Why do a Science Degree?

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Australian Council of Deans of Science

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SUMMARY

This occasional paper reviews the findings of the ACDS commissioned report, *What did you do with your science degree*? In terms of investigating the employment profile of graduates of a discipline three, five and ten years post their first graduation, this report is the first of its kind in Australia.

The first conclusion from this survey is that there is not an oversupply of science graduates. Graduates of science courses have much lower unemployment rate than the national average, in the main are employed using the skills they learned, enjoy their jobs, and have average salaries in the top ten to twenty percent of the workforce for their age group.

This leads to the second conclusion, that a science degree is an attractive start to a worthwhile career. Science graduates do not follow a particular defined career pathway, although there is a gradual shift with time from graduation from technical and science professional jobs towards managerial positions. Like most careers these days, the careers of science graduates can be expected to involve one or more periods of further education, and shifts in position which rest on individual skills and attributes as much as on technical knowledge.

The low percentage of science graduates entering the education sector is of considerable concern for the future attraction of matriculants into science and related areas. Recent work reports a current shortage of qualified science teachers particularly in the physical sciences and mathematics (Goodrum et al, 2001), and an ageing profile for the current cohort of science teachers. Low movement of science graduates into science education now will exacerbate the shortage of teachers in the future. A detailed survey of current and future requirements for science teachers is urgently needed **as is action to attract and maintain science graduates into the teaching profession**.

Fifty-six percent of the Science graduates surveyed have undertaken further formal study in either science or non-science areas, indicating that a majority realise that completing a first degree does not complete their education. Science Faculties are responding by further enhancing generic skills such as communication and information technology in science courses **to further improve the career prospects of future graduates and strengthen their foundation for life long learning**.

Why do a Science degree? For graduates currently in the workforce, the answer has been a high level of interest and career pathways that are seen as interesting and providing considerable levels of personal satisfaction if not a high degree of job security. For the future, we expect that graduates in science and technology will be taking a leading place in building Australia's Knowledge Economy, with the rewards and recognition that go with that vital role.

The complete report *"What Did You Do With Your Science Degree?"* can be found on the ACDS website which is www.acds.edu.au

Building Australia's Science and Technology capacity – Do we have enough scientists?

The year 2000 saw the submission to Government of two reports of vital importance. These were:

- the report into the Nation's Science capabilities by the Chief Scientist, Robin Batterham, *A Chance to Change* (Batterham, 2000);
- the report of the Innovation Summit Implementation Group, *Innovation: Unlocking the Future* (Miles, 2000).

The Government has followed these reports with *Backing Australia's Ability* (Commonwealth of Australian, 2001). This statement outlined the Government's commitment to building a strong economic future for Australia, based on knowledge and high technology. Their plan to achieve this included a commitment to allocate $3 billion to science and technology over the next five years.

Realisation of the promise for Australia's future that is encapsulated in each of these reports will require engagement of the country's best and most able young people in endeavours related to science and technology. We will need to use the Government's investment well, by using it to perform excellent and innovative science and technology, and capturing the economic potential of this output to build future wealth. Can we meet the challenge?

In 1999, the Australian Council of Deans of Science (ACDS), which represents the Science sectors of all 37 of Australia's Universities, published a report it had commissioned) to investigate participation in university science courses over the past 10 years *(Trends in Science Education*; Dobson and Calderon, 1999). By analysing data from the 1996 Census and results from the Graduate Destination Survey for 1997, Dobson and Calderon concluded that, "short term excesses in supply (*of graduates*) may not reflect the long term outlook" (p76). The report also demonstrated, in a stark fashion, the decline of enrolments in the "enabling sciences" of Mathematics, Physics and Chemistry over the past ten years.

Graduate Destination Surveys, carried out each year by the Careers Council of Australia, generally report large numbers of science graduates seeking employment at the time of the survey. However, these data are collected from new graduates three months after graduation. Government analysis has suggested a supply of graduates in some disciplines exceeding employer demand (Borthwick and Murphy, 1998), but there is no data available that addresses the longer term career prospects and directions of science graduates as a group.

Is it difficult to have an interesting, satisfying and well-paid career as a science graduate? This would seem to be a key question in attempting to explain the continuing decrease in interest and hence enrolments in the enabling sciences in Australia. If the answer is "no", then the data will be vital in countering negative perceptions about science careers, which are often cited by students and their parents as reasons for choosing other areas of study.

Understanding the career prospects for Science Graduates – the ACDS Survey

In an attempt to obtain a clearer picture of employment patterns for science graduates, the ACDS commissioned a study of persons who graduated with a first science degree in the period 1990-2000. This survey was conducted by the Centre for the Study of Higher Education at the University of Melbourne and has resulted in the recently released report,

What did you do with your science degree? (McInnis *et al*, 2001) (hereafter referred to as the Report).

The ACDS asked the project team to address a series of wide ranging questions related to the employment of science graduates:

Q1 Are Australian universities producing too many science graduates?
Q2 Is there a career structure for science graduates?
Q3 Are many science graduates underemployed?
Q4 Is there more than a small minority of science graduates employed in the area of science in which they were initially educated?
Q5 Are higher degree graduates more restricted in employment avenues than those with a pass degree?
Q6 Do science graduates find worthwhile employment in areas outside of their major discipline?
Q7 Are the skills developed in a science degree valued by employers?
Q8 Are science graduates seen by employers as having better problem-solving skills than other graduates?
Q9 What additional training, if any, do science graduates undertake prior to their first position?

In this occasional paper, we draw on conclusions in the report and our own interpretation of the data gathered to provide answers to most of these questions. Some questions remain unanswered by this survey. On the other hand, additional important information resulted from the survey data.

The project surveyed 1,245 students who had completed a Pass or Honours degree in science during the past ten years. 37% of the sample completed their undergraduate degrees in the 1990-93 period, 35% in the 1994-1996 period and 28% in the 1997-1999 period. The survey therefore provides a broader view than that available from the Careers Council data which concentrate on employment levels three months after graduation. The students were graduates of six different Universities selected to represent the broad range of Australian Universities. In addition, interviews were held with thirty-two science degree holders, selected employers and recruitment agencies were also consulted.

It is worth noting that this study appears to be the first of its kind for any cohort of graduates. It is hoped that appropriate bodies may institute similar surveys of graduates from other areas to ascertain whether patterns revealed here for science graduates reflect the experiences of graduates from other disciplines.

The Findings – status of science graduates 1-10 years after graduation
Employment – what jobs do science graduates have?

One way of attempting to answer Q1, (*Are Australian universities producing too many science graduates*?) is to analyse the unemployment rates for science graduates.

Table 1 (This table appears in full as Table 3.10 in the Report):
Unemployment rates for males and females, according to major area of study in their undergraduate Science degree (%), N=1,245

	Unemploment rate (%)		
Major area of u/g science degree	**Males**	**Females**	**Total**
Computer Sciences	0	2	1
Life Sciences	4	2	3
Mathematical Sciences	0	3	1
Physical Sciences	4	2	4
Medical/Health Sciences	0	5	3
General Science (include Psychology, Geography)	5	3	3

The overall unemployment rate is 3%, ranging from 2% for those graduating in the early 90's to 4% for those of the late 90's. This contrasts with an overall unemployment rate for the Australian population in excess of 6%. On these data, the answer to Q1 is clearly "no", universities are not producing too many science graduates.

Further analysis is required before we can be confident the answer to Q1 is indeed "no". An obvious question is whether the graduates are utilising their science skills. The survey found that almost 60% of respondents agreed that they used the skills acquired in their undergraduate degree in their job, while about 80% of graduates said that their undergraduate science degree was "directly" or "somewhat" related to their current or most recent job. The majority of respondents agreed that their undergraduate science degree was important in obtaining employment with 41% saying that it was essential in obtaining their current or most recent job and 34% saying it contributed a great deal to obtaining the job.

Further evidence for this point can be gained from Table 2.

This Table verifies that approximately 75% of Science graduates are employed in science, technology and related positions.

The observation that around 25-30% of respondents appear to be employed in non-science positions, confirms that science graduates are finding managerial and professional employment outside science and technology (Q3 and Q6).

Table 2 (Report Table 3.1):
Current occupations of employed male and female respondents (%)

Occupation category	Employed (FT and PT) N=1,154		Employed FT N=958	
	Males	Females	Males	Females
Science Manager	4	4	5	4
IT Manager	1	1	1	1
Other Manager	6	8	7	9
Science Technical	6	7	6	7
Other Technical	8	11	8	11
Science Professional	25	21	25	22
IT Professional	19	8	20	10
Medical/Health Professional	5	11	6	10
Science Education Professional	5	5	4	5
Other Professional	15	20	15	20
All other work	5	5	4	2

The answer to Q4, (*Is there more than a small minority of science graduates employed in the area of science in which they were initially educated?*) is difficult to provide from this survey. However, some insight can be obtained from Figure 1 (extracted from Figures 4.1 to 4.6 in the Report). It is apparent that the graduates from the more vocationally oriented Computer Science and Medical/Health Science degrees are primarily employed as professionals in their respective disciplines. Life Sciences and Physical Sciences graduates have a wider spread of jobs but the largest category is “Science Professional” and approximately one half of the respondents have found employment in the science field. Mathematical Science and General Science graduates are chiefly employed in non-science areas but usually in a professional capacity.

The figures would also appear to confirm that the answer to Q6, (*Do science graduates find worthwhile employment in areas outside of their major discipline?*) is affirmative, but that at this relatively early stage of their careers, 1-10 years after completion of their undergraduate degree, the majority of science graduates is building their career progression in areas more strongly utilising their undergraduate training.

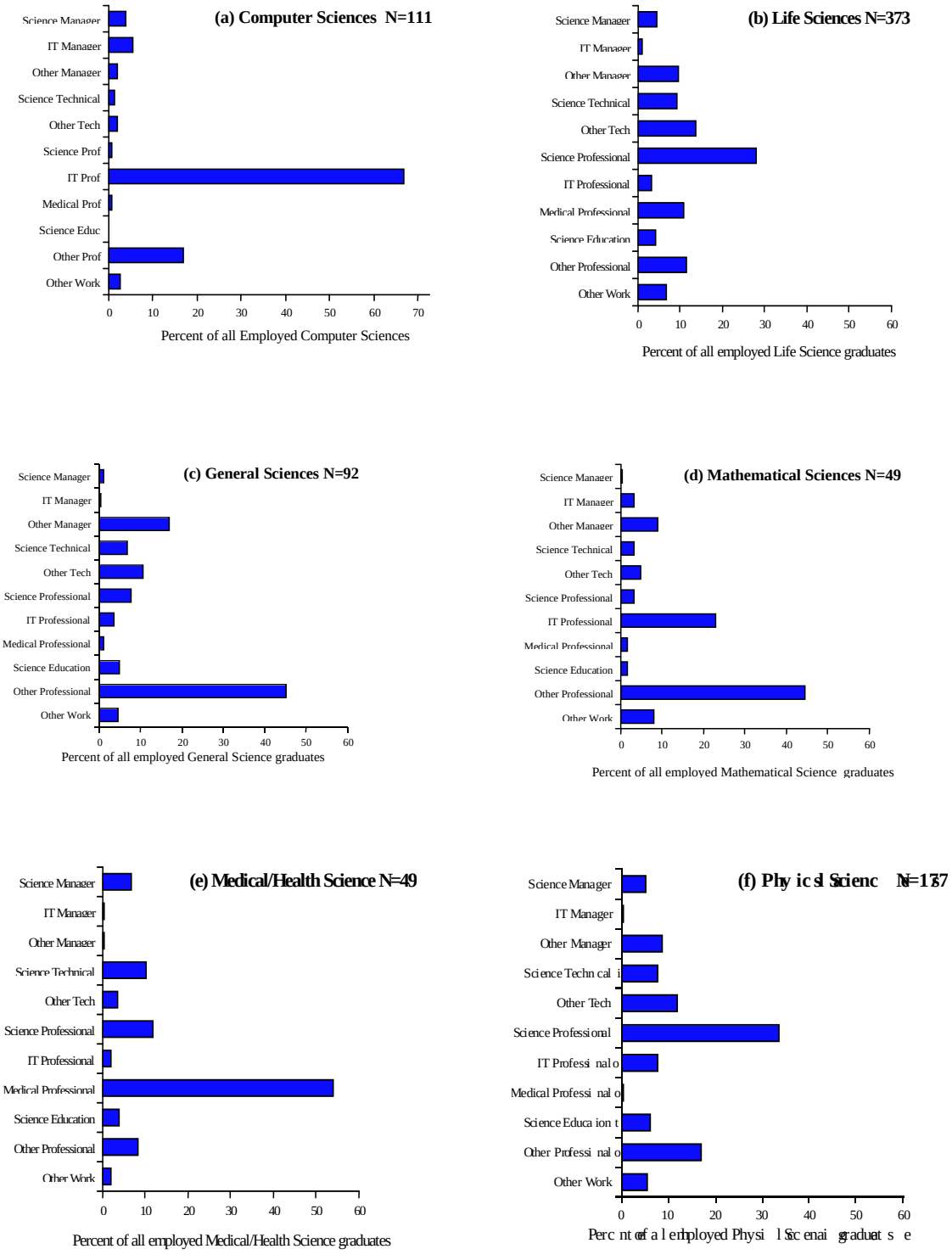

Figure 1 (Report Figures 4.1 to 4.6): Occupation outcomes for science graduates (N=851)

It is disappointing and of some considerable concern that the participation of all graduates in Science Education appears to be small, with none of the disciplines exceeding 10% and most no more than 5%. This finding confirms that found by the Chief Scientist in his recent report (Batterham, 2000). The ACDS fears that, without enthusiastic and qualified teachers, the current difficulty in attracting students into science and technology will continue, to the Nation's detriment.

There is an urgent need to ascertain, at a National level, what numbers of science teachers are required simply to meet the need for renewal, as the current cohort of teachers reaches retirement age. As well, if the expectations of recent Government reports are correct, then we can expect an increased demand for teaching and teachers across the broad science and technology sector for the future.

Employment – Are science graduates underemployed?

The original intention of the question Q3 (*Are many science graduates underemployed?*) was to ascertain whether many science graduates were in positions not commensurate with their qualifications, or ones that did not utilise their skills even remotely. The data from Figure 1 would imply that this situation is not prevalent.

The report addressed the definition of underemployment as defined by the Australian Bureau of Statistics, that is, someone who is working part time but is seeking full time employment.

Using the ABS definition, the overall rate of underemployment identified from this survey is 3%, with recent graduates more likely to be underemployed. Life and Medical/Health graduates were slightly more likely to be underemployed than graduates of other disciplines. Respondents who undertook vocational postgraduate training were more likely to be underemployed than those with research higher degrees. This outcome may result from graduates training for a particular vocational outcome being prepared to take part time work while awaiting an opportunity in their area of choice.

Employment – Is there a career structure for science graduates?

One reason frequently put forward for not undertaking science studies is that there is no defined career structure as perceived, for example, in medicine or engineering. This was the motivation for asking Q2 (*Is there a career structure for science graduates?*).

What is a career structure? No longer is it a "job for life" starting at the bottom in an organisation and working one's way up the ladder. People will now make many changes during their working life, not only from organisation to organisation, but between jobs using different types of skills. This is the expectation for science graduates as well as for all other types of employees. As the Report puts it so well, "Notions of a career and a working life are becoming increasingly diverse and much more individually based and entrepreneurial. In an era where generic skills, portability of qualifications and transferable skills are key concepts underlying the vocational training system; where rapid change is occurring in the skills required in many areas of employment; and where there is greater fluidity of employment options for people with a range of skills, the notion of a set career structure based solely on the nature and type of initial training is no longer appropriate".

The Report investigated whether science graduates regarded their current position as one which formed a part of a desired career path. As the Report finds, “Being in a desired career position appears to be related to both the level and type of a respondent’s position. Over 60% of IT Managers, IT professionals, Medical/Health professionals, and Science Educators say they are in a desired position and around 50% of professionals in areas other than Science, IT and Medical/Health say they are.”

Just over 50% of Science technicians regard their jobs as a stepping stone to a desired career position, which is perhaps to be expected. Also, nearly 60% of Science professionals are also in the ‘stepping stone’ category, indicating they expect to move to a better, more rewarding or different position in the future. This is not surprising among a group of graduates between one and ten years from completion of their degree. Occupation groups which include significant proportions of people who see their job as an ‘interim job not leading to a career position’ are Science technicians, and technicians in other than IT, Science and Medical/Health areas”. These findings suggest that science graduates find themselves on a satisfactory career pathway once they are working in a professional capacity in an area related to their primary University degree. Some idea of subsequent career progression can be obtained by considering the types of employment in which graduates find themselves as a function of years since graduation from their first science degree.

Figure 2 (Report Figure 4.7):
Employment distribution of SCIENCE GRADUATES by time since graduation, expressed as a percentage.

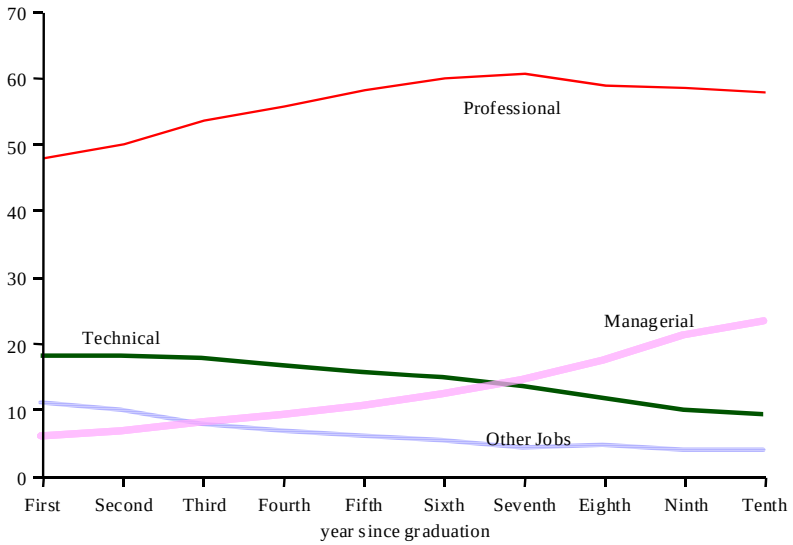

Figure 2 confirms that over time, most science graduates find employment in positions which they see as “desired” for their career direction, i.e. professional and managerial positions, while engagement in technical or other types of positions decreases. The percentage in professional employment rises until the seventh year since graduation, then falls, presumably as graduates progress from this point into managerial positions.

Figure 3 (Report Figure 4.10):
Distribution of SCIENCE GRADUATES by time since graduation: employment in Science and other positions and full-time study

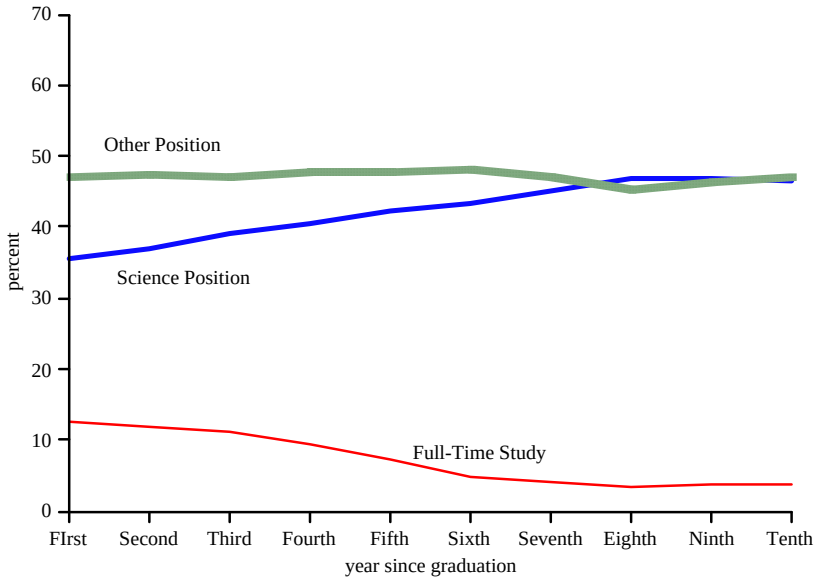

Figure 3 gives another perspective on career progression for graduates. The percentage in Science-related positions rose until the eighth year almost entirely reflecting the drop in the percentage in full time study. The percentage in other positions, which includes IT positions, remains fairly constant over the whole period.

- The Report thus has a very positive message to send to science graduates or those contemplating science studies most science graduates are able, relatively rapidly, to move into positions (professional, managerial) which they see as part of a desired career pathway;
- Most rely on the background provided by their science studies to enable subsequent career moves;
- Over time, science graduates as a group progress from technical to professional and then to managerial positions, indicating satisfactory career progression;
- As expected from the nature of the modern working life, there are many career pathways, building on their initial skills and knowledge, open to science graduates.

Skills

Q7 (*Are the skills developed in a science degree valued by employers?*) and Q8 (*Are science graduates seen by employers as having better problem-solving skills than other graduates?*) dealt with the skills that science graduates take to their jobs. A survey of employers and recruitment agencies found that "employers now tended to seek people with a variety of skills, including being able to communicate well with others. Most of those consulted are looking for people who can make decisions, who have team-work skills, interpersonal skills, are 'project management minded' and have good problem solving skills. They noted that while technical skills are clearly essential for many positions, for others, the type of degree matters less than a range of other skills and previous experience. The 'other' skills include the ability

to communicate, adaptability, resourcefulness, and for some jobs, creativity. For higher level positions, demonstrated ability to handle a high level of responsibility is required."

As the Report concluded, "The sheer range of skills now expected of science graduates is a challenge, for them and for Faculties of Science".

A clearer picture of the skills needed for employment and gained from the undergraduate degree is obtained from the graduate respondents themselves. When asked to agree with a list of attributes which might have been gained from the undergraduate course and what attributes were important in employment, an analysis of replies provided the data in Table 3. Three attributes are closely matched:

- analytic skills;
- an ability to use research to inform analysis and decision making;
- an awareness that knowledge is always being revised and extended.

While 95% of respondents agreed that problem-solving skills were important in employment, it is disappointing and of some concern that only 75% agreed that they had gained this skill from their undergraduate degree. Of similar concern is the mismatch for the skills; the ability to work independently, the ability to work with others, written communication skills, oral communication skills and flexibility and adaptability. The indication is that there is some need for Faculties of Science to take stock of the generic skills embedded in their courses.

Over the last ten years, access to computers for undergraduates has been greatly enhanced and the use of computers become more integrated into science courses. This advancement is reflected in the survey data where only 40% of graduates up to 1996 agreed that they had gained an ability to use Information Technology effectively from their course whereas 61% of the graduates from 1997 agreed that they had gained this ability.

Similarly, in recent years, there has been an increasing awareness among Science Faculties of the need to encompass the teaching of generic skills within their curriculum. Preferably, this is not seen as separate from the teaching of science. Rather, the use and further development of basic skills in communication, problem solving and teamwork are becoming an integral part of the way science is taught and assessed. At the time, students often do not connect the acquisition or practising of skills with their classroom experiences, which they interpret as placing the greatest emphasis on content (facts and principles). A more explicit discussion of teaching styles in relation to skills acquisition ("why am I asking you to do it this way?") may be beneficial for both staff and students.

Many students in science now undertake combined degrees that allow for learning of other skills alongside their scientific training. In addition, most graduates in any discipline engage in additional education as their career advances such as undertaking a Management Degree at an appropriate stage. Awareness of these options must be encouraged in science graduates and in all undergraduates, so that they are not surprised to find that their first degree does not provide them with the complete educational basis that they will need for the rest of their career.

Table 3 (Report Table 9.1): Respondents agreeing that attributes were gained in an undergraduate Science course, and that they are important in current employment, and differences between the two (% of respondents) N=958

	Attribute gained in an u/g course	Attribute important in employment	Differences in percent agreeing
Analytical skills	82	86	-4
Problem-solving skills	76	95	-19
Subject-specific knowledge and understanding	76	58	18
An ability to use research to inform analysis and decision-making	75	75	0
An awareness that knowledge is always being revised and extended	75	77	-2
The ability to work independently	67	91	-24
A capacity to deal with complexity and ambiguity	59	81	-22
Written communication skills	57	82	-25
The ability to work with others	54	90	-36
The ability to use information technology effectively	45	85	-40
Flexibility and adaptability	45	90	-45
An awareness of the social implications of developments in your discipline/field	41	52	-11
Oral communication skills	41	89	-48
An understanding of other points of view	40	76	-36
Management skills	20	79	-59
A sense of confidence and competence for working in an international environment	19	51	-32
An understanding of other cultures	14	42	-28

Salary levels for Science Graduates

Further evidence of the worth of a science graduate to an employer is in the level of remuneration received by the employee. The Report analysed the salaries of respondents by area of major in the undergraduate science degree. The median annual salaries for full time employed by areas of major are shown in Table 4. The reader is reminded that the salaries quoted are averaged over all of the graduates surveyed (3, 5 or 10 years since first

graduation), with the “average” respondent being 5 years since graduation from their undergraduate degree, and so expected to be in the 25-28 age group.

Table 4 (Report Table 3.2): Median (gross) annual incomes of full-time employed respondents with different major areas of study in their undergraduate Science degree, N=958.

Major area of u/g Science degree	$
Computer Sciences	75,000
Mathematical Sciences	50,000
Medical/Health Sciences	50,000
Physical Sciences	47,000
Life Sciences	45,000
General Science (inc. Psychology, Geography)	42,000

When salaries are coupled with job security, it is not surprising that IT professionals and IT managers had the highest level of job satisfaction along with the Medical/Health professional. The latter group also expressed a high level of interest in their job and use of science skills as did the Science Education professional and the Science professional.

The Report concludes that the findings “tend to support a view that Science professionals rate their jobs highest on having an interesting job and having their skills used and valued, rather than on job satisfaction including job security and income. It would seem that for a good proportion of science-trained employees, there is a trade-off between finding a job which interests them and in which they can exercise at least some of their science skills, and finding a job that is highly paid”.

The outcome for science graduates can be compared with data for the general population, taken from "Income Distribution Australia" (Australian Bureau of Statistics, 1999-2000). The data looks at overall income for single income earners in the 25-34 age group, which includes the age range of science graduates covered in the Report. For the general population, approximately 14% in this group earn $50,000 pa or more, while 23% earn $40,000 or more. This places the average outcome for science graduates within the top 20% or less of the population, when it is recognised that the age distribution in the science graduates is somewhat different from that of the ABS sample. In addition, the data looks only at average salary and not at the range of salaries that are being earned.

Additional training

Q9 asked what additional training science graduates undertake **prior** to entering their first position. The Report extended this question and gathered data on **any** extra training undertaken by respondents following their undergraduate degree. A total of 55% of respondents had completed further qualifications, made up of a subsequent science

qualification (28%), a qualification in an area other than science (19%) and qualifications in both science and an area other than science (8%).

Q5 addressed the question as to whether higher degree graduates have more restricted employment avenues than those with a pass degree. The survey demonstrated the following trends:

- Occupations of respondents with a pass or honours BSc tend to be spread principally across the range of managerial, technical and professional levels in both science and other than science areas. However, the largest group (20%) are Science professionals. A further 20% of honours graduates are in other professions. Around 15% of both pass and honours graduates are IT professionals;

- Respondents whose highest science qualification is a combined degree that includes science are predominantly in professional positions other than Science, Medical/Health or IT, but 20% are IT professionals;

- 58% of PhD holders are Science professionals; the next largest group is the 13% who are in professions other than IT, Science or Medical/Health, 10% are in other technical positions. Undertaking a PhD adds an extra 3-4 years to the period required for education—hence this group will, on average, have entered the workforce more recently than the pass and honours graduates;

- Around one-quarter of respondents whose highest level of science qualification is a coursework masters are Medical/Health professionals; another quarter are in other professions. Respondents with a Masters degree requiring research were more likely than coursework graduates to be Science professionals;

- If a graduate diploma was the highest science qualification, respondents tended to be spread across a range of occupations and levels; however, a notable proportion, 18%, were in Science Education.

As The Report states, “a higher degree is not a guarantee of getting a desired position or a job where science skills are used, as the qualitative comments from both the survey and the interviews show”. This outcome would suggest that the answer to Q5 is “yes”, and that higher degree graduates select more restricted employment avenues. Given the duration of the higher degree however, the times since graduation selected for the study, mean that the responses refer only to the early stage of their careers.

Concluding Remarks

Why do a Science degree? The answer, as indicated by the earlier Report commissioned by the ACDS, *What did you do with your Science degree*, is multi-faceted. Primarily, a love of science is a prerequisite. Based on the replies from the respondents in this current Report, a science degree leads to an interesting job. Being a science graduate opens up opportunities for being creative and to contribute directly to wealth creation for the nation. This new Report demonstrates that Science Graduates can expect reasonably good career structures, with a natural progression from scientific to managerial positions, building on their science training. Remuneration of science graduates on average places them in the top 20-25% of the population for their age group, with graduates in “high demand” areas, such as IT, doing much better than this average. Given the ages and career stages of the graduates included in

this survey, many have not yet achieved their ultimate career goals and are in positions which they see as providing a stepping stone to desired career positions. Job security was seen as a negative aspect by many respondents, since positions in the technical and early science professional area often involve relatively short term contracts. The issues of security and of external recognition are ones which will need to be addressed if the best of the nation's young people are to be attracted into the science sector over the next decade. If the rate of employment of science graduates in positions appropriate to their qualifications is taken as an indication, then the evidence of the survey is that universities are not producing too many science graduates for today's market. For the future, there is increasing expectation that there will be a serious shortfall of persons with such qualifications. Knowledge-based industries such as biotechnology, information technology, nanotechnology and photonics will be extremely greedy in their consumption of science graduates, providing that action foreshadowed by the Government encourages these industries to flourish.

The authors of the Report are quite right in their conclusion that, "Science Faculties must be at the forefront of the national effort to provide research and innovative solutions to lead and support the changing national priorities. Much of this effort will depend on the quality of undergraduate programs in science and the effective use of graduate skills in the workforce. However, there are some major gaps in our knowledge of what graduates do with their science degrees and how Faculties of Science might best address their needs, and the emerging national priorities".

Most science graduates, and graduates generally, will need further training no matter what their selected vocation. This Report goes part of the way to defining the way forward. However, science degrees will continue to serve the dual purposes of a generalist and specialised course. As a generalist course, these degrees have the responsibility to prepare their graduates with the right balance of specific and generic skills for employment in science and related areas. Science degrees also must serve the purpose of identifying and nurturing future Science professionals. It would not be appropriate to overload such degrees with generic skills training, separate from scientific content. The rapid advancement of science already places enormous pressures on contemporary degrees that are only three years in duration.

The inescapable conclusion from this survey is that there is not an oversupply of science graduates—quite the contrary. Future projections are for a shortage of science graduates, particularly in the enabling disciplines and for graduates undertaking Science Teaching. The national leaders, supported by organisations such as the Australian Council of Deans of Science must address this potential shortage by promoting to the community at large science and technology, and their professionals, as imperatives for the future living standards of the country. Remuneration and other job conditions for those working in science and technology must be made comparable to those that our graduates find so attractive overseas. Otherwise, attempts to develop a knowledge economy are doomed to failure.

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