables

Code	Full description	Short name used occasionally in this study
01	Natural and Physical Sciences	Science / sciences
02	Information Technology	Information Technology
03	Engineering and Related Technologies	Engineering
04	Architecture & Building	Architecture
05	Agriculture, Environmental and Related sSudies.	Agriculture
06	Health	Health
07	Education	Education
08	Management and Commerce	Management
09	Society and Culture	Society & Culture
10	Creative Arts	Creative Arts
11	Food, Hospitality and Personal Services	Food, etc. services
12	Mixed Field	Mixed Field
0	Non-Award	Non-Award

A word of caution

Although it is useful to aggregate courses according to their content, simply having a highly detailed classification does not ensure comparability between universities *unless identical coding practices are observed by all those universities*. Many university courses, particularly at the undergraduate level, are generalist degrees. The BSc is a good example of a generalist degree and some universities offer a higher proportion of generalist degrees than others do. Generalist degrees were rather more common in the past than they are now, and a university might enrol all 'science' undergraduates in a single, generic BSc. Today, some universities offer 'branded' degrees rather than generic ones.

Students enrolled in generalist BSc degrees across the country might specialise in one area of science or another, but even according to the most detailed field of education classification, the BSc course can usually be described only in a very general way. First year students often will not know whether they will major in mathematics, chemistry or biology (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 DEEWR enrolment files over recent years. For example, Table 4.11 shows that in 2009, there were over 64,000 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 15,105 of the students (23.4 per cent) were classified as being in *019999 Natural and Physical Sciences [courses] 'not elsewhere classified'*. A further 18,792 students (29.1 per cent) were classified as being enrolled in a detailed field of education which in a strict sense does not exist, but if it did, would be: *010000 Natural and Physical Sciences [courses] – General.* Another 2,469 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 56 per cent of 'science' students in 2009 were enrolled in generalist degrees. The existence of a classification containing 37 detailed options does not help provide detail. Of course, some students ARE reported as being enrolled in more specifically described courses. These include courses in fields such as medical science, forensic science, food science, and laboratory technology, but the great majority of 'BSc' (and other) students have been reported as being enrolled in a generalist or 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 university performance compared with other nations with a grain of salt, pending knowledge of what is being compared, and what information was supplied.

Counting students

There are three main ways of enumerating students and student activity. First, there are headcounts of the number of students enrolled in university programmes. The detail of how this happens is not of concern here, but student enrolment headcounts are accumulated and reported by universities in an 'enrolment file'.

Second, there are headcounts of students when they complete their university studies. Every student enumerated here will also have been counted in the enrolment file for one or more semesters, but here students are reported in a 'course completion' file when they have successfully completed all the requirements of the course/s they were enrolled in.

There is a third collection of student information, which is based on the number of subjects or amount of a year's academic work a student is involved in. 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 termed 'Equivalent Full Time Student Units' (EFTSU)). EFTSL is therefore 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 that is applicable to a student undertaking a full year of study in a particular year, of a particular course. 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 and subsequent domestic student tuition fees were calculated. A student taking more than (or less than) a standard year's workload will usually generate more than (or less than) 1.000 EFTSL, but if a student is only doing half a year's workload, they will generate 0.500 EFTSL.

Student load took on increased significance in 1989, because student fees (particularly the higher education contribution scheme for domestic students) are calculated based on student load. Students are charged fees only for the teaching (and related) resources they consume during their studies.

Because many students attend and study for less than a full year's study load, counts of enrolments in courses will usually exceed the amount of student load generated by those enrolled students.

For example, as is shown in tables that follow, in 2009, Australian higher education institutions had 1,134,866 students enrolled in their courses, and between them, they generated 813,049 EFTSL. On this basis, the 'average' university student is about 72 per cent full-time.

Fiddles and riddles?

Australian higher education statistics are among the best available in the world. The system documentation provides universities with clear guidelines for universities to follow. Data validation computer programmes 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. Anecdotally, it has been suggested that some errors arose because of the administrative burden associated with DEEWR'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 consistency and integrity. The student learning entitlement was abolished from 1 January 2012 (DEEWR, n.d.), so that can no longer be held as scape goat.

The close analysis of DEEWR's aggregated data files necessitated by this study identified a number of data shortcomings related to how universities classify courses and subjects into fields of education and discipline groups, and in some instances, by providing incomplete information. 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 DEEWR. In the main, these have not affected data analysis at the broad level. Areas of shortcomings and inconsistencies in the detailed application of statistical variables in statistical collections of student data are discussed in various places in this study.

Chapter 3

The Sector 2002 – 2009/2010: A summary of nation-wide patterns in course enrolments, subject enrolments, and course completions

This chapter looks at overall developments over the past decade in the sector in order to provide a context for changes that have occurred in science courses. The chapter first considers enrolments, student load, and then course completions. The first data year shown is 2002, and where information was available, the most recent year is 2010. Data for 2010 were taken from statistical tables made available in 2011 by DEEWR. Data for years 2002 to 2009 were taken from aggregated data sets (provided by DEEWR and its antecedents, via its website) for those years. Deriving tables from aggregated data sets allows the researcher to produce a wide range of cross tabulations that are not available in the standard tables formats produced by DEEWR. As noted in the previous chapter, the system of providing aggregated data sets is no longer being maintained by DEEWR, apparently on indeterminate privacy grounds.

The term 'university' has been used throughout this volume, but in fact, not all the students shown in these tables are enrolled at universities. Included in higher education enrolments for 2010 are 64,187 students enrolled in courses offered by what are described by DEEWR as *Non-table A/B Providers*, predominantly private higher education providers. The Australian sector also comprises two private universities that also receive government funding.

The analysis here starts with an examination of course enrolments in the higher education sector overall. Several tables of course enrolments with information about all fields of education precede chapters devoted to learning and teaching in the Natural and Physical Sciences.

Course enrolments

A student is 'enrolled' if he or she has been admitted to a programme offered by a higher education provider at the census date, or if that person is still entitled to continue with their studies and has not formally indicated before the census date that they have withdrawn from or deferred their studies.

Table 3.1 shows course enrolments by all students according to course level. The overall student population increased by 33.0 per cent between 2002 and 2010 and *undergraduate* enrolments continue to be the majority course level, representing slightly more than 71 per cent of all students consistently this decade. Undergraduate numbers increased by nearly 203,000 or 31.3 per cent from 2002 to 2010. Australian higher education now has over 850,000 undergraduates. Within undergraduate numbers, the spectacular proportionate increase in associate degrees, diplomas and enabling courses should be noted.

Proportionately, enrolments in *other postgraduate* courses increased the most, by 45.1 per cent, or over 82,000. Courses in this category include master's by course work programmes, and graduate and postgraduate diplomas, graduate certificates and doctorates by coursework.

Higher degree by research enrolments (that is, enrolments in master's by research programmes and PhDs) increased by 11,531, or 26.1 per cent over the period. The proportion of total enrolments represented by each level changed little over the period. From Table 3.1 it can be seen that higher degrees by research have gone from about 4.9 to 4.7 per cent of all enrolments.

Table 3.2 shows course enrolments by all students according to course level, gender, attendance mode, attendance type and Indigenous status. The proportion of women at Australian universities continues its gentle rise. Since 2002, women's proportion of all enrolments has increased from 54.4

per cent to 55.6 per cent. The number of women grew by 35.8 per cent (to 662,675 in 2010), compared with 29.7 per cent (or 529,982) for the number of men. In fact, there have been more women at Australian universities since 1987 (DEETYA, 1998, Table 2.1).

The number of international students continues to rise to the point that in 2010, there were over 335,000 international students enrolled in Australian higher education institutions. Over the decade, their number increased by 81.2 per cent, or by over 150,000. Of this number, approximately 82,500 were enrolled offshore in 2009. It can be calculated from the table that the year-by-year growth has not been consistent. Not observable in Table 3.2, the increase between 2002 and 2003 was over 25,000 enrolments by international students, with lower increases until a 'recovery' in more recent years. The biggest single enrolment growth year for international students was between 2008 and 2009, of 26,807, but the following year, an additional 14,303 international students enrolled at Australian institutions. Nonetheless, this represents strong overall growth.

Table 3.1: Enrolments 2002 – 2010. Students in all Fields of Education by Course Level

Course Level	2002		2005		2009		2010		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Higher Degree by Research										
PhD	34040	3.8%	38953	4.1%	44292	3.9%	47066	3.9%	13026	38.3%
Master's by Research	10169	1.1%	9248	1.0%	8393	0.7%	8674	0.7%	-1495	-14.7%
Sub-total	44209	4.9%	48201	5.0%	52685	4.6%	55740	4.7%	11531	26.1%
Other Postgraduate										
Doctorate by Coursework	1494	0.2%	1841	0.2%	1465	0.1%	1414	0.1%	-80	-5.4%
Master's by Coursework	112042	12.5%	146299	15.3%	175961	15.5%	184226	15.4%	72184	64.4%
Postgraduate Qualifying	733	0.1%	476	0.0%	415	0.0%	427	0.0%	-306	-41.7%
Postgraduate Diploma – New	30707	3.4%	29870	3.1%	31423	2.8%	31615	2.7%	908	3.0%
Postgraduate Diploma – Ext.	14428	1.6%	13212	1.4%	15773	1.4%	16196	1.4%	1768	12.3%
Graduate Certificate	22999	2.6%	23605	2.5%	30251	2.7%	30837	2.6%	7838	34.1%
Sub-total	182403	20.3%	215303	22.5%	255288	22.5%	264715	22.2%	82312	45.1%
Undergraduate										
Bachelor's Graduate Entry	13892	1.5%	14465	1.5%	14110	1.2%	14486	1.2%	594	4.3%
Bachelor's (Hons.)	12599	1.4%	11809	1.2%	12374	1.1%	16708	1.4%	4109	32.6%
Bachelor's	597348	66.6%	626457	65.4%	724901	63.9%	760383	63.8%	163035	27.3%
Associate Degree	2411	0.3%	2856	0.3%	8880	0.8%	10498	0.9%	8087	335.4%
Advanced. Diploma	3802	0.4%	3314	0.3%	4589	0.4%	5170	0.4%	1368	36.0%
Diploma	6871	0.8%	4232	0.4%	24451	2.2%	25176	2.1%	18305	266.4%
Other Undergraduate	3720	0.4%	2394	0.3%	1505	0.1%	1346	0.1%	-2374	-63.8%
Enabling Course	7089	0.8%	5704	0.6%	14164	1.2%	16956	1.4%	9867	139.2%
Sub-total	647732	72.2%	671231	70.1%	804974	70.9%	850723	71.3%	202991	31.3%
Non-Award Courses	22277	2.5%	22442	2.3%	21919	1.9%	21479	1.8%	-798	-3.6%
Total	**896621**	**100.0%**	**957177**	**100.0%**	**1134866**	**100.0%**	**1192657**	**100.0%**	**296036**	**33.0%**

Table 3.2 also shows that most of the growth has been of internal and full-time students, numbers of which increased by over 239,000 and over 263,000 enrolments, respectively. To some extent, the expanded number of enrolments by international students, the majority of whom are full-time and internal, will be driving both of these trends. This supposition is subjected to further analysis below. Students enrolled as multi-modal have also increased strongly in number and proportion.

Finally, Table 3.2 provides a summary of Indigenous student enrolments, which increased by 25 per cent over the period, less than the overall increase of 33 per cent. Of course, part of the reason for that is that more of the growth this decade has come from international students. It can be calculated from the table that compared with domestic students, the Indigenous proportion

increased slightly, from 1.25 per cent in 2002, to 1.29 per cent in 2010. One point that should be noted about Indigenous student enrolments is that some universities are failing to identify all of their students as Indigenous or not. In 2002, the enrolments by students in the 'no information' category were about five-times higher than the number of Indigenous students reported. Fortunately, the trend is in the right direction: in 2009, the difference was only four-times. DEEWR has released a table showing the number of Indigenous student enrolments for 2010, but not the other two categories. Further analysis reported elsewhere revealed 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 (Dobson, 2007). Therefore, the data quality problems identified are not widespread, but in 2005, at least, related to relatively few universities.

Table 3.2: Enrolments 2002 – 2010. Students in all Fields of Education by Gender, Citizenship Status, Attendance Mode, Attendance Type and Indigenous Status

	2002		2005		2009		2010		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Gender										
Female	487988	54.4%	521328	54.5%	629249	55.4%	662675	55.6%	174,687	35.8%
Male	408633	45.6%	435849	45.5%	505617	44.6%	529982	44.4%	121,349	29.7%
Citizenship Status										
International	185058	20.6%	239495	25.0%	320970	28.3%	335273	28.1%	150,215	81.2%
Domestic	711563	79.4%	717682	75.0%	813896	71.7%	857384	71.9%	145,821	20.5%
Attendance Mode										
Internal	724914	80.8%	761970	79.6%	924592	81.5%	964446	80.9%	239,532	33.0%
External	139228	15.5%	133697	14.0%	139188	12.3%	146274	12.3%	7,046	5.1%
Multi-Modal	32479	3.6%	61510	6.4%	71086	6.3%	81937	6.9%	49,458	152.3%
Attendance Type										
Full-time	574580	64.1%	636872	66.5%	794452	70.0%	838312	70.3%	263,732	45.9%
Part-time	322041	35.9%	320305	33.5%	340414	30.0%	354345	29.7%	32,304	10.0%
Indigenous Status										
Indigenous	8871	1.0%	8370	0.9%	10465	0.9%	11088	0.9%	2,217	25.0%
Not Indig.	841471	93.8%	902620	94.3%	1083989	95.5%	*			
No Info.	46279	5.2%	46187	4.8%	40412	3.6%	*			
Total	**896621**	**100.0%**	**957177**	**100.0%**	**1134866**	**100.0%**	**1192657**	**100.0%**	**296,036**	**33.0%**

* Figures not yet released

In order to show some of the overall enrolment trends, Figure 2 summarises the proportion of certain student groups to the total. The lines are roughly horizontal, with a couple of exceptions. The proportion of international students has increased from about one-fifth of the total, and it appears likely that the proportion will soon be to be working towards one-third and higher. The proportion of full-time enrolments is also showing an upward trend, and as stated above, it is likely that the increase in international student enrolments is behind that.

Figure 2: Proportion of all enrolments represented by certain groups of students.

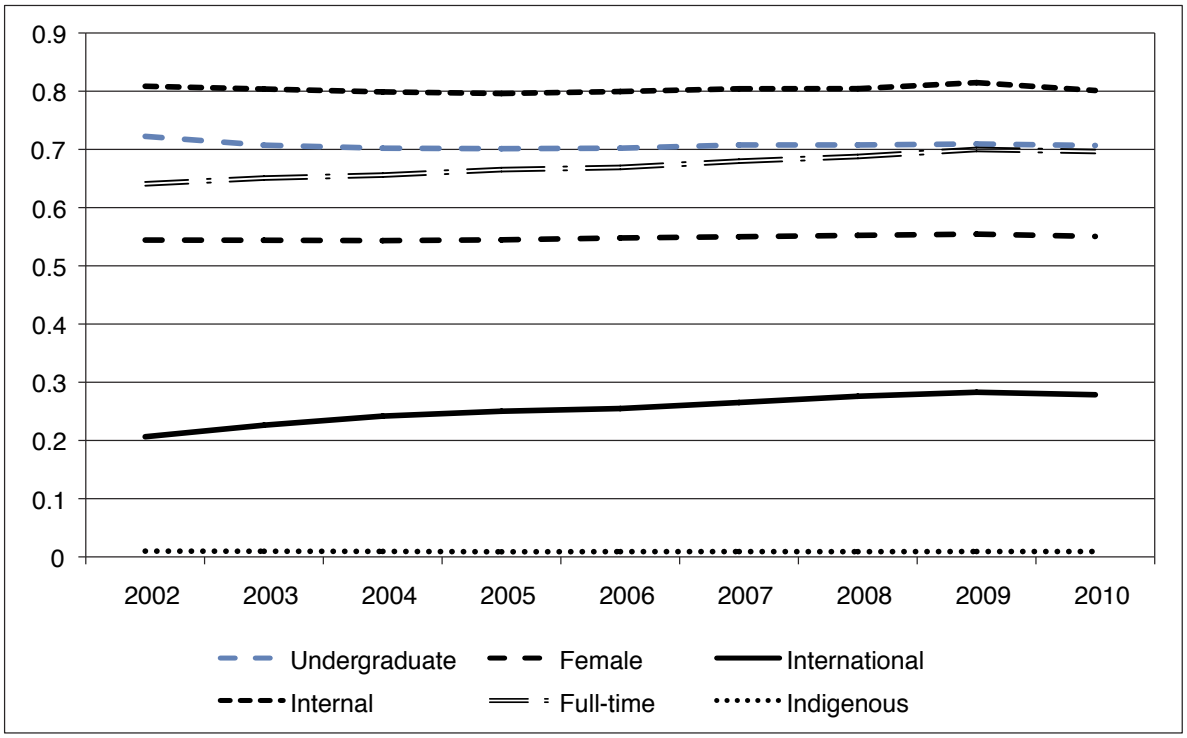


Figure 2 also shows that women are clearly in the majority. The gentle gradient on the line perhaps disguises the consistent growth. For instance, looking at Table 3.2, it is possible to calculate that the number of women enrolled at Australian institutions in 2010 increased by 5.3 per cent when compared with 2009, an increase of 33,426. The equivalent figures for men were 4.8 per cent, and 24,365.

Table 3.3 shows changes in enrolments by state / territory across the sector, over the period 2002 to 2010. The most populous states' institutions increased their enrolments the most (New South Wales and Victoria), with the largest proportionate growth coming from Multi-state institutions, Tasmania and Western Australia. Overall, states / territories' proportion of all enrolments changed little, with New South Wales and Victoria having over 57 per cent of total enrolments between them. The early 2011 distribution of population by state / territory was as shown next to each state / territory in the table. As can be seen, states / territories tend to have university populations that match their overall population. There are a few small over- or under-representations of population, but 1.9 per cent of students enrolled at multi-state universities make an exact figure difficult to achieve. In addition, 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, the Central Queensland University has city campuses in Brisbane, Sydney, and Melbourne, and the University of Ballarat has a Sydney-based campus (Birrell, 2006, p.55). No doubt, there are others.

Some other universities now also have large numbers of out-of-state enrolments, including New South Wales' Charles Sturt University, which attracts considerable numbers of proximately-domiciled students from the state of Victoria. Further, some universities have a considerable number of offshore enrolments. This topic will be discussed further below.

This leads logically to a consideration of which institutions are the largest and which have grown the most. Table 3.4 shows that some universities have gone through a period of contraction during the course of this decade. The most spectacular examples of 'down-sizing' occurred at Central

Queensland and Charles Sturt Universities, which 'lost' 2,224 and 1,987 enrolments, respectively, between 2002 and 2010. However, an analysis of DEEWR statistics shows that both universities have shown a strong turn around since 2008.

Table 3.3: Enrolments 2002 – 2010. Students in all Fields of Education by State / Territory

State		2002		2005		2009		2010		Growth	
	#	No.	%	No.	%	No.	%	No.	%	No.	%
Australian Capital Territory	1.6%	24283	2.7%	27911	2.7%	30099	2.7%	32,634	2.7%	8,351	34.4%
New South Wakes	32.6%	289886	32.3%	297191	32.3%	354924	32.3%	372,988	31.3%	83,102	28.7%
Northern Territory	1.0%	6432	0.7%	5917	0.7%	7685	0.7%	8219	0.7%	1,787	27.8%
Queensland	20.0%	170880	19.1%	185922	19.1%	205223	19.1%	215,636	18.1%	44,756	26.2%
South Australia	7.5%	60459	6.7%	66486	6.7%	79187	6.7%	82,122	6.9%	21,663	35.8%
Tasmania	2.3%	15706	1.8%	18020	1.8%	21683	1.8%	23,452	2.0%	7,746	49.3%
Victoria	24.8%	228561	25.5%	242951	25.5%	294318	25.5%	308,041	25.8%	79,480	34.8%
Western Australia	10.1%	88520	9.9%	97180	9.9%	121079	9.9%	126,748	10.6%	38,228	43.2%
Multi-State		11894	1.3%	15599	1.3%	20668	1.3%	22,817	1.9%	10,923	91.8%
Total		896621	100.0%	957177	100.0%	1134866	100.0%	1192657	100.0%	296,036	33.0%

% of Australian population

Several institutions had spectacular increases in their enrolments between 2002 and 2010. Leading the way in growth terms are RMIT (Vic, +13,585 enrolments), Curtin (Western Australia, +12,644), Griffith (Queensland, +11,650), Monash (Victoria, +10,540) and three universities increased their enrolment by more than 9,000 each: Macquarie, Newcastle and Sydney. Bond University in Queensland was a new university at the start of the decade, so its proportionate increase has been considerable.

Table 3.4: Enrolments 2002 – 2010. Students in all Fields of Education by State / Territory and University

State / University	2002		2005		2009		2010		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
ACT										
Australian Defence	1885	0.2%	2079	0.2%		0.0%		0.0%		
Canberra	10419	1.2%	11498	1.2%	12520	1.1%	18569	1.6%	8150	78.2%
Australian National University	11979	1.3%	14317	1.5%	17579	1.5%	14011	1.2%	2032	17.0%
Other Institutions		0.0%	17	0.0%		0.0%	54	0.0%		
Sub-total	**24283**	**2.7%**	**27911**	**2.9%**	**30099**	**2.7%**	**32634**	**2.7%**	**8351**	**34.4%**
New South Wales										
Charles Sturt	39776	4.4%	33560	3.5%	34437	3.0%	37789	3.2%	-1987	-5.0%
Macquarie	27239	3.0%	29985	3.1%	35195	3.1%	37085	3.1%	9846	36.1%
New England	18202	2.0%	18146	1.9%	17817	1.6%	18068	1.5%	-134	-0.7%
New South Wales	42333	4.7%	39183	4.1%	46370	4.1%	49517	4.2%	7184	17.0%
Newcastle	23502	2.6%	25114	2.6%	30357	2.7%	32737	2.7%	9235	39.3%
Southern Cross	11961	1.3%	13127	1.4%	16067	1.4%	15749	1.3%	3788	31.7%
Sydney	42305	4.7%	45630	4.8%	50432	4.4%	51435	4.3%	9130	21.6%
Uni. Tech, Sydney	29290	3.3%	31602	3.3%	33807	3.0%	34634	2.9%	5344	18.2%
Western Sydney	35361	3.9%	33309	3.5%	35265	3.1%	37856	3.2%	2495	7.1%
Wollongong	18764	2.1%	22124	2.3%	25524	2.2%	27127	2.3%	8363	44.6%
Other Institutions	1153	0.1%	5411	0.6%	29653	2.6%	30991	2.6%	29838	
Sub-total	**289886**	**32.3%**	**297191**	**31.0%**	**354924**	**31.3%**	**372988**	**31.3%**	**83102**	**28.7%**
Northern Territory										
Batchelor	820	0.1%	593	0.1%	671	0.1%	439	0.0%	-381	-46.5%
Charles Darwin/NTU	5612	0.6%	5324	0.6%	7014	0.6%	7780	0.7%	2168	38.6%
Sub-total	**6432**	**0.7%**	**5917**	**0.6%**	**7685**	**0.7%**	**8219**	**0.7%**	**1787**	**27.8%**

Table 3.4: Enrolments 2002 – 2010. Students in all Fields of Education by State / Territory and University *continued*

State / University	2002		2005		2009		2010		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Queensland										
Bond	51	0.0%	4493	0.5%	6562	0.6%	6900	0.6%	6849	13429.4%
Central Queensland	21763	2.4%	25569	2.7%	19220	1.7%	19519	1.6%	-2244	-10.3%
Griffith	30969	3.5%	34648	3.6%	39964	3.5%	42619	3.6%	11650	37.6%
James Cook	13189	1.5%	14820	1.5%	17623	1.6%	18835	1.6%	5646	42.8%
Queensland	37498	4.2%	37177	3.9%	40583	3.6%	43830	3.7%	6332	16.9%
QUT	39192	4.4%	38527	4.0%	40570	3.6%	41946	3.5%	2754	7.0%
Southern Queensland	24271	2.7%	24694	2.6%	25103	2.2%	25572	2.1%	1301	5.4%
Sunshine Coast	3947	0.4%	5153	0.5%	8053	0.7%	8956	0.8%	5009	126.9%
Other Institutions		0.0%	841	0.1%	7545	0.7%	7459	0.6%	7459	
Sub-total	**170880**	**19.1%**	**185922**	**19.4%**	**205223**	**18.1%**	**215636**	**18.1%**	**44756**	**26.2%**
South Australia										
Adelaide	16188	1.8%	18943	2.0%	22174	2.0%	23917	2.0%	7729	47.7%
South Australia	30627	3.4%	31988	3.3%	36442	3.2%	18435	1.5%	-12192	-39.8%
Flinders	13644	1.5%	14660	1.5%	17177	1.5%	35940	3.0%	22296	163.4%
Other Institutions		0.0%	895	0.1%	3394	0.3%	3830	0.3%	3830	
Sub-total	**60459**	**6.7%**	**66486**	**6.9%**	**79187**	**7.0%**	**82122**	**6.9%**	**21663**	**35.8%**
Tasmania										
Australian Maritime	1956	0.2%	1260	0.1%		0.0%		0.0%	-1956	
Tasmania	13750	1.5%	16760	1.8%	21588	1.9%	23354	2.0%	9604	69.8%
Other Institutions		0.0%		0.0%	95	0.0%	98	0.0%	98	
Sub-total	**15706**	**1.8%**	**18020**	**1.9%**	**21683**	**1.9%**	**23452**	**2.0%**	**7746**	**49.3%**
Victoria										
Ballarat	6615	0.7%	9782	1.0%	12888	1.1%	11643	1.0%	5028	76.0%
Deakin	33033	3.7%	33238	3.5%	36814	3.2%	38520	3.2%	5487	16.6%
La Trobe	24930	2.8%	27208	2.8%	30571	2.7%	32179	2.7%	7249	29.1%
Melbourne	39378	4.4%	41827	4.4%	45448	4.0%	46867	3.9%	7489	19.0%
Monash	52010	5.8%	54950	5.7%	59925	5.3%	62550	5.2%	10540	20.3%
RMIT	38280	4.3%	38214	4.0%	49233	4.3%	51865	4.3%	13585	35.5%
Swinburne	14404	1.6%	16018	1.7%	22046	1.9%	23216	1.9%	8812	61.2%
Victoria / VUT	19475	2.2%	20393	2.1%	22471	2.0%	24063	2.0%	4588	23.6%
Other Institutions	436	0.0%	1321	0.1%	14922	1.3%	17138	1.4%	16702	3830.7%
Sub-total	**228561**	**25.5%**	**242951**	**25.4%**	**294318**	**25.9%**	**308041**	**25.8%**	**79480**	**34.8%**
Western Australia										
Curtin	33240	3.7%	38506	4.0%	43413	3.8%	45884	3.8%	12644	38.0%
Edith Cowan	23829	2.7%	23585	2.5%	26458	2.3%	27622	2.3%	3793	15.9%
Murdoch	12734	1.4%	13201	1.4%	17704	1.6%	18101	1.5%	5367	42.1%
Notre Dame	2832	0.3%	4787	0.5%	8317	0.7%	8853	0.7%	6021	212.6%
Western Australia	15885	1.8%	17082	1.8%	21907	1.9%	23119	1.9%	7234	45.5%
Other Institutions		0.0%	19	0.0%	3280	0.3%	3169	0.3%	3169	
Sub-total	**88520**	**9.9%**	**97180**	**10.2%**	**121079**	**10.7%**	**126748**	**10.6%**	**38228**	**43.2%**
Multi-State										
Australian Catholic	11894	1.3%	13263	1.4%	17969	1.6%	20004	1.7%	8110	68.2%
Other Institutions		0.0%	2336	0.2%	2699	0.2%	2813	0.2%	2813	
Sub-total	**11894**	**1.3%**	**15599**	**1.6%**	**20668**	**1.8%**	**22817**	**1.9%**	**10923**	**91.8%**
Total	**896621**	**100.0%**	**957177**	**100.0%**	**1134866**	**100.0%**	**1192657**	**100.0%**	**296036**	**33.0%**

Table 3.5 examines the situation according to primary enrolments by broad field of education. Over the period 2002 to 2010, Health, and Management and Commerce, two of the three largest fields of education increased in size the most, increasing their proportion of the total. Some other fields increased their proportion of the total by small amounts: Architecture, Creative Arts and Engineering. Other fields declined in relative proportions: Agriculture, Education, Information Technology, Natural and Physical Sciences and Society and Culture. 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 the decline in enrolments at the Australian Maritime College (See Table 3.4 for the overall pattern).
The most spectacular decline has been in Information Technology, although there was an increase between 2008 and 2009. Information Technology enrolments declined by 34.5 per cent between 2002 and 2010.

Table 3.5: Enrolments 2002 – 2010. Students by Broad Field of Education (Primary Course#)

	2002		2005		2009		2010		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Broad Field of Education										
Agriculture, Environmental & Rel.	18341	2.0%	17004	1.8%	17199	1.5%	18245	1.5%	-96	-0.5%
Architecture & Building	17756	2.0%	19697	2.1%	26043	2.3%	27533	2.3%	9777	55.1%
Creative Arts	53214	5.9%	58318	6.1%	75845	6.7%	79973	6.7%	26759	50.3%
Education	85149	9.5%	91273	9.5%	100503	8.9%	105416	8.8%	20267	23.8%
Engineering	59863	6.7%	64191	6.7%	77564	6.8%	83666	7.0%	23803	39.8%
Food, Hosp., Pers.	150	0.0%	90	0.0%	1148	0.1%	1099	0.1%	949	632.7%
Health	96318	10.7%	108360	11.3%	150800	13.3%	162611	13.6%	66293	68.8%
Information Technology	73402	8.2%	59825	6.3%	48153	4.2%	48068	4.0%	-25334	-34.5%
Management & Commerce	228789	25.5%	260748	27.2%	318468	28.1%	325508	27.3%	96719	42.3%
Natural & Physical Sciences	60601	6.8%	65204	6.8%	72789	6.4%	78858	6.6%	18257	30.1%
Society & Culture	178868	19.9%	188173	19.7%	217911	19.2%	232624	19.5%	53756	30.1%
Mixed Field	1893	0.2%	1861	0.2%	6513	0.6%	7577	0.6%	5684	300.3%
Non-Award	**22277**	**2.5%**	**22433**	**2.3%**	**21930**	**1.9%**	**21479**	**1.8%**	**-798**	**-3.6%**
Total	**896621**	**100.0%**	**957177**	**100.0%**	**1134866**	**100.00%**	**1192657**	**100.0%**	**296036**	**33.0%**

As is outlined in the next chapter, some students enrol concurrently 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 table) PLUS students enrolled in a Natural and Physical Sciences course as a supplementary course.

Enrolments in Management and Commerce programmes expanded the most over the period, by 42.3 per cent. There were nearly 97,000 more students enrolled in Management and Commerce courses at the end of the decade compared with 2002. Other 'winners' were Health (+66,293, or 68.8 per cent), Society and Culture (+53,756 or 30.1 per cent) and Creative Arts (+26,759 or 50.3 per cent). In the science and technology disciplines, Engineering (+23,803 or 39.8 per cent) and Natural and Physical Sciences (+18,257 or 30.1 per cent) increased. Declines in Agriculture and Information Technology were already mentioned. Although Natural and Physical Sciences enrolments and Society and Culture enrolments they increased considerably over the period, both grew at less than the system-wide average. Based on these broad figures, it can be observed that in a numerical sense, enrolments in courses in the Natural and Physical Sciences have almost held their ground this century. Of course, in societies where economic growth is based on innovation and technology-driven change, perhaps 'holding ground' is not good enough.

Onshore and offshore students

Students at Australian universities can study through campuses in Australia, or overseas. Most of the 1.13 million university students in 2009 were 'onshore' students, about 92.7 per cent of them. That is, the students in question undertake their studies in Australia. Almost 72 per cent of all students are domestic students, the remainder being international students (see also Table 3.2). Among domestic students, all but a few study in Australia, whether they are internal (i.e. 'on-campus' students), external (i.e. 'off-campus' students), or mixed mode (i.e., a bit of both). International students are more likely to be studying at Australian campuses overseas.

The relevant information to establish whether a student is studying in Australia or abroad comes through the postcode of the campus, as reported by universities. However, with international students, it is also necessary to establish whether a student has a student visa that provides the authorisation for them to study in Australia. The categories of student described in higher education statistics as 'domestic' students are a mixture of Australian citizens, permanent residents (including permanent humanitarian visa holders), and citizens of New Zealand. Students without these characteristics are classified as international students, and they are of two types. The first type holds of a student visa that permits access to Australia for a period of time to undertake studies. The other category has no visa, and therefore are unable to study onshore.

Table 3.6: Enrolments 2002, 2005 & 2009. Students in all Fields of Education by Citizenship Status, Attendance Mode and Campus Location (Onshore / Offshore)

	2002			2005			2009		
	On- shore	Off- shore	% On- shore	On- shore	Off- shore	% On- shore	On- shore	Off- shore	% On- shore
Domestic									
Internal	562122	348	99.9%	552179	553	99.9%	624875	1582	99.7%
External	112770	14	100.0%	110950	44	100.0%	125380	593	99.5%
Multi-modal	36309		100.0%	53949	6	100.0%	61303	163	99.7%
Sub-total	**711201**	**362**	**99.9%**	**717078**	**603**	**99.9%**	**811558**	**2338**	**99.7%**
International – Visa #									
Internal	112252	218	99.8%	152273	729	99.5%	218712	1194	99.5%
External	1712	34	98.1%	3395	133	96.2%	2665	43	98.4%
Multi-modal	2571	1	100.0%	5159	15	99.7%	8522	31	99.6%
Sub-total	**116535**	**253**	**99.8%**	**160827**	**877**	**99.5%**	**229899**	**1268**	**99.5%**
International – Other *									
Internal	11171	34409	24.5%	2619	53616	4.7%	1939	76290	2.5%
External	13401	8888	60.1%	11527	7648	60.1%	8554	1953	81.4%
Multi-modal	292	109	72.8%	309	2072	13.0%	417	650	39.1%
Sub-total	**24864**	**43406**	**36.4%**	**14455**	**63336**	**18.6%**	**10910**	**78893**	**12.1%**
All Students									
Internal	685545	34975	95.1%	707071	54898	92.8%	845526	79066	91.4%
External	127883	8936	93.5%	125872	7825	94.1%	136599	2589	98.1%
Multi-modal	39172	110	99.7%	59417	2093	96.6%	70242	844	98.8%
Total	**852600**	**44021**	**95.1%**	**892360**	**64816**	**93.2%**	**1052367**	**82499**	**92.7%**

Student has a temporary entry permit or is a diplomat or a dependent of a diplomat (except New Zealand) and resides in Australia
* International – Other: Not one of the categories of 'domestic' student, and student is residing outside Australia during the unit of study

Unfortunately, as can be seen in Table 3.6, some of the latter group of international students (that is, the ones with no visa to study onshore) were reported by universities as being 'onshore'. Strictly speaking, this is not possible, unless those students are enrolled as external students and studying by distance education. The most likely reason for these aberrations is that students changed visa status,

but this information was not updated and reported by their university. In 2002, for example, 11,171 students were reported as having no visa, but nonetheless were apparently studying as internal students. The suggestion that this was an error is supported by the fact that the number dropped considerably between 2002 and 2005, and again by 2009. The data in Tables 3.6 and 3.7 were drawn from special data sets purchased from DEEWR. The equivalent files for 2007 and 2008 were not available. The author already had files for 2002 to 2006, and colleagues from Monash University's Centre for Population and Urban Research had already obtained an equivalent file for 2009.

Table 3.7: Enrolments 2002, 2005 & 2009. Students in selected Fields of Education by Citizenship Status, Visa Type and Campus Location (Onshore / Offshore)

	2002			2005			2009		
	On- shore	Off- shore	% On-shore	On- shore	Off- shore	% On-shore	On- shore	Off- shore	% On-shore
Natural & Physical Sciences									
Domestic	53996	7	100.0%	56531	2	100.0%	59330	40	99.9%
International – Visa #	5241		100.0%	7928	16	99.8%	11082	27	99.8%
International – Other *	749	597	55.6%	936	1219	43.4%	406	1904	17.6%
Sub-total	**59986**	**604**	**99.0%**	**65395**	**1237**	**98.1%**	**70818**	**1971**	**97.3%**
Information Technology									
Domestic	42124	6	100.0%	29320	22	99.9%	21262	13	99.9%
International – Visa #	22609	34	99.8%	21606	244	98.9%	19290	136	99.3%
International – Other *	3320	5273	38.6%	1271	7362	14.7%	441	7011	5.9%
Sub-total	**68053**	**5313**	**92.8%**	**52197**	**7628**	**87.2%**	**40993**	**7160**	**85.1%**
Engineering									
Domestic	46273	2	100.0%	45431	9	100.0%	52845	10	100.0%
International – Visa #	10422	3	100.0%	13898	68	99.5%	19190	40	99.8%
International – Other *	1277	1886	40.4%	597	4188	12.5%	330	5149	6.0%
Sub-total	**57972**	**1891**	**96.8%**	**59926**	**4265**	**93.4%**	**72365**	**5199**	**93.3%**
Other Fields of Education									
Domestic	568808	347	99.9%	585796	570	99.9%	678121	2275	99.7%
International – Visa #	78263	216	99.7%	117395	549	99.5%	180337	1065	99.4%
International – Other *	19518	35650	35.4%	11651	50567	18.7%	9733	64829	13.1%
Sub-total	**666589**	**36213**	**94.8%**	**714842**	**51686**	**93.3%**	**868191**	**68169**	**92.7%**
All Fields of Education									
Domestic	711201	362	99.9%	717078	603	99.9%	811558	2338	99.7%
International – Visa #	116535	253	99.8%	160827	877	99.5%	229899	1268	99.5%
International – Other *	24864	43406	36.4%	14455	63336	18.6%	10910	78893	12.1%
Total	**852600**	**44021**	**95.1%**	**892360**	**64816**	**93.2%**	**1052367**	**82499**	**92.7%**

Student has a temporary entry permit or is a diplomat or a dependent of a diplomat (except New Zealand) and resides in Australia
* Not one of the categories of 'domestic' student, and student is residing outside Australia during the unit of study

This information is provided as background to show that few students enrolled in courses in the Natural and Physical Sciences tend to study offshore. However, the proportion of Engineering students at offshore campuses is only slightly below the national average, and information technology students are more likely (on average) to be studying offshore. However, in these three cases, the proportion has increased over the course of the decade.

What have been the drivers of these sector-wide enrolment trends?

One of the main drivers of the trends in higher education enrolments this decade has been the increasing number of enrolments by international students. Figure 2 enabled this to be plainly seen. Table 3.8 further makes the point by comparing enrolments by domestic and international students in those areas of higher education that have expanded more rapidly than others have. Between 2002 and 2009, there was an increase of nearly 136,000 enrolments by international students, and international students increased their proportion of all enrolments from 20.6 per cent, to 28.3 per cent between 2002 and 2009.

First, the influence on attendance type can be seen. The number of full-time international students increased by almost 129,000 between 2002 and 2009, a growth rate of 93.7 per cent. This should be compared with an increase of about 91,000, or 88.9 per cent for domestic students. The proportion of international students attending full time increased from 74.3 per cent to 83.0 per cent, and full-time international students' proportion of all full-time students increased from 23.9 per cent of all full-time enrolments in 2002, to 33.5 per cent in 2009.

Table 3.8: Enrolments 2002 & 2009. The impact on the expansion of enrolments by international students on enrolment trends by Attendance Type, Selected Universities and Selected Fields of Education

	International Student Enrolments						Growth 2002 -2009			
	2002			2009			Inter- national		Domestic	
	No.	% Of Internat. Enrol-ments	% of All Enrol-ments	No.	% Of Internat. Enrol-ments	% of All Enrol-ments	No.	% Of Internat. Enrol-ments	No.	% Of Domestic Enrol-ments
Attendance Type										
Full-time	137574	74.3%	23.9%	266520	83.0%	33.5%	128946	93.7%	90926	88.9%
Selected universities										
Curtin	11313	6.1%	34.0%	18143	5.7%	41.8%	6830	60.4%	3343	15.2%
Monash	14499	7.8%	27.9%	21114	6.6%	35.2%	6615	45.6%	1300	3.5%
Macquarie	6598	3.6%	24.2%	12402	3.9%	35.2%	5804	88.0%	2152	10.4%
RMIT	13371	7.2%	34.9%	24710	7.7%	50.2%	11339	84.8%	-386	-1.5%
Sydney	7378	4.0%	17.4%	11969	3.7%	23.7%	4591	62.2%	3536	10.1%
All Other Inst.	131899	71.3%	18.7%	232632	72.5%	25.9%	100733	76.4%	92388	60.2%
Field of Education										
Mgt & Commerce	81602	44.1%	35.7%	165807	51.7%	52.1%	84205	103.2%	5474	3.7%
Information Tech.	31236	16.9%	42.6%	26878	8.4%	55.8%	-4358	-14.0%	-20891	-49.5%
Engineering	13588	7.3%	22.7%	24709	7.7%	31.9%	11121	81.8%	6580	14.2%
Other FoE	58632	31.7%	11.0%	103576	32.3%	15.0%	44944	76.7%	111170	108.6%
Total	**185058**	**100.0%**	**20.6%**	**320970**	**100.0%**	**28.3%**	**135912**	**73.4%**	**102333**	**14.4%**

Second, some universities increased in size largely due to the expansion of international student enrolments. Most universities increased their numbers of international students, but growth was particularly influential at the universities shown in Table 3.6. RMIT showed the greatest numerical growth, increasing their international student enrolments by 11,339 between 2002 and 2009. This represented a growth rate of 84.8 per cent. At the same time, RMIT shed domestic student enrolments, having 386 fewer by 2009, compared with 2002. RMIT now has more international students than any other, having eclipsed Monash in 2006. At RMIT, international students are now in the majority (50.2 per cent), this proportion having been 34.9 per cent in 2002. Growth in the numbers of domestic students has been modest at the universities shown in Table 3.5, compare with the growth in international numbers.

Third, system-wide expansion has not been consistent across fields of education, with international students pushing Management and Commerce in particular. By 2009, over half of international students were enrolled in programmes in Management and Commerce, up from 44.1 per cent in 2002. These students are also in the majority, with 52.1 per cent of all enrolments in Management and Commerce programmes being by international students. However, this is a lower proportion of international students than is enrolled in Information Technology courses, but the actual number of enrolments in that field of education is declining. The decline among international students, however, is much less than the rate for domestic students. Although modest in comparison with Management and Commerce, international student enrolments have also had a major impact on Engineering. International students now make up 31.9 per cent of all enrolments in Engineering programmes, up from 22.7 per cent in 2002. The international student presence in other fields of education increased from 11.0 per cent to 15.0 per cent.

Student load: teaching and learning

So far, student enrolments in *courses* have been considered. This section looks at the *subjects* students study as part of those courses, for years 2002 to 2009. (Data for 2010 were not available at time of writing). Repeating a couple of points from Chapter 2, 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 termed '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 and subsequent domestic student tuition fees are calculated. A student taking more than (or less than) a standard year's workload will usually generate more than (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-disciplinary teaching and service teaching (provided by departments in one faculty to students in the courses of another). That is, the subjects students enrol in are neither necessarily restricted to a single discipline, nor to those taught by a single academic department or faculty. Table 3.9 shows how much of the teaching provided in Australia's universities is in the humanities and social sciences, via the 09 Society and Culture discipline group, and the large amount of service teaching that is provided to students enrolled in 08 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 03 Engineering and Related Technologies will study not only subjects from the engineering group, but might also study physics and mathematics, which are from the 01 Natural and Physical Sciences discipline group.

In the paragraphs below, tables consider the patterns of teaching and learning between 2002 and 2009, considering first the sector as a whole, followed by an examination of 'science' teaching, and then the pattern of study by students enrolled in 'science' courses.

Table 3.9 shows that in 2009, the 1.3 million full and part-time students enrolled in courses at Australia's public and private universities (and other institutions) shown in Table 3.1 studied subjects equivalent to 813,049 full time students. This represented an increase of more than 186,000 equivalent full-time students (or 29.7 per cent) between 2002 and 2009. The table also shows the disciplines of the subjects taught and 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 58,000 equivalent full time students between 2002 and 2009. The disciplines of Society and Culture and Health also increased considerably, by 37,600 and 37,081equivalent full time students, respectively.

The only discipline in which there was a decrease in teaching was Information Technology, which was taught to 15,030 fewer equivalent full time students in 2009 compared with 2002. Most disciplines maintained their relative proportion of total teaching, but the decline in Information Technology was offset by growth in Health and Management and Commerce.

Table 3.9: Student Load 2002 – 2009. Distribution of All Teaching by Broad Discipline Group

Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture, Environmental & Related	8704	1.4%	8675	1.3%	8850	1.2%	9906	1.2%	1202	13.8%
Architecture & Building	11970	1.9%	13476	2.0%	14980	2.1%	17667	2.2%	5697	47.6%
Creative Arts	46607	7.4%	48896	7.3%	52895	7.3%	62362	7.7%	15755	33.8%
Education	51547	8.2%	56065	8.3%	58844	8.1%	62204	7.7%	10657	20.7%
Engineering	36874	5.9%	39225	5.8%	41809	5.8%	49196	6.1%	12322	33.4%
Food, Hosp., Pers.	107	0.0%	160	0.0%	331	0.0%	678	0.1%	571	531.7%
Health	57512	9.2%	67099	10.0%	81637	11.2%	94594	11.6%	37081	64.5%
Information Technology	55237	8.8%	46667	6.9%	37821	5.2%	40207	4.9%	-15030	-27.2%
Management & Commerce	114663	18.3%	132784	19.7%	150088	20.7%	172673	21.2%	58010	50.6%
Natual & Physical Sciences	73735	11.8%	79297	11.8%	85722	11.8%	94618	11.6%	20883	28.3%
Society & Culture	169408	27.0%	181163	26.9%	191743	26.4%	207008	25.5%	37600	22.2%
Mixed Field	384	0.1%	585	0.1%	1172	0.2%	1936	0.2%	1552	404.4%
Total	**626749**	**100.0%**	**674093**	**100.0%**	**725892**	**100.0%**	**813049**	**100.0%**	**186301**	**29.7%**

Whereas Table 3.9 showed the level of *teaching* in each broad discipline area, Table 3.10 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 Information Technology and Agriculture courses. Obviously, this was principally because fewer students were enrolled in courses in those fields of education in 2009 than there had been in 2002 (see Table 3.5). The table also shows that the student load taught to students enrolled in Management and Commerce courses increased the most, by 76,883 equivalent full time students, or 53.0 per cent. (It can be seen in Table 3.8 that there had been an expansion in Management and Commerce enrolments of nearly 90,000 enrolments between 2002 and 2009).

A comparison of Tables 3.9 and 3.10 provides a rough indication of levels of service teaching. For example, Table 3.9 indicated that teaching in the Natural and Physical Sciences amounted to 94,618 equivalent full time students in 2009. In the same year, Table 3.10 shows that 57,277 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 students other than 'science' students.

Table 3.10: Student Load 2002 – 2009. Distribution of All Teaching by Broad Field of Education

Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture, Environmental & Rel.	12852	2.1%	11683	1.7%	10676	1.5%	11740	1.4%	-1111	-8.6%
Architecture & Building	13595	2.2%	15143	2.2%	17322	2.4%	20243	2.5%	6648	48.9%
Creative Arts	42184	6.7%	45641	6.8%	51013	7.0%	59004	7.3%	16820	39.9%
Education	60202	9.6%	65581	9.7%	69262	9.5%	71184	8.8%	10982	18.2%
Engineering	46895	7.5%	49205	7.3%	52624	7.2%	60544	7.4%	13648	29.1%
Food, Hosp., Pers.	131	0.0%	64	0.0%	366	0.1%	810	0.1%	679	517.5%
Health	71506	11.4%	82899	12.3%	99724	13.7%	115671	14.2%	44165	61.8%
Information Technology	51322	8.2%	41155	6.1%	31319	4.3%	33504	4.1%	-17818	-34.7%

Table 3.10: Student Load 2002 – 2009. Distribution of All Teaching by Broad Field of Education *continued*

Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Management & Commerce	145127	23.2%	171764	25.5%	194505	26.8%	222011	27.3%	76883	53.0%
Natural & Physical Sciences	47964	7.7%	51552	7.6%	52687	7.3%	57227	7.0%	9263	19.3%
Society & Culture	125711	20.1%	129669	19.2%	135983	18.7%	148638	18.3%	22927	18.2%
Mixed Field	1043	0.2%	1212	0.2%	1833	0.3%	3633	0.4%	2590	248.3%
Non-Award	8215	1.3%	8525	1.3%	8578	1.2%	8839	1.1%	624	7.6%
Total	**626749**	**100.0%**	**674093**	**100.0%**	**725892**	**100.0%**	**813049**	**100.0%**	**186301**	**29.7%**

More detail on this point is available from Table 3.11, which shows the nominal and proportional distribution of teaching and learning, respectively, in 2009.

Table 3.11: Student Load 2009. Teaching and Learning Matrix of Teaching in All Disciplines to students enrolled in All Fields of Education – EFTSL

Teaching in discipline of:	Courses in field of education of:											
	Agri-culture	Archi-tecture	Crea-tive Arts	Educa-tion	Engi-neer-ing	Health	IT	Mgt & Comm.	N & P Sci-ences	Society & Cul-ture.	Other #	Total
Number												
Agriculture, Environmental & Rel.	5939	436	33	256	313	330	65	368	1571	489	106	9906
Architecture & Building	516	15383	534	28	285	6	17	651	51	120	78	17667
Creative Arts	64	1047	45634	2003	352	302	1158	2985	409	7332	1075	62362
Education	39	4	501	57419	18	492	55	277	360	2092	948	62204
Engineering	398	841	612	136	42992	141	1316	1086	1204	162	308	49196
Health	133	18	52	1420	116	87892	18	521	2486	1449	487	94594
Information Technology	84	284	1344	284	2504	87	25743	7593	858	830	596	40207
Management & Commerce	385	750	2853	308	2392	1166	2410	151532	1055	7221	2601	172673
Natural & Physical Sciences	3253	200	340	2521	9916	18945	1577	8165	43403	4620	1679	94619
Society & Culture	929	1281	7071	6795	1616	6199	1088	48202	5811	124219	3796	207008
Other #			30	10	40	112	57	631	18	104	1608	2614
Total	11740	20243	59004	71184	60544	115671	33504	222011	57227	148638	13283	813050
Per Cent												
Agriculture, Environmental & Rel.	60.0%	4.4%	0.3%	2.6%	3.2%	3.3%	0.7%	3.7%	15.9%	4.9%	1.1%	100.0%
Architecture & Building	2.9%	87.1%	3.0%	0.2%	1.6%	0.0%	0.1%	3.7%	0.3%	0.7%	0.4%	100.0%
Creative Arts	0.1%	1.7%	73.2%	3.2%	0.6%	0.5%	1.9%	4.8%	0.7%	11.8%	1.7%	100.0%
Education	0.1%	0.0%	0.8%	92.3%	0.0%	0.8%	0.1%	0.4%	0.6%	3.4%	1.5%	100.0%
Engineering	0.8%	1.7%	1.2%	0.3%	87.4%	0.3%	2.7%	2.2%	2.4%	0.3%	0.6%	100.0%
Health	0.1%	0.0%	0.1%	1.5%	0.1%	92.9%	0.0%	0.6%	2.6%	1.5%	0.5%	100.0%
Information Technology	0.2%	0.7%	3.3%	0.7%	6.2%	0.2%	64.0%	18.9%	2.1%	2.1%	1.5%	100.0%
Management & Commerce	0.2%	0.4%	1.7%	0.2%	1.4%	0.7%	1.4%	87.8%	0.6%	4.2%	1.5%	100.0%
Natural & Physical Sciences	3.4%	0.2%	0.4%	2.7%	10.5%	20.0%	1.7%	8.6%	45.9%	4.9%	1.8%	100.0%
Society & Culture	0.4%	0.6%	3.4%	3.3%	0.8%	3.0%	0.5%	23.3%	2.8%	60.0%	1.8%	100.0%
Other #	0.0%	0.0%	1.1%	0.4%	1.5%	4.3%	2.2%	24.1%	0.7%	4.0%	61.5%	100.0%
Total	**1.4%**	**2.5%**	**7.3%**	**8.8%**	**7.4%**	**14.2%**	**4.1%**	**27.3%**	**7.0%**	**18.3%**	**1.6%**	**100.0%**

Other includes Food, Hospitality...., Mixed Fields and Non-Award Course students

In particular, perusal of Table 3.11 shows that there is more service teaching in science disciplines than in any other. Reading from the row [Natural & Physical Sciences] that represents teaching in science disciplines, it can be seen that only 45.9 per cent of this teaching went to students in science courses. Perhaps this is an obvious state of affairs, because subjects such as mathematics,

chemistry, biology and physics will often be part of courses in fields of education other than science. For example, Table 3.11 shows that 20.0 per cent of 'science' teaching went to students enrolled in Health courses, 10.5 per cent to Engineering students and 8.6 per cent to Management and Commerce students.

Three other disciplines are also responsible for high levels of service teaching: Agriculture, Environmental and Related Studies (40.0 per cent), Information Technology (36 per cent) and Society and Culture (40 per cent). In the case of Agriculture, 15.9 per cent of teaching went to students in science courses, with over four per cent going to students in Architecture and Society and Culture, respectively. Over 23 per cent of Society and Culture teaching went to students in courses in Management and Commerce and nearly 19 per cent of Information Technology Teaching also went to students in Management and Commerce.

Course completions: higher education outputs 2002 – 2009

For both students and universities, the desired outcome of study in a university programme is for a course completion, in the form of the awarding of a degree, diploma or certificate. Course completions are a lagging indicator, because statistics of course completions are reported by universities in the year following the year of completion.

Figure 3 provides a summary of the number of course completions between 2002 and 2009 (plotted against the axis on the left-hand side), and the proportion of these completions by course level on the right. The growth from about 200,000 completions per year in 2002 has increased to over 270,000 per year by 2009. The lines on the graph indicate a decline in the proportion of the total made up by undergraduate completions and the reciprocal increase in the proportion of completions in courses at the other postgraduate level.

Figure 3: Course Completions 2002 -2009 – All Course Levels

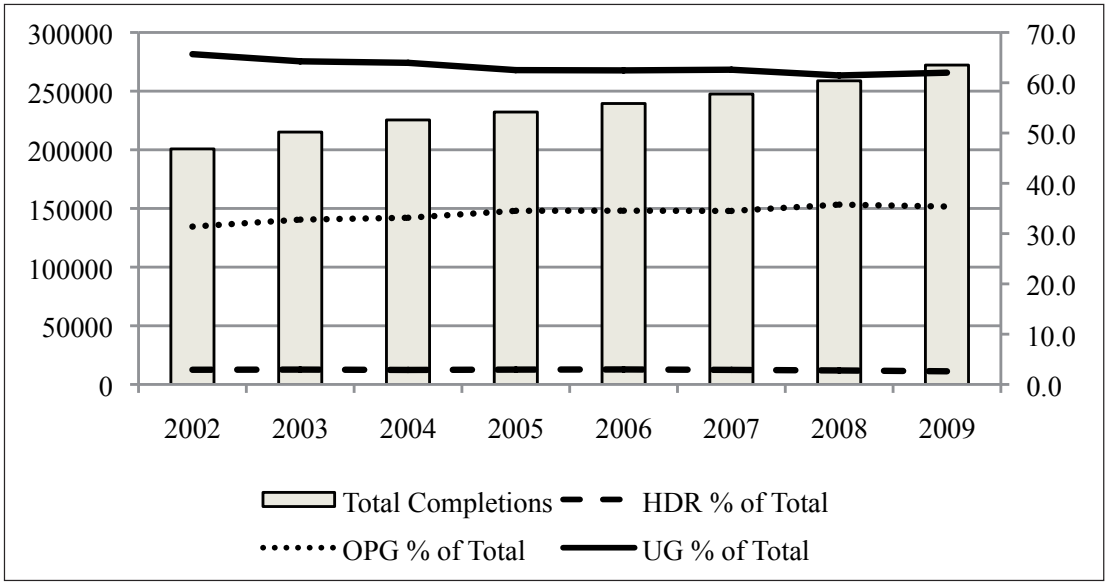


Table 3.12: Course Completions 2002 – 2009. Completions in All Fields of Education by Course Level

Course Level	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Higher Degree by Research										
Higher Doctorate	21	0.0%	32	0.0%	28	0.0%	29	0.0%	8	38.1%
PhD	4291	2.1%	5244	2.3%	5721	2.3%	5796	2.1%	1505	35.1%
Master's by Research	1551	0.8%	1576	0.7%	1420	0.6%	1296	0.5%	-255	-16.4%
Sub-total	**5863**	**2.9%**	**6852**	**3.0%**	**7169**	**2.9%**	**7121**	**2.6%**	**1258**	**21.5%**
Other P/G										
Doctorate by Coursework	103	0.1%	267	0.1%	274	0.1%	264	0.1%	161	156.3%
Master's by Coursework	34153	17.0%	49695	21.4%	52029	21.0%	59696	21.9%	25543	74.8%
Postgraduate Qualifying	155	0.1%	79	0.0%	26	0.0%	58	0.0%	-97	-62.6%
Postgraduate Dip – New	13992	7.0%	14124	6.1%	14038	5.7%	13835	5.1%	-157	-1.1%
Postgraduate Dip – Cont.	4837	2.4%	4955	2.1%	5787	2.3%	7463	2.7%	2626	54.3%
Graduate Certificate	9777	4.9%	11066	4.8%	13264	5.4%	15004	5.5%	5227	53.5%
Sub-total	**62914**	**31.3%**	**79919**	**34.4%**	**85144**	**34.4%**	**96056**	**35.3%**	**33142**	**52.7%**
Undergraduate										
Bachelor's Graduate Entry	4355	2.2%	4244	1.8%	3908	1.6%	3252	1.2%	-1103	-25.3%
Bachelor's Honours	9210	4.6%	10005	4.3%	10162	4.1%	10146	3.7%	936	10.2%
Bachelor's	113268	56.4%	127109	54.7%	129970	52.5%	141322	51.9%	28054	24.8%
Associate Degree	443	0.2%	401	0.2%	1735	0.7%	1845	0.7%	1402	316.5%
Advanced Diploma	1217	0.6%	998	0.4%	1116	0.5%	1395	0.5%	178	14.6%
Diploma	1862	0.9%	1394	0.6%	7213	2.9%	10135	3.7%	8273	444.3%
Other U/G	1509	0.8%	999	0.4%	835	0.3%	694	0.3%	-815	-54.0%
Sub-total	**131864**	**65.7%**	**145150**	**62.5%**	**154939**	**62.6%**	**168789**	**62.0%**	**36925**	**28.0%**
Total	**200744**	**100.0%**	**232188**	**100.0%**	**247526**	**100.0%**	**272230**	**100.0%**	**71486**	**35.6%**

Table 3.12 provides numerical advice about system-wide course completions by course level. The general pattern of change by each course level could be discerned from Figure 3, but Table 3.12 shows that the biggest proportionate growth occurred among *other postgraduate* course completions. There was an increase of 33,303 completions, or 52.8 per cent between 2002 and 2009. During the period, other postgraduate course completions increased from 31.4 per cent to 35.4 per cent. This roughly corresponds to the relative proportionate decline of course completions at the undergraduate level.

Table 3.13 examines the distribution of system-wide course completions by gender and citizenship status. Women represented 56.2 per cent of all course completions in 2009, up from 55.5 per cent in 2002. The number of female completers increased by 37.4 per cent (+41,670) compared with 33.4 per cent among men (+29,816).

As was the case with enrolment trends, there has been strong growth in the number of international students completing university qualifications. The number of international completions nearly doubled between 2002 and 2009, and the rate of increase far outstripped that for domestic students. The international proportion of course completions increased from 24.5 per cent in 2002, to 35.7 per cent in 2009. Part of the reason for this is likely to be that a higher proportion of international students than domestic students are enrolled full-time.

Table 3.13: Course Completions 2002 – 2009: Completions in All Fields of Education by Gender and Citizenship Status

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Gender										
Female	111427	55.5%	129615	55.8%	138442	55.9%	153097	56.2%	41670	37.4%
Male	89317	44.5%	102573	44.2%	109084	44.1%	119133	43.8%	29816	33.4%
Citizenship Status #										
International	49192	24.5%	69373	29.9%	81596	33.0%	97160	35.7%	47968	97.5%
Domestic	151552	75.5%	162815	70.1%	165930	67.0%	175070	64.3%	23518	15.5%
Total	**200744**	**100.0%**	**232188**	**100.0%**	**247526**	**100.0%**	**272230**	**100.0%**	**71486**	**35.6%**

Blanks Incl. in Domestic: 2005 11; 2007 250.

Table 3.14 shows the number of course completions by university within state / territory. Naturally, larger institutions have more course completers, so it is not surprise that Monash produced the most graduates in 2009, ahead of the Universities of Melbourne and Sydney. There is some equalisation at the top, however, with Sydney increasing its number of course completers by more than either Monash or Melbourne, and by more than double the rate of those universities. The biggest increase over the period was experienced by RMIT. This is probably linked to RMIT's expanded number of international students.

Table 3.14: Course Completions 2002 – 2009. Completions by State / Territory and University

State & Institution	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Australian Capital Territory										
Australian Defence	428	0.2%	514	0.2%		0.0%		0.0%	-428	
Australian National	2655	1.3%	3996	1.7%	4284	1.7%	4701	1.7%	2046	77.1%
Canberra	2822	1.4%	3463	1.5%	2932	1.2%	2878	1.1%	56	2.0%
Other Institutions #			3							
Sub-total	**5905**	**2.9%**	**7976**	**3.4%**	**7216**	**2.9%**	**7579**	**2.8%**	**1674**	**28.3%**
New South Wales										
Charles Sturt	7433	3.7%	7415	3.2%	7727	3.1%	7229	2.7%	-204	-2.7%
Macquarie	5946	3.0%	7581	3.3%	8156	3.3%	8419	3.1%	2473	41.6%
New England	2858	1.4%	3825	1.6%	3681	1.5%	3453	1.3%	595	20.8%
New South Wales	9040	4.5%	9318	4.0%	9271	3.7%	9787	3.6%	747	8.3%
Newcastle	4533	2.3%	5406	2.3%	5616	2.3%	5895	2.2%	1362	30.0%
Southern Cross	2657	1.3%	2578	1.1%	2589	1.0%	3318	1.2%	661	24.9%
Sydney	8777	4.4%	13067	5.6%	12269	5.0%	13445	4.9%	4668	53.2%
Uni. Tech. Sydney	7613	3.8%	10433	4.5%	8329	3.4%	8804	3.2%	1191	15.6%
Western Sydney	9607	4.8%	8657	3.7%	8180	3.3%	7953	2.9%	-1654	-17.2%
Wollongong	4063	2.0%	5698	2.5%	5914	2.4%	6068	2.2%	2005	49.3%
Other Institutions #	317	0.2%	1004	0.4%	5258	2.1%	8985	3.3%	8668	2734.4%
Sub-total	**62844**	**31.3%**	**74982**	**32.3%**	**76990**	**31.1%**	**83356**	**30.6%**	**20512**	**32.6%**
Northern Territory										
Batchelor	73	0.0%	70	0.0%	69	0.0%	23	0.0%	-50	-68.5%
Charles Darwin/NTU	933	0.5%	717	0.3%	873	0.4%	850	0.3%	-83	-8.9%
Sub-total	**1006**	**0.5%**	**787**	**0.3%**	**942**	**0.4%**	**873**	**0.3%**	**-133**	**-13.2%**

Table 3.14: Course Completions 2002 – 2009. Completions by State / Territory and University *continued*

State & Institution	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Queensland										
Bond	7	0.0%	1040	0.4%	1116	0.5%	1379	0.5%	1372	19600%
Central Queensland	5802	2.9%	5366	2.3%	6595	2.7%	4637	1.7%	-1165	-20.1%
Griffith	6278	3.1%	7809	3.4%	8717	3.5%	9860	3.6%	3582	57.1%
James Cook	2016	1.0%	2586	1.1%	2898	1.2%	3894	1.4%	1878	93.2%
Queensland	8301	4.1%	8843	3.8%	8681	3.5%	9005	3.3%	704	8.5%
QUT	8819	4.4%	9760	4.2%	9492	3.8%	9987	3.7%	1168	13.2%
Southern Queensland	3637	1.8%	4172	1.8%	5160	2.1%	5331	2.0%	1694	46.6%
Sunshine Coast	634	0.3%	1027	0.4%	1226	0.5%	1277	0.5%	643	101.4%
Other Institutions #		0.0%	154	0.1%	1096	0.4%	1483	0.5%	1483	
Sub-total	35494	17.7%	40757	17.6%	44981	18.2%	46853	17.2%	11359	32.0%
South Australia										
Adelaide	**4126**	**2.1%**	**4575**	**2.0%**	**5245**	**2.1%**	**5224**	**1.9%**	**1098**	**26.6%**
South Australia	6377	3.2%	7961	3.4%	8450	3.4%	9575	3.5%	3198	50.1%
Flinders	3439	1.7%	3792	1.6%	4141	1.7%	4514	1.7%	1075	31.3%
Other Institutions #		0.0%	127	0.1%	628	0.3%	1103	0.4%	1103	
Sub-total	**13942**	**6.9%**	**16455**	**7.1%**	**18464**	**7.5%**	**20416**	**7.5%**	**6474**	**46.4%**
Tasmania										
Australian Maritime	923	0.5%	441	0.2%	351	0.1%		0.0%	-923	
Tasmania	3104	1.5%	3177	1.4%	4112	1.7%	4336	1.6%	1232	39.7%
Other Institutions #		0.0%		0.0%	5	0.0%	13	0.0%	13	
Sub-total	**4027**	**2.0%**	**3618**	**1.6%**	**4468**	**1.8%**	**4349**	**1.6%**	**322**	**8.0%**
Victoria										
Ballarat	2104	1.0%	2461	1.1%	3242	1.3%	3036	1.1%	932	44.3%
Deakin	6697	3.3%	8041	3.5%	7617	3.1%	8489	3.1%	1792	26.8%
La Trobe	6189	3.1%	7553	3.3%	7676	3.1%	8324	3.1%	2135	34.5%
Melbourne	11259	5.6%	12851	5.5%	13199	5.3%	13969	5.1%	2710	24.1%
Monash	13166	6.6%	14362	6.2%	15438	6.2%	16546	6.1%	3380	25.7%
RMIT	7827	3.9%	7780	3.4%	8410	3.4%	12909	4.7%	5082	64.9%
Swinburne	2944	1.5%	3068	1.3%	3629	1.5%	4573	1.7%	1629	55.3%
Victoria / VUT	4099	2.0%	5080	2.2%	4037	1.6%	4762	1.7%	663	16.2%
Other Institutions #	75	0.0%	250	0.1%	2273	0.9%	4463	1.6%	4388	5850.7%
Sub-total	**54360**	**27.1%**	**61446**	**26.5%**	**65521**	**26.5%**	**77071**	**28.3%**	**22711**	**41.8%**
Western Australia										
Curtin	8084	4.0%	8697	3.7%	9842	4.0%	10622	3.9%	2538	31.4%
Edith Cowan	4950	2.5%	5840	2.5%	5679	2.3%	6239	2.3%	1289	26.0%
Murdoch	2875	1.4%	2702	1.2%	2913	1.2%	2931	1.1%	56	1.9%
Notre Dame	503	0.3%	672	0.3%	917	0.4%	1569	0.6%	1066	211.9%
Western Australia	3957	2.0%	4425	1.9%	4209	1.7%	4714	1.7%	757	19.1%
Other Institutions #		0.0%		0.0%	1149	0.5%	1076	0.4%	1076	
Sub-total	**20369**	**10.1%**	**22336**	**9.6%**	**24709**	**10.0%**	**27151**	**10.0%**	**6782**	**33.3%**
Multi-State										
Australian Catholic	2797	1.4%	3480	1.5%	3844	1.6%	4194	1.5%	1397	49.9%
Other Institutions #		0.0%	351	0.2%	391	0.2%	388	0.1%	388	
Sub-total	**2797**	**1.4%**	**3831**	**1.6%**	**4235**	**1.7%**	**4582**	**1.7%**	**1785**	**63.8%**
Total	**200744**	**100.0%**	**232188**	**100.0%**	**247526**	**100.0%**	**272230**	**100.0%**	**71486**	**35.6%**

Table 3.15 presents the number of course completions by *broad* field of education. There were fewer graduations in Agriculture, Environmental and Related Studies in 2009 than in 2002, as was also the case with Information Technology. Whereas there has been year-by-year decline since 2003 in Information Technology, the number of completions in Agriculture now seems to be on the way up. As elsewhere, Management and Commerce experienced the largest increase. Numbers increased by 35,520, or 63.4 per cent over the period. The next largest increases were in Health (+11,536, or 48.5 per cent) and Society and Culture (+11,591, or 32.2 per cent). The increase in the number of completions in the Creative Arts was the next highest (+6,237 or 51.7 per cent), followed by Engineering (+3,367 or 31.5 per cent), then Natural and Physical Sciences (+3,009 or 22.9 per cent).

Table 3.15: Course Completions 2002-2009. Completions by Broad Field of Education (Primary Course Only)

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Field of Education										
Agriculture, Environmental & Rel.	3870	1.9%	3735	1.6%	3379	1.4%	3546	1.3%	-324	-8.4%
Architecture & Building	4168	2.1%	4515	1.9%	4715	1.9%	5862	2.2%	1694	40.6%
Creative Arts	12070	6.0%	15475	6.7%	15924	6.4%	18307	6.7%	6237	51.7%
Education	22993	11.5%	25805	11.1%	26668	10.8%	27589	10.1%	4596	20.0%
Engineering	10696	5.3%	12673	5.5%	12845	5.2%	14063	5.2%	3367	31.5%
Food, Hosp., Pers.	36	0.0%	28	0.0%	213	0.1%	485	0.2%	449	1247.2%
Health	23808	11.9%	26707	11.5%	30470	12.3%	35344	13.0%	11536	48.5%
Information Technology	18087	9.0%	17670	7.6%	13779	5.6%	11970	4.4%	-6117	-33.8%
Management & Commerce	56035	27.9%	68489	29.5%	78833	31.9%	91555	33.6%	35520	63.4%
Natural & Physical Sciences	13158	6.6%	15244	6.6%	16083	6.5%	16167	5.9%	3009	22.9%
Society & Culture	35823	17.9%	41847	18.0%	44617	18.0%	47342	17.4%	11519	32.2%
Total	**200744**	**100.0%**	**232188**	**100.0%**	**247526**	**100.0%**	**272230**	**100.0%**	**71486**	**35.6%**

Obviously, the larger fields of education have the most enrolments, and subsequently generate the most course completions. Using figures calculated from Table 3.12, Management and Commerce produced the most graduates and diplomats in 2009, and its proportion of the total increased from 27.9 per cent in 2002 to 33.6 per cent in 2009. Other changes between 2002 and 2009 have been less spectacular, with the possible exception of information technology. It produced 9.0 per cent of course completers in 2002, but by 2009, it had dropped to 4.4 per cent. The proportion of course completions in health increased from 11.9 per cent to 13.0 per cent, but in general, most fields of education declined relatively, including the proportion of course completions in the Natural and Physical Sciences. These declined from 6.6 per cent to 5.9 per cent between 2002 and 2009.

The next chapter provide additional detail on enrolments, student load and course completions by students enrolled in programmes in the Natural and Physical Sciences, and the one following examines teaching in the Natural and Physical Sciences.

Chapter 4

How many 'science' students are there, what do they do, and how many complete?

This chapter takes a closer look at science students since 2002. Data for years 2002 to 2009 have been extracted from the DEEWR aggregated data sets of enrolments, student load and course completions.

Science – a summary

Some Australian university students enrol in two university programmes simultaneously. An example of one of the more common 'combined course' enrolments is the many university students enrolled in a law degree while being enrolled in an arts, commerce/economics or science degree. Therefore, the total number of 'science' students is greater than was shown in Table 3.5, because some students are enrolled in science as a supplementary course. For purposes of simplicity, 'science students' should be taken as being those students enrolled in a course, whether as a primary or supplementary enrolment, in the 01 Natural and Physical Sciences field of education.

Table 4.1 shows that in 2009, there were 82,158 science students, comprising 72,789 students enrolled in a science programme as a primary course, of which 66,994 were enrolled in a single course only, and 9,369 students enrolled in a science programme as a supplementary course.

Table 4.1: Enrolments 2002 – 2009. Students enrolled in Natural and Physical Sciences Courses by Primary Course and Supplementary Course

Broad Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Enrolled in a N&P Sciences Course as a primary course										
Single Natural & Physical Sciences Course Only	54572	80.0%	59232		61555	79.7%	66994	81.5%	12422	22.8%
Agriculture, Environmental & Rel.	33	0.0%	23		21	0.0%	17	0.0%	-16	-48.5%
Creative Arts	22	0.0%	29		27	0.0%	38	0.0%	16	72.7%
Education	382	0.6%	625		671	0.9%	804	1.0%	422	110.5%
Engineering	851	1.2%	669		704	0.9%	745	0.9%	-106	-12.5%
Health	59	0.1%	141		206	0.3%	181	0.2%	122	206.8%
Information Technology	328	0.5%	365		287	0.4%	238	0.3%	-90	-27.4%
Management & Commerce	873	1.3%	850		720	0.9%	614	0.7%	-259	-29.7%
Natural & Physical Sciences	587	0.9%	514		562	0.7%	669	0.8%	82	14.0%
Society & Culture	2894	4.2%	2756		2663	3.4%	2489	3.0%	-405	-14.0%
Sub-total – Primary	60601	88.9%	65204		67416	87.3%	72789	88.6%	12188	20.1%
Enrolled in a Natural & Physical Sciences Course as a supplementary course										
Natural & Physical Sciences	7587	11.1%			9770	12.7%	9369	11.4%	1782	23.5%
Total enrolments in a science course	**68188**	**100.0%**			**77195**	**100.0%**	**82158**	**100.0%**	**13970**	**20.5%**

Subsequent enrolment tables in this chapter are concerned with these 82,158 enrolments in 2009, and the equivalent numbers in other years. The growth in science enrolments overall was 20.5 per cent, (which should be compared with the growth in enrolments of science primary enrolments of 20.1 per cent). The tables that follow identify changes in science enrolments according to a range of variables since 2002.

Table 4.2 examines enrolments in science programmes according to course level.

Table 4.2: Enrolments 2002 – 2009. Students enrolled in Natural and Physical Sciences Courses by Course Level

Course Level	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Higher Degree by Research										
PhD	6553	9.6%	8122	10.9%	8677	11.2%	9163	11.2%	2610	39.8%
Master's by Research	1081	1.6%	973	1.3%	928	1.2%	957	1.2%	-124	-11.5%
Sub-total	**7634**	**11.2%**	**9095**	**12.2%**	**9605**	**12.4%**	**10120**	**12.3%**	**2486**	**32.6%**
Other Postgraduate										
Doctorate by Coursework	7	0.0%	10	0.0%	17	0.0%	9	0.0%	2	28.6%
Master's by Coursework	1690	2.5%	2102	2.8%	3002	3.9%	4151	5.1%	2461	145.6%
Postgraduate Qualifying	48	0.1%	40	0.1%	20	0.0%	15	0.0%	-33	-68.8%
Postgraduate Diploma – New	574	0.8%	611	0.8%	657	0.9%	711	0.9%	137	23.9%
Postgraduate Diploma – Ext.	402	0.6%	511	0.7%	600	0.8%	681	0.8%	279	69.4%
Graduate Certificate	544	0.8%	599	0.8%	875	1.1%	981	1.2%	437	80.3%
Sub-total	**3265**	**4.8%**	**3873**	**5.2%**	**5171**	**6.7%**	**6548**	**8.0%**	**3283**	**100.6%**
Undergraduate										
Bachelor's Graduate Entry	101	0.1%	39	0.1%	48	0.1%	27	0.0%	-74	-73.3%
Bachelor's (Hons.)	3230	4.7%	3262	4.4%	3503	4.5%	3567	4.3%	337	10.4%
Bachelor's	53123	77.9%	57862	77.6%	58421	75.7%	61047	74.3%	7924	14.9%
Associate Degree	15	0.0%	18	0.0%	113	0.1%	208	0.3%	193	
Advanced. Diploma	46	0.1%	45	0.1%	20	0.0%	105	0.1%	59	128.3%
Diploma	150	0.2%	92	0.1%	174	0.2%	402	0.5%	252	168.0%
Other Undergraduate	564	0.8%	125	0.2%	41	0.1%	32	0.0%	-532	-94.3%
Enabling Course	60	0.1%	162	0.2%	99	0.1%	102	0.1%	42	70.0%
Sub-total	**57289**	**84.0%**	**61605**	**82.6%**	**62419**	**80.9%**	**65490**	**79.7%**	**8201**	**14.3%**
Total	**68188**	**100.0%**	**74573**	**100.0%**	**77195**	**100.0%**	**82158**	**100.0%**	**13970**	**20.5%**

By comparing Table 4.2 with Table 3.1, it is possible to calculate that higher degrees by research are a higher proportion of enrolments in science than in fields of education overall. In the case of science, research degree enrolments comprised 11.2 per cent of all science enrolments in 2002, increasing to 12.3 per cent by 2009. During this period, research degree enrolments in science increased by 2,486, or 32.6 per cent. System-wide growth at this level was 26.1 per cent, and higher degree by research enrolments declined from 4.9 per cent of the total in 2002, to 4.6 per cent in 2009. The number of master's by research enrolments is in decline, but rather than this being a reflection of a decline in science, it is a reflection of a broader fashion. The number of enrolments in master's by research courses has declined in every field of education.

At the Other Postgraduate level, there has been strong proportionate growth in science enrolments (100.6 per cent), off a low base. The enrolments at this level in 2009 represented 2.6 per cent of all university enrolments whereas science enrolments at all course levels were about 7.2 per cent. In science, an additional 2,461 students were enrolled in these courses in master's by coursework programmes in 2009 compared with 2002, an increase of 145.6 per cent. The system-wide increase was 57.0 per cent.

Expansion in undergraduate science enrolments was lower than the overall pattern. The 2002 to 2009 period saw an increase of 8,201 or 14.3 per cent. Overall, undergraduate numbers increased by more than 24 per cent between 2002 and 2009. Within science, undergraduate enrolments declined from 84.0 per cent in 2002 to 79.7 per cent in 2009. Bachelor degree enrolments in science courses (including graduate entry and honours bachelor degree courses) increased in number from 56,454 to 64,641 between 2002 and 2009, but this represented a growth rate of only about 14.5 per cent. This compares with the system-wide growth rate for bachelor degree enrolments of 20.4 per cent. Science is behind the pace!

What Table 4.2 does show is that insofar as science enrolments are concerned, growth has been stronger at the levels of PhD, master's by coursework and bachelor's (increases of 2,610, 2,461 and 8,187 enrolments, respectively). These increases represent 39.8 per cent, 145.6 per cent and 14.5 per cent, respectively. The table also shows that science PhDs have increased their proportion of all science enrolments from 9.6 per cent in 2002 to 11.2 per cent in 2009. Similarly, master's by coursework enrolments increased from 2.5 per cent to 5.1 per cent in the same period.

Table 4.3 examines the science student population by gender, citizenship status and Indigenous status. Women are in the majority as they are in all fields of education but engineering and information technology, representing about 52 per cent throughout the decade. The proportion of women declined very slightly each year since 2006. Across the system, the proportion of women increased by 28.9 per cent. In science, it was by 18.7 per cent. It should be noted that the rate of increase by male students in science (+22.5 per cent) was also less than the sector average for the period 2002 – 2009 (+23.7 per cent).

Table 4.3: Enrolments 2002 – 2009. Students enrolled in Natural and Physical Sciences Courses by Gender, Citizen Status, Attendance Mode, Attendance Type and Indigenous status

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Gender										
Female	35693	52.3%	39284	52.7%	40179	52.0%	42352	51.5%	6659	18.7%
Male	32495	47.7%	35289	47.3%	37016	48.0%	39806	48.5%	7311	22.5%
Citizenship Status										
International	6937	10.2%	10370	13.9%	11937	15.5%	14296	17.4%	7359	106.1%
Domestic	61251	89.8%	64203	86.1%	65258	84.5%	67862	82.6%	6611	10.8%
Attendance Mode										
Internal	61706	90.5%	66226	88.8%	68034	88.1%	73209	89.1%	11503	18.6%
External	4627	6.8%	4809	6.4%	5127	6.6%	5069	6.2%	442	9.6%
Multi-Modal	1855	2.7%	3538	4.7%	4034	5.2%	3880	4.7%	2025	109.2%
Attendance Type										
Full-time	52868	77.5%	59030	79.2%	60847	78.8%	65475	79.7%	12607	23.8%
Part-time	15320	22.5%	15543	20.8%	16348	21.2%	16683	20.3%	1363	8.9%
Total	**68188**	**100.0%**	**74573**	**100.0%**	**77195**	**100.0%**	**82158**	**100.0%**	**13970**	**20.5%**

International students constituted 10.2 per cent in 2002, rising to 17.4 per cent by 2009, so the Natural & Physical Sciences are lagging in the regard. The growth rate over the period by international students was 106.1 per cent, compared with only 10.8 per cent for domestic students. The rate of increase of domestic students was only half the rate it was for all students. Even though the proportion of international students in science increased strongly, it must be remembered that overall, international students were 28.3 per cent of all enrolments in 2009.

Science students are overwhelmingly internal students (that is, on-campus), but across the decade the rate moved from 90.5 per cent to 89.1 per cent. This proportion compares with the 80 per cent that pertains system-wide.

Similarly, science students tend to be enrolled full-time, and the proportion increased slightly between 2002 and 2009, from 77.5 per cent to 79.7 per cent. Within universities overall, 70.0 per cent of students were enrolled full-time in 2009, up from 64.1 per cent in 2002.

There are few Indigenous students in science courses, just as is the case overall. However, the science rate is about 0.5 per cent, compared to the system-wide proportion of about 0.9 per cent.

Examining major trends graphically, Figure 4 shows the proportionate increase in numbers of overseas students and full-time students, and the relative consistency of the other variables examined.

Figure 4: Proportion of enrolments in Natural and Physical Sciences courses represented by certain groups of students.

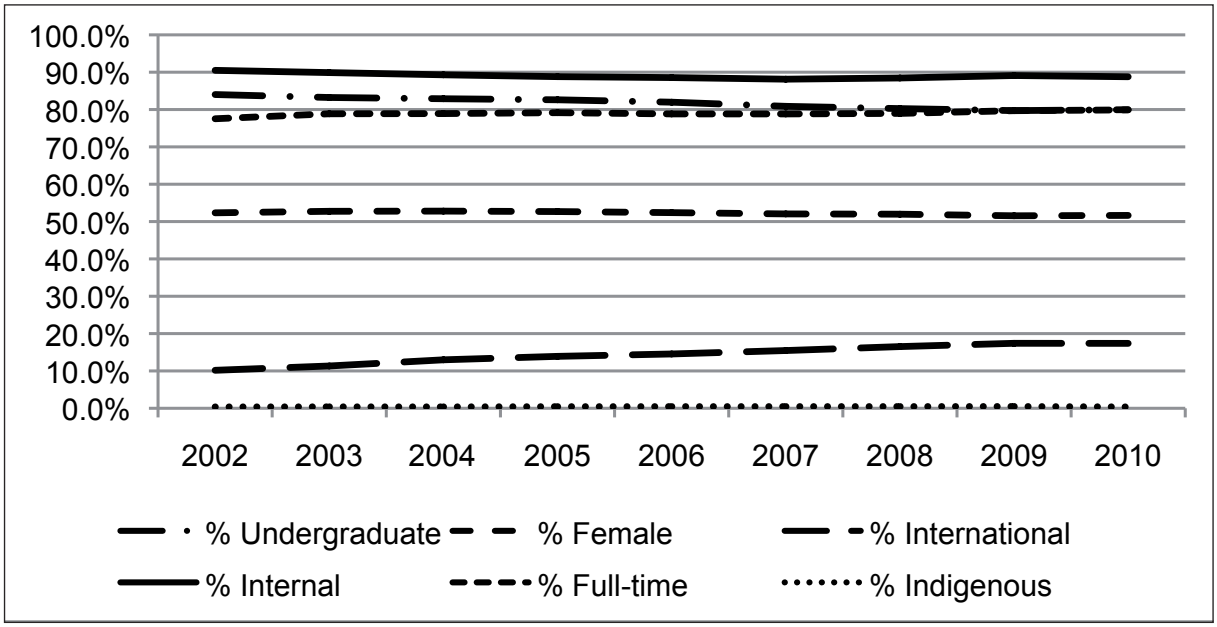


Table 4.4 shows the distribution of science students by state or territory. The figures next to the name of each state / territory are the proportion of all students enrolled in universities in that state / territory in 2011. Comparing the percentage distributions of students provides an indicator of relative over- or under-representation of science students state by state. The proportion of science students is higher than the overall population in the Australian Capital Territory, Victoria and Western Australia, but lower in New South Wales, Queensland, South Australia, Tasmania and the Northern Territory. Western Australia was the largest-growing state so far as science was concerned in the period 2002 to 2009, with numbers increasing by 3,896 or 55.3 per cent. Growth of science was also strong in Victoria, and an additional 4,893 students were enrolled in science courses in 2009 compared with 2002. 'Science' is all but non-existent in the Multi-State institutions, of which the Australian Catholic University is the main institution.

Table 4.4: Enrolments 2002 – 2009. Students enrolled in Natural and Physical Sciences courses by State / Territory

State / Territory		2002		2005		2007		2009		Growth	
	#	No.	%	No.	%	No.	%	No.	%	No.	%
Australian Capital Territory	1.6%	2909	4.3%	3283	4.4%	3360	4.4%	3315	4.0%	406	14.0%
New South Wakes	32.6%	19693	28.9%	20998	28.3%	20957	27.7%	23233	28.4%	3540	18.0%
Northern Territory	1.0%	409	0.6%	305	0.4%	302	0.4%	214	0.3%	-195	-47.7%
Queensland	20.0%	13287	19.5%	14169	19.1%	13986	18.5%	14026	17.5%	739	5.6%
South Australia	7.5%	4823	7.1%	5065	6.8%	5187	6.9%	5271	6.7%	448	9.3%
Tasmania	2.3%	1505	2.2%	1700	2.3%	1683	2.2%	1761	2.1%	256	17.0%
Victoria	24.8%	18496	27.1%	21178	28.5%	21358	28.3%	23389	28.4%	4893	26.5%
Western Australia	10.1%	7050	10.3%	7529	10.1%	8699	11.5%	10946	12.5%	3896	55.3%
Multi-State		16	0.0%	6	0.0%	8	0.0%	3	0.0%	-13	-81.3%
Total		**68188**	**100.0%**	**74233**	**100.0%**	**75540**	**100.0%**	**82158**	**100.0%**	**13970**	**20.5%**

Figures show State / Territory population as a proportion of the national population

Table 4.5 shows enrolment numbers in science courses by university, ranked in order of the number of science students in 2009. The largest universities overall have the most science students, and the Group of Eight universities are represented at the top of the ranked list of universities with the most

science students. (Murdoch University, not in the Group of Eight was just ahead of Australian National University in eighth place). Top placed University of Melbourne had 9.4 per cent of the nation's science students in 2009, compared with 9.0 per cent in 2002.

Table 4.5: Enrolments 2002 – 2009. Students enrolled in Natural and Physical Sciences courses by University, Ranked by Enrolments 2009

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Institution										
Melbourne	6156	9.0%	7156	9.6%	7454	9.7%	7702	9.4%	1546	25.1%
Monash	4536	6.7%	5763	7.7%	6173	8.0%	6474	7.9%	1938	42.7%
Queensland	4699	6.9%	4899	6.6%	5101	6.6%	5461	6.6%	762	16.2%
Sydney	4185	6.1%	4600	6.2%	4863	6.3%	5098	6.2%	913	21.8%
New South Wales	4059	6.0%	4243	5.7%	4772	6.2%	5076	6.2%	1017	25.1%
Western Australia	2615	3.8%	3169	4.2%	3697	4.8%	4568	5.6%	1953	74.7%
Adelaide	2584	3.8%	2822	3.8%	2905	3.8%	2831	3.4%	247	9.6%
Murdoch	1836	2.7%	2363	3.2%	2581	3.3%	2688	3.3%	852	46.4%
Austra;ian National	2097	3.1%	2376	3.2%	2483	3.2%	2629	3.2%	532	25.4%
RMIT	2226	3.3%	2446	3.3%	2400	3.1%	2623	3.2%	397	17.8%
Uni. Tech, Sydney	2255	3.3%	2297	3.1%	2368	3.1%	2473	3.0%	218	9.7%
La Trobe	1913	2.8%	2053	2.8%	2073	2.7%	2406	2.9%	493	25.8%
Curtin	1919	2.8%	1953	2.6%	2089	2.7%	2362	2.9%	443	23.1%
QUT	2020	3.0%	2356	3.2%	2390	3.1%	2196	2.7%	176	8.7%
Western Sydney	1676	2.5%	1944	2.6%	1848	2.4%	2190	2.7%	514	30.7%
Griffith	1441	2.1%	1868	2.5%	1956	2.5%	2026	2.5%	585	40.6%
Flinders	1580	2.3%	1724	2.3%	1789	2.3%	1792	2.2%	212	13.4%
Wollongong	1911	2.8%	1599	2.1%	1647	2.1%	1779	2.2%	-132	-6.9%
Macquarie	1326	1.9%	1525	2.0%	1629	2.1%	1765	2.1%	439	33.1%
Tasmania	1324	1.9%	1619	2.2%	1620	2.1%	1761	2.1%	437	33.0%
Newcastle	1635	2.4%	1673	2.2%	1668	2.2%	1672	2.0%	37	2.3%
James Cook	2102	3.1%	1826	2.4%	1845	2.4%	1659	2.0%	-443	-21.1%
Deakin	1725	2.5%	1700	2.3%	1606	2.1%	1643	2.0%	-82	-4.8%
Swinburne	920	1.3%	725	1.0%	965	1.3%	1561	1.9%	641	69.7%
Southern Queensland	1910	2.8%	1750	2.3%	1488	1.9%	1424	1.7%	-486	-25.4%
Charles Sturt	1146	1.7%	1224	1.6%	1400	1.8%	1374	1.7%	228	19.9%
Edith Cowan	680	1.0%	806	1.1%	703	0.9%	975	1.2%	295	43.4%
New England	827	1.2%	1041	1.4%	1014	1.3%	846	1.0%	19	2.3%
Southern Cross	626	0.9%	621	0.8%	710	0.9%	845	1.0%	219	35.0%
Canberra	583	0.9%	565	0.8%	557	0.7%	686	0.8%	103	17.7%
Sunshine Coast	475	0.7%	618	0.8%	616	0.8%	668	0.8%	193	40.6%
South Australia	659	1.0%	681	0.9%	607	0.8%	648	0.8%	-11	-1.7%
Victoria / VUT	773	1.1%	663	0.9%	619	0.8%	533	0.6%	-240	-31.0%
Central QLD	640	0.9%	726	1.0%	580	0.8%	420	0.5%	-220	-34.4%
Ballarat	247	0.4%	225	0.3%	258	0.3%	366	0.4%	119	48.2%
Notre Dame	0	0.0%	76	0.1%	116	0.2%	165	0.2%	165	
Bond	0	0.0%	47	0.1%	83	0.1%	151	0.2%	151	
Ch. Darwin/NTU	369	0.5%	301	0.4%	174	0.2%	131	0.2%	-238	-64.5%
Batchelor	40	0.1%	69	0.1%	112	0.1%	83	0.1%	43	107.5%
Aust. Catholic	16	0.0%	0	0.0%	26	0.0%	3	0.0%	-13	-81.3%
Other Institutions	457	0.7%	461	0.6%	210	0.3%	405	0.5%	-52	-11.4%
Total	**68188**	**100.0%**	**74573**	**100.0%**	**77195**	**100.0%**	**82158**	**100.0%**	**13970**	**20.5%**

Table 4.2 showed that the predominant 'science' degrees that students enrol in at Australian universities are at the bachelor's level (about 79 per cent) and PhD (over 11 per cent). This study provides more detail on these two course levels in sections below.

The concept of 'student load' was introduced above (see Tables 3.9 to 3.11, and the surrounding text). Analysing student load is a useful way to establish the specific disciplines studied by students. However, the sections from the start of this chapter to this point have examined enrolments at all course levels in the Natural and Physical Sciences broad field of education. To examine student load across all course levels would lead to a form of averaging that could provide 'information' that would inform less than if such an examination were to be undertaken at specific courses levels. Therefore, analyses of student load have been done for bachelor's degree students, and then for PhD students (see p36 ff).

Science graduates

This section presents a broad consideration of course completions in courses from the Natural and Physical Sciences. A more detailed analysis has been prepared below relating to graduates at the bachelor's and PhD levels.

In examining the number of graduates in courses in a single field of education, it is necessary to remember that some students pursue two programmes simultaneously. (See Table 4.1, for example). Therefore the tables here show the number of students that completed a 'science' degree, whether that completion was in a science programme as a primary or a supplementary course. Students completing two Natural and Physical Sciences courses have been counted only once, as a true reflection of the number of *people* awarded a science qualification.

Table 4.6 summarises the number of students awarded a science qualification in the years shown, according to whether the science course completion was in the primary or supplementary course. Five or six per cent of science courses are completed as secondary courses. Not visible from the table is that all of the supplementary course completions were at the three bachelor's levels. Over the period, the number of science course completions increased by 3,120, or 22.3 per cent. This rate is lower than that of all course completions of 35.6 per cent (per Table 3.10).

Table 4.6: Course Completions 2002 – 2009. Natural and Physical Sciences – All Course Levels by Primary or Supplementary Course

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Natural and Physical Sciences as primary course	13158	94.2%	15244	93.8%	16083	94.0%	16167	94.6%	3009	22.9%
Natural and Physical Sciences as supplementary course										
Education	62	0.4%	121	0.7%	143	0.8%	127	0.7%	65	104.8%
Engineering	210	1.5%	261	1.6%	264	1.5%	252	1.5%	42	20.0%
Health	66	0.5%	110	0.7%	157	0.9%	167	1.0%	101	153.0%
Information Technology	21	0.2%	49	0.3%	30	0.2%	18	0.1%	-3	-14.3%
Management & Commerce	120	0.9%	237	1.5%	199	1.2%	194	1.1%	74	61.7%
Society & Culture	329	2.4%	215	1.3%	222	1.3%	156	0.9%	-173	-52.6%
Other Fields of Education	7	0.1%	8	0.0%	7	0.0%	12	0.1%	5	71.4%
Sub-total	**815**	**5.8%**	**1001**	**6.2%**	**1022**	**6.0%**	**926**	**5.4%**	**111**	**13.6%**
Total	**13973**	**100.0%**	**16245**	**100.0%**	**17105**	**100.0%**	**17093**	**100.0%**	**3120**	**22.3%**

Table 4.7 shows the distribution of course completions in the Natural and Physical Sciences in years from 2002 to 2009 by course level. The course levels that increased the most were master's by coursework, bachelor's degrees, and PhDs. Bachelor's and PhD completions are dealt with below, but given the strong numerical and proportionate growth in master's by coursework, these are considered in Table 4.8.

Table 4.7: Course Completions 2002 – 2009. Natural and Physical Sciences by Course Level

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Higher Degree by Research										
Higher Doctorate	8	0.1%	14	0.1%	7	0.0%	5	0.0%	-3	-37.5%
PhD	1062	7.6%	1256	7.7%	1369	8.0%	1388	8.1%	326	30.7%
Master's by Research	206	1.5%	204	1.3%	153	0.9%	167	1.0%	-39	-18.9%
Sub-total	**1276**	**9.1%**	**1474**	**9.1%**	**1529**	**8.9%**	**1560**	**9.1%**	**284**	**9.1%**
Other P/G										
Doctorate by Coursework		0.0%	1	0.0%		0.0%	2	0.0%	2	
Master's by Coursework	441	3.2%	660	4.1%	834	4.9%	1162	6.8%	721	163.5%
Postgraduate Qualifying	13	0.1%	12	0.1%	3	0.0%	2	0.0%	-11	-84.6%
Postgraduate Dip – New	189	1.4%	229	1.4%	207	1.2%	260	1.5%	71	37.6%
PPostgraduate Dip – Cont.	100	0.7%	158	1.0%	176	1.0%	213	1.2%	113	113.0%
Graduate Certificate	223	1.6%	241	1.5%	388	2.3%	429	2.5%	206	92.4%
Sub-total	**966**	**6.9%**	**1301**	**8.0%**	**1608**	**9.4%**	**2068**	**12.1%**	**1102**	**35.3%**
Undergraduate										
Bachelor's Graduate Entry	38	0.3%	14	0.1%	9	0.1%	9	0.1%	-29	-76.3%
Bachelor's Honours	2431	17.4%	2539	15.6%	2660	15.6%	2534	14.8%	103	4.2%
Bachelor's	9117	65.2%	10822	66.6%	11139	65.1%	10778	63.1%	1661	18.2%
Assoc. Degree	5	0.0%	4	0.0%	5	0.0%	14	0.1%	9	180.0%
Advanced Diploma	4	0.0%	35	0.2%	16	0.1%	32	0.2%	28	700.0%
Diploma	32	0.2%	36	0.2%	137	0.8%	97	0.6%	65	203.1%
Other U/G	104	0.7%	20	0.1%	2	0.0%	1	0.0%	-103	-99.0%
Sub-total	**11731**	**84.0%**	**13470**	**82.9%**	**13968**	**81.7%**	**13465**	**78.8%**	**1734**	**55.6%**
Total	**13973**	**100.0%**	**16245**	**100.0%**	**17105**	**100.0%**	**17093**	**100.0%**	**3120**	**22.3%**

Table 4.8 looks at the distribution of course completions of science master's by coursework. The biggest field of education for master's by coursework completions was 'Other Natural and Physical Sciences', and within this group, in 2009, 229 were awarded in Food Science and Biotechnology, 107 in Medical Science, and 174 were in other Natural and Physical Sciences – Other, or were not specified.

Table 4.8: Course Completions 2002 – 2009. Natural and Physical Sciences – Masters by Coursework students by Narrow Field of Education, Gender, Citizenship Status and University ('Top Ten')

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Narrow Field of Education										
Biological Sciences	66	15.0%	133	20.2%	179	21.5%	254	21.9%	188	284.8%
Chemical Sciences	11	2.5%	15	2.3%	10	1.2%	26	2.2%	15	136.4%
Earth Sciences	32	7.3%	35	5.3%	46	5.5%	61	5.2%	29	90.6%
Mathematical Sciences	49	11.1%	80	12.1%	95	11.4%	136	11.7%	87	177.6%
Physical Sciences	46	10.4%	48	7.3%	76	9.1%	76	6.5%	30	65.2%
Other Natural & Physical Sciences	237	53.7%	349	52.9%	428	51.3%	609	52.4%	372	157.0%
Gender										
Female	207	46.9%	329	49.8%	395	47.4%	549	47.2%	342	165.2%
Male	234	53.1%	331	50.2%	439	52.6%	613	52.8%	379	162.0%
Citizenship Status										
International	222	50.3%	376	57.0%	506	60.7%	759	65.3%	537	241.9%
Domestic	219	49.7%	284	43.0%	328	39.3%	403	34.7%	184	84.0%

Table 4.8: Course Completions 2002 – 2009. Natural and Physical Sciences – Masters by Coursework students by Narrow Field of Education, Gender, Citizenship Status and University ('Top Ten') *continued*

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
University 'Top 10' (2009)										
New South Wales	103	23.4%	87	13.2%	122	14.6%	134	11.5%	31	30.1%
Queensland	22	5.0%	77	11.7%	83	10.0%	133	11.4%	111	504.5%
RMIT	9	2.0%	37	5.6%	62	7.4%	115	9.9%	106	1177.8%
Swinburne	13	2.9%	26	3.9%	29	3.5%	86	7.4%	73	561.5%
Sydney	30	6.8%	61	9.2%	89	10.7%	84	7.2%	54	180.0%
Macquarie	13	2.9%	28	4.2%	51	6.1%	55	4.7%	42	323.1%
Australian National	12	2.7%	12	1.8%	32	3.8%	52	4.5%	40	333.3%
James Cook	19	4.3%	31	4.7%	54	6.5%	51	4.4%	32	168.4%
Western Australia	9	2.0%	14	2.1%	13	1.6%	48	4.1%	39	433.3%
Wollongong	19	4.3%	20	3.0%	32	3.8%	44	3.8%	25	131.6%
Sub-total	249	56.5%	393	59.5%	567	68.0%	802	69.0%	553	222.1%
Other Universities	192	43.5%	267	40.5%	267	32.0%	360	31.0%	168	87.5%
Total	**441**	**100.0%**	**660**	**100.0%**	**834**	**100.0%**	**1162**	**100.0%**	**721**	**163.5%**

Back to basics: a closer look at bachelor degrees

- **Enrolments**

More students enrol in degrees at the bachelor level than at any other. Table 4.9 compares Natural and Physical Sciences bachelor's degree enrolments with those for all fields of education, and examines science enrolments by gender, citizenship and Indigenous status. The number of students includes those enrolled in 'science' as either a primary course or a supplementary course. In 2009, this comprised 55,272 students enrolled in a Natural and Physical Sciences primary course and 9,369 as a supplementary course, totalling 64,641 enrolments. It shows that the proportion of Natural and Physical Sciences to all fields of education declined slightly over the period, from 9.0 per cent in 2002, to 8.6 per cent in 2009, but the proportion had been rising between 2002 and 2005. In 2009, several hundred fewer students enrolled in a science programme as a supplementary course compared with several earlier years. Time will tell if this represents the start of a trend, or whether one or more universities simply changed the way they coded into primary or supplementary courses in 2009.

Table 4.9 looks first at the gender distribution in science courses. As mentioned, science enrolments at the bachelor's level constituted 9.0 per cent of all bachelor's enrolments by 2002, and by 2009, this proportion had declined to 8.6 per cent. At the same time, the proportion of female bachelor's students decreased from 8.6 per cent, to 7.9 per cent. At the same time as the number of women in bachelor's degrees in all fields of education increased by 20.7 per cent, the increase in the number of women in science courses was only 11.4 per cent. The number of male bachelor's degree students in science (+18.1 per cent) increased at a lower rate than in all fields of education (+20.1 per cent), but the differential was not as great as among women.

Table 4.9: Enrolments 2002 – 2009. Bachelor's Degree Student Enrolments in All Fields of Education and Natural and Physical Sciences by Gender, Citizenship Status and Indigenous Status

Gender Total	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
All Fields of Education #	623839		652731		690393		751385		127546	20.4%
Science – Primary	48867		51794		52193		55272		6405	13.1%
Science – Supplementary	7587		9369		9779		9369		1782	23.5%
Science – All	56454	9.0%	61163	9.4%	61972	9.0%	64641	8.6%	8187	14.5%
Female students										
All Fields of Education #	353357		368307		390850		426599		73242	20.7%
Science	30430	8.6%	32933	8.9%	32902	8.4%	33899	7.9%	3469	11.4%
Male students										
All Fields of Education #	270482		284424		299543		324786		54304	20.1%
Science	26024	9.6%	28230	9.9%	29070	9.7%	30742	9.5%	4718	18.1%
International										
All Fields of Education #	108019		133741		146469		173994		65975	61.1%
Science	4538	4.2%	7397	5.5%	7847	5.4%	8481	4.9%	3943	86.9%
Domestic										
All Fields of Education #	515820		518990		543924		577391		61571	11.9%
Science	51916	10.1%	53766	10.4%	54125	10.0%	56160	9.7%	4244	8.2%
Indigenous students										
All Fields of Education #	5209		5521		6131		6988		1779	34.2%
Science	223	4.3%	294	5.3%	320	5.2%	355	5.1%	132	59.2%
Science % of All	**4.30%**		**5.30%**		**5.20%**		**5.10%**			

Primary course bachelor's degree enrolments only

The rate of increase in the number of international students in science bachelor's level courses exceeded that for international students in all fields of education, but in science, this growth was off a low base. Over the period, the number of international students in science courses increased by 86.9 per cent, compared with an increase of 61.1 per cent overall. International students' presence in science increased from being 4.2 per cent of all international students in 2002, to 4.9 per cent in 2009. However, the proportion had been over five per cent between 2004 and 2008.

Domestic student growth was lower than international student growth across the board. Overall, growth was 11.9 per cent, and among science students, 8.2 per cent. Science bachelor's students were 10.1 per cent of all bachelor's degree students in 2002, and this proportion slipped slightly to 9.7 per cent by 2009.

As noted earlier, there are few Indigenous students in universities, but at the bachelor's degree level, the increase of Indigenous presence in science was 59.2 per cent, compared with 34.2 per cent in all bachelor's degrees. The underrepresentation of Indigenous students in science can be seen in the fact that they represented 5.1 per cent of all bachelor's degree enrolments, less than the overall science representation at the bachelor level (8.6 per cent in 2009).

Table 4.10 looks at Natural and Physical Sciences bachelor's students and the universities they were enrolled at in 2002 to 2009, ranked by number of students in 2009.

Table 4.10: Enrolments 2002 – 2009. Bachelor's Degree Student Enrolments in Natural and Physical Sciences Courses by University – Ranked by 2009 Enrolments

University	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Melbourne	5464	9.7%	6332	10.4%	6426	10.4%	6495	10.0%	1031	18.9%
Monash	4121	7.3%	4766	7.8%	4974	8.0%	5137	7.9%	1016	24.7%
Sydney	4034	7.1%	4456	7.3%	4635	7.5%	4750	7.3%	716	17.7%
New South Wales	3317	5.9%	3533	5.8%	3838	6.2%	3960	6.1%	643	19.4%
Western Australia	2126	3.8%	2703	4.4%	3197	5.2%	3922	6.1%	1796	84.5%
Queensland	3759	6.7%	3741	6.1%	3713	6.0%	3914	6.1%	155	4.1%
Murdoch	1641	2.9%	2094	3.4%	2268	3.7%	2276	3.5%	635	38.7%
Uni. Tech, Sydney	1980	3.5%	2005	3.3%	2079	3.4%	2245	3.5%	265	13.4%
Adelaide	2152	3.8%	2271	3.7%	2314	3.7%	2240	3.5%	88	4.1%
Western Sydney	1229	2.2%	1768	2.9%	1792	2.9%	2098	3.2%	869	70.7%
La Trobe	1635	2.9%	1752	2.9%	1789	2.9%	1994	3.1%	359	22.0%
Curtin	1632	2.9%	1656	2.7%	1758	2.8%	1927	3.0%	295	18.1%
RMIT	1775	3.1%	1833	3.0%	1792	2.9%	1904	2.9%	129	7.3%
Griffith	1289	2.3%	1698	2.8%	1764	2.8%	1765	2.7%	476	36.9%
QUT	1778	3.1%	2012	3.3%	1957	3.2%	1743	2.7%	-35	-2.0%
Australian National	1489	2.6%	1516	2.5%	1526	2.5%	1609	2.5%	120	8.1%
Flinders	1397	2.5%	1429	2.3%	1506	2.4%	1476	2.3%	79	5.7%
Deakin	1534	2.7%	1468	2.4%	1380	2.2%	1364	2.1%	-170	-11.1%
Wollongong	1512	2.7%	1289	2.1%	1292	2.1%	1346	2.1%	-166	-11.0%
Newcastle	1310	2.3%	1291	2.1%	1310	2.1%	1283	2.0%	-27	-2.1%
Southern Queensland	1859	3.3%	1684	2.8%	1376	2.2%	1259	1.9%	-600	-32.3%
Macquarie	1083	1.9%	1098	1.8%	1071	1.7%	1156	1.8%	73	6.7%
Tasmania	970	1.7%	1084	1.8%	1060	1.7%	1088	1.7%	118	12.2%
James Cook	1385	2.5%	1340	2.2%	1139	1.8%	1018	1.6%	-367	-26.5%
Charles Sturt	834	1.5%	869	1.4%	1034	1.7%	998	1.5%	164	19.7%
Edith Cowan	614	1.1%	731	1.2%	611	1.0%	909	1.4%	295	48.0%
Swinburne	495	0.9%	310	0.5%	415	0.7%	714	1.1%	219	44.2%
New England	687	1.2%	734	1.2%	734	1.2%	682	1.1%	-5	-0.7%
South Australia	564	1.0%	598	1.0%	531	0.9%	592	0.9%	28	5.0%
Sunshine Coast	465	0.8%	541	0.9%	533	0.9%	578	0.9%	113	24.3%
Canberra	444	0.8%	462	0.8%	460	0.7%	517	0.8%	73	16.4%
Victoria / VUT	613	1.1%	565	0.9%	474	0.8%	391	0.6%	-222	-36.2%
Central Queensland	565	1.0%	657	1.1%	508	0.8%	333	0.5%	-232	-41.1%
Ballarat	194	0.3%	183	0.3%	173	0.3%	275	0.4%	81	41.8%
Notre Dame	0	0.0%	74	0.1%	116	0.2%	165	0.3%	165	
Charles Darwin/NTU	291	0.5%	256	0.4%	218	0.4%	160	0.2%	-131	-45.0%
Southern Cross	0	0.0%	0	0.0%	40	0.1%	122	0.2%	122	
Bond	0	0.0%	42	0.1%	65	0.1%	117	0.2%	117	
Batchelor	0	0.0%	24	0.0%	33	0.1%	24	0.0%	24	
Other Institutions	217	0.4%	298	0.5%	71	0.1%	95	0.1%	-122	-56.2%
Total	**56454**	**100.0%**	**61163**	**100.0%**	**61972**	**100.0%**	**64641**	**100.0%**	**8187**	**14.5%**

The University of Melbourne had the most bachelor's students in Natural and Physical Sciences courses, and they represented more than 17 per cent of all of that university's primary bachelor's degree enrolments, and 10.0 per cent of the nation's Natural and Physical Sciences bachelor's degree students in 2009. Monash University has the second-most science bachelor's students but those students represent a much lower proportion of all Monash bachelor enrolments. Six of the Group of Eight universities occupy the first six places in terms of rank order. The Group of Eight's proportion

of primary bachelor degree students in the Natural and Physical Sciences is 44.5 per cent. Growth in Go8 science enrolments represented 65.0 per cent of the growth between 2002 and 2009.

Table 4.11 summarises bachelor's degree enrolments according to the narrow field of education (four-digit level) between 2002 and 2009. The only growth of any consequence has occurred in 'Other Natural and Physical Sciences' courses. This is where generalist BSc degrees have been coded. The fact that many undergraduate degrees are generalist in nature reduces the usefulness of the field of education classification for analyses of undergraduate enrolments.

Table 4.11: Enrolments 2002 – 2009. Bachelor's Degree Student Enrolments in Natural and Physical Sciences Courses by Narrow Field of Education

Narrow Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences	11583	20.5%	12283	20.1%	12248	19.8%	11328	17.5%	-255	-2.2%
Chemical Sciences	1172	2.1%	1217	2.0%	1244	2.0%	895	1.4%	-277	-23.6%
Earth Sciences	878	1.6%	709	1.2%	731	1.2%	928	1.4%	50	5.7%
Mathematical Sciences	2510	4.4%	2516	4.1%	2268	3.7%	2024	3.1%	-486	-19.4%
Physical Sciences	889	1.6%	978	1.6%	825	1.3%	686	1.1%	-203	-22.8%
Other Natural & Physical Sciences	39422	69.8%	43460	71.1%	44656	72.1%	48780	75.5%	9358	23.7%
Total	**56454**	**100.0%**	**61163**	**100.0%**	**61972**	**100.0%**	**64641**	**100.0%**	**8187**	**14.5%**

Table 4.12 provides more detail, and a brief examination confirms the observation made above that many science students, and perhaps more specifically those enrolled at the bachelor level, are in generalist degrees.

In 2009, over 36,000 science bachelor's students (over half) were enrolled in courses coded to 'Natural and Physical Sciences', 'Natural and Physical Sciences not elsewhere classified' (nec), and 'Other Natural and Physical Sciences'. Over 9,100 students were enrolled in courses coded to the Medical Sciences detailed Field of Education. Next most populous were Biological Sciences courses, with over 8,000 enrolments in 2009. A further 1,739 students were enrolled in courses coded to Food Technology courses, but numbers in this field of education have declined over the course of the decade. Forensic Science is becoming increasingly popular. 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 university policies were to coding science courses to the field of education classification. However, it does seem that MOST universities code MOST science courses at the bachelor level to 'general' fields of education.

Table 4.12: Enrolments 2002 – 2009. Bachelor's Degree Student Enrolments in Natural and Physical Sciences Courses by Detailed Field of Education. Ranked by Enrolments 2009

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Detailed Field of Education										
Natural & Physical Sciences General	17382	30.8%	15885	26.0%	16233	26.2%	18792	29.1%	1410	8.1%
Natural and Physical Sci. nec	13385	23.7%	15034	24.6%	14351	23.2%	15105	23.4%	1720	12.9%
Medical Science	4399	7.8%	6669	10.9%	8368	13.5%	9161	14.2%	4762	108.3%
Biological Sciences	3671	6.5%	4191	6.9%	4276	6.9%	4423	6.8%	752	20.5%
Biological Sciences nec	4554	8.1%	4921	8.0%	4874	7.9%	3655	5.7%	-899	-19.7%
Other Natural & Physical Sci.	1128	2.0%	2333	3.8%	2339	3.8%	2469	3.8%	1341	118.9%
Food Science and Biotech.	2525	4.5%	2571	4.2%	2159	3.5%	1739	2.7%	-786	-31.1%
Biochemistry and Cell Biol.	930	1.6%	1000	1.6%	1127	1.8%	1180	1.8%	250	26.9%

Table 4.12: Enrolments 2002 – 2009. Bachelor's Degree Student Enrolments in Natural and Physical Sciences Courses by Detailed Field of Education. Ranked by Enrolments 2009 *continued*

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Forensic Science	252	0.4%	613	1.0%	828	1.3%	1118	1.7%	866	343.7%
Mathematics	803	1.4%	999	1.6%	973	1.6%	982	1.5%	179	22.3%
Marine Science	706	1.3%	686	1.1%	709	1.1%	840	1.3%	134	19.0%
Mathematical Sciences	1153	2.0%	916	1.5%	844	1.4%	717	1.1%	-436	-37.8%
Geology	359	0.6%	312	0.5%	409	0.7%	690	1.1%	331	92.2%
Physics	718	1.3%	890	1.5%	759	1.2%	644	1.0%	-74	-10.3%
Human Biology	714	1.3%	629	1.0%	608	1.0%	629	1.0%	-85	-11.9%
Chemical Sciences	662	1.2%	658	1.1%	630	1.0%	458	0.7%	-204	-30.8%
Chemical Sciences nec	496	0.9%	559	0.9%	614	1.0%	437	0.7%	-59	-11.9%
Pharmacology	325	0.6%	354	0.6%	378	0.6%	382	0.6%	57	17.5%
Ecology and Evolution	533	0.9%	572	0.9%	417	0.7%	364	0.6%	-169	-31.7%
Mathematical Sciences nec	448	0.8%	512	0.8%	393	0.6%	261	0.4%	-187	-41.7%
Zoology	314	0.6%	137	0.2%	128	0.2%	172	0.3%	-142	-45.2%
Microbiology	239	0.4%	227	0.4%	174	0.3%	110	0.2%	-129	-54.0%
Geophysics	30	0.1%	80	0.1%	104	0.2%	86	0.1%	56	186.7%
Earth Sciences nec	323	0.6%	211	0.3%	134	0.2%	86	0.1%	-237	-73.4%
Statistics	106	0.2%	89	0.1%	58	0.1%	64	0.1%	-42	-39.6%
Earth Sciences	125	0.2%	90	0.1%	71	0.1%	63	0.1%	-62	-49.6%
Astronomy	29	0.1%	31	0.1%	26	0.0%	25	0.0%	-4	-13.8%
Physics and Astronomy	142	0.3%	57	0.1%	40	0.1%	17	0.0%	-125	-88.0%
Laboratory Technology	26	0.0%	1	0.0%	0	0.0%	14	0.0%	-12	-46.2%
Genetics	34	0.1%	2	0.0%	3	0.0%	8	0.0%	-26	-76.5%
Botany	52	0.1%	12	0.0%	9	0.0%	5	0.0%	-47	-90.4%
Atmospheric Sciences	16	0.0%	8	0.0%	11	0.0%	2	0.0%	-14	-87.5%
Geochemistry	21	0.0%	1	0.0%	2	0.0%	1	0.0%	-20	-95.2%
Hydrology	4	0.0%	7	0.0%	0	0.0%	0	0.0%	-4	
Inorganic Chemistry	14	0.0%	0	0.0%	0	0.0%	0	0.0%	-14	
Total	**56454**	**100.0%**	**61163**	**100.0%**	**61972**	**100.0%**	**64641**	**100.0%**	**8187**	**14.5%**

nec = not elsewhere classified

- **Student load: what goes into a science bachelor degree?**

When looking at individual broad fields of education, such as Natural and Physical Sciences, analysing student load enables one to assess what students are studying in their courses. Even if it is not possible to provide a detailed field of education for a generalist degree such as BSc, the subjects studied within a generalist degree can be defined and described more specifically. For example, if a subject happens to be called Physics 101, it can be classified quite specifically as *010301 Physics.*

On the other hand, care still has to be exercised, because not all universities split up their subject offerings in the same way. For instance, *University α* might offer a single chemistry subject in first year, called Chemistry 101, in which they cover teaching of both organic and inorganic chemistry. *University α* would therefore assign discipline group code *010500 Chemical Sciences*. *University β*, on the other hand might teach first year chemistry as two discrete subjects, Organic Chemistry A and Inorganic Chemistry A. *University β* would therefore assign these two subjects discipline codes *010501 Organic Chemistry* and *010503 Inorganic Chemistry*, respectively. If ever the policy question arose 'How much inorganic chemistry is taught by Australian universities?', a complete

answer could not be arrived at just by summing the student load in discipline group code 010503, because such a methodology would under count some inorganic chemistry teaching and learning by failing to include inorganic chemistry teaching by *University α*.

Table 4.13 examines what science students in bachelor's degrees have been studying in as their courses since 2002. Using 2009 data to interpret this table, it shows that on average, a bachelor's degree (including Bachelor's honours and bachelor's graduate entry) comprised 35.8 per cent Biological Sciences, 10.5 per cent Chemical Sciences, and so on. The overall distribution between narrow discipline groups within the broad discipline group 01 Natural and Physical Sciences has not varied much, but the proportion of subjects taken from non-science disciplines fell from 30.6 per cent in 2002 to 26.5 per cent in 2009. Biological Sciences, Earth Sciences and Other Natural and Physical Sciences each increased slightly. The rate of growth in the enabling sciences, that is, Chemical Sciences, Mathematical Sciences, and Physical Sciences, has been less than for the rest of the science narrow disciplines, and each of Chemical Sciences, Mathematical Sciences and Physical Sciences declined slightly over the period as a proportion of the total. It is possible from this table to measure the extent to which a 'science bachelor's degree' has changed over the course of the past few years, and to that end, Figure 5 plots the make-up of a bachelor's degree in 2002, 2005, 2007 and 2009.

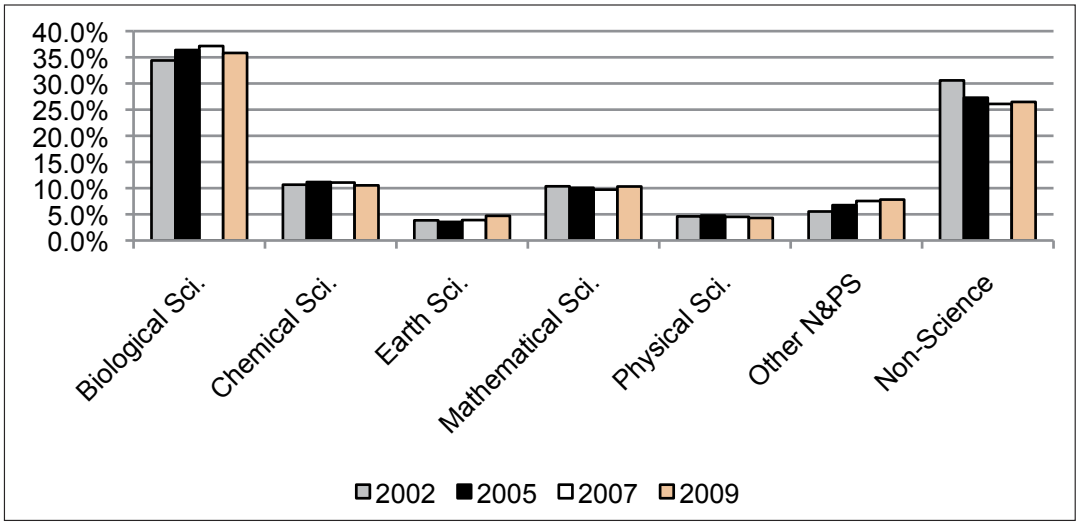
Table 4.13: Student Load 2002 – 2009. Content of Natural and Physical Sciences Bachelor's Degrees by Narrow Discipline Group

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Narrow Field of Education										
Biological Sciences	13755	34.4%	15415	36.4%	15759	37.2%	16184	35.8%	2429	17.7%
Chemical Sciences	4264	10.7%	4732	11.2%	4695	11.1%	4757	10.5%	493	11.6%
Earth Sciences	1540	3.9%	1504	3.6%	1655	3.9%	2128	4.7%	588	38.2%
Mathematical Sci.	4141	10.4%	4267	10.1%	4122	9.7%	4660	10.3%	519	12.5%
Physical Sciences	1842	4.6%	2020	4.8%	1913	4.5%	1948	4.3%	106	5.8%
Other Natural & Phys.Sci.	2215	5.5%	2861	6.8%	3200	7.5%	3531	7.8%	1316	59.4%
Non-Science	12232	30.6%	11559	27.3%	11066	26.1%	11958	26.5%	-274	-2.2%
Total	**39989**	**100.0%**	**42356**	**100.0%**	**42409**	**100.0%**	**45165**	**100.0%**	**5176**	**12.9%**

The Figure shows the fact of little movement in recent years in most narrow disciplines within science, but perhaps the damage had been done in earlier years. Earlier studies on university science in Australia showed that in 1989, mathematical sciences represented 17.3 per cent of all science teaching (Dobson, 2007).

The higher education statistics system in Australia provides the possibility to examine students and their courses and subjects in detail, as has been done in Table 4.14. However, it is difficult to tell if what is observable in each section of Table 4.14 represents changing study patterns by the nation's bachelor degree students, or changes in the way universities code their subjects to detailed discipline groups.

Figure 5: The Average Science Bachelor's Degree – 2002-2009



In the case of Biological Sciences, there has been an overall increase of 2,428 EFTSL between 2002 and 2009, but this observation masks internal variations. According to the table, teaching of detailed discipline group *biological sciences* declined by 1,683 EFTSL, but this was more than matched by increases in *biochemistry and cell biology*, *human biology*, and to a lesser extent, *genetics* and *microbiology*. Has this anything to do with changes of emphasis within the Biological Sciences?

Teaching to science bachelor's degree students increased modestly in narrow discipline group Chemical Sciences (+493 EFTSL or 11.6 per cent), with a small decline in the generic *chemical sciences* detailed field of study, an increases in *organic, inorganic,* and *chemical sciences nec*.

Earth Sciences seems to be of increasing interest to science bachelor's degree students.

From Table 4.14, it would seem that Mathematical Sciences teaching has become more specific, because the general *mathematical sciences* detailed discipline group, with more-than-compensating increases in *mathematics* and *statistics*. A similar change seems to have occurred in the Physical Sciences. Within the narrow discipline group Other Natural & Physical Sciences, there have been increases in most of the detailed discipline groups.

An interesting fact that can be gleaned from Table 4.14 is that there is a strong tendency for general/non-specific detailed discipline groups, and for 'not elsewhere classified' discipline groups. Within the Biological Sciences, in 2009, 27.1 per cent of students were enrolled in these 'not very specified' categories (3,076 + 1,307 EFTSL). In Chemical Sciences, it was 81 per cent, but there are only two discrete specific categories in the Chemical Sciences. Many universities might teach both organic and inorganic chemistry within the same subject, and therefore such subjects would need to be coded to a non-specific detailed discipline group. In the Earth Sciences, it was 44.6 per cent, but there are seven detailed discipline groups from which to pick. Again, perhaps the detailed discipline group classification is too detailed for the realities of earth sciences teaching in Australian universities.

In the Mathematical Sciences, in 2009, only 5.6 per cent of teaching was classified as other than *mathematics* or *statistics*, but in 2002, it had been 28 per cent.

Few students are enrolled in subjects that are non-specifically identified in the Physical Sciences, but there is no category 'physical sciences not elsewhere classified'.

Speaking as a non-scientist, one wonders what the 989 equivalent full-time students enrolled in subjects classified as 'Natural and Physical Sciences not elsewhere classified' could be studying. After all, the discipline group classification does provide 38 detailed disciplines from which to pick.

Table 4.14: Student Load 2002 – 2009. Content of Natural and Physical Science Bachelor's Degrees by Narrow and Detailed Discipline Group

Narrow & Detailed Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences										
Biological Sciences	4758	11.9%	2727	6.4%	2772	6.5%	3076	6.8%	-1683	-35.4%
Biochemistry and Cell Biol.	2032	5.1%	3395	8.0%	3487	8.2%	3492	7.7%	1460	71.9%
Botany	430	1.1%	503	1.2%	449	1.1%	343	0.8%	-86	-20.1%
Ecology and Evolution	784	2.0%	746	1.8%	675	1.6%	744	1.6%	-40	-5.1%
Marine Science	236	0.6%	326	0.8%	329	0.8%	355	0.8%	119	50.5%
Genetics	802	2.0%	1352	3.2%	1380	3.3%	1382	3.1%	581	72.5%
Microbiology	1069	2.7%	1538	3.6%	1555	3.7%	1502	3.3%	434	40.6%
Human Biology	1992	5.0%	3035	7.2%	3315	7.8%	3359	7.4%	1367	68.7%
Zoology	644	1.6%	766	1.8%	728	1.7%	623	1.4%	-21	-3.3%
Biological Sciences nec	1010	2.5%	1028	2.4%	1069	2.5%	1307	2.9%	297	29.4%
Sub-total	13755	34.4%	15415	36.4%	15759	37.2%	16184	35.8%	2428	17.7%
Chemical Sciences										
Chemical Sciences	2542	6.4%	2571	6.1%	2561	6.0%	2475	5.5%	-68	-2.7%
Organic Chemistry	515	1.3%	694	1.6%	681	1.6%	649	1.4%	134	26.0%
Inorganic Chemistry	155	0.4%	244	0.6%	249	0.6%	260	0.6%	106	68.3%
Chemical Sciences nec	1052	2.6%	1223	2.9%	1205	2.8%	1373	3.0%	321	30.5%
Sub-total	4264	10.7%	4732	11.2%	4695	11.1%	4757	10.5%	493	11.6%
Earth Sciences										
Earth Sciences	639	1.6%	491	1.2%	520	1.2%	647	1.4%	8	1.3%
Atmospheric Sciences	70	0.2%	96	0.2%	99	0.2%	127	0.3%	57	82.0%
Geology	433	1.1%	469	1.1%	575	1.4%	776	1.7%	343	79.3%
Geophysics	51	0.1%	82	0.2%	84	0.2%	115	0.3%	63	124.3%
Geochemistry	11	0.0%	12	0.0%	13	0.0%	16	0.0%	5	44.9%
Soil Science	29	0.1%	33	0.1%	40	0.1%	50	0.1%	21	74.1%
Hydrology	24	0.1%	41	0.1%	39	0.1%	47	0.1%	23	94.8%
Oceanography	57	0.1%	69	0.2%	61	0.1%	47	0.1%	-10	-17.2%
Earth Sciences nec	227	0.6%	211	0.5%	225	0.5%	303	0.7%	77	33.8%
Sub-total	1540	3.9%	1504	3.5%	1655	3.9%	2128	4.7%	588	38.2%
Mathematical Sciences										
Mathematical Sciences	1083	2.7%	336	0.8%	292	0.7%	114	0.3%	-969	-89.5%
Mathematics	1884	4.7%	2436	5.8%	2387	5.6%	2833	6.3%	949	50.3%
Statistics	1082	2.7%	1342	3.2%	1312	3.1%	1565	3.5%	483	44.7%
Mathematical Sciences nec	92	0.2%	153	0.4%	131	0.3%	148	0.3%	56	61.0%
Sub-total	4141	10.4%	4267	10.1%	4122	9.7%	4660	10.3%	519	12.5%
Physical Sciences										
Physics and Astronomy	432	1.1%	52	0.1%	36	0.1%	32	0.1%	-400	-92.7%
Physics	1303	3.3%	1840	4.3%	1762	4.2%	1782	3.9%	479	36.7%
Astronomy	107	0.3%	128	0.3%	115	0.3%	134	0.3%	27	25.4%
Sub-total	1842	4.6%	2020	4.8%	1913	4.5%	1948	4.3%	106	5.7%
Other N&PS										
Other N&PS	118	0.3%	83	0.2%	61	0.1%	126	0.3%	9	7.3%
MedSci	348	0.9%	471	1.1%	588	1.4%	702	1.6%	354	101.6%
Forensic Sci	102	0.3%	221	0.5%	298	0.7%	270	0.6%	168	165.5%
Food Sci/Biotech	615	1.5%	587	1.4%	511	1.2%	513	1.1%	-102	-16.6%
Pharmacol.	382	1.0%	666	1.6%	758	1.8%	782	1.7%	400	104.6%
LabTech	140	0.3%	189	0.4%	180	0.4%	150	0.3%	10	6.9%
N&PS nec	511	1.3%	644	1.5%	804	1.9%	989	2.2%	478	93.6%
Sub-total	2215	5.5%	2861	6.8%	3200	7.5%	3531	7.8%	1316	59.4%
Non-Science	12232	30.6%	11559	27.3%	11066	26.1%	11958	26.5%	-274	-2.2%
Total	**39989**	**100.0%**	**42356**	**100.0%**	**42409**	**100.0%**	**45165**	**100.0%**	**5176**	**12.9%**

nec = not elsewhere classified

The next two tables examine binary sub-populations of science students, to see if there are any differences in the patterns between what women and men study for their science bachelor's degree, and commencing students and continuing students. The latter is to measure the extent to which some disciplines might be taken primarily in the first year of science programmes.

Table 4.15 looks at gender differences according to narrow discipline group for students enrolled in science bachelor's degrees. The overall proportion of women has increased slightly since 2002, with year-by-year oscillations. They have ranged from 54 to 56 per cent each year. This proportion is relevant because it allows us to see which disciplines women prefer as part of their science degree. It would seem that they prefer Biological Sciences and Other Natural and Physical sciences subjects ahead of all others. Women's representation in the Chemical Sciences approximates their overall presence, but in the other enabling sciences, Mathematical Sciences and Physical Sciences, they are considerably under-represented. This is particularly the case in the Physical Sciences, in which the female presence is now less than one-third.

Table 4.15: Student Load 2002 – 2009. Content of Natural and Physical Science Bachelor's Degrees by Narrow Discipline Group and Gender

Narrow Discipline Group	2002	2005	2007	2009	Growth	
	No.	No.	No.	No.	No.	%
Biological Sciences						
Sub-total female & male science bachelor students	13755	15415	15759	16184	2429	17.7%
Female% of Sub-total	63.2%	62.1%	60.7%	59.5%		
Chemical Sciences						
Sub-total	4264	4732	4695	4757	493	11.6%
Female% of Sub-total	56.5%	54.3%	52.6%	52.0%		
Earth Sciences						
Sub-total female & male science bachelor students	1540	1504	1655	2128	588	38.2%
Female% of Sub-total	44.0%	45.2%	43.7%	40.8%		
Mathematical Sciences						
Sub-total female & male science bachelor students	4141	4267	4122	4660		
Female% of Sub-total	44.5%	43.0%	42.9%	42.3%		
Physical Sciences						
Sub-total female & male science bachelor students	1842	2020	1913	1948	106	5.8%
Female% of Sub-total	37.8%	32.7%	32.2%	32.0%		
Other N&PS						
Sub-total female & male science bachelor students	2215	2861	3200	3531	1316	59.4%
Female% of Sub-total	64.4%	62.2%	60.9%	60.2%		
Non-Science						
Sub-total female & male science bachelor students	12232	11559	11066	11958	-274	-2.2%
Female% of Sub-total	54.1%	55.6%	55.9%	55.1%		
All Discipline Groups						
Total female & male science bachelor students	39989	42356	42409	45165	5176	12.9%
Female% of Sub-total	55.9%	55.5%	54.9%	53.8%		

'science' = Natural & Physical Sciences

Looking at commencing and continuing students in bachelor's degrees in science is relevant, because it is the closest measure available for looking at students starting out in a bachelor degree (see Table 4.16). From the glossary (Appendix 2), it can be seen that a student is a commencing student if s/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 moves into Bachelor of Science (Honours) at the same university is not considered to be a commencing student. If the patterns of commencing students taking subjects is higher than their overall presence in the student body, it is an indication that that fewer students take subjects in those disciplines after their commencing (usually first) year. Typically, commencing students have consumed 35 or 36 per cent of the teaching to science bachelor's degree teaching, although this did rise to over 38 per cent in 2009.

Table 4.16: Student Load 2002 – 2009. Content of Natural and Physical Science Bachelor's Degrees by Narrow Discipline Group and Commencing Status

Narrow Discipline Group	2002	2005	2007	2009	Growth	
	No.	No.	No.	No.	No.	%
Biological Sciences						
Commencing	4284	4769	4664	5092	808	18.9%
Continuing	9472	10646	11095	11092	1620	17.1%
Sub-total	13755	15415	15759	16184	2429	17.7%
Commencing % of Sub-total	31.1%	30.9%	29.6%	31.5%		
Chemical Sciences						
Commencing	2416	2583	2608	2789	373	15.4%
Continuing	1848	2149	2087	1968	120	6.5%
Sub-total	4264	4732	4695	4757	493	11.6%
Commencing % of Sub-total	56.7%	54.6%	55.5%	58.6%		
Earth Sciences						
Commencing	436	486	537	652	216	49.5%
Continuing	1104	1018	1118	1476	372	33.7%
Sub-total	1540	1504	1655	2128	588	38.2%
Commencing % of Sub-total	28.3%	32.3%	32.4%	30.6%		
Mathematical Sciences						
Commencing	2130	2169	2094	2511	381	17.9%
Continuing	2010	2098	2028	2149	139	6.9%
Sub-total	4141	4267	4122	4660	519	12.5%
Commencing % of Sub-total	51.5%	50.8%	50.8%	53.9%		
Physical Sciences						
Commencing	994	1034	958	1105	111	11.2%
Continuing	848	985	954	843	-5	-0.6%
Sub-total	1842	2020	1913	1948	106	5.8%
Commencing % of Sub-total	54.0%	51.2%	50.1%	56.7%		
Other N&PS						
Commencing	562	699	772	989	427	76.0%
Continuing	1654	2162	2428	2542	888	53.7%
Sub-total	2215	2861	3200	3531	1316	59.4%
Commencing % of Sub-total	25.3%	24.4%	24.1%	28.0%		
Non-Science						
Commencing	3858	3403	3326	4103	245	6.4%
Continuing	8374	8156	7740	7855	-519	-6.2%
Sub-total	12232	11559	11066	11958	-274	-2.2%
Commencing % of Sub-total	31.5%	29.4%	30.1%	34.3%		
All Discipline Groups						
Commencing	14680	15143	14959	17241	2561	17.4%
Continuing	25308	27213	27450	27924	2616	10.3%
Total	**39989**	**42356**	**42409**	**45165**	**5176**	**12.9%**
Commencing % of Sub-total	**36.7%**	**35.8%**	**35.3%**	**38.2%**		

An examination of the table indicates that the proportion of student load in the enabling sciences taught to commencing students is higher than in the other Natural and Physical Sciences disciplines, this indicates that many students do not continue with the enabling sciences once they are out of first year. In Table 4.16, commencing students represent more than half of the teaching in all three enabling sciences disciplines, when their overall presence is slightly more than one-third in the other 'science' disciplines. Another way of looking at this is that if the proportion of student load taught to commencing students is high, those students are less likely to be majoring in those subjects.

- **How many BSc graduates are being produced?**

Table 4.17 looks at course completions in bachelor's level courses and the levels within, for the Natural and Physical Sciences and all fields of education. In 2009, there were 3,252 course completions nation-wide in graduate entry bachelor's programmes, but only nine of these were in the natural and physical sciences. This represents about 0.1 per cent of science completions in graduate entry bachelor's courses, compared with 2.1 per cent in all fields of education. Graduate entry bachelor's programmes are clearly in decline in all fields of education, and they have not been embraced by the sciences.

Honours is clearly a bigger part of undergraduate science than overall, because honours completions represented 19.0 per cent of all bachelor's degree completions in science. For all fields of education, they represented 6.6 per cent. In both cases, there has been a decline since 2002 in the proportion of honours graduates. Science honours completions represented 26.4 per cent of all completions at this level in 2002, and 25.0 per cent in 2009 (calculated from Table 4.17).

The proportionate increase in science bachelor's course completions between 2002 and 2009 was 18.2 per cent, compared with the increase in bachelor's level completions in all fields of education of 24.8 per cent.

Table 4.17: Course Completions 2002 – 2009. Bachelor's Degrees in Natural and Physical Sciences and All Fields of Education

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Natural and Physical Sciences										
Bachelor's Grad. Entry	38	0.3%	14	0.1%	9	0.1%	9	0.1%	-29	-76.3%
Bachelor's Honours	2431	21.0%	2539	19.0%	2660	19.3%	2534	19.0%	103	4.2%
Bachelor's	9117	78.7%	10822	80.9%	11139	80.7%	10778	80.9%	1661	18.2%
Total	11586	100.0%	13375	100.0%	13808	100.0%	13321	100.0%	1735	15.0%
All Fields of Study										
Bachelor's Grad. Entry	4355	3.4%	4244	3.0%	3908	2.7%	3252	2.1%	-1103	-25.3%
Bachelor's Honours	9210	7.3%	10005	7.1%	10162	7.1%	10146	6.6%	936	10.2%
Bachelor's	113268	89.3%	127109	89.9%	129970	90.2%	141322	91.3%	28054	24.8%
Total	**126833**	**100.0%**	**141358**	**100.0%**	**144040**	**100.0%**	**154720**	**100.0%**	**27887**	**22.0%**

Table 4.18 summarises the number of bachelor's degree course completions by gender and citizenship status. This table would have also included information about Indigenous students, but there is an irregularity in the DEEWR past course completions files for 2008 and 2009, rendering the Indigenous student categories unreliable in those years.

Table 4.18: Course Completions 2002 – 2009. Bachelor's Degree Students in Natural and Physical Sciences Courses by Gender and Citizenship Status

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Gender										
Female	6621	57.1%	7729	57.8%	7847	56.8%	7311	54.9%	690	10.4%
Male	4965	42.9%	5646	42.2%	5961	43.2%	6010	45.1%	1045	21.0%
Citizenship Status										
International	895	7.7%	1878	14.0%	2186	15.8%	2048	15.4%	1153	128.8%
Domestic	10691	92.3%	11497	86.0%	11622	84.2%	11273	84.6%	582	5.4%
Total	**11586**	**100.0%**	**13375**	**100.0%**	**13808**	**100.0%**	**13321**	**100.0%**	**1735**	**15.0%**

Table 4.19 has been included mainly for form, because as has been mentioned earlier, most undergraduate programmes in science are linked to generalist fields of education. The table shows that 52.8 per cent of students completed a science bachelor's course were coded as either being in a generalist course, or a science bachelor's programme 'not elsewhere classified' (3,111 + 603 + 3,290 in 2009). Table 4.19 shows narrow field of education Other Natural and Physical Sciences broken out to its component detailed fields of education, to enable the reader to appreciate the high proportion of bachelor's degree completions in science that are coded non-specifically.

Table 4.19: Course Completions 2002 – 2009. Bachelor's Degree Students in Natural and Physical Science Courses by Narrow and Detailed Field of Education

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Narrow / Detailed Discipline Group										
Biological Sciences	3061	26.4%	3433	25.7%	3217	23.3%	3138	23.6%	77	2.5%
Chemical Sciences	293	2.5%	245	1.8%	311	2.3%	255	1.9%	-38	-13.0%
Earth Sciences	282	2.4%	223	1.7%	147	1.1%	170	1.3%	-112	-39.7%
Mathematical Sciences	504	4.4%	511	3.8%	497	3.6%	356	2.7%	-148	-29.4%
Physical Sciences	119	1.0%	166	1.2%	150	1.1%	110	0.8%	-9	-7.6%
Other Natural & Physical Sciences:										
Natual & Physical Sciences General	2460	21.2%	2992	22.4%	3066	22.2%	3111	23.4%	651	26.5%
Other Natual & Physical Sciences	168	1.5%	505	3.8%	556	4.0%	603	4.5%	435	258.9%
Medical Science	972	8.4%	1528	11.4%	1767	12.8%	1638	12.3%	666	68.5%
Forensic Science	37	0.3%	70	0.5%	156	1.1%	169	1.3%	132	356.8%
Food Science & Biotechnology.	422	3.6%	574	4.3%	518	3.8%	389	2.9%	-33	-7.8%
Pharmacology	52	0.4%	120	0.9%	134	1.0%	99	0.7%	47	90.4%
Laboratory Technology	10	0.1%	0	0.0%	1	0.0%	5	0.0%	-5	-50.0%
Other Natural & Physical Sciences nec	3206	27.7%	3008	22.5%	3288	23.8%	3290	24.7%	84	2.6%
Sub-total	7327	63.2%	8797	65.8%	9486	68.7%	9304	69.8%	1977	27.0%
Total	**11586**	**100.0%**	**13375**	**100.0%**	**13808**	**100.0%**	**13321**	**100.0%**	**1735**	**15.0%**

nec = not elsewhere classified

Science and the PhD

The PhD is a relatively recent phenomenon in Australia. As noted in a report by the Australian Academy of Science, until the second half of the 1940s, 'in the absence of well established honours degrees in science and the PhD, the bright young scientist worked for a further year on a research topic after his (sic) BSc degree, and gained an MSc. On the basis of this they then competed for a variety of university travelling scholarships…With one of these, they then went to Britain to undertake the research study of the PhD degree" (AAS, 1974, p14).

The history of the PhD in Australia is closely bound up with 'science', with an early push having come from the University of Melbourne: '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, p8).

The PhD is now well entrenched in Australian academic life, and is a usually threshold that must be crossed in order to join the academic community. Most academic disciplines now require their teachers and researchers to hold a PhD, but this has perhaps been the case for longer in the science disciplines than in some others.

- **PhD enrolments**

Table 4.20 compares PhD enrolments in science with enrolments at this level in all fields of education The proportion of science PhDs increased slightly over the period, from 19.3 per cent to 20.7 per cent. The number increased from 6,553 to 9,163, an increase of 39.8 per cent. In contrast with bachelor-level enrolments, PhD enrolments in science are increasing at a higher rate than other fields of education.

Table 4.20: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses and All Fields of Education

					Growth	
	2002	2005	2007	2009	No.	%
Broad Field of Education						
Natural and Physical Sciences	6553	8122	8677	9163	2610	39.8%
Other Fields of Education	27487	30831	32750	35129	7642	27.8%
Total PhD Enrolments	**34040**	**38953**	**41427**	**44292**	**10252**	**30.1%**
Nat. & Phys Sciences % of Total	**19.3%**	**20.9%**	**20.9%**	**20.7%**		

Table 4.21 considers only PhD enrolments in science courses by gender, citizenship status and Indigenous status. The number of women increased by 1,520 between 2002 and 2009, an increase of 51.3 per cent. The number of enrolments by men increased by 1,090 or 30.3 per cent in the same period. The proportion of female science PhD enrolees increased from 45.0 per cent to 48.8 per cent.

Table 4.21: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses by Gender, Citizenship Status and Indigenous status

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Gender										
Female	2950	45.0%	3856	47.5%	4189	48.3%	4470	48.8%	1520	51.5%
Male	3603	55.0%	4266	52.5%	4488	51.7%	4693	51.2%	1090	30.3%
Citizenship Status										
International	945	14.4%	1372	16.9%	1822	21.0%	2479	27.1%	1534	162.3%
Domestic	5608	85.6%	6750	83.1%	6855	79.0%	6684	72.9%	1076	19.2%
Indigenous Status										
Indigenous	13	0.2%	17	0.2%	19	0.2%	24	0.3%	11	84.6%
Not Indigenous	6430	98.1%	7862	96.8%	8573	98.8%	8970	97.9%	2540	39.5%
No Information	111	1.7%	243	3.0%	85	1.0%	169	1.8%	58	52.3%
Total	**6553**	**100.0%**	**8122**	**100.0%**	**8677**	**100.0%**	**9163**	**100.0%**	**2610**	**39.8%**

Growth in international student PhDs was also evident. These students increased their presence from 14.4 per cent to 27.1 per cent between 2002 and 2009.

Indigenous students are under-represented across the board in Australian higher education, no less among PhD enrolments. The proportion of students not identified according to their Indigenous status remains much higher than the number of Indigenous students enrolled in PhDs in science. At least the proportion of these has dropped from about nine times in 2002 to (only) five times in 2009.

Table 4.22 examines the distribution of PhD enrolments in Natural and Physical Sciences by state / territory and university. The universities with the most PhD students in science are the Group of Eight universities, with Monash the largest with 1,016 PhD enrolments, followed by the Universities of Queensland and Melbourne, the Australian National University, the Universities of Sydney, New South Wales, Adelaide and Western Australia. The situation with Monash needs further

investigation, however, because the table reveals a quantum leap in science PhD enrolments between 2002 and 2005. (In fact, this increase occurred between 2002 and 2003, but data for 2003 are not shown in this table. A 223 per cent increase from 244 to 788 over two years seems an unlikely result). This is examined below (see Table 4.25 and associated text).

Table 4.22: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses by State / Territory and University

State / Territory & University	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Australian Capital Territory										
Australian Defence	21	0.3%	18	0.2%		0.0%		0.0%		
Canberra	56	0.9%	58	0.7%	64	0.7%	57	0.6%	1	1.8%
Australian National	534	8.1%	702	8.6%	748	8.6%	774	8.4%	240	44.9%
Sub-total	**611**	**9.3%**	**778**	**9.6%**	**812**	**9.4%**	**831**	**9.1%**	**220**	**36.0%**
NewSouth Wales										
Wollongong	162	2.5%	196	2.4%	213	2.5%	266	2.9%	104	64.2%
Western Sydney	111	1.7%	57	0.7%	16	0.2%	5	0.1%	-106	-95.5%
New South Wales	402	6.1%	438	5.4%	439	5.1%	485	5.3%	83	20.6%
Newcastle	167	2.5%	196	2.4%	183	2.1%	201	2.2%	34	20.4%
Uni. Tech, Sydney	164	2.5%	188	2.3%	183	2.1%	166	1.8%	2	1.2%
Macquarie	125	1.9%	227	2.8%	290	3.3%	330	3.6%	205	164.0%
Southern Cross	56	0.9%	4	0.0%	2	0.0%	1	0.0%	-55	-98.2%
New England	86	1.3%	222	2.7%	182	2.1%	34	0.4%	-52	-60.5%
Sydney	511	7.8%	530	6.5%	578	6.7%	703	7.7%	192	37.6%
Sub-total	**1784**	**27.2%**	**2058**	**25.3%**	**2086**	**24.0%**	**2191**	**23.9%**	**407**	**22.8%**
Northern Territory										
Charles Darwin/NTU	28	0.4%	63	0.8%	31	0.4%	27	0.3%		-3.6%
Queensland										
James Cook	205	3.1%	255	3.1%	263	3.0%	274	3.0%	69	33.7%
Central Queensland	44	0.7%	49	0.6%	58	0.7%	71	0.8%	27	61.4%
Southern Queensland	28	0.4%	25	0.3%	31	0.4%	34	0.4%	6	21.4%
Queensland	672	10.3%	794	9.8%	921	10.6%	974	10.6%	302	44.9%
Griffith	83	1.3%	100	1.2%	106	1.2%	115	1.3%	32	38.6%
QUT	167	2.5%	185	2.3%	190	2.2%	213	2.3%	46	27.5%
Sunshine Coast	7	0.1%	15	0.2%	14	0.2%	22	0.2%	15	214.3%
Sub-total	**1206**	**18.4%**	**1423**	**17.5%**	**1583**	**18.2%**	**1703**	**18.6%**	**497**	**41.2%**
South Australia										
Adelaide	310	4.7%	404	5.0%	451	5.2%	439	4.8%	129	41.6%
South Australia	42	0.6%	56	0.7%	67	0.8%	35	0.4%	-7	-16.7%
Flinders	134	2.0%	159	2.0%	178	2.1%	196	2.1%	62	46.3%
Sub-total	**486**	**7.4%**	**619**	**7.6%**	**696**	**8.0%**	**670**	**7.3%**	**184**	**37.9%**
Tasmania										
Tasmania	244	3.7%	281	3.5%	318	3.7%	322	3.5%	78	32.0%
Victoria										
Ballarat	20	0.3%	21	0.3%	18	0.2%	32	0.3%	12	60.0%
Swinburne	65	1.0%	83	1.0%	110	1.3%	167	1.8%	102	156.9%
Victoria / VUT	83	1.3%	68	0.8%	101	1.2%	96	1.0%	13	15.7%
La Trobe	192	2.9%	208	2.6%	193	2.2%	208	2.3%	16	8.3%
Deakin	118	1.8%	170	2.1%	159	1.8%	157	1.7%	39	33.1%
RMIT	180	2.7%	179	2.2%	166	1.9%	182	2.0%	2	1.1%
Monash	244	3.7%	788	9.7%	884	10.2%	1016	11.1%	772	316.4%
Melbourne	595	9.1%	713	8.8%	803	9.3%	816	8.9%	221	37.1%
Sub-total	**1497**	**22.8%**	**2230**	**27.5%**	**2434**	**28.1%**	**2674**	**29.2%**	**1177**	**78.6%**

Table 4.22: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses by State / Territory and University *continued*

State / Territory & University	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Western Australia										
Murdoch	121	1.8%	139	1.7%	156	1.8%	154	1.7%	33	27.3%
Western Australia	357	5.4%	299	3.7%	317	3.7%	341	3.7%	-16	-4.5%
Edith Cowan	40	0.6%	30	0.4%	27	0.3%	4	0.0%	-36	-90.0%
Curtin	179	2.7%	202	2.5%	217	2.5%	246	2.7%	67	37.4%
Sub-total	**697**	**10.6%**	**670**	**8.2%**	**717**	**8.3%**	**745**	**8.1%**	**48**	**6.9%**
Total	**6553**	**100.0%**	**8122**	**100.0%**	**8677**	**100.0%**	**9163**	**100.0%**	**2610**	**39.8%**

Table 4.23 considers the distribution of PhD enrolments in the sciences by narrow field of education. In particular, the decline in PhDs in the Earth Sciences should be noted, and the fact that growth is being pushed predominantly by enrolments in Other Natural and Physical Sciences and Biological Sciences. More detail of the distribution of PhD enrolments can be seen in Table 4.24.

Table 4.23: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses by Narrow Field of Education

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Narrow Field of Education										
Biological Sciences	2802	42.8%	3448	42.5%	3712	42.8%	3906	42.6%	1104	39.4%
Chemical Sciences	853	13.0%	904	11.1%	1006	11.6%	1138	12.4%	285	33.4%
Earth Sciences	629	9.6%	527	6.5%	478	5.5%	527	5.8%	-102	-16.2%
Mathematical Sciences	414	6.3%	480	5.9%	503	5.8%	534	5.8%	120	29.0%
Physical Sciences	702	10.7%	858	10.6%	931	10.7%	989	10.8%	287	40.9%
Other Natural & Physical Sciences	1153	17.6%	1905	23.5%	2047	23.6%	2069	22.6%	916	79.4%
Total	**6553**	**100.0%**	**8122**	**100.0%**	**8677**	**100.0%**	**9163**	**100.0%**	**2610**	**39.8%**

Table 4.24: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses by Detailed Field of Education

Narrow & Detailed Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences										
Biological Sciences	637	9.7%	1321	16.3%	1463	16.9%	1536	16.8%	899	141.1%
Biochemistry and Cell Biol.	447	6.8%	431	5.3%	430	5.0%	392	4.3%	-55	-12.3%
Botany	186	2.8%	151	1.9%	137	1.6%	126	1.4%	-60	-32.3%
Ecology and Evolution	125	1.9%	125	1.5%	124	1.4%	110	1.2%	-15	-12.0%
Marine Science	90	1.4%	133	1.6%	150	1.7%	200	2.2%	110	122.2%
Genetics	95	1.4%	102	1.3%	92	1.1%	101	1.1%	6	6.3%
Microbiology	238	3.6%	223	2.7%	200	2.3%	244	2.7%	6	2.5%
Human Biology	252	3.8%	237	2.9%	255	2.9%	217	2.4%	-35	-13.9%
Zoology	299	4.6%	187	2.3%	180	2.1%	190	2.1%	-109	-36.5%
Biological Sciences nec	433	6.6%	538	6.6%	681	7.8%	790	8.6%	357	82.4%
Sub-total	**2802**	**42.8%**	**3448**	**42.5%**	**3712**	**42.8%**	**3906**	**42.6%**		
Chemical Sciences										
Chemical Sciences	503	7.7%	616	7.6%	720	8.3%	731	8.0%	228	45.3%
Organic Chemistry	30	0.5%	19	0.2%	12	0.1%	40	0.4%	10	33.3%
Inorganic Chemistry	13	0.2%	5	0.1%	2	0.0%	13	0.1%	0	0.0%
Chemical Sciences nec	307	4.7%	264	3.3%	272	3.1%	354	3.9%	47	15.3%
Sub-total	**853**	**13.0%**	**904**	**11.1%**	**1006**	**11.6%**	**1138**	**12.4%**		

Table 4.24: Enrolments 2002 – 2009. PhD Students in Natural and Physical Sciences Courses by Detailed Field of Education *continued*

Narrow & Detailed Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Earth Sciences										
Earth Sciences	161	2.5%	214	2.6%	216	2.5%	272	3.0%	111	68.9%
Atmospheric Sciences	8	0.1%	5	0.1%	4	0.0%	3	0.0%	-5	-62.5%
Geology	256	3.9%	152	1.9%	119	1.4%	87	0.9%	-169	-66.0%
Geophysics	6	0.1%	5	0.1%	3	0.0%	3	0.0%	-3	-50.0%
Geochemistry	10	0.2%		0.0%	5	0.1%	7	0.1%	-3	-30.0%
Soil Science	23	0.4%	1	0.0%	1	0.0%		0.0%	-23	
Hydrology	2	0.0%		0.0%	1	0.0%	1	0.0%		-50.0%
Oceanography	8	0.1%		0.0%	3	0.0%	9	0.1%	1	12.5%
Earth Sciences nec	155	2.4%	150	1.8%	126	1.5%	145	1.6%	-10	-6.5%
Sub-total	**629**	**9.6%**	**527**	**6.5%**	**478**	**5.5%**	**527**	**5.8%**		
Mathematical Sciences										
Mathematical Sciences	119	1.8%	100	1.2%	110	1.3%	101	1.1%	-18	-15.1%
Mathematics	196	3.0%	219	2.7%	208	2.4%	216	2.4%	20	10.2%
Statistics	31	0.5%	42	0.5%	47	0.5%	39	0.4%	8	25.8%
Mathematical Sciences nec	68	1.0%	119	1.5%	138	1.6%	178	1.9%	110	161.8%
Sub-total	**414**	**6.3%**	**480**	**5.9%**	**503**	**5.8%**	**534**	**5.8%**		
Physical Sciences										
Physics and Astronomy	73	1.1%	96	1.2%	54	0.6%	80	0.9%	7	9.6%
Physics	604	9.2%	684	8.4%	788	9.1%	831	9.1%	227	37.6%
Astronomy	25	0.4%	78	1.0%	89	1.0%	78	0.9%	53	212.0%
Sub-total	**702**	**10.7%**	**858**	**10.6%**	**931**	**10.7%**	**989**	**10.8%**		
Other N&P Sciences										
Natural & Physical Sciences	69	1.1%	63	0.8%	71	0.8%	53	0.6%	-16	-23.2%
Other Natural & Physical Sciences	162	2.5%	440	5.4%	458	5.3%	545	5.9%	383	236.4%
Medical Science	126	1.9%	264	3.3%	404	4.7%	441	4.8%	315	250.0%
Forensic Science		0.0%	18	0.2%	22	0.3%	15	0.2%	15	
Food Sci. and Biotechnology	97	1.5%	117	1.4%	102	1.2%	104	1.1%	7	7.2%
Pharmacology	161	2.5%	119	1.5%	110	1.3%	112	1.2%	-49	-30.4%
Laboratory Technology	1	0.0%		0.0%		0.0%	8	0.1%	7	700.0%
Natural and Physical Sciences nec	537	8.2%	884	10.9%	880	10.1%	791	8.6%	254	47.3%
Sub-total	1153	17.6%	1905	23.5%	2047	23.6%	2069	22.6%		
Total	**6553**	**100.0%**	**8122**	**100.0%**	**8677**	**100.0%**	**9163**	**100.0%**	**2610**	**39.8%**

nec = not elsewhere classified

The fact that analysis based on detailed fields of education provides an opportunity for misleading results has been made several times in this study. Having a detailed classification is only useful if what is being classified suits the classification, and if universities use the classification in the same way as each other. It is clear that having a six-digit classification is of little help at the bachelor's level, because many undergraduate degrees are generalist by nature (such as the BSc, for example, see Tables 4.11/4.12). However, this ought not be a problem at the PhD level, because students write dissertations on highly specific topics, and this should lend itself to description using a detailed classification.

The other relevant matter concerns universities following the same methodology as each other when classifying courses. By way of example, earlier it was noted that Monash University reported a huge increase in its enrolments in PhDs in the Natural and Physical Sciences between 2002 and 2009. Table 4.25 provides an example of how 'trends' can be set that are probably nothing more than a change of heart or correcting a past error.

In 2002, Monash reported 502 enrolments in a PhD in narrow field of education 0601 Medical Studies, within broad field of education '06 Health'. In the same year, Monash reported three students as being enrolled in a PhD in a narrow field of education in '0109 Biological Sciences'. The following year, it appears that there was a switch between these two narrow fields, but this is only supposition based on an observation of these figures. However, the time series effect is to have reduced PhDs in medical studies by 497 enrolments over a seven-year period, and an overall decline in Health PhD enrolments of 329. Meanwhile, PhDs in Biological Sciences increased by 644.

Table 4.25: Enrolments 2002 – 2009. Monash University: PhD Students in Health and Natural & Physical Sciences Courses by Narrow Field of Education

Broad and Narrow Field of Education	2002	2003	2004	2005	2006	2007	2008	2009	Growth	
Health										
Medical Studies	502	122	40	18	13	8	5	6	-497	-99.0%
Nursing	7	8	12	18	18				-7	
Pharmacy	42	50	63	67	75	89	107	114	65	154.8%
Public Health	36	46	47	47	66	11	1	16	-35	-97.2%
Other Health #	7	8	9	8	12	140	152	167		
Sub-total Health	594	234	171	158	184	248	265	303	-329	-55.4%
Natural & Physical Sciences										
Biological Sciences	3	401	465	507	542	612	647	689	644	
Earth Sciences	12	13	16	18	18	1			-12	
Mathematical Sci.	32	30	32	39	40	19	6	12	-26	-81.3%
Other Natural & Physical Sciences	197	225	221	224	228	252	286	315	89	45.2%
Sub-total Natural & Physical Sciences	244	669	734	788	828	884	939	1016	695	284.8%
Total Health & Natural & Physical Sciences	**838**	**903**	**905**	**946**	**1012**	**1132**	**1204**	**1306**	**468**	**55.8%**

Includes extremely low numbers in radiography, rehabilitation therapies, dental studies and optical science

- **Student load and science PhDs**

Analysing patterns in student load consumption is the only way to discern what is actually being studied by students enrolled in generalist undergraduate programmes such as the BSc, but it is a less useful measure for analysing the scholastic bent of PhD students. PhD students, one would expect, are likely to be enrolled in a course linked to a detailed field of education that closely matches the topic of their dissertation.

Table 4.26 provides a summary of the student load consumed by students enrolled in PhDs in field of education Natural and Physical Sciences. Among the things that can be noticed is that not all of these 'science' students are studying 'science' disciplines. In fact, in 2009, 617 equivalent full-time PhD 'science' students were studying outside the Natural and Physical Sciences disciplines.

Between 2002 and 2009, there was growth in most narrow discipline groups, but there was an 18.5 per cent drop in Earth Sciences PhDs. Biological Sciences, Chemical Sciences, Mathematical Sciences and Physical Sciences all increased their share of the pool, as did non-science disciplines.

Table 4.27 extends the reach of the previous table by looking at the content of science PhDs by detailed discipline group. As has been stated in other contexts, it is not possible to know whether the changes at the detailed discipline group level actually tell us anything about preferences or trends, or whether one or more universities has changed the way it codes subjects (even at the PhD level) to discipline groups. Under narrow discipline group Biological Sciences, the table shows declines at the detailed discipline group level in *biological sciences, botany* and *zoology,* and

increases in *biochemistry and cell biology, microbiology* and *human biology.* This observation is the same as the one made about enrolments table 4.24, above.

Table 4.26: Student Load 2002 – 2009: Content of Natural and Physical Sciences PhD Courses by Narrow Discipline Group

Natural & Physical Sciences	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences	2226	42.0%	2820	43.4%	2962	43.3%	3129	42.9%	903	40.6%
Chemical Sciences	665	12.6%	735	11.3%	862	12.6%	998	13.7%	333	50.1%
Earth Sciences	619	11.7%	535	8.2%	465	6.8%	504	6.9%	-115	-18.5%
Mathematical Sciences	308	5.8%	374	5.8%	410	6.0%	473	6.5%	165	53.8%
Physical Sciences	512	9.7%	646	9.9%	689	10.1%	775	10.6%	262	51.2%
Other Natural & Physical Sciences	628	11.9%	667	10.3%	802	11.7%	793	10.9%	165	26.4%
Sub-total Natural & Physical Sciences Disciplines	4957	93.6%	5778	89.0%	6190	90.5%	6672	91.5%	1714	34.6%
Non-Science	337	6.4%	717	11.0%	652	9.5%	617	8.5%	281	83.3%
Total	**5294**	**100.0%**	**6494**	**100.0%**	**6842**	**100.0%**	**7289**	**100.0%**	**1995**	**37.7%**

Table 4.27: Student Load 2002 – 2009. Content of Natural and Physical Sciences PhD Courses by Detailed Discipline Group

Detailed Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences										
Biological Sciences	823	15.5%	717	11.0%	598	8.7%	663	9.1%	-160	-19.4%
Biochemistry and Cell Biology	365	6.9%	433	6.7%	497	7.3%	520	7.1%	155	42.6%
Botany	104	2.0%	88	1.3%	69	1.0%	66	0.9%	-38	-36.8%
Ecology and Evolution	89	1.7%	108	1.7%	131	1.9%	132	1.8%	43	47.9%
Marine Science	71	1.3%	93	1.4%	126	1.8%	161	2.2%	90	126.7%
Genetics	76	1.4%	74	1.1%	66	1.0%	85	1.2%	9	12.0%
Microbiology	134	2.5%	277	4.3%	253	3.7%	286	3.9%	152	113.1%
Human Biology	150	2.8%	360	5.5%	423	6.2%	357	4.9%	208	138.8%
Zoology	172	3.2%	136	2.1%	127	1.9%	126	1.7%	-46	-26.8%
Biological Sciences nec	242	4.6%	535	8.2%	673	9.8%	733	10.1%	491	203.1%
Sub-total	**2226**	**42.0%**	**2820**	**43.4%**	**2962**	**43.3%**	**3129**	**42.9%**	**903**	**40.6%**
Chemical Sciences										
Chemical Sciences	318	6.0%	398	6.1%	506	7.4%	523	7.2%	204	64.2%
Organic Chemistry	94	1.8%	40	0.6%	44	0.6%	93	1.3%		-0.9%
Inorganic Chemistry	15	0.3%	49	0.8%	57	0.8%	65	0.9%	50	331.2%
Chemical Sciences nec	238	4.5%	248	3.8%	254	3.7%	317	4.3%	79	33.3%
Sub-total	**665**	**12.6%**	**735**	**11.3%**	**862**	**12.6%**	**998**	**13.7%**	**333**	**50.1%**
Earth Sciences										
Earth Sciences	206	3.9%	189	2.9%	169	2.5%	214	2.9%	8	4.0%
Atmospheric Sciences		0.0%		0.0%	6	0.1%	18	0.2%	18	
Geology	186	3.5%	111	1.7%	96	1.4%	74	1.0%	-112	-60.3%
Geophysics	20	0.4%	49	0.8%	44	0.6%	18	0.2%	-3	-12.6%
Geochemistry	12	0.2%	5	0.1%	7	0.1%	8	0.1%	-4	-30.8%
Soil Science	5	0.1%	1	0.0%	2	0.0%	1	0.0%	-4	-89.2%
Hydrology	2	0.0%	2	0.0%	1	0.0%	1	0.0%		-42.7%

Table 4.27: Student Load 2002 – 2009. Content of Natural and Physical Sciences PhD Courses by Detailed Discipline Group *continued*

Detailed Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Oceanography	3	0.1%		0.0%	3	0.0%	8	0.1%	5	128.6%
Earth Sciences nec	185	3.5%	179	2.8%	138	2.0%	163	2.2%	-22	-11.8%
Sub-total	**619**	**11.7%**	**535**	**8.2%**	**465**	**6.8%**	**504**	**6.9%**	**-115**	**-18.5%**
Mathematical Sciences										
Mathematical Sciences	79	1.5%	95	1.5%	93	1.4%	90	1.2%	11	14.5%
Mathematics	181	3.4%	225	3.5%	254	3.7%	288	4.0%	107	58.8%
Statistics	31	0.6%	30	0.5%	30	0.4%	38	0.5%	7	23.1%
Mathematical Sciences nec	16	0.3%	24	0.4%	32	0.5%	56	0.8%	40	244.9%
Sub-total	**308**	**5.8%**	**374**	**5.8%**	**410**	**6.0%**	**473**	**6.5%**	**165**	**53.8%**
Physical Sciences										
Physics and Astronomy	132	2.5%	147	2.3%	12	0.2%	26	0.4%	-106	-80.0%
Physics	357	6.7%	441	6.8%	616	9.0%	692	9.5%	335	93.7%
Astronomy	23	0.4%	58	0.9%	60	0.9%	57	0.8%	33	143.7%
Sub-total	**512**	**9.7%**	**646**	**9.9%**	**689**	**10.1%**	**775**	**10.6%**	**262**	**51.2%**
Other Natural & Physical Sciences										
Other Natural & Physical Sciences	195	3.7%	189	2.9%	193	2.8%	173	2.4%	-22	-11.1%
MedSci	114	2.2%	213	3.3%	356	5.2%	355	4.9%	241	210.4%
Forensic Science	9	0.2%	4	0.1%	5	0.1%	16	0.2%	7	75.2%
Food Science / Biotechnology	113	2.1%	87	1.3%	52	0.8%	60	0.8%	-52	-46.4%
Pharmacology	115	2.2%	87	1.3%	72	1.1%	61	0.8%	-54	-47.1%
LabTech	1	0.0%		0.0%	1	0.0%	2	0.0%	1	91.5%
Natural & Physical Sciences nec	80	1.5%	87	1.3%	123	1.8%	126	1.7%	46	55.6%
Sub-total	**628**	**11.9%**	**667**	**10.3%**	**802**	**11.7%**	**793**	**10.9%**	**165**	**26.3%**
Non-Science										
Information Technology	12	0.2%	31	0.5%	15	0.2%	17	0.2%	5	45.9%
Engineering	41	0.8%	60	0.9%	58	0.9%	62	0.9%	21	50.0%
Agriculture	96	1.8%	183	2.8%	138	2.0%	76	1.0%	-20	-20.8%
Health	80	1.5%	258	4.0%	253	3.7%	278	3.8%	197	245.5%
Society & Culture	80	1.5%	177	2.7%	179	2.6%	180	2.5%	100	124.9%
Other non-science disciplines	27	0.5%	8	0.1%	9	0.1%	4	0.1%	-23	-86.0%
Sub-total	**310**	**5.9%**	**709**	**10.9%**	**643**	**9.4%**	**613**	**8.4%**	**303**	**97.8%**
Total	**5294**	**100.0%**	**6494**	**100.0%**	**6842**	**100.0%**	**7289**	**100.0%**	**1995**	**37.7%**

nec = not elsewhere classified

- **PhD graduates**

The University of Melbourne awarded the three first Australian PhDs in 1948 (CBCS, 1952). In the early years, the majority of PhDs awarded in Australia were in science, although the proportion of 'science' PhDs to the total has declined since the first awarding of the degree. Over the first 20 years of the awarding of the PhD in Australia, science PhDs represented 60 per cent of all those awarded, and a further 14 per cent were awarded in agriculture and engineering. Of the accumulated total of PhDs awarded to 2009 (more than 94,000), about one-third have been awarded in science (including information technology / computer science), with about 18 per cent being awarded in agriculture and engineering (Dobson, unpublished).

Table 4.28 compares the number of PhDs awarded in science with those awarded in all fields of education. The proportion awarded to science PhD students has slipped just a little.

Table 4.28: Course Completions 2002 – 2009. PhDs in Natural and Physical Sciences Courses c.f. All Fields of Education

Broad Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Natural & Physical Sciences	1062	24.7%	1256	24.0%	1369	23.9%	1388	23.9%	326	30.7%
Other Fields of Education	3229	75.3%	3988	76.0%	4352	76.1%	4408	76.1%	1179	36.5%
Total	**4291**	**100.0%**	**5244**	**100.0%**	**5721**	**100.0%**	**5796**	**100.0%**	**1505**	**35.1%**

Table 4.29 looks at the number of science PhDs awarded, by narrow field of education. The proportion in all narrow fields except for Other Natural and Physical Sciences declined a little, but there were small increases in the physical sciences (+41, or 37.3 per cent) and other natural and physical sciences (+150, or 89.3 per cent). Table 4.30 provides an opportunity to see what the Other Natural and Physical Sciences completions were in.

Table 4.29: Course Completions 2002 – 2009. PhDs in Natural and Physical Sciences Courses by Narrow Field of Education

Narrow Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences	471	44.4%	479	38.1%	569	41.6%	586	42.2%	115	24.4%
Chemical Sciences	170	16.0%	152	12.1%	169	12.3%	175	12.6%	5	2.9%
Earth Sciences	77	7.3%	100	8.0%	74	5.4%	83	6.0%	6	7.8%
Mathematical Sciences	66	6.2%	74	5.9%	67	4.9%	75	5.4%	9	13.6%
Physical Sciences	110	10.4%	122	9.7%	117	8.5%	151	10.9%	41	37.3%
Other Natural & Physical Sciences	168	15.8%	329	26.2%	373	27.2%	318	22.9%	150	89.3%
Total	**1062**	**100.0%**	**1256**	**100.0%**	**1369**	**100.0%**	**1388**	**100.0%**	**326**	**30.7%**

On the surface, Table 4.30 provides more information about the detailed field of education Science PhDs were completed in, but the largest categories are the less-defined ones. Within the Biological Sciences, in 2009 there were 204 PhD completions in the generic Biological Sciences field, and another 103 in Biological Sciences not elsewhere classified. Together these two sub-categories comprise over half of PhDs awarded in the biological sciences. According to the statistics, within Biological Sciences, there were declines in *biochemistry and cell biology*, *botany, microbiology and zoology*. Overall, the increase in the Biological Sciences of 115 PhDs (+24.4 per cent) was lower than the overall increase for all 'science' narrow fields of education of 30.7 per cent.

Table 4.30: Course Completions 2002-2009. PhDs in Natural and Physical Sciences Courses by Narrow and Detailed Field of Education

Detailed Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences										
Biological Sciences	110	10.4%	155	12.3%	208	15.2%	204	14.7%	94	85.5%
Biochemistry and Cell Biology	82	7.7%	89	7.1%	81	5.9%	69	5.0%	-13	-15.9%
Botany	47	4.4%	20	1.6%	26	1.9%	25	1.8%	-22	-46.8%
Ecology and Evolution	10	0.9%	15	1.2%	18	1.3%	26	1.9%	16	160.0%
Marine Science	15	1.4%	15	1.2%	5	0.4%	28	2.0%	13	86.7%
Genetics	16	1.5%	7	0.6%	12	0.9%	19	1.4%	3	18.8%
Microbiology	49	4.6%	32	2.5%	53	3.9%	37	2.7%	-12	-24.5%
Human Biology	40	3.8%	61	4.9%	53	3.9%	45	3.2%	5	12.5%
Zoology	51	4.8%	27	2.1%	26	1.9%	30	2.2%	-21	-41.2%
Biological Sciences nec	51	4.8%	58	4.6%	87	6.4%	103	7.4%	52	102.0%
Sub-total	**471**	**44.4%**	**479**	**38.1%**	**569**	**41.6%**	**586**	**42.2%**	**115**	**24.4%**

Table 4.30: Course Completions 2002-2009. PhDs in Natural and Physical Sciences Courses by Narrow and Detailed Field of Education *continued*

Detailed Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Chemical Sciences										
Chemical Sciences	83	7.8%	93	7.4%	110	8.0%	133	9.6%	50	60.2%
Organic Chemistry	12	1.1%	4	0.3%	6	0.4%	5	0.4%	-7	-58.3%
Inorganic Chemistry	6	0.6%	2	0.2%	2	0.1%		0.0%	-6	
Chemical Sciences nec	69	6.5%	53	4.2%	51	3.7%	37	2.7%	-32	-46.4%
Sub-total	**170**	**16.0%**	**152**	**12.1%**	**169**	**12.3%**	**175**	**12.6%**	**5**	**2.9%**
Earth Sciences										
Earth Sciences	14	1.3%	29	2.3%	36	2.6%	45	3.2%	31	221.4%
Atmospheric Sciences		0.0%	2	0.2%	1	0.1%		0.0%	0	
Geology	29	2.7%	48	3.8%	9	0.7%	14	1.0%	-15	-51.7%
Geophysics	2	0.2%	1	0.1%		0.0%	2	0.1%	0	0.0%
Geochemistry		0.0%	3	0.2%		0.0%		0.0%	0	
Soil Science	2	0.2%		0.0%		0.0%		0.0%	-2	
Hydrology	1	0.1%		0.0%		0.0%		0.0%		
Oceanography	3	0.3%		0.0%		0.0%	1	0.1%	-2	-66.7%
Earth Sciences nec	26	2.4%	17	1.4%	28	2.0%	21	1.5%	-5	-19.2%
Sub-total	**77**	**7.3%**	**100**	**8.0%**	**74**	**5.4%**	**83**	**6.0%**	**6**	**7.8%**
Mathematical Sciences										
Mathematical Sciences	16	1.5%	11	0.9%	17	1.2%	20	1.4%	4	25.0%
Mathematics	33	3.1%	37	2.9%	31	2.3%	28	2.0%	-5	-15.2%
Statistics	5	0.5%	5	0.4%	5	0.4%	2	0.1%	-3	-60.0%
Mathematical Sciences nec	12	1.1%	21	1.7%	14	1.0%	25	1.8%	13	108.3%
Sub-total	**66**	**6.2%**	**74**	**5.9%**	**67**	**4.9%**	**75**	**5.4%**	**9**	**13.6%**
Physical Sciences										
Physics and Astronomy	15	1.4%	12	1.0%	8	0.6%	9	0.6%	-6	-40.0%
Physics	93	8.8%	105	8.4%	102	7.5%	127	9.1%	34	36.6%
Astronomy	2	0.2%	5	0.4%	7	0.5%	15	1.1%	13	650.0%
Sub-total	**110**	**10.4%**	**122**	**9.7%**	**117**	**8.5%**	**151**	**10.9%**	**41**	**37.3%**
Other Natural and Physical Sciences										
Natural & Physical Sciences General	9	0.8%	6	0.5%	6	0.4%	5	0.4%	-4	-44.4%
Other Natural and Physical Sciences	26	2.4%	76	6.1%	88	6.4%	79	5.7%	53	203.8%
Medical Science	20	1.9%	45	3.6%	49	3.6%	73	5.3%	53	265.0%
Forensic Science		0.0%		0.0%	1	0.1%	4	0.3%	4	
Food Science and Biotechnology	18	1.7%	25	2.0%	26	1.9%	13	0.9%	-5	-27.8%
Pharmacology	33	3.1%	29	2.3%	18	1.3%	19	1.4%	-14	-42.4%
Laboratory Technology		0.0%		0.0%		0.0%	2	0.1%	2	
Natural and Physical Sciences nec	62	5.8%	148	11.8%	185	13.5%	123	8.9%	61	98.4%
Sub-total	**168**	**15.8%**	**329**	**26.2%**	**373**	**27.2%**	**318**	**22.9%**	**150**	**89.3%**
Total	**1062**	**100.0%**	**1256**	**100.0%**	**1369**	**100.0%**	**1388**	**100.0%**	**326**	**30.7%**

nec = not elsewhere classified

Looking at the enabling sciences, the Chemical Sciences produced only five PhDs more in 2009 than they had in 2002, an increase of 2.9 per cent. The Chemical sciences slipped back as a proportion of all PhDs awarded to Natural and Physical Sciences students, from 16.0 per cent in 2002, to 12.9 per cent in 2009. Mathematical sciences PhDs also increased only marginally, with nine more PhDs in 2009 compared with 2002. Mathematical sciences' proportion of all completions declined from 6.2 to 5.4 per cent. Things were a bit brighter for the physical sciences. PhDs in the Physical Sciences awarded to science students increased by 41 from 110 in 2002 to 151 in 2009, or 37.3 per cent.

PhDs in Earth Sciences increased in number by six over the period, but Earth Sciences as a percentage of all PhDs in Natural and Physical Sciences fields of education declined from 7.3 per cent to 6.0 per cent.

The largest growth is to be found in Other Natural and Physical Sciences, but again, most of the growth has been reported in nondescript areas. In 2009, over 60 per cent of PhD completions were in 'Other Natural and Physical Sciences' and 'Natural and Physical Sciences nec' (79 + 123). Not visible in Table 4.30, the University of Western Australia was responsible for 51 of the 79 of the PhD completions reported as 'Other Natural and Physical Sciences' in 2009, and between them the Australian National University and Monash reported 97 of the 116 PhD course completions in 'Natural and Physical Sciences nec' (see also Table 4.33).

Table 4.31 is intended to show the gender differences in PhD graduations in the Natural and Physical Sciences. From the table, it can be seen that women are more drawn to PhDs in the Biological Sciences than men (by over 14 percentage points in 2009), and less attracted to the enabling sciences and Earth Sciences. The female proportion of all PhD completions in the Natural and Physical Sciences is increasing over time (up from 41.9 per cent in 2002 to 47.3 per cent in 2009). 2009 was the first year in which there was a female majority in PhD completions overall (50.1 per cent), apart from the aberrant first year that PhDs were awarded (1948), when two of the first three PhDs awarded went to women (Dobson, 2012). The growth rate of female PhD graduates is stronger than for men, at 47.4 per cent over the period in question. The growth rate among men was 18.6 per cent.

Table 4.31: Course Completions 2002-2009. PhDs in Natural and Physical Sciences Courses by Gender and Narrow Field of Education

Gender & Narrow Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Female										
Biological Sciences	236	53.0%	249	44.9%	311	47.8%	327	49.8%	91	38.6%
Chemical Sciences	65	14.6%	60	10.8%	78	12.0%	69	10.5%	4	6.2%
Earth Sciences	24	5.4%	41	7.4%	27	4.1%	31	4.7%	7	29.2%
Mathematical Sciences	17	3.8%	15	2.7%	19	2.9%	31	4.7%	14	82.4%
Physical Sciences	24	5.4%	35	6.3%	34	5.2%	31	4.7%	7	29.2%
Other Natural & Physical Sciences	79	17.8%	155	27.9%	182	28.0%	167	25.5%	88	111.4%
Sub-total	445	100.0%	555	100.0%	651	100.0%	656	100.0%	211	47.4%
Male										
Biological Sciences	235	38.1%	230	32.8%	258	35.9%	259	35.4%	24	10.2%
Chemical Sciences	105	17.0%	92	13.1%	91	12.7%	106	14.5%	1	1.0%
Earth Sciences	53	8.6%	59	8.4%	47	6.5%	52	7.1%		-1.9%
Mathematical Sciences	49	7.9%	59	8.4%	48	6.7%	44	6.0%	-5	-10.2%
Physical Sciences	86	13.9%	87	12.4%	83	11.6%	120	16.4%	34	39.5%
Other Natural & Physical Sciences	89	14.4%	174	24.8%	191	26.6%	151	20.6%	62	69.7%
Sub-total	**617**	**100.0%**	**701**	**100.0%**	**718**	**100.0%**	**732**	**100.0%**	**115**	**18.6%**
Total	**1062**		**1256**		**1369**		**1388**		**326**	**30.7%**

Table 4.32 compares and contrasts PhD production of international and domestic PhD graduates. The proportion of international students among PhD completers has increased from 15.6 per cent in 2002, to 23.3 per cent in 2009, and the growth rate over the period was 95.2 per cent. Domestic growth in PhD completions was 18.8 per cent. A lower proportion of international students undertook Biological Sciences PhDs (34.6 per cent, compared with 44.5 per cent of domestic students), but it was the biggest single narrow field of education. A higher proportion of international than domestic students completed PhDs in Chemical Sciences, Mathematical Sciences, Earth Sciences and Physical Sciences.

Table 4.32: Course Completions 2002-2009. PhDs in Natural and Physical Sciences Courses by Citizenship Status and Narrow Field of Education

Citizenship Status & Narrow Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
International										
Biological Sciences	71	42.8%	68	33.2%	113	39.0%	112	34.6%	41	57.7%
Chemical Sciences	18	10.8%	31	15.1%	38	13.1%	48	14.8%	30	166.7%
Earth Sciences	18	10.8%	18	8.8%	17	5.9%	27	8.3%	9	50.0%
Mathematical Sciences	13	7.8%	15	7.3%	17	5.9%	23	7.1%	10	76.9%
Physical Sciences	19	11.4%	18	8.8%	29	10.0%	39	12.0%	20	105.3%
Other Natural & Physical Sciences	27	16.3%	55	26.8%	76	26.2%	75	23.1%	48	177.8%
Sub-total	**166**	**100.0%**	**205**	**100.0%**	**290**	**100.0%**	**324**	**100.0%**	**158**	**95.2%**
Domestic										
Biological Sciences	400	44.6%	411	39.1%	456	42.3%	474	44.5%	74	18.5%
Chemical Sciences	152	17.0%	121	11.5%	131	12.1%	127	11.9%	-25	-16.4%
Earth Sciences	59	6.6%	82	7.8%	57	5.3%	56	5.3%	-3	-5.1%
Mathematical Sci.	53	5.9%	59	5.6%	50	4.6%	52	4.9%		-1.9%
Physical Sciences	91	10.2%	104	9.9%	88	8.2%	112	10.5%	21	23.1%
Other Natural & Physical Sciences	141	15.7%	274	26.1%	297	27.5%	243	22.8%	102	72.3%
Sub-total	**896**	**100.0%**	**1051**	**100.0%**	**1079**	**100.0%**	**1064**	**100.0%**	**168**	**18.8%**
Total	**1062**		**1256**		**1369**		**1388**		**326**	**30.7%**

- **Science fiction?**

The final table in this chapter, Table 4.33, identifies the universities that awarded PhDs in the detailed field of education '019999 Natural and Physical Sciences not elsewhere classified'. There are 35 other named detailed fields of education that PhD students could graduate from (see Appendix 1), so it would be interesting to find out just what fields those graduates were actually working in.

Overall, only a low proportion of PhD completions in the Natural and Physical Sciences have been reported as being '019999 Natural and Physical Sciences nec' (8.9 per cent in 2009), but some universities have reported a considerable proportion of their science PhD completions as having been in this detailed field of education. In proportionate terms, the Universities of Canberra and New England, and Monash, Curtin and Australian National universities regularly have PhD science graduates completing their studies in any of the defined detailed fields of education, up to 100 per cent in some cases. Numerically speaking, Monash, the Australian National University and the University of New England have the most PhDs coming out of this nondescript field of education. The other universities graduate very few students at this level through that field of education. It would appear, therefore, that some universities report with less precision than most.

Table 4.33: Course completions 2002 – 2009. PhDs Completed in Natural and Physical Sciences in Narrow Field of Education '019999 Natural and Physical Sciences – nec' and All Natural and Physical Sciences Narrow Fields of Education

	2002	2003	2004	2005	2006	2007	2008	2009
Natural & Physical Sciences nec								
Australian National	17	26	42	49	41	43	45	46
Canberra	3	6	5	8	7	14	10	7
Curtin	2	11	12	6	5	5	5	9
James Cook						33	1	
Monash	36	41	40	36	38	53	43	51
New England			32	40	32	34	12	10
Other universities	4	1		9	6	3		23
Total	**62**	**85**	**131**	**148**	**129**	**185**	**116**	**123**
All Natural & Physical Sciences								
Australian National	88	104	115	105	127	131	128	120
Canberra	3	6	5	8	7	14	10	7
Curtin	5	27	34	24	13	25	22	29
James Cook	38	33	39	33	37	33	22	30
Monash	56	71	95	115	124	140	158	164
New England	10	16	32	40	32	34	12	10
Other universities	862	949	911	931	948	992	1016	1028
Total	1062	1206	1231	1256	1288	1369	1368	1388
Natural & Physical Sciences nec % of All Natural & Physical Sciences								
Australian National	19.3%	25.0%	36.5%	46.7%	32.3%	32.8%	35.2%	38.3%
Canberra	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Curtin	40.0%	40.7%	35.3%	25.0%	38.5%	20.0%	22.7%	31.0%
James Cook	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	4.5%	0.0%
Monash	64.3%	57.7%	42.1%	31.3%	30.6%	37.9%	27.2%	31.1%
New England	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Other universities	0.5%	0.1%	0.0%	1.0%	0.6%	0.3%	0.0%	2.2%
Total	**5.8%**	**7.0%**	**10.6%**	**11.8%**	**10.0%**	**13.5%**	**8.5%**	**8.9%**

nec = not elsewhere classified

Chapter 5

To whom is science taught, and what is taught?

This chapter is an examination of *teaching* in the subjects classified within the Natural and Physical Sciences discipline. This is a particularly important area of inquiry because of the ubiquitous nature of science in university courses other than Natural and Physical Sciences courses. Table 3.11 demonstrated the fact that in 2009, only 45.9 per cent of *science* teaching was provided to *science* students (with students in Health, Engineering, and Management and Commerce courses being the major other recipients of 'science' teaching). That is, over 54 per cent of teaching of subjects in the Natural and Physical Sciences disciplines is to students other than those enrolled in Natural and Physical Sciences courses. All tables in this chapter are expressed in terms of *student load* (measured in EFTSL – equivalent full-time student load), that is, the tables provide a measure of equivalent full-time students (see also Chapter 2).

Table 5.1 looks at the change over time of the amount of teaching in the Natural and Physical Sciences that has been provided to all students in the sector, at all course levels. Science teaching increased by 20,833, or 28.3 per cent. This rate of increase was less than for the sector overall (29.7 per cent, see Table 3.9), but higher than (for example) teaching in subjects in the Society and Culture broad discipline (+22.2 per cent). At the narrow discipline group level, the largest numerical growth occurred in the Biological Sciences (+7,925 or 26.0 per cent), and the Mathematical Sciences (+5,699 or 27.8 per cent). The highest proportionate growth occurred in Other Natural and Physical Sciences (+4,033 or 65.1 per cent), a subject that will be analysed later in this study. Table 5.1 also shows that there has been little change in the relative proportion of each narrow discipline group, however the relative size of Other Natural and Physical Sciences has increased at the expense of all other narrow discipline groups within the broad discipline group Natural and Physical Sciences.

Table 5.1: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences Narrow Discipline Groups to Students in all Fields of Education

Narrow Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences	30512	41.4%	33568	42.3%	36242	42.3%	38437	40.6%	7925	26.0%
Chemical Sciences	7621	10.3%	8317	10.5%	8789	10.3%	9333	9.9%	1712	22.5%
Earth Sciences	3897	5.3%	3747	4.7%	3956	4.6%	4747	5.0%	850	21.8%
Mathematical Sciences	20519	27.8%	21285	26.8%	22808	26.6%	26218	27.7%	5699	27.8%
Physical Science	4994	6.8%	4929	6.2%	5251	6.1%	5657	6.0%	664	13.3%
Other Natural & Physical Sciences	6192	8.4%	7452	9.4%	8678	10.1%	10226	10.8%	4033	65.1%
Total	**73735**	**100.0%**	**79297**	**100.0%**	**85722**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

The next two tables examine science teaching by narrow discipline group and course level. Table 5.1 demonstrates that there had been little proportionate change in narrow discipline groups; Table 5.2 looks more closely at the distribution by course level.

At the higher degree by research level (comprising PhDs and master's by research courses, with about 84 per cent and 16 per cent respectively of all enrolments in higher degrees by research in 2009: calculated from Table 3.1), there was an overall increase of 1,811 equivalent full-time students, or 27.5 per cent). Between 2002 and 2009, the proportion of students enrolled in higher degrees by research taking Biological Sciences declined from 46.4 per cent to 43.1 per cent, but it remains the largest narrow discipline group for research students. Meanwhile, there were proportionate increases in all other narrow discipline groups except Earth Sciences. Earth Sciences numbers declined by 110 over the period as their proportion declined from 12.2 per cent to 8.3 per

cent. The strongest proportionate growth and second-strongest numerical growth occurred in other Natural and Physical Sciences.

At the other postgraduate level, a relatively minor course level in science teaching, representing 2.9 per cent of science teaching in 2002, rising to 4.9 per cent in 2009, the proportion made up by the Physical Sciences and Earth Sciences have declined slightly.

At the bachelor degree level, relative declines in teaching in the Mathematical Sciences, Chemical Sciences and Physical Sciences have been offset by slight relative increases in other narrow discipline groups.

Table 5.2: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences Narrow Discipline Groups to Students in all Fields of Education by Narrow Discipline Group within Course Level

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Higher Degrees by Research										
Biological Sciences	3056	46.4%	3410	47.1%	3456	44.4%	3619	43.1%	563	18.4%
Chemical Sciences	772	11.7%	831	11.5%	961	12.3%	1123	13.4%	351	45.4%
Earth Sciences	803	12.2%	750	10.4%	667	8.6%	693	8.3%	-110	-13.7%
Mathematical Sciences	420	6.4%	479	6.6%	574	7.4%	652	7.8%	232	55.3%
Physical Science	594	9.0%	742	10.3%	790	10.1%	889	10.6%	295	49.7%
Other Natural and Physical Sciences	942	14.3%	1023	14.1%	1343	17.2%	1423	16.9%	481	51.0%
Sub-total	**6587**	**100.0%**	**7236**	**100.0%**	**7790**	**100.0%**	**8398**	**100.0%**	**1811**	**27.5%**
Other Postgraduate										
Biological Sciences	543	25.1%	624	22.1%	942	25.4%	1252	26.8%	710	130.9%
Chemical Sciences	38	1.8%	55	1.9%	112	3.0%	193	4.1%	155	407.0%
Earth Sciences	153	7.1%	182	6.4%	210	5.7%	236	5.1%	83	54.1%
Mathematical Sciences	788	36.4%	1270	44.9%	1633	44.1%	1732	37.1%	944	119.9%
Physical Science	189	8.7%	170	6.0%	195	5.3%	246	5.3%	57	30.2%
Other N&PS	452	20.9%	528	18.7%	614	16.6%	1008	21.6%	556	123.1%
Sub-total	**2163**	**100.0%**	**2829**	**100.0%**	**3705**	**100.0%**	**4668**	**100.0%**	**2505**	**115.8%**
Bachelor's										
Biological Sciences	26272	41.9%	28893	43.3%	31161	44.3%	32666	42.9%	6394	24.3%
Chemical Sciences	6559	10.5%	7169	10.7%	7341	10.4%	7507	9.9%	948	14.4%
Earth Sciences	2795	4.5%	2685	4.0%	2916	4.1%	3622	4.8%	826	29.6%
Mathematical Sciences	18388	29.3%	18334	27.5%	18318	26.0%	20618	27.1%	2230	12.1%
Physical Science	4069	6.5%	3871	5.8%	4031	5.7%	4148	5.4%	80	2.0%
Other Natural and Physical Sciences	4582	7.3%	5792	8.7%	6613	9.4%	7615	10.0%	3032	66.2%
Sub-total	**62664**	**100.0%**	**66744**	**100.0%**	**70381**	**100.0%**	**76175**	**100.0%**	**13510**	**21.6%**
Other Undergraduate										
Biological Sciences	642	27.7%	640	25.7%	682	17.7%	900	16.7%	258	40.2%
Chemical Sciences	252	10.9%	262	10.5%	375	9.7%	511	9.5%	259	102.8%
Earth Sciences	145	6.2%	130	5.2%	164	4.3%	197	3.7%	52	35.9%
Mathematical Sciences	923	39.8%	1202	48.3%	2282	59.3%	3216	59.8%	2293	248.4%
Physical Science	142	6.1%	145	5.8%	236	6.1%	374	7.0%	232	163.4%
Other Natural and Physical Sciences	216	9.3%	109	4.4%	108	2.8%	180	3.3%	-36	-16.7%
Sub-total	**2321**	**100.0%**	**2488**	**100.0%**	**3847**	**100.0%**	**5378**	**100.0%**	**3057**	**131.7%**
Total	**73735**	**100.0%**	**79297**	**100.0%**	**85722**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

Table 5.3 presents similar information, but the presentation order is different. Biological Sciences' distribution showed minor changes only, with small declines at higher degree by research and bachelor's levels being offset by an increase at the other postgraduate level.

As far as Chemical Sciences teaching is concerned, there was a decrease in the proportion of teaching in this narrow discipline group going towards the bachelor's level, with the slack having been taken up by higher degree by research students and those in courses at the other postgraduate level.

For Earth Sciences, an actual decline of 110 equivalent full-time students at the higher degree by research level means that the proportion at this level dropped from 12.2 per cent in 2002 to 8.3 per cent in 2009. However, it appears that the Earth Sciences narrow discipline group has strengthened at the bachelor's level.

The distribution of Mathematical Sciences teaching has shifted away from bachelor's degrees to other postgraduate and other course levels, and teaching in the Physical Sciences has moved towards higher degrees by research, other postgraduate and other courses, also at the expense of bachelor's-level teaching.

Teaching in 'Other Natural and Physical Sciences' increased more than in other narrow discipline groups (with the exception of teaching in the Biological Sciences). The increase in teaching in this narrow discipline group was 4,069 or 68.1 per cent (compared with the growth in the Biological Sciences of 7,649 or 25.4 per cent).

Table 5.3: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences Narrow Discipline Groups to Students in all Fields of Education by Course Level within Narrow Discipline Group

Narrow Discipline Group & Course Level	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences										
Higher Degrees by Research	3056	10.2%	3410	10.3%	3456	9.7%	3619	9.6%	563	18.4%
Other Postgraduate	543	1.8%	624	1.9%	942	2.6%	1252	3.3%	710	130.9%
Bachelor's	26272	87.4%	28893	87.4%	31161	87.3%	32666	86.6%	6394	24.3%
Other	193	0.6%	140	0.4%	119	0.3%	175	0.5%	-18	-9.4%
Sub-total	**30063**	**100.0%**	**33068**	**100.0%**	**35679**	**100.0%**	**37712**	**100.0%**	**7649**	**25.4%**
Chemical Sciences										
Higher Degree by Research	772	10.5%	831	10.3%	961	11.4%	1123	12.7%	351	45.4%
Other Postgraduate	38	0.5%	55	0.7%	112	1.3%	193	2.2%	155	407.0%
Bachelor's	6559	89.0%	7169	89.0%	7341	87.2%	7507	85.1%	948	14.4%
Other	251	3.4%	262	3.3%	375	4.5%	510	5.8%	259	103.0%
Sub-total	**7369**	**100.0%**	**8055**	**100.0%**	**8414**	**100.0%**	**8822**	**100.0%**	**1453**	**19.7%**
Earth Sciences										
Higher Degree by Research	803	21.4%	750	20.7%	667	17.6%	693	15.2%	-110	-13.7%
Other Postgraduate	153	4.1%	182	5.0%	210	5.5%	236	5.2%	83	54.1%
Bachelor's	2795	74.5%	2685	74.2%	2916	76.9%	3622	79.6%	826	29.6%
Other	146	3.9%	130	3.6%	163	4.3%	196	4.3%	50	34.2%
Sub-total	**3752**	**100.0%**	**3617**	**100.0%**	**3793**	**100.0%**	**4551**	**100.0%**	**799**	**21.3%**
Mathematical Sciences										
Higher Degree by Research	420	2.1%	479	2.4%	574	2.8%	652	2.8%	232	55.3%
Other Postgraduate	788	4.0%	1270	6.3%	1633	8.0%	1732	7.5%	944	119.9%
Bachelor's	18388	93.8%	18334	91.3%	18318	89.2%	20618	89.6%	2230	12.1%
Other	924	4.7%	1202	6.0%	2283	11.1%	3216	14.0%	2292	248.1%
Sub-total	**19595**	**100.0%**	**20082**	**100.0%**	**20525**	**100.0%**	**23002**	**100.0%**	**3406**	**17.4%**
Physical Sciences										
Higher Degree by Research	594	12.2%	742	15.5%	790	15.7%	889	16.8%	295	49.7%
Other Postgraduate	189	3.9%	170	3.6%	195	3.9%	246	4.7%	57	30.2%
Bachelor's	4069	83.9%	3871	80.9%	4031	80.4%	4148	78.5%	80	2.0%
Other	142	2.9%	145	3.0%	235	4.7%	374	7.1%	232	163.4%
Sub-total	**4852**	**100.0%**	**4784**	**100.0%**	**5016**	**100.0%**	**5283**	**100.0%**	**432**	**8.9%**

Table 5.3: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences Narrow Discipline Groups to Students in all Fields of Education by Course Level within Narrow Discipline Group *continued*

Narrow Discipline Group & Course Level	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Other Natural and Physical Sciences										
Higher Degree by Research	942	15.8%	1023	13.9%	1343	15.7%	1423	14.2%	481	51.0%
Other Postgraduate	452	7.6%	528	7.2%	614	7.2%	1008	10.0%	556	123.1%
Bachelor's	4582	76.7%	5792	78.9%	6613	77.2%	7615	75.8%	3032	66.2%
Other	216	3.6%	109	1.5%	108	1.3%	180	1.8%	-36	-16.7%
Sub-total	**5976**	**100.0%**	**7343**	**100.0%**	**8569**	**100.0%**	**10046**	**100.0%**	**4069**	**68.1%**
All Natural and Physical Sciences										
Higher Degree by Research	6587	8.9%	7236	9.1%	7790	9.1%	8398	8.9%	1811	27.5%
Other Postgraduate	2163	2.9%	2829	3.6%	3705	4.3%	4668	4.9%	2505	115.8%
Bachelor's	62664	85.0%	66744	84.2%	70381	82.1%	76175	80.5%	13510	21.6%
Other	2321	3.1%	2488	3.1%	3846	4.5%	5377	5.7%	3056	131.7%
Total	**73735**	**100.0%**	**79297**	**100.0%**	**85722**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

Earlier, figures in Table 3.11 demonstrated the nature of science teaching at university as predominantly a matter of service teaching. The table showed that less than 46 per cent of the teaching of disciplines classified as *01 Natural and Physical Sciences* went towards teaching students enrolled in courses from within the broad Field of Education *01 Natural and Physical Sciences*. To summarise, Table 5.4 extends Table 3.11 to show the ubiquity of university science at the *narrow* discipline group in 2009.

Among several things, Table 5.4 shows that 40.6 per cent of teaching in the 'science' disciplines was in the Biological Sciences, followed proportionately by the Mathematical Sciences (27.7 per cent), Other Natural and Physical Sciences (10.8 per cent), Chemical Sciences (9.9 per cent), with 5.0 per cent and 6.0 per cent respectively for Physical Sciences and Earth Sciences. It also shows that 45.9 per cent of 'science' teaching went to students enrolled in 'science' courses, with 20 per cent going to students enrolled in Health courses and 10.5 per cent to students enrolled in Engineering courses, and so on. The fact that 8.8 per cent of Natural and Physical Sciences teaching went to students enrolled in courses in Management and Commerce might seem rather high, but about 94 per cent of this was because of the 7,713 equivalent full-time Management and Commerce students enrolled in subjects in the Mathematical Sciences. Overall, students enrolled in management courses consumed more Mathematical Sciences (29.4 per cent) than students from any other field of education, including those enrolled in courses in the Natural and Physical Sciences (21.7 per cent). Even engineering students consumed a higher proportion of mathematics teaching than science students did (22.9 per cent).

Table 5.4: Student Load 2009. Teaching and Learning of Natural and Physical Sciences by Narrow Discipline Group and Broad Field of Education

Broad Field of Education	Biological Sciences	Chemical Sciences	Earth Sciences	Mathematical Sciences	Physical Sciences	Other Nat. & Phys Sciences	Total
EFTSL – No.							
Natural and Physical Sciences	20590	6056	2858	5698	3092	5110	43403
Health	12729	1347	7	828	270	3763	18945
Engineering	371	883	603	5992	1868	200	9916
Management. & Commerce	239	65	55	7713	32	60	8165
Society & Culture	1472	257	244	2149	101	396	4620
Agriculture, Environmental & Related	1458	441	719	385	47	204	3253
Education	1010	146	77	867	84	337	2521
Information Technology	29	18	12	1462	42	14	1577
Other Fields of Education	539	121	172	1123	122	142	2218
Total	38437	9333	4747	26218	5657	10226	94618
Disc. Gr. % of Total	40.6%	9.9%	5.0%	27.7%	6.0%	10.8%	100.0%
EFTSL – %							
Natural and Physical Sciences	53.6%	64.9%	60.2%	21.7%	54.6%	50.0%	45.9%
Health	33.1%	14.4%	0.2%	3.2%	4.8%	36.8%	20.0%
Engineering	1.0%	9.5%	12.7%	22.9%	33.0%	2.0%	10.5%
Management. & Commerce	0.6%	0.7%	1.2%	29.4%	0.6%	0.6%	8.6%
Society & Culture	3.8%	2.7%	5.1%	8.2%	1.8%	3.9%	4.9%
Agriculture, Environmental & Related	3.8%	4.7%	15.2%	1.5%	0.8%	2.0%	3.4%
Education	2.6%	1.6%	1.6%	3.3%	1.5%	3.3%	2.7%
Information Technology	0.1%	0.2%	0.2%	5.6%	0.7%	0.1%	1.7%
Other Fields of Education	1.4%	1.3%	3.6%	4.3%	2.2%	1.4%	2.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Of teaching in Biological Sciences, 53.6 per cent went to students enrolled in Natural and Physical Sciences courses, and 33.1 per cent to students in Health courses. Main consumers of teaching in the Chemical Sciences were science students (64.9 per cent), Health students (14.4 per cent) and engineering students (9.5 per cent). Earth Sciences teaching went predominantly to science (60.2 per cent), engineering (12.7 per cent) and agriculture (15.2 per cent) students; physical science subjects were taught mainly to science students (54.6 per cent) and engineering (33.0 per cent). Teaching in Other Natural and Physical Sciences went to students enrolled in science courses (50.0 per cent) and health course students (36.8 per cent).

Table 5.5 examines the gendered distribution of science teaching by narrow discipline group. Patterns are clearly different, with Biological Sciences dominating teaching to women. Although there has been a slight redistribution of the teaching to female students, around one-half of teaching to women from the science narrow disciplines is in the Biological Sciences, and about one-fifth in Mathematical Sciences. The propensity for women to study subjects from Other Natural and Physical Sciences has also increased. By comparison, the pattern for male students was that about 31 per cent studied Biological Sciences and about 35 per cent studied in the Mathematical Sciences. A number of minor proportionate changes between disciplines occurred, but the disinclination of women to study physical sciences should be noted.

Table 5.5: Student Load 2009. Teaching and Learning of Natural and Physical Sciences by Gender and Narrow Discipline Group

Narrow Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Female										
Biological Sciences	19478	51.0%	21426	51.6%	22945	51.4%	24167	49.3%	4689	24.1%
Chemical Sciences	4056	10.6%	4314	10.4%	4508	10.1%	4819	9.8%	764	18.8%
Earth Sciences	1623	4.2%	1563	3.8%	1611	3.6%	1888	3.9%	265	16.3%
Mathematical Sciences	7835	20.5%	8246	19.9%	8905	20.0%	10346	21.1%	2511	32.0%
Physical Sciences	1461	3.8%	1331	3.2%	1380	3.1%	1476	3.0%	14	1.0%
Other Natural and Physical Sciences	3757	9.8%	4618	11.1%	5267	11.8%	6299	12.9%	2542	67.7%
Sub-total	**38210**	**100.0%**	**41498**	**100.0%**	**44615**	**100.0%**	**48995**	**100.0%**	**10786**	**28.2%**
Male										
Biological Sciences	11034	31.1%	12142	32.1%	13297	32.3%	14270	31.3%	3236	29.3%
Chemical Sciences	3565	10.0%	4003	10.6%	4281	10.4%	4513	9.9%	948	26.6%
Earth Sciences	2274	6.4%	2184	5.8%	2345	5.7%	2859	6.3%	585	25.7%
Mathematical Sciences	12684	35.7%	13038	34.5%	13903	33.8%	15872	34.8%	3188	25.1%
Physical Sciences	3532	9.9%	3598	9.5%	3871	9.4%	4182	9.2%	649	18.4%
Other Natural and Physical Sciences	2436	6.9%	2834	7.5%	3410	8.3%	3927	8.6%	1491	61.2%
Sub-total	**35526**	**100.0%**	**37799**	**100.0%**	**41107**	**100.0%**	**45623**	**100.0%**	**10097**	**28.4%**
Total	**73736**	**100.0%**	**79297**	**100.0%**	**85722**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

Looking at citizenship status (see Table 5.6), it can be seen that international students have a stronger focus on mathematics than domestic students, although the proportion of teaching from mathematical sciences declined for both international and domestic students. Domestic students are more likely to be undertaking subjects from the Biological Sciences. In 2009, 43.6 per cent of domestic students studied subjects from the Biological Sciences, compared with 30.1 per cent of international students.

Table 5.6: Student Load 2009. Teaching and learning of Natural and Physical Sciences by Citizenship Status and Narrow Discipline Group

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
International										
Biological Sciences	2905	30.2%	4666	33.2%	5519	32.7%	6256	30.1%	3351	115.4%
Chemical Sciences	799	8.3%	1185	8.4%	1429	8.5%	1761	8.5%	963	120.6%
Earth Sciences	358	3.7%	462	3.3%	588	3.5%	871	4.2%	513	143.1%
Mathematical Sciences	4102	42.7%	5548	39.5%	6631	39.2%	8372	40.3%	4270	104.1%
Physical Sciences	629	6.5%	714	5.1%	841	5.0%	1093	5.3%	464	73.7%
Other Natural and Physical Sciences	824	8.6%	1488	10.6%	1892	11.2%	2442	11.7%	1618	196.3%
Sub-total	**9617**	**100.0%**	**14063**	**100.0%**	**16901**	**100.0%**	**20795**	**100.0%**	**11178**	**116.2%**
Domestic										
Biological Sciences	27607	43.1%	28902	44.3%	30722	44.6%	32181	43.6%	4574	16.6%
Chemical Sciences	6822	10.6%	7132	10.9%	7360	10.7%	7571	10.3%	749	11.0%
Earth Sciences	3539	5.5%	3285	5.0%	3368	4.9%	3876	5.3%	337	9.5%
Mathematical Sciences	16417	25.6%	15737	24.1%	16176	23.5%	17846	24.2%	1428	8.7%
Physical Science	4364	6.8%	4215	6.5%	4410	6.4%	4565	6.2%	200	4.6%
Other Natural and Physical Sciences	5368	8.4%	5964	9.1%	6785	9.9%	7784	10.5%	2416	45.0%
Sub-total	**64119**	**100.0%**	**65234**	**100.0%**	**68822**	**100.0%**	**73823**	**100.0%**	**9705**	**15.1%**
Total	**73736**	**100.0%**	**79297**	**100.0%**	**85723**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

The field of education / discipline group classifications provide six narrow categories, and 38 detailed categories for the broad field of education Natural and Physical Sciences. Whereas it is not possible to link a generic degree (such as BSc) to a specific field of education, because students tend to study across a range of disciplines, this is not the situation for the subjects a student studies. For example, a typical first year BSc student will be enrolled in a course that can be described no more specifically than 'Natural and Physical Sciences – general', but if the student enrols in subjects in biology, mathematics, geology and physics, it is clear what the appropriate discipline categories would be for each of those subjects. Taking this example further, if first year biology at the university in question is an introductory programme that exposes students to a plethora of biological subject matter, that subject would probably be correctly coded to 'biological sciences'. If the subject were exclusively about human biology, then it would correctly be linked to 'human biology'.

Although having a highly detailed classification system COULD lead to highly specific and accurate statistics, it might not indicate this at all. For example, in Table 5.7, what should one read into the decline in Biological Sciences (-3,724) vis á vis the growth in *biochemistry and cell biology* (+2,176), *human biology* (+6,035) and *biological sciences not elsewhere classified* (+2,371)? Do these changes represent a real change in what students are studying within the Biological Sciences, or is it a reflection of other things? Among the many things that could lead to such changes, the coding practices of individual universities is likely to be the main reason for the change, not that there has been any change of pattern.

That said, Table 5.7 presents changes between 2002 and 2009 by detailed discipline group. Rather than identifying and reporting the changes, this task will be left to the reader. If teaching in *mathematical sciences* has declined by 3,384 EFTSL, while *mathematics* and *statistics* have increased by 4,819 and 3,989 EFTSL respectively, the most likely reason is that universities have changed the way they classify subjects.

Table 5.7: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to Students in all Fields of Education by Narrow and Detailed Discipline Group

Detailed Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences										
Biological Sciences	9490	12.9%	5732	7.2%	5328	6.2%	5767	6.1%	-3724	-39.2%
Biochemistry and Cell Biology	3498	4.7%	5182	6.5%	5626	6.6%	5675	6.0%	2176	62.2%
Botany	813	1.1%	883	1.1%	796	0.9%	673	0.7%	-140	-17.2%
Ecology and Evolution	1798	2.4%	1676	2.1%	1667	1.9%	1713	1.8%	-84	-4.7%
Marine Science	590	0.8%	690	0.9%	689	0.8%	777	0.8%	187	31.7%
Genetics	1183	1.6%	1854	2.3%	1817	2.1%	1848	2.0%	665	56.2%
Microbiology	1923	2.6%	2561	3.2%	2457	2.9%	2464	2.6%	540	28.1%
Human Biology	7766	10.5%	10892	13.7%	12949	15.1%	13801	14.6%	6035	77.7%
Zoology	1155	1.6%	1315	1.7%	1277	1.5%	1053	1.1%	-101	-8.8%
Biological Sciences nec	2296	3.1%	2782	3.5%	3635	4.2%	4667	4.9%	2371	103.3%
Sub-total	**30512**	**41.4%**	**33568**	**42.3%**	**36242**	**42.3%**	**38437**	**40.6%**	**7925**	**26.0%**
Chemical Sciences										
Chemical Sciences	4450	6.0%	4477	5.6%	4855	5.7%	4953	5.2%	503	11.3%
Organic Chemistry	897	1.2%	1025	1.3%	1050	1.2%	1064	1.1%	167	18.6%
Inorganic Chemistry	280	0.4%	422	0.5%	463	0.5%	486	0.5%	206	73.6%
Chemical Sciences nec	1994	2.7%	2393	3.0%	2420	2.8%	2831	3.0%	837	42.0%
Sub-total	**7621**	**10.3%**	**8317**	**10.5%**	**8789**	**10.3%**	**9333**	**9.9%**	**1712**	**22.5%**

Table 5.7: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to Students in all Fields of Education by Narrow and Detailed Discipline Group *continued*

Detailed Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Earth Sciences										
Earth Sciences	1353	1.8%	1048	1.3%	1083	1.3%	1262	1.3%	-91	-6.8%
Atmospheric Sciences	119	0.2%	167	0.2%	188	0.2%	287	0.3%	168	141.2%
Geology	937	1.3%	950	1.2%	1097	1.3%	1404	1.5%	467	49.8%
Geophysics	84	0.1%	167	0.2%	161	0.2%	184	0.2%	100	118.6%
Geochemistry	29	0.0%	21	0.0%	26	0.0%	30	0.0%	1	4.2%
Soil Science	228	0.3%	234	0.3%	227	0.3%	226	0.2%		-0.6%
Hydrology	217	0.3%	220	0.3%	229	0.3%	269	0.3%	52	24.0%
Oceanography	99	0.1%	122	0.2%	105	0.1%	108	0.1%	9	8.9%
Earth Sciences nec	831	1.1%	819	1.0%	840	1.0%	977	1.0%	146	17.5%
Sub-total	**3897**	**5.3%**	**3747**	**4.7%**	**3956**	**4.6%**	**4747**	**5.0%**	**850**	**21.8%**
Mathematical Sciences										
Mathematical Sciences	4680	6.3%	1866	2.4%	1774	2.1%	1296	1.4%	-3384	-72.3%
Mathematics	8587	11.6%	9997	12.6%	10943	12.8%	13405	14.2%	4819	56.1%
Statistics	6569	8.9%	8779	11.1%	9335	10.9%	10558	11.2%	3989	60.7%
Mathematical Sciences nec	683	0.9%	642	0.8%	755	0.9%	958	1.0%	276	40.4%
Sub-total	**20519**	**27.8%**	**21285**	**26.8%**	**22808**	**26.6%**	**26218**	**27.7%**	**5699**	**27.8%**
Physical Science										
Physics and Astronomy	1146	1.6%	303	0.4%	154	0.2%	133	0.1%	-1013	-88.4%
Physics	3580	4.9%	4284	5.4%	4769	5.6%	5170	5.5%	1590	44.4%
Astronomy	267	0.4%	342	0.4%	328	0.4%	354	0.4%	87	32.4%
Sub-total	**4994**	**6.8%**	**4929**	**6.2%**	**5251**	**6.1%**	**5657**	**6.0%**	**664**	**13.3%**
Other Natural and Physical Sciences										
Other Natural and Phys Sci	674	0.9%	424	0.5%	501	0.6%	600	0.6%	-74	-11.0%
Medical Science	1273	1.7%	1809	2.3%	2231	2.6%	2563	2.7%	1290	101.4%
Forensic Science	193	0.3%	351	0.4%	425	0.5%	475	0.5%	281	145.4%
Food Science and Biotech	1074	1.5%	1069	1.3%	1044	1.2%	1217	1.3%	143	13.3%
Pharmacology	1515	2.1%	2233	2.8%	2507	2.9%	2898	3.1%	1383	91.3%
Laboratory Technology	182	0.2%	226	0.3%	246	0.3%	244	0.3%	62	33.8%
Natural and Physical Sci nec	1281	1.7%	1340	1.7%	1725	2.0%	2230	2.4%	949	74.0%
Sub-total	**6192**	**8.4%**	**7452**	**9.4%**	**8678**	**10.1%**	**10226**	**10.8%**	**4034**	**65.1%**
Total	**73735**	**100.0%**	**79297**	**100.0%**	**85722**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

nec = 'not elsewhere classified'

Science: the ultimate service discipline

The point was made in text adjacent to Table 3.11 that some university teaching is provided widely to students across the university. Over half of all teaching in science disciplines is to students enrolled in other courses, particularly those in courses in the Health, Engineering, and Management and Commerce. Teaching in Society and Culture disciplines is also widely spread (40 per cent of this teaching is service teaching), predominantly to students enrolled in Management and Commerce programmes. Economics and econometrics, classified as a narrow discipline within Society and Culture, probably make up a considerable proportion of this service teaching.
In proportionate terms, teaching in Agriculture, Environmental and Related Studies also considerable (about 40 per cent), but teaching in this discipline is only about 20 per cent of teaching in the Natural and Physical Sciences and less than eight per cent of teaching in Society and Culture disciplines.

The provision of teaching to science students was considered in some detail in Chapter 4. The rest of this chapter, however, is an analysis of the 'service' aspects of teaching subjects classified as Natural and Physical Sciences. The focus will be on teaching to students enrolled in courses other than those in the Natural and Physical Sciences field of education. Most of this will relate to bachelor's-level teaching, as this represents over 80 per cent of all teaching in the Natural and Physical Sciences (see Table 5.2), and PhDs (8.9 per cent).

First, Table 5.8 summarises the distribution of teaching in Natural and Physical Sciences disciplines according to whether that teaching is to students enrolled in science courses, or courses in other fields of education. The table shows teaching at all course levels. The table shows the proportion of teaching in science that constitutes service teaching is slowly increasing over time.

Fields of education Agriculture, Environmental and Related Studies and Information Technology have both suffered declining enrolments in recent years, so it is understandable that the extent of service teaching to these fields has declined. Teaching to students in Health, Engineering and Management and Commerce courses were the principal recipients of service teaching.

Table 5.8: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to Students in Fields of Education other than Natural and Physical Sciences by Broad Field of Education

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Broad Field of Education										
Natural &Physical Sciences	34723	47.1%	38587	48.7%	40046	46.7%	43403	45.9%	8680	25.0%
Other fields of education:										
Agriculture, Environmental & Related	3763	5.1%	3545	4.5%	3189	3.7%	3253	3.4%	-509	-13.5%
Architecture	144	0.2%	122	0.2%	174	0.2%	200	0.2%	56	38.6%
Creative Arts	266	0.4%	242	0.3%	305	0.4%	340	0.4%	74	27.9%
Education	1727	2.3%	2044	2.6%	2749	3.2%	2521	2.7%	794	46.0%
Engineering	7645	10.4%	7621	9.6%	8682	10.1%	9916	10.5%	2271	29.7%
Health	12766	17.3%	13983	17.6%	16507	19.3%	18945	20.0%	6179	48.4%
Information Technology	3167	4.3%	1859	2.3%	1531	1.8%	1577	1.7%	-1590	-50.2%
Management & Commerce	4863	6.6%	6267	7.9%	7280	8.5%	8165	8.6%	3302	67.9%
Society & Culture	3634	4.9%	3937	5.0%	4138	4.8%	4620	4.9%	986	27.1%
Other Fields of Education #	1037	1.4%	1091	1.4%	1123	1.3%	1679	1.8%	642	61.9%
Sub-total	**39012**	**52.9%**	**40710**	**51.3%**	**45677**	**53.3%**	**51215**	**54.1%**	**12203**	**31.3%**
Total	**73735**	**100.0%**	**79297**	**100.0%**	**85722**	**100.0%**	**94618**	**100.0%**	**20883**	**28.3%**

Includes teaching to students in non-award courses

Table 5.9 shows the distribution of service teaching by course level. The main recipient course levels are students enrolled in non-science PhDs, master's by course work and bachelor's degrees, and they are examined in the tables that follow.

Table 5.9: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to Students in Fields of Education other than Natural and Physical Sciences by Course Level

Course Level	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
PhD	830	2.1%	782	1.9%	927	2.0%	1041	2.0%	211	25.4%
Master's by Coursework	724	1.9%	1266	3.1%	1592	3.5%	1762	3.4%	1038	143.5%
Postgraduate – Other	549	1.4%	491	1.2%	635	1.4%	607	1.2%	57	10.4%
Bachelor's	34908	89.5%	35947	88.3%	39037	85.5%	42967	83.9%	8060	23.1%
Undergraduate – Other #	2002	5.1%	2224	5.5%	3485	7.6%	4838	9.4%	2837	141.7%
Total – Non-Science Fields of Ed.	**39012**	**100.0%**	**40710**	**100.0%**	**45677**	**100.0%**	**51215**	**100.0%**	**12203**	**31.3%**

Includes teaching to students enrolled in undergraduate diplomas, enabling courses and non-award

The next three tables relate to science teaching to students enrolled in non-science PhD programmes. The main non-science PhD recipients in 2009 were in Health and Agriculture, Environmental and Related Studies (357 and 346 EFTSL, respectively), and Education and Engineering (105 and 104 EFTSL, respectively). A couple of major changes in pattern stand out. First, there was a considerable drop in science teaching to PhD students in Health, and the most likely reason for this is that Monash University changed the way it coded certain students at the PhD level (at least) in 2003. In essence, a body of students that had been coded within the Health field of education were redesignated as being in the Natural and Physical Sciences field of education. See also Table 4.25. The other change has been the sudden increase in the teaching of science to PhD students enrolled in Education programmes between 2005 and 2007. A closer examination of data files revealed that this change occurred at Curtin University of Technology, but unlike the Monash case, there was no substitution of enrolments between fields of education.

Table 5.10: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to PhD Students in Fields of Education other than Natural and Physical Sciences by Broad Field of Education

Broad Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture, Environmental & Related	212	25.6%	363	46.4%	324	35.0%	346	33.3%	134	63.2%
Education	5	0.6%	2	0.2%	99	10.7%	105	10.0%	99	1915.3%
Engineering	36	4.4%	55	7.0%	105	11.3%	104	10.0%	68	187.4%
Health	504	60.7%	263	33.6%	283	30.5%	357	34.3%	-147	-29.2%
Society & Culture	57	6.8%	77	9.8%	90	9.7%	99	9.6%	43	75.4%
Other Fields of Education	16	1.9%	23	3.0%	25	2.7%	30	2.9%	14	90.0%
Total	**830**	**100.0%**	**782**	**100.0%**	**927**	**100.0%**	**1041**	**100.0%**	**211**	**25.4%**

Table 5.11 shows the distribution of science teaching to non-science PhD students by narrow field of education. The figures indicate a redistribution of disciplines. Biological Sciences teaching declined by 220 EFTSL (44.3 per cent) between 2002 and 2009, and teaching in Other Natural and Physical Sciences increased by 269 EFTSL. Closer inspection suggests that the main reason for this relates to changes at Monash University. Perhaps Monash designated the PhD students in question from being enrolled in a Health course to a science course at the same time as they designated the teaching to those students from being a Natural and Physical Sciences discipline to a Health discipline. The aforementioned change in circumstances at Curtin in teaching students in education PhDs is in Other Natural and Physical Sciences, unfortunately described no further. This added 91 and 95 EFTSL in 2007 and 2009, respectively.

Table 5.11: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to PhD Students in Fields of Education other than Natural and Physical Sciences by Narrow Discipline Group

Narrow Discipline Group	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences	498	60.0%	323	41.3%	262	28.3%	277	26.6%	-220	-44.3%
Chemical Sciences	30	3.6%	38	4.9%	52	5.6%	76	7.3%	46	151.6%
Earth Sciences	77	9.3%	134	17.2%	125	13.4%	120	11.5%	43	55.7%
Mathematical Sciences	48	5.7%	44	5.6%	109	11.7%	118	11.3%	70	146.6%
Physical Science	10	1.3%	16	2.0%	25	2.7%	15	1.4%	4	39.5%
Other Natural and Physical Sciences	167	20.1%	226	28.9%	355	38.2%	436	41.9%	269	161.1%
Total	830	100.0%	782	100.0%	927	100.0%	1041	100.0%	211	25.4%

Table 5.12 presents a matrix of teaching and learning for 2009 of non-science PhD students receiving science teaching. Of the 277 EFTSL of teaching in the Biological Sciences, 49.7 per cent was provided to Agriculture, Environmental and Related Studies students, and 40.2 per cent to students enrolled in Health PhDs. Earth Sciences teaching was also predominantly provided to Agriculture, Environmental and Related Studies students of 106 EFTSL, or 88.4 per cent of all PhD-level service teaching in earth sciences. About half of the PhD-level teaching in the Mathematical Sciences went to Engineering students enrolled in PhDs, and 18.0 per cent to PhD students in Information Technology. Of the Other Natural and Physical Sciences teaching, closer examination of the data files reveals that supervision of PhD students enrolled in courses in the Health field of education was predominantly in Medical Science or Pharmacology, and Natural and Physical Sciences, *not elsewhere classified*.

Table 5.12: Student Load 2009. Distribution of Teaching in Natural and Physical Sciences to PhD students in Fields of Education other than Natural and Physical Sciences by Fields of Education and Narrow Discipline Group

Broad Field of Education Narrow Discipline Group	Agriculture, Environmental & Related	Architecture	Education	Engineering	Health	Information Technology	Management & Commerce	Society & Culture	Total
EFTSL – No.									
Biological Sciences	138	2	0	10	111	1	1	15	277
Chemical Sciences	34			9	32			1	76
Earth Sciences	106		0	11	1			2	120
Mathematical Sciences	3		9	59	10	21	5	11	118
Physical Science			0	14	0			1	15
Other Natural and Physical Sciences	66		95	1	203		1	70	436
Total	**346**	**2**	**105**	**104**	**357**	**22**	**6**	**99**	**1041**
EFTSL – %									
Biological Sciences	49.7%	0.5%	0.0%	3.6%	40.2%	0.4%	0.2%	5.3%	100.0%
Chemical Sciences	45.4%	0.0%	0.0%	11.6%	41.7%	0.0%	0.0%	1.3%	100.0%
Earth Sciences	88.4%	0.0%	0.1%	9.6%	0.4%	0.0%	0.0%	1.5%	100.0%
Mathematical Sciences	2.2%	0.0%	7.3%	50.4%	8.7%	18.0%	3.9%	9.4%	100.0%
Physical Science	0.0%	0.0%	1.7%	92.7%	1.3%	0.0%	0.0%	4.3%	100.0%
Other Natural and Physical Sciences	15.0%	0.0%	21.9%	0.2%	46.5%	0.0%	0.2%	16.1%	100.0%
Total	**33.3%**	**0.1%**	**10.0%**	**10.0%**	**34.3%**	**2.1%**	**0.6%**	**9.6%**	**100.0%**

Table 5.13 looks at service teaching in science disciplines to students enrolled in non-science master's by coursework programmes. For once, Biological Sciences is not the largest category, but two-thirds of its teaching in master's by coursework is to students enrolled in health courses, and 21.8 per cent to those enrolled in agriculture and environmental studies programmes.

Over three-quarters of teaching to non-science master's by coursework students in the Mathematical Sciences in 2009 was to Management and Commerce students. Most of the teaching in Other Natural and Physical Sciences goes to students enrolled in master's by coursework courses in health, and most of this (further examination of the files reveal) is split almost equally between *medical science, pharmacology* and *natural and physical sciences not elsewhere classified*.

Table 5.13: Student Load 2009. Distribution of Teaching in Natural and Physical Sciences to Master's by Coursework Students in Fields of Education other than Natural and Physical Sciences by Field of Education and Narrow Discipline Group

Broad Field of Education Narrow Discipline Group	Agriculture, Environmental & Related	Education	Engineering	Health	Information Technology	Mgt. & Commerce	Society & Culture	Other	Total
EFTSL – No.									
Biological Sciences	47	3	11	145	1	1	7	1	217
Chemical Sciences	9	0	1	10		1	0	0	21
Earth Sciences	26	1	44	0	0	1	1	1	73
Mathematical Sciences	3	47	31	79	87	930	41	0	1217
Physical Science		0	3	3			0	0	6
Other Natural and Physical Sciences	11	2	10	168	4	8	24	0	227
Total	**96**	**52**	**100**	**405**	**92**	**941**	**73**	**2**	**1762**
EFTSL – %									
Biological Sciences	21.8%	1.5%	5.1%	66.9%	0.5%	0.6%	3.2%	0.3%	100.0%
Chemical Sciences	44.0%	1.7%	5.2%	44.9%	0.0%	3.5%	0.6%	0.0%	100.0%
Earth Sciences	35.3%	0.7%	59.8%	0.2%	0.3%	0.8%	1.5%	1.4%	100.0%
Mathematical Sciences	0.2%	3.8%	2.6%	6.5%	7.1%	76.4%	3.3%	0.0%	100.0%
Physical Science	0.0%	2.2%	51.1%	44.6%	0.0%	0.0%	2.2%	0.0%	100.0%
Other Natural and Physical Sciences	4.9%	0.7%	4.5%	73.9%	1.8%	3.6%	10.6%	0.1%	100.0%
Total	**5.5%**	**3.0%**	**5.7%**	**23.0%**	**5.2%**	**53.4%**	**4.1%**	**0.1%**	**100.0%**

The next three tables relate to students enrolled in non-science bachelor's degrees. Table 5.14 shows that there has been a decline in teaching to Agriculture and Information Technology students amounting to 2,315 equivalent full-time students. However, there was overall growth of over 8,000 EFTSL, about half of which went to students enrolled in health bachelor's degrees. Engineering students and Management and Commerce students also receive extensive exposure to teaching in Natural and Physical Sciences disciplines.

Table 5.14: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to Bachelor's students in Fields of Education other than Natural and Physical Sciences by Broad Field of Education

Broad Field of Education	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture, Environmental & Related	3273	9.4%	2953	8.2%	2651	6.8%	2703	6.3%	-571	-17.4%
Education	1610	4.6%	1948	5.4%	2399	6.1%	2205	5.1%	595	37.0%
Engineering	7375	21.1%	7242	20.1%	7881	20.2%	8905	20.7%	1529	20.7%
Health	11755	33.7%	13156	36.6%	15592	39.9%	17736	41.3%	5981	50.9%
Information Technology	3052	8.7%	1742	4.8%	1354	3.5%	1308	3.0%	-1744	-57.1%
Mgt. & Commerce	4526	13.0%	5440	15.1%	5483	14.0%	6087	14.2%	1561	34.5%
Society & Culture	3001	8.6%	3222	9.0%	3329	8.5%	3693	8.6%	691	23.0%
Other Fields of Education	313	0.9%	244	0.7%	348	0.9%	330	0.8%	17	5.4%
Total	**34908**	**100.0%**	**35947**	**100.0%**	**39037**	**100.0%**	**42967**	**100.0%**	**8060**	**23.1%**

The predominant narrow discipline groups in which bachelor's-level teaching is provided are Biological Sciences and Mathematical Sciences. There is a long gap then to teaching in Other Natural and Physical Sciences, Chemical Sciences, Physical Sciences and Earth Sciences.

Table 5.15: Student Load 2002 – 2009. Distribution of Teaching in Natural and Physical Sciences to PhD Students in Fields of Education other than Natural and Physical Sciences by Narrow Discipline Group

	2002		2005		2007		2009		Growth	
	No.	%	No.	%	No.	%	No.	%	No.	%
Biological Sciences	12516	35.9%	13478	37.5%	15403	39.5%	16482	38.4%	3966	31.7%
Chemical Sciences	2295	6.6%	2437	6.8%	2646	6.8%	2750	6.4%	455	19.8%
Earth Sciences	1255	3.6%	1182	3.3%	1261	3.2%	1493	3.5%	238	19.0%
Mathematical Sciences	14247	40.8%	14067	39.1%	14196	36.4%	15958	37.1%	1711	12.0%
Physical Science	2227	6.4%	1852	5.2%	2118	5.4%	2201	5.1%	-26	-1.2%
Other Natural and Physical Sciences	2367	6.8%	2931	8.2%	3413	8.7%	4084	9.5%	1716	72.5%
Total	**34908**	**100.0%**	**35947**	**100.0%**	**39037**	**100.0%**	**42967**	**100.0%**	**8060**	**23.1%**

Finally, Table 5.16 is a teaching and learning matrix for 2009 of teaching to bachelor's degree students in non-science fields of education. Overall, Health students are main consumers of service teaching from Natural and Physical Sciences disciplines (41.3 per cent), followed by Engineering (20.7 per cent) and Management and Commerce students (14.2 per cent). Health students take about three-quarters of service teaching in the Biological Sciences, almost half of service teaching in Chemical Sciences and over three-quarters of teaching in Other Natural and Physical Sciences.

Table 5.16: Student Load 2009. Distribution of Teaching in Natural and Physical Sciences to Students Enrolled in Bachelor's Degrees in Fields of Education other than Natural and Physical Sciences by Broad Field of Education and Narrow Discipline Group

	Agriculture, Environmental & Related	Architecture	Creative Arts	Education	Engineering	Health	Information Technology	Mgt. & Commerce	Society & Culture	Total
EFTSL – No.										
Biological Sciences	1236	40	33	974	293	12278	23	230	1374	16482
Chemical Sciences	388	3	9	119	732	1286	18	63	132	2750
Earth Sciences	564	75	7	75	514	7	10	54	188	1493
Mathematical Sciences	365	53	63	765	5514	661	1209	5659	1669	15958
Physical Science	46	7	17	74	1667	265	40	30	55	2201
Other Natural and Physical Sciences	104	17	8	199	184	3239	9	50	274	4084
Total	**2703**	**194**	**136**	**2205**	**8905**	**17736**	**1308**	**6087**	**3693**	**42967**
EFTSL– %										
Biological Sciences	7.5%	0.2%	0.2%	5.9%	1.8%	74.5%	0.1%	1.4%	8.3%	100.0%
Chemical Sciences	14.1%	0.1%	0.3%	4.3%	26.6%	46.8%	0.6%	2.3%	4.8%	100.0%
Earth Sciences	37.8%	5.0%	0.5%	5.0%	34.4%	0.4%	0.7%	3.6%	12.6%	100.0%
Mathematical Sciences	2.3%	0.3%	0.4%	4.8%	34.6%	4.1%	7.6%	35.5%	10.5%	100.0%
Physical Science	2.1%	0.3%	0.8%	3.4%	75.8%	12.1%	1.8%	1.4%	2.5%	100.0%
Other Natural and Physical Sciences	2.6%	0.4%	0.2%	4.9%	4.5%	79.3%	0.2%	1.2%	6.7%	100.0%
Total	**6.3%**	**0.5%**	**0.3%**	**5.1%**	**20.7%**	**41.3%**	**3.0%**	**14.2%**	**8.6%**	**100.0%**

Teaching in the Mathematical Sciences tends to be to Engineering, and Management and Commerce students (just over one-third to each), with about 10 per cent to students enrolled in bachelor's-level courses in Society and Culture.

Biological Sciences and Mathematical Sciences disciplines make up about 38 per cent each of all service teaching in the Natural and Physical Sciences, with lower proportions from the other 'science' disciplines.

This chapter demonstrated that the Natural and Physical Sciences comprise teaching that is critical to students studying in all Fields of Education, not just those students enrolled in 'science' degrees. The 'reach' of science is therefore considerable, and has a major impact on undergraduate and postgraduate graduations across the system.

Chapter 6

Science students and 'fees'

Any history of the funding of Australian higher education will clearly demonstrate that there have been three main sources of funds: governments (both state and federal), students (by way of tuition and other fees), and 'other' (bequests, donations, external income). In the early days of Australian universities, state governments, student fees and bequests were the principal sources of university revenue (Stanley, 1992). From World War II, the proportion of funding increased steadily, to the point that tuition fees, which had always been part of the higher education system in Australia to some extent, were abolished by the Whitlam government, effective from 1974, when funding of the system was assumed by the federal government. More information and detail are available from DEET, (1993).

Even though there had been tuition fees before 1974, many students did not pay them because the system of commonwealth scholarships paid the tuition fees of recipients, and even provided some students with an income stream. The fees hiatus did not last long, however. From 1979, international students, who had also been beneficiaries of the Whitlam largesse, were required to pay an 'Overseas Student Charge', which amounted to about one-third of the average course cost. This fee was replaced in 1986 when fees for overseas students were increased to cover the full cost of tuition plus a capital component. (See Smart and Ang, 1993 for the evolution of fees for overseas students).

Domestic students became liable for partial tuition fees from 1989, via the income contingent higher education contribution scheme (HECS). HECS (and its successors) has moved from being a scheme with a single fee structure for students irrespective of what they were studying to a scheme that charges differential HECS, depending on the discipline of the subject the student is enrolled in (from 1997). HECS (and successor) debts are interest-free, but an annual adjustment takes changes in the cost of living into account.

Table 6.1 provides a summary of the distribution of student load in 2005 and 2009 by broad discipline group. It was prepared from tables from DEEWR statistics publications relating to 2005 and 2009.Therefore this table shows the distribution according to who is enrolled in subjects covered by the Natural and Physical Sciences. As could be seen in Table 3.11, only 45.9 per cent of the teaching of Natural and Physical Sciences subjects goes to students enrolled in Natural and Physical Sciences courses. Natural and Physical Sciences students also pay fees when they study subjects from other disciplines. Between 2005 and 2009, Natural and Physical Sciences teaching has a slightly lower proportion of its support from the Commonwealth, and more from international student fees.

Natural and Physical Sciences teaching is one of the discipline groups receiving a higher proportion of Commonwealth support, but was slightly less dependent in 2009 than in 2005. The proportion of income from international student fees is increasing, but it is still at the lower end of the scale. Contrast the situation in the Natural and Physical Sciences with that in Management and Commerce.

Table 6.1: Student Load 2002 and 2009. Student Load by Broad Discipline Group and Liability Status Category

	Agriculture	Engineering	Health	Information Technology	Management & Commerce	Natural & Physical Sciences	Society and Culture	Other Disciplines	Total
2005									
Commonwealth supported	68.1%	56.6%	69.4%	39.7%	39.4%	71.5%	65.5%	74.9%	60.8%
Domestic fee-paying	18.0%	11.9%	17.0%	9.4%	14.4%	10.9%	16.2%	11.4%	13.8%
International student fees	13.9%	31.5%	13.6%	50.9%	46.2%	17.7%	18.2%	13.7%	25.4%
Total Per Cent	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total EFTSL	**8682**	**39227**	**67142**	**47039**	**134074**	**79546**	**183132**	**119923**	**678760**
2009									
Commonwealth supported	64.5%	57.2%	68.9%	37.6%	32.8%	68.5%	62.1%	72.8%	57.8%
Domestic fee-paying	16.9%	8.8%	15.1%	7.7%	11.7%	9.5%	16.7%	11.5%	12.8%
International student fees	18.6%	34.0%	16.0%	54.7%	55.6%	22.0%	21.2%	15.7%	29.4%
Total Per Cent	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total EFTSL	**9906**	**49196**	**94594**	**40207**	**172673**	**94618**	**207008**	**144845**	**813047**

Source: 2005 based on DEST (2006) Selected Higher Education Student Statistics Table 3.5.3
2009 based on DEEWR Table 5.2

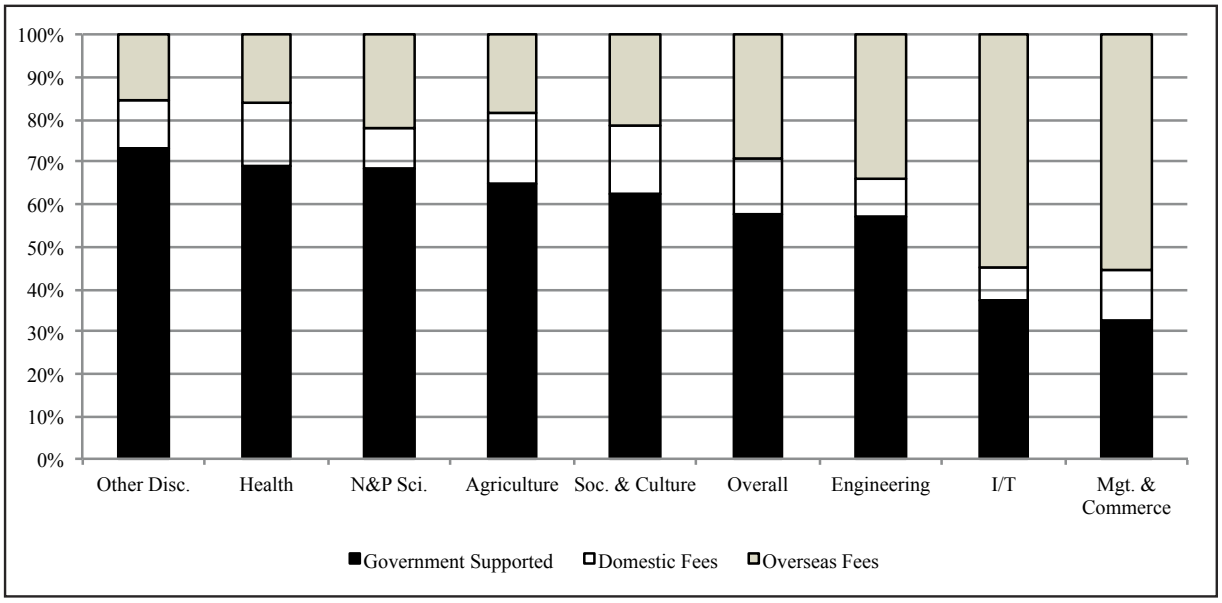
Table 6.2 is in the same format as the previous table, but provides information in more detail. Figure 6 provides similar information graphically. The steady increase in the proportion of funds from international students is clear.

Table 6.2 Student Load by Broad Discipline Group 2009 by Liability Status Category – Detail

	Agriculture	Engineering	Health	Information Technology	Management & Commerce	Natural & Physical Sciences	Society and Culture	Other Disciplines	Total
Commonwealth supported students									
Student Contribution liable	64.3%	56.7%	68.8%	36.6%	32.5%	66.2%	61.3%	70.6%	56.8%
Contribution Exempt	0.2%	0.4%	0.1%	1.0%	0.3%	2.3%	0.8%	2.3%	1.0%
Sub-total	**64.5%**	**57.1%**	**68.9%**	**37.6%**	**32.8%**	**68.5%**	**62.1%**	**72.9%**	**57.8%**
Domestic fee-paying students									
FEE-HELP	4.1%	1.4%	6.5%	3.1%	5.7%	1.8%	8.6%	5.9%	5.7%
Paid Upfront	3.0%	2.4%	4.6%	2.3%	4.9%	1.4%	4.7%	2.7%	3.7%
Tuition fee Exempt	0.9%	0.5%	0.3%	0.3%	0.1%	0.5%	0.3%	0.3%	0.3%
Non-award students	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.3%	0.2%	0.3%
Research Training Scheme	8.8%	4.4%	3.6%	1.8%	0.7%	5.6%	2.8%	2.4%	2.8%
Sub-total	**16.9%**	**8.8%**	**15.2%**	**7.7%**	**11.6%**	**9.5%**	**16.7%**	**11.5%**	**12.8%**
Overseas student fees	18.6%	34.0%	16.0%	54.7%	55.6%	22.0%	21.2%	15.6%	29.4%
Total Per Cent	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total EFTSL	**9,906**	**49,196**	**94,594**	**40,207**	**172,673**	**94,618**	**207,008**	**144,845**	**813,047**

Source: [Table 5.2 DEEWR 2009 stats]

Figure 6: Proportion of support from government, and student fees (Domestic and International)



The point of this chapter was to show that 'science' is one of the disciplines that is more dependent on government funding than some others are, and that is less able to derive its funding via fees.

Chapter 7

Conclusion

Is science going well? From the vast quantities of data available in Australian higher education, it is possible to conclude that the Natural and Physical Sciences held their ground in the 2000s. However, caution is required in considering the health of science teaching and learning at Australian universities.

University statistics have to be handled and interpreted with care. This study focussed on the period 2002 to 2009/2010 for good reason: the rules and definitions behind the statistics have remained unchanged during this period. As noted in Chapter 1, there were changes in course and subject classifications and the enumeration methodology in 2001 and 2002 respectively.

On top of these objective changes to the data collections, universities do not necessarily classify and report on student matters in the same way, nor do they necessarily follow the same methodologies through time. For example, the classifications for courses and subjects can be defined at the broad, narrow or detailed level. Some universities report some results at the broad level when it would be possible for them to have reported at the narrow, or even detailed level. As was shown in Table 4.30, many PhD completions in the Natural and Physical Sciences were reported non-specifically, despite the existence of 31 specific detailed fields of education and another 6 less specific, 28.4 per cent of PhD graduates were reported according to nondescript detailed fields of education, or to narrow fields of education 'not elsewhere classified'.

A second source of temporal variation can occur if universities alter their coding practices. This was exemplified in Table 4.25, which showed how Monash University ceased coding certain PhD enrolments in Health, apparently moving them to Biological Sciences within Natural and Physical Sciences. Such changes mean that the actual long-term trends are less clear than one might expect. If universities don't have proceedures in place to ensure consistency it is likely that reporting will vary over time.

Looking at the tables in this volume, enrolments in primary courses in the Natural and Physical Sciences (all levels) increased by over 18,000, or 30.1 per cent (see Table 3.5). Over that period, enrolments in all fields of education increased by 33.0 per cent, leaving the Natural and Physical Sciences slightly behind the pace. Natural and Physical Sciences enrolments represented 6.8 per cent in 2002 and 6.6 per cent in 2010. Particularly strong growth in enrolments in Health (+66,293), and Management and Commerce (+96,719) programmes were the main drivers of university enrolments over the decade. Health increased its proportion of all enrolments from 10.7 per cent to 13.6 per cent and Management and Commerce from 25.5 per cent to 27.3 per cent. Growth in Management and Commerce has been driven by substantial increases in numbers of international students, currently over 55 per cent of all enrolments in this field of education, up from around 35 per cent in 2002.

Bachelor's degree students make up the majority of the students in Australian universities. Across all fields of education, bachelor degree students represented about 66 per cent of all enrolments in 2009, whereas in the Natural and Physical Sciences, the proportion was almost 79 per cent. The relatively higher proportion in the Natural and Physical Sciences arises mainly because there are fewer students in master's by coursework degrees, a particularly popular course level in the fields of education with higher proportions of international fee-paying students (particularly Information Technology and Management and Commerce).

As noted earlier, many bachelor's degrees are generalist degrees, so if one is interested in detailed trends, it is necessary to examine the subjects science students take as part of their bachelor's degrees. The changes in the composition of bachelors' degrees in the Natural and Physical Sciences at the start of the twenty-first century were outlined in Table 4.13 and Figure 5. The Biological Sciences remain the principal discipline in science bachelor's degrees, which in 2009 represented nearly 36 per cent of the average Natural and Physical Sciences bachelor's degree. There was little change across the disciplines, but Other Natural and Physical Sciences expanded a little. At the same time, there was an absolute decline in the proportion of teaching to science students in non-science areas.

An examination of PhDs across the system shows that the proportion in science increased slightly between 2002 and 2009, from 19.3 per cent to 20.7 per cent of the total. System wide growth in PhD enrolments was 30.1 per cent, and 39.8 per cent in PhD enrolments in the Natural and Physical Sciences (see Table 4.23). The subject matter of PhDs in the Natural and Physical Sciences changed little between 2002 and 2009. The Biological Sciences continue to be the major area of interest among PhD students, and enrolments increased by 1,104 (or 39.4 per cent) over the period. The principal growth area was Other Natural and Physical Sciences, which expanded by 916 enrolments (or 79.4 per cent) (see Table 4.23). However, a closer examination shows that much of the growth was a reflection of some universities failing to report as specifically as the field of education classification would allow (see Table 4.24), and a change in coding practice at Monash University between 2002 and 2003 (see Table 4.25). This point was also noted above.

An examination of student load statistics shows clearly that the Natural and Physical Sciences are a major source of service teaching, that is, teaching 'science' subjects to students enrolled in 'non-science' courses.. Table 3.11 revealed that in 2009, a minority of teaching in the Natural and Physical Sciences disciplines was delivered to students enrolled in 'science' courses. Whereas 45.9 per cent of the teaching in the Natural and Physical Sciences went to 'science' students, 20.0 per cent went to students enrolled in Health courses, 10.5 per cent went to Engineering students, and 8.6 per cent went to students in Management and Commerce (particularly in mathematics). The Natural and Physical Sciences, therefore, are widely distributed. As was shown in Table 5.1, over the first decade of the twenty-first century, the proportions altered little between the major Natural and Physical Sciences disciplines. Biological Sciences teaching represented 41 to 42 per cent in the years shown in the Table, with Chemical Sciences, Earth Sciences, Mathematical Sciences and Physical Sciences contributing 10 per cent, five per cent, 27 to 28 per cent and six or seven per cent, respectively. There was a slight increase in the proportion of teaching in Other Natural and Physical Sciences, but this could also be a reflection of non-specific reporting by some universities.

It is unfortunate that it is not possible to provide an authoritative long-term time series of what has happened in 'learning' within courses that are part of the Natural and Physical Sciences broad field of education, or the 'teaching' in the subjects that are classified within the Natural and Physical Sciences broad discipline group. As has been stressed in a number of places, it is not possible to provide an exact comparison of the situation in 2000 and before with that pertaining to 2002 and later. However, earlier studies undertaken for the ACDS pointed to considerable declines in the 1990s in the enabling sciences built around chemistry, mathematics and physics (ACDS, 1999). Figures indicate that the proportion of science degrees in 1989 in 'physics' represented 8.3 per cent of all student load, and that this had declined to 5.6 per cent by 1997 (when courses were still linked to fields of study). Equivalent figures for other areas were 'chemistry' 13.7 per cent in 1989 to 11.3 per cent in 1997 and 'mathematics' 17.3 per cent in 1989 to 10.9 per cent in 1997. However, 'biology' increased from 24.6 per cent to 31.1 per cent in 1997. These few figures demonstrate that the major changes occurred in the 1990s, and that the 2000s have presented a fairly flat profile. In one sense, it could be said that university science hasn't recovered from its decline in the 1990s.

Much of the concern expressed (by the ACDS and others) about long-term trends in science have related to the relative decline in the enabling sciences of chemistry, mathematics and physics. Another way to identify trends in students' changing preferences for different science disciplines is to examine the proportion of student load in a given discipline group taken by commencing students, compared with when they are continuing students. As was shown in Table 4.16, students consume higher proportions of student load in enabling science disciplines when they are commencing students than when they are continuing students. This indicates that higher proportions of students discontinue their study of enabling sciences after first year. In other words, students are less likely to complete majors chemistry, mathematics and physics than they are in biology and other narrow disciplines within the Natural and Physical Sciences. From Table 4.16, one can see that in 2009, about 59 per cent of Chemical Sciences was taken by commencing students, and 54 per cent and 57 per cent of Mathematical Sciences and Physical Sciences respectively. These proportions should be compared with the other Natural and Physical Sciences disciplines, and non-science disciplines, of which one-third or less was taken by commencing students, an indication that students tend to study more of these disciplines in years after they were commencing students.

The Natural and Physical Sciences held their ground during the first decade of the twenty-first century, so on one level, perhaps there is little to be concerned about. However, one should ask if this is good enough for a technologically-advanced society. Typically one expects innovation to come out of science and technology, rather than from say, management, commerce, and health, areas that have been the most dynamic in enrolment expansion this century.

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Appendix 1

Fields of Education and Discipline Groups

Broad, Narrow and Detailed (Source: DEEWR)	
01	Natural and Physical Sciences
010100 010101 010103 010199	Mathematical Sciences Mathematics Statistics Mathematical Sciences not elsewhere classified
010300 010301 010303	Physics and Astronomy Physics Astronomy
010500 010501 010503 010599	Chemical Sciences Organic Chemistry Inorganic Chemistry Chemical Sciences not elsewhere classified
010700 010701 010703 010705 010707 010709 010711 010713 010799	Earth Sciences Atmospheric Sciences Geology Geophysics Geochemistry Soil Science Hydrology Oceanography Earth Sciences not elsewhere classified
010900 101901 010903 101905 010907 010909 010911 010913 010915 010999	Biological Sciences Biochemistry and Cell Biology Botany Ecology and Evolution Marine Science Genetics Microbiology Human Biology Zoology Biological Sciences not elsewhere classified
019900 019901 019903 019905 019907 019909 019999	Other Natural and Physical Sciences Medical Science Forensic Science Food Science and Biotechnology Pharmacology Laboratory Technology Natural and Physical Sciences not elsewhere classified
Other Broad Fields of Education (Broad Discipline Groups)	
02	Information Technology
03	Engineering and Related Technologies
04	Architecture and Building
05	Agriculture, Environmental and Related Studies
06	Health
07	Education
08	Management and Commerce
09	Society and Culture
10	Creative Arts
11	Food, Hospitality and Personal Services
12	Mixed Field Programmes

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 DEEWR'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 (EFTSL) aggregated for all the courses being undertaken by the student in the Collection Year is 0.75 or more.
Part-time	student load (EFTSL) 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 programme undertaken at a higher education institution. An award course is a programme 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 LEVEL
DEEWR terminology is 'course type'. Course level means (for example) PhD, bachelor's, postgraduate diploma, etc.

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 programme, 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'.

Notes