



Who's Teaching Science?

Meeting the demand for qualified science teachers in Australian secondary schools

Report prepared for
Australian Council of Deans of Science



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Foreword

Call to Action:

The data presented in this report highlight a number of serious problems that will inhibit the growth of Australia, both economically and culturally. It is imperative that all governments and education authorities implement rigorous workplace planning for teaching of science in schools as a matter of urgency, in order to remedy the current situation and prevent its reoccurrence. Such planning should be focused at the discipline level and not simply at the generic area of “science”. It must involve upgrading the discipline background of science teachers along with their pedagogical skills. It should be across sectors and states.

Background:

Previous commissioned surveys by the Australian Council of Deans of Science (ACDS) reported a continuing decline in enrolments in the enabling sciences and mathematics at the secondary and tertiary levels of education¹. Furthermore, it is recognised that very few science graduates are selecting a teaching career². The Council feared that the nation was entering a cycle with the only possible outcome being a dearth of graduates with qualifications in the enabling sciences and mathematics. Certainly there would be insufficient graduates skilled in science to support the development of a knowledge-based economy.

Australia suffers from an absence of comprehensive data on the age profile of secondary school science teachers, their qualifications in the discipline areas they are required to teach and their views regarding the teaching profession. This lack of information hampered the review by Professor Kwong Lee Dow titled *Australia's Teachers: Australia's Future*³ which looked at, among other things, future workplace needs. The ACDS strongly believes that the future of science is too important for this paucity of data to continue. Hence it commissioned this report.

Anecdotal evidence abounds concerning the number of teachers who are unqualified to teach science in particular discipline areas, but are required to do so for various reasons. The ACDS recognizes the enormous contribution of science and mathematics teachers in our schools – both at primary and secondary level. The ACDS sees this report as a basis for providing them with further support. The report should also further link science as taught at university with science as taught in the school sector.

While a preliminary attempt was made in this study to include mathematics, a number of contributing factors prevented this. It is the intention of the Council to consider commissioning a second study concentrating on mathematics teaching once the full impact of the data reported here is realized.

The ACDS is particularly concerned about the teaching situation for the enabling disciplines of chemistry and physics. It is clear from this study that, compared relatively to the situation for chemistry and physics, the position of biology teaching in schools is strong. Biology, and probably geology, are not far from a complete coverage by suitably qualified teachers in the senior years. This bodes well for the important and rapidly developing fields of biotechnology, nanoscience and molecular science. It is the case however, that these fields and many others in the biological sciences also require a strong foundation in chemistry and physics. The data in this report will provide a reference point to ensure the relatively benign state of biology teaching continues.

¹ *Science at the Crossroads? A Study of trends in university science from Dawkins to now: 1989-2002 ACDS Occasional Paper No 4*, available at: <http://www.acds.edu.au>

² *Why do a Science Degree? ACDS Occasional Paper No 2*, available at: <http://www.acds.edu.au>

³ Available at: http://www.dest.gov.au/schools/teachingreview/documents/Agenda_for_Action.pdf

Geology is not taught widely within Australian high schools and the information presented here confirms this. The limited availability of geology at school level may well in part be related to the demise of a number of university geology departments in the country.

Key Findings:

- Nearly 43 per cent of senior school physics teachers lacked a physics major, and one in four had not studied the subject beyond first-year. This, coupled together with the reported difficulties in attracting physics teachers (40 per cent of schools surveyed), paints an alarming picture. No matter how good their pedagogical skills, teachers who lack knowledge in their discipline are manifestly unprepared.
- Among senior school chemistry teachers, one in four lacked a chemistry major, whereas 14 per cent of senior school biology teachers lacked a biology major.
- There is a clear preference among heads of secondary school science departments for staff with a university degree in science supplemented by an education qualification, rather than a university degree in teaching with some study in science.
- There is agreement among heads of secondary school science departments that, in future, teachers of senior science should have at least a major in the appropriate discipline area – a view supported by the ACDS.
- There is a relatively high percentage of Year 7/8 teachers with no university exposure to any of the four surveyed disciplines: even at the senior years of schooling, up to 6 per cent of teachers have not studied these subjects beyond first year at university, if at all.
- There is concern of the heads of secondary school science departments at the difficulty in recruiting suitably qualified staff, especially in light of the age profile of existing staff: more than one third of male science teachers are at least 50 years of age.
- There is a need for early career teachers to have effective mentoring.

Recommendations:

The Australian Council of Deans of Science calls on State and Federal governments, as well as secondary and tertiary education authorities to:

1. take note of this report;
2. implement rigorous workplace planning to ensure that sufficient numbers of suitably qualified teachers of science disciplines are available to nurture future generations of school students;
3. cooperate across sectorial, State and Territory boundaries to develop a national science teacher workforce plan;
4. work with the university sector to develop international best practice in science teacher education programmes;
5. adopt minimum standards, focused on science as well as pedagogy, of qualifications for science teachers at the various levels of secondary school education;
6. in the medium term, introduce a meaningful accreditation mechanism for science teachers, involving minimum qualification levels in science as well as pedagogy.

Professor Tim Brown (President), Professor David Finlay and Professor Bill MacGillivray
(Past Presidents)

Australian Council of Deans of Science

Executive summary

This report examines the characteristics of teachers currently teaching science in Australian secondary schools, focussing on their level of university education in science, their age profile and their present attitudes towards their careers. The objective is to examine issues associated with the quality and supply of science teachers.

The project's findings are based on a national survey of science teachers and heads of secondary school science departments. The survey was conducted within a carefully stratified sample of secondary schools chosen to ensure representativeness across all states and territories and across all school sectors. The project received 1207 responses from science teachers, a response rate of 40 per cent. This sample is estimated to be nine per cent of the nation's science teachers. The project also received 266 responses from heads of science departments, a response rate of 42 per cent.

The four science disciplines examined most closely were biology, chemistry, physics and geology/earth science.

The age distribution and tertiary qualifications of science teachers

- The age profile for teachers shows a bulge of 'baby-boomers' in the 45-54 year age bracket that is particularly prominent for males. With the impending retirement of this generation of teachers, a shortfall in teacher supply seems likely.
- Over one third of the respondents indicated that they had been employed elsewhere before embarking on a teaching career, and one in seven had previously been employed as scientists.
- 93 per cent of the teachers surveyed were university trained, with the majority (90%) having studied science subjects in a Science Faculty rather than an Education Faculty. Heads of science departments expressed a preference, on balance, for teachers who had been prepared by Science Faculties.
- Chemistry and Biology were the most commonly and extensively studied university subjects. Far fewer respondents had studied Physics and Geology/Earth Sciences, particularly beyond first year. This pattern was most pronounced among younger teachers.
- Fourteen per cent of respondents lacked a minor in any of the four subjects Biology, Chemistry, Physics and Geology. These teachers formed sixteen per cent of all teachers of junior school science, twelve per cent of middle school science teachers and nearly six per cent of senior school science teachers.
- Nearly eight per cent of all respondents had not studied any of the four subjects Biology, Chemistry, Physics and Geology at university. These teachers formed eight per cent of all teachers who were teaching junior science, five per cent of all teachers of middle school science and less than two per cent of all teachers of senior school science.
- Generally, the heads of science departments were satisfied with the science qualifications of the staff teaching science in their schools, but the levels of satisfaction were markedly lower for junior and middle school science than for senior school science.

Discipline-specific qualifications of senior school science teachers

- Most (90%) heads of secondary school science departments defined the minimum qualification necessary to teach senior school science classes as an undergraduate university degree with a major in the relevant discipline.
- Senior school Biology teachers were the most highly trained in their discipline. Eighty-six per cent had a major in Biology and almost 27 per cent had studied Biology to fourth-year. Only four per cent of Biology teachers had no tertiary background in the subject.
- Nearly forty-three per cent of senior school Physics teachers lacked a Physics major, and one in four had not studied the subject beyond first-year.

- One in four teachers of senior school Chemistry lacked a Chemistry major.
- Geology teachers had the lowest levels of discipline-specific qualifications. More than half of these teachers had not studied any Geology at a tertiary level.
- Compared to their older colleagues, younger teachers were more likely to have studied Biology and less likely to have studied Physics.

Supply of science teachers

- Thirty per cent of schools reported difficulty in filling vacancies for Chemistry teachers, while forty per cent had difficulty recruiting suitably qualified Physics teachers. Shortages were most acutely experienced when schools had short-term (e.g. six month) vacancies to fill.
- Catholic schools experienced the shortage of suitably qualified senior school Chemistry and Physics teachers most acutely, with two-thirds reporting difficulty recruiting Physics teachers and more than half reporting difficulty recruiting Chemistry teachers.
- Many heads of secondary school science departments believed replacing retiring staff in Chemistry and Physics would become increasingly difficult.

Retaining science teachers in the secondary school system

- One-quarter of the heads of secondary school science departments surveyed reported difficulty retaining science teachers. This difficulty was most frequently mentioned by Government schools: more than one in three heads from Government schools expressed concern about their schools' ability to retain staff.
- Teachers themselves reported considerable uncertainty about their career plans. This was especially true of early-career teachers and senior school Biology teachers. Nearly forty per cent of teachers with fewer than five years teaching experience and more than fifty per cent of senior school Biology teachers were unsure if they would still be teaching in five years time.
- When asked if there were aspects of the profession that they found unsatisfactory, the overwhelming response from teachers concerned the long hours and high workloads involved. This was of particular concern to female teachers. In addition, lack of motivation on the part of students frustrated many teachers, particularly male teachers and teachers in Government schools.

Attracting new people to a career in science teaching

- The desire to share their love of science with young people was the most commonly cited motivational factor attracting the teachers surveyed to the profession of secondary school science teaching.
- Both teachers and heads of science departments believed that increased salaries were necessary in order to attract suitably qualified people to a career in science teaching. Specifically, many respondents highlighted the need for schools to offer salaries that were competitive with industry if they were to attract Science graduates to teaching.
- One in four respondents believed that the 'low status' of the teachers in the wider community was a negative factor affecting recruitment of people to the teaching profession.

Conclusions

The results of this study highlight the growing need to attract more people to the study of Chemistry and Physics at tertiary level, and to provide these students with both the training and incentives to pursue teaching careers in secondary schools. Secondary schools report current and increasing difficulty in attracting and retaining suitably qualified teachers in both these disciplines. Indeed, a large proportion of current teachers of senior school Chemistry and Physics lack a major in the discipline – the minimum level of qualification deemed satisfactory by most heads of secondary school science departments. The shortage of suitably qualified science teachers is likely to be exacerbated in the coming years as the bulge of 'baby boomers' approach retirement age.

More broadly, the study's findings reveal a high level of disillusionment among science teachers, evident in the ambivalence of many towards remaining in the profession. The science teachers who responded to this study had a common love of science and a desire to share this enthusiasm with young people. However, for many this commitment was being tested by long hours and high workloads. The evidence from this study is that teaching science in schools is currently considered to be a less glamorous alternative than working in industry and certainly a less financially rewarding one. This problem may well be characteristic of the teaching profession as a whole, but is perhaps of particular significance in the field of science where the lure of the opportunity to work on leading-edge developments in well-resourced environments is strong. Part of the sector's challenge, therefore, is to raise the appeal of teaching and of teaching science in particular.

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Special thanks must be given to the State and Territory Education Departments, Catholic Dioceses and Independent Schools who granted us permission to conduct the research. Finally, we wish to thank the science teachers and the heads of science departments in schools who took time from their busy schedules to respond to our invitation to participate in the survey. We recognise the many demands on teachers and are indebted to the many teachers who responded to the survey with comprehensive and thoughtful comments.

Kerri-Lee Harris
Felicity Jensz
Gabrielle Baldwin

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Chapter 1: Context of the study

In recent years there has been concern with the downturn in the number of young Australians interested in studying science and the apparent decline in the appeal of careers in science. The concern arises not only from the role that highly qualified science graduates will play in Australia's economic, technological and social advancement, but also from the importance of ensuring a suitably high level of understanding of science within the Australian community.

The quality of science teaching in Australian secondary schools is central to nurturing scientific understanding, inquiry and enthusiasm and to laying the foundations for the education and training of future generations of Australian scientists and researchers. The importance of well qualified, committed science teachers in motivating and inspiring students hardly needs reiterating, nor does the importance of ensuring appropriate conditions and resources for the teaching of science in schools.

The academic qualifications and future supply of science teachers are now national issues. This is evident in the 2003 report *Australia's Teachers: Australia's Future* commissioned by the Department of Education, Science and Training (DEST 2003a, 2003b) and the report prepared by the Science Teachers Association of Western Australian in 2000, *Review of the Quality and Supply of Science Teachers* (STAWA 2000). Both reports made recommendations for ways in which the quality and supply of teachers could be improved. One suggestion was that more detailed information on the working lives of teachers and their intentions for the future should be collected (DEST 2003b, p17). With this objective in mind, and using the report prepared by the Science Teachers Association of Western Australian (STAWA 2000) as a guide, the present study sought to gather data from teachers in all states and territories, and across all school sectors.

As the present report reveals, Australia's science teachers are a rapidly greying workforce. The projected number of retirements in the next 5-10 years and the limited flow of incoming and early career science teachers, especially in the physical sciences, are matters that require coordinated policy action. The contribution of this study is new information on the characteristics, expectations and attitudes of science teachers that might assist in the training, recruitment and retention of future teachers. The project's findings are presented around three themes:

- the demographics and qualifications of the teachers currently teaching science in secondary schools (Chapter 3);
- the growing issues for schools in staffing science subjects (Chapter 4), and;
- the difficulties faced by schools in attracting and retaining science teachers (Chapter 5).

Chapter 6 discusses the implications, especially for policy, of the project's findings.

Chapter 2: The study's purpose and method

2.1 Purpose

The aims of this research project were to investigate whether or not shortages exist in the availability of science teachers in Australia, to explore the future of secondary science teaching in light of the supply and demand of science teachers, and to examine the circumstances that are needed to attract and retain suitably qualified science teachers.

The study was informed by the recent review, *Australia's Teachers: Australia's Future*, chaired by Professor Kwong Lee Dow, that called for the collection of comprehensive statistics relating to teachers, teacher workforce trends and teacher education, noting in particular a gap in the information available on specific fields (DEST 2003a, p96). The review recommended that research be undertaken on the working lives of teachers, their intentions and motivations, and the ways in which conditions of schooling and employment might enhance the attractiveness of careers in teaching. The current study, through the information collected from heads of secondary school science departments and science teachers, contributes important new information on these issues.

The project examined the following questions:

1. To what extent are secondary science subjects being taught by teachers appropriately qualified in those disciplines?
2. Do the age profile and career plans of current science teachers provide any indications about the supply of appropriately qualified teachers in the future?
3. What factors influence teachers positively or negatively about science teaching as a profession?
4. What are the opportunities for attracting people to a career in science teaching?

2.2 Methodology

The methodology of the study involved two questionnaire-based surveys that were mailed to:

- heads of science departments in secondary schools
- science teachers in secondary schools

Data from the returned surveys were coded and analysed using SPSS. Responses to the open questions were also coded and are incorporated as direct quotes in the report as appropriate. Further details of the methodology, including details of sample selection, design of the questionnaire, and comments on methodological issues, are included as appendices to this report.

Permission to approach schools was requested in writing from the relevant governing bodies of schools within each state, territory or diocese. All governing bodies, with the exception of the Education Policy and Planning Section of the ACT, granted permission to survey their staff. Independent schools were approached individually.

Schools were selected from a stratified random sample of secondary schools across Australia. The specification of the sampling method, prepared by the Australian Council for Educational Research, included all eight states and territories, all geographical areas (highly accessible, accessible, moderately accessible, remote and very remote), the three school sectors (Government, Catholic and Independent) and all socioeconomic

sectors (high, medium and low socio-economic regions as defined by the ABS postcode classification).

2.2.1 Heads of science departments survey

The survey of the heads of science departments was designed to elicit information on:

- the number of science teachers in the school;
- the science units offered and, if appropriate, the reasons for not offering units;
- the heads' views on the appropriateness of the science qualifications of the science teachers at their school;
- the heads' views on the minimum level of university science background that a teacher ought to have completed to be equipped to teach science at various year levels;
- the perceived differences, if any, between teachers prepared by Education Faculties and by Science Faculties;
- the recruitment and retention of science teachers, and
- views and suggestions on strategies and possibilities for attracting appropriately qualified people to science teaching.

The questionnaires were individually tailored to include the specific science subjects taught within the curriculum of each state and territory. Specifically, each science subject taught at the year 11 or 12 level within a particular state or territory was listed on the questionnaire for that state or territory. However, the overall structure of the questionnaires was the same for all states and territories.

The initial letters of invitation to participate in the survey were sent to the heads of science departments via the Principals of their schools. Permission for involvement of the school was then assumed if the Principal passed the questionnaire on to the Head of the science department.

The overall response rate to the questionnaires mailed to the heads of science departments was 42.3 per cent (n=266/629).

2.2.2 Science teachers survey

As with the survey of the heads of science departments, the questionnaires for the science teachers were tailored to reflect the science curriculum of each state or territory, resulting in eight distinct questionnaires. However, the overall structure of the questionnaires was again the same for all states and territories.

The survey was designed to elicit information on:

- the science subjects taught by the respondent;
- the highest tertiary education qualifications of the respondent;
- the specific science subjects studied at university and whether these subjects were taught by Science or Education Faculties;
- sex and age;
- previous employment;
- number of years experience as a secondary school teacher;
- career plans for 2009 (i.e. five years from the date of the survey);
- initial factors that attracted the respondent to the profession;
- any dissatisfying aspects of their teaching position, and
- views on the possible ways for attracting appropriately qualified people to science teaching.

The overall response rate to the teachers survey was forty per cent (n=1207/2989).

Box 1: Definitions of selected terms as applied within this report

School: a school or college within the secondary education sector.

Year groups within secondary schools

Junior school: year levels 7 and 8

Middle school: year levels 9 and 10

Senior school: year levels 11 and 12

Teachers

Junior school teachers: teachers of junior school science classes (who may also teach science at other year levels)

Middle school teachers: teachers of middle school science classes (who may also teach science at other year levels)

Senior school teachers: teachers of senior school classes in Biology, Chemistry, Physics or Geology (who may also teach other year levels and/or other senior school subjects)

School subjects

Biology: All curricula included a subject called 'Biology'. Additional biology-related subjects (e.g. Human Biology in Western Australian schools; Psychology in Victorian schools) were not included in this study's analysis of Biology teaching.

Physics: All curricula included a subject called 'Physics'. Additional physics-related subjects (e.g. Physical Science in Tasmanian schools) were not included in this study's analysis of Physics teaching.

Chemistry: All curricula included a subject called 'Chemistry'. Additional chemistry-related subjects (e.g. Environmental Science in Tasmanian schools) were not included in this study's analysis of Chemistry teaching.

Geology: Most curricula included an earth science related subject called 'Geology', 'Earth Science' (QLD) or 'Earth & Environmental Science' (NSW), and these are collectively referred to as 'Geology' in this study. The curricula of Victoria and Tasmania, however, included no such subjects. 'Environmental Science' (Vic, Tas) was not included in this study's analysis of Geology teaching.

Physical science(s) refers collectively to Chemistry, Physics and Geology as defined above.

Qualifications

Qualification: the highest science-related post-secondary academic qualifications attained by the respondent.

Minor: a subject area studied to and including second-year level at university, but not beyond.

Major: a subject area studied to and including third-year level at university, or further (e.g. Honours).

The definitions of minor and major apply to all university qualifications, irrespective of whether the respondent studied the science subjects within a Science Faculty or an Education Faculty.

Chapter 3: The demographics and qualifications of science teachers

This chapter presents an overview of the demographic characteristics of the 1207 teachers who responded to the survey. After presenting data on the distribution of age and gender (Section 3.2), number of years of teaching experience (Section 3.3) and the tertiary qualifications of the respondents (Section 3.4), Section 3.5 describes the level of science qualifications obtained by teachers in the subject areas for which they have responsibility. Much of the analysis is based on the distinction between the three school levels described previously (Box 1; 'junior', 'middle' and 'senior'), with some analysis of differences across state/territories and by school sector.

3.1 Location and sector representation

Response to the survey of teachers was received from all eight states and territories (Table 3.1). The three sectors (Catholic, Government and Independent) were included, with the exception of the ACT Government school sector where permission to survey the schools was declined by the Territory government. The 1207 respondents represent nearly nine per cent of all science teachers in Australia.

There was significant variation in the proportion of representation from different states and territories, ranging from three per cent of NSW teachers to forty per cent of those in the Northern Territory (Table 3.1). This was due to the sampling strategy employed, a strategy designed to ensure adequate representation from the smaller states/territories (see Appendix 1). The sample was more evenly distributed across sectors, ranging from 7.6 per cent of Government schools to 11.3 per cent of Independent schools (Table 3.1).

Table 3.1 Number of secondary school science teachers responding to the Science Teachers survey, grouped by state and sector.

	Catholic schools	Government schools	Independent schools	Total number of teachers	Percentage ¹ of teachers represented
ACT	32	*	9	41	14.5%
NSW	47	69	24	140	3.0%
NT	3	27	13	43	40.2%
QLD	26	126	32	184	7.5%
SA	34	144	55	233	25.7%
TAS	35	85	19	139	37.3%
VIC	88	144	68	300	8.3%
WA	44	53	30	127	10.0%
Total number of teachers	309	648	250	1207	
Percentage ¹ of teachers represented	10.5%	7.6%	11.3%		Nationwide 8.8%

*ACT Government declined permission for the involvement of government schools in this study
¹ estimate, based on ACER figures for the total number of teachers in each state or sector

A large majority of respondents (90%) worked within schools that were classified as either 'highly accessible' or 'accessible' on the ARIA coding system for geographical locations (see Appendix 2). This is in accordance with the pattern of population distribution across Australia, as 94 per cent of the nation's population reside within these locations.

3.2 Gender and age representation

Nationally, male respondents outnumbered female respondents (53.5% and 46.5% respectively). However, there were differences in the gender-balance of responses by state and territory. Females formed two-thirds of the ACT and Northern Territory cohorts, but only around forty per cent of the respondents from each of South Australia and Western Australia. Nor did responses from the three sectors match the overall pattern, with female respondents forming 54 per cent of the Catholic school sample (Chi-square: 7.22 $P < 0.05$).

The mean age of respondents was 41 years with no difference between the three sectors. Between states there was a slight difference in age distribution, with teachers from the ACT and Tasmania being the eldest at an average age of 44 years. Teachers from Queensland and Western Australia were on average 40 years of age.

The male respondents were typically older than female respondents (mean ages of 44 and 39, respectively; Fig. 3.1). Thirty-seven per cent of male respondents were at least fifty years of age, compared to nineteen per cent of female respondents in this age bracket. Conversely, one-quarter of all female respondents were less than 30 years of age, compared to only thirteen per cent of males in this youngest age group.

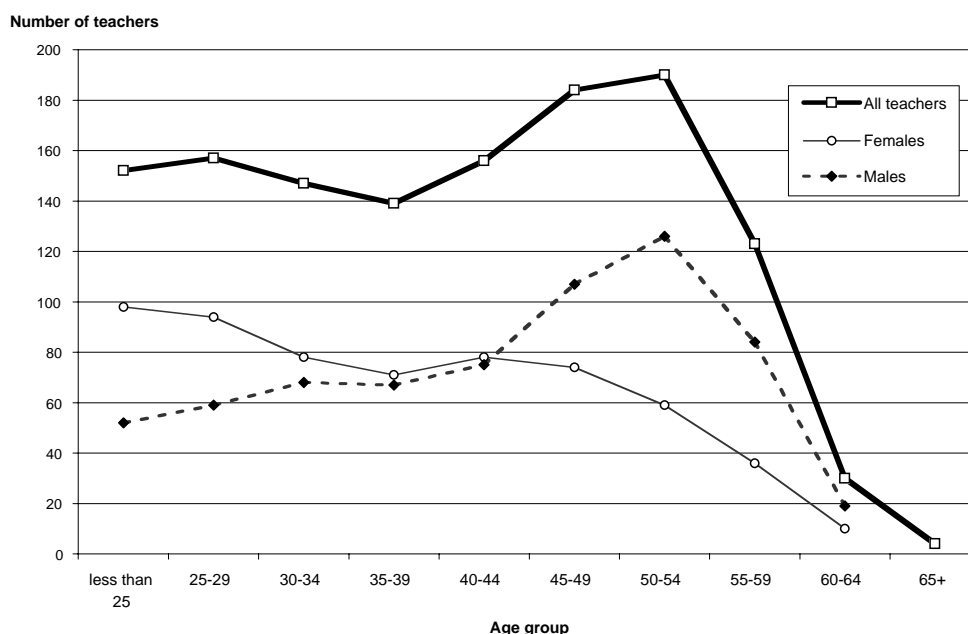


Figure 3.1 Age distribution of teachers in the sample (overall and by sex)

The 'less than 25' and '65+' age groups have been adjusted to take account of the differing width of these age bands.

3.3 Employment histories

3.3.1 Years of employment

The science teachers in the sample had taught, on average, for 15 years. The mean period of service for male teachers was 17 years, which was five years longer than the average period of teaching for female teachers (Fig. 3.2). The average period of service for teachers in 'highly accessible' and 'accessible' areas was on par with the national average. However, teachers from less accessible locations had taught for only 11 years on average. Although there was no difference between sectors, there was a difference in

the average length of service between states. Teachers in Tasmania and New South Wales had taught on average the longest at 17 years, with teachers in the Northern Territory being slightly under the national average at 12 years of service.

Number of teachers

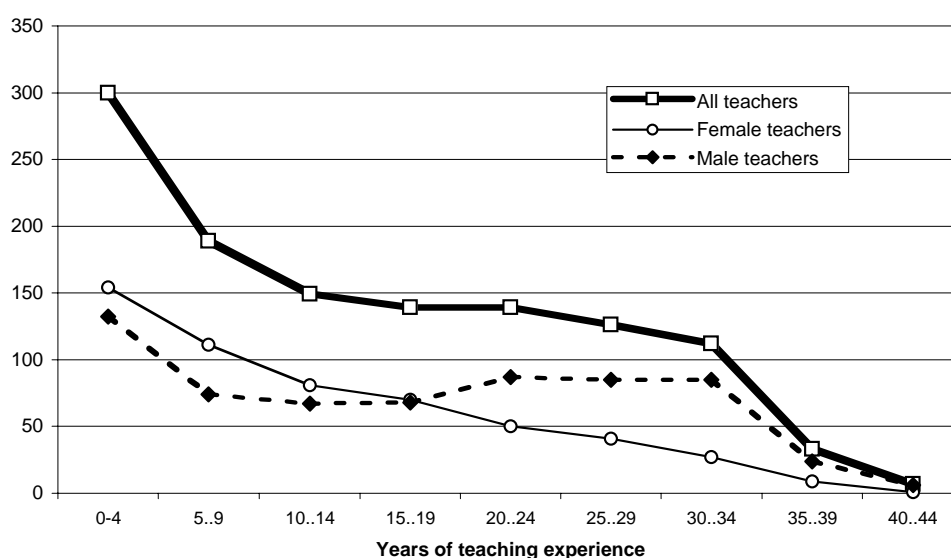


Figure 3.2 Years of secondary school science teaching experience

In the first ten years of employment, female teachers were slightly younger than their male colleagues (Table 3.2), suggesting that males start teaching at a later age than females.

Table 3.2 Average age of science teachers (by years employed and gender)

	Average age (years)										Overall mean age
	<3 yrs exp.	3-4 yrs exp.	5-9 yrs exp.	10-14 yrs exp.	15-19 yrs exp.	20-24 yrs exp.	25-29 yrs exp.	30-34 yrs exp.	35-39 yrs exp.	>39 yrs exp.	
All teachers	30	33	35	39	43	49	51	54	58	62	41
Female teachers	28	31	34	39	43	48	51	55	58	62	39
Male teachers	32	33	36	39	44	49	51	54	58	62	44

3.3.2 Previous employment

Over one third of the respondents (n=430/1207) indicated that they had been employed elsewhere before embarking on a teaching career. Forty per cent of these teachers had been employed as scientists, with no significant gender difference (48.2% females and 51.8% males). The remainder listed non-professional employment (33%), engineering (6%) or one of a range of other professions (20%) as their previous occupation.

3.4 Tertiary qualifications

3.4.1 Overview

The overwhelming majority (93%) of the respondents were university trained. Of those who specified the institution, the majority (78%) were graduates from Australian universities. Only nine per cent of the university-trained teachers had studied for their degrees at an overseas institution.

Most respondents held 'science-based' degrees (72%). Only a small proportion (5%) had completed postgraduate study in the Sciences (Table 3.3). 'Bachelor of Education' graduates were also well represented in the study (21%), with a further four per cent holding Masters degrees in Education. This pattern was consistent across gender and across the three sectors (Catholic, Government and Independent), with the exception that teachers with higher degrees in Science were concentrated in the Independent school sector. While Independent-school teachers represented only 21 per cent of the sample, they employed 33 per cent of those with higher degrees in science (Chi-square: 8.27 $P < 0.05$).

Table 3.3 Highest science-related tertiary qualifications held by teachers responding to this study.

	Highest science-related tertiary qualification obtained	Total number of teachers (n=1199)	Percentage of respondents (%)
Science-based	Undergraduate Diploma (Science)	28	2.3
	Bachelor of Science	733	71.9
	BSc + second degree	18	
	Higher Degree in Science	65	
	Other science-related Bachelor degree ¹	45	
Education-based	Bachelor of Education (Science)	218	24.6
	Bachelor of Education (Sc) + other u'grad	36	
	Master of Education	27	
	Master of Education + other	14	
	Other	15	1.3

¹ For example: Agriculture, Metallurgy or Engineering

3.4.2 Subjects studied at university level

The majority of respondents to the survey (85%) held either a minor or major in at least one of the following subject areas: Biology, Chemistry, Physics or Geology. Chemistry and Biology were the subjects most commonly included in the tertiary degrees of respondents (78% and 71% respectively) (Table 3.4; Fig. 3.3), with more than sixty per cent of respondents having studied both disciplines. Physics was studied by more than sixty per cent of the survey group, but half of these teachers had only studied the subject in first year (Table 3.4). Figure 3.3 illustrates this pronounced difference between discipline-specific qualifications when the level of study is also considered. Forty-five per cent of all teachers surveyed held a major in Biology, and one in three held a major in Chemistry. In contrast, just 17 per cent of the teachers surveyed were similarly qualified in Physics. Geology was studied by still fewer respondents (Table 3.4; Fig. 3.3). Only one in four of the teachers surveyed had studied any tertiary-level Geology, and just eight per cent had studied the subject beyond second year.

Table 3.4 Frequencies and percentages of science teachers to have studied each of four subjects at tertiary level (for at least one year of study).

Number and percentage of respondents (teachers; n=1207) to have studied each of four principal subject areas at university				
	Biology	Chemistry	Physics	Geology
Number of teachers	861	945	736	311
Percentage of sample (%)	71.3	78.3	60.1	25.8

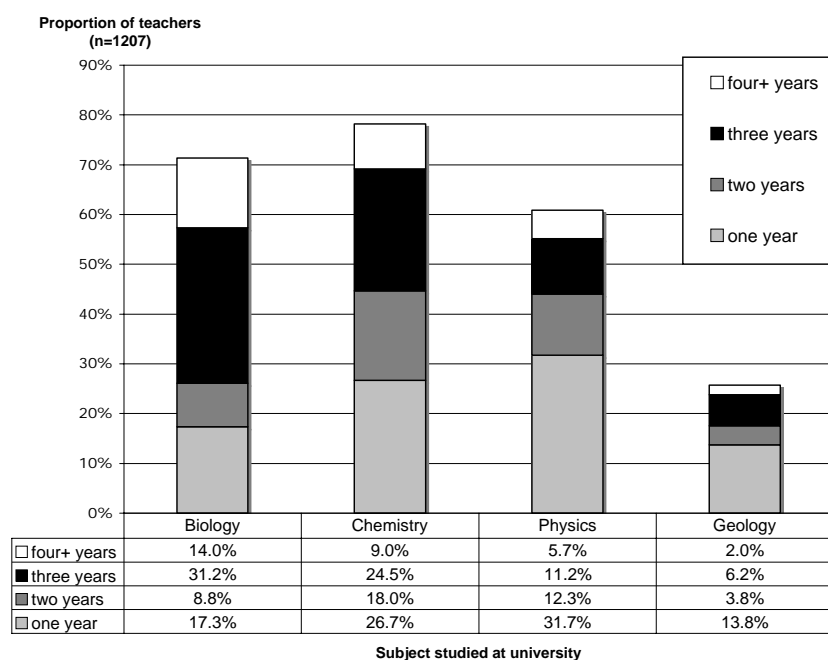


Figure 3.3 Highest level of university study attained by subject

Eight per cent of respondents had studied none of these four subjects at tertiary level. Of this group, most (90%) taught junior and/or middle school science only (discussed further in Section 3.5).

Compared to their older colleagues, younger teachers were more likely to have studied Biology and less likely to have studied Physics (Fig. 3.4). Of the 231 respondents under the age of thirty years, more than sixty per cent had studied Biology to at least second year at university and nearly fifty per cent held a Biology major. However, only sixteen per cent of the teachers under 30 years of age had studied Physics beyond first year at university. In contrast, less than half the 345 respondents over fifty years of age had studied Biology beyond first year, while almost one third of these older teachers had studied Physics to second year or beyond.

Most of the tertiary science subjects studied by the surveyed teachers were taught within Science Faculties (90%). However, those teachers with Bachelor of Education qualifications were less likely to have studied in Science Faculties (Table 3.5). More than one-third of the science subjects studied by this group were taught within Education Faculties.

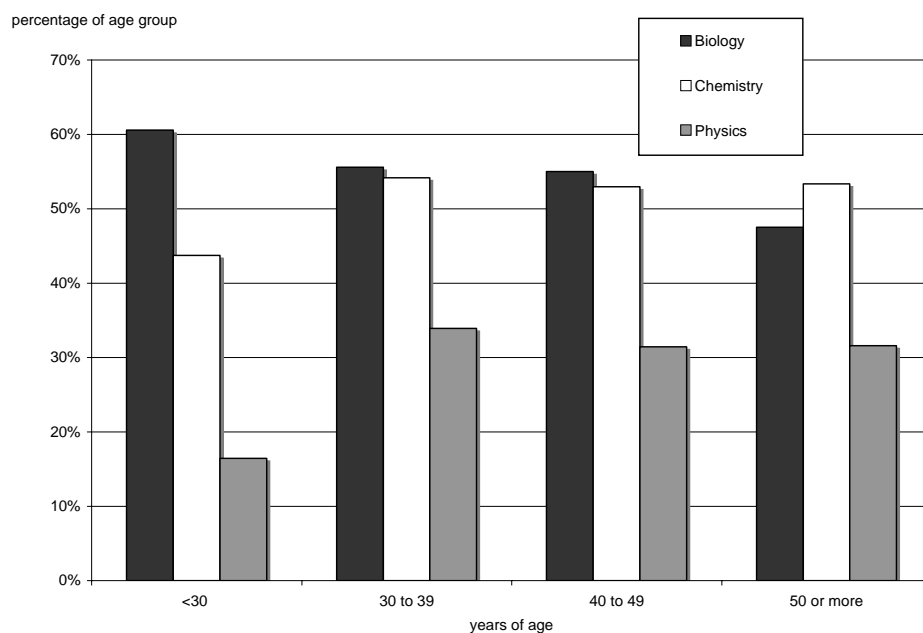


Figure 3.4 Percentage of teachers in each age group to have attained at least a minor at university (for each of 3 subjects: Biology, Chemistry and Physics).

Table 3.5 Percentage of Bachelor of Education graduates studying within a Science or Education Faculty (over four science subjects)

Faculty	Biology (n=149) %	Chemistry (n=130) %	Physics (n=108) %	Geology (n=63) %
Science	55.0	56.9	50.0	54.0
Education	34.9	36.2	38.0	41.3
Science & Education	10.1	6.9	12.0	4.8

3.5. The teachers of junior, middle and senior school science classes

3.5.1 Overview

This section provides a description of the science teachers surveyed, grouped on the basis of the year levels that they taught: junior, middle and/or senior school (Table 3.6; Figs. 3.5a, 3.5b). As the discipline-specific analysis is confined to four principal subject areas (see Section 2.1), the senior school category includes only four 'subjects': Biology, Chemistry, Physics and Geology.

Table 3.6 The number of respondents teaching the various combinations of junior, middle and senior school science, their average age and years of teaching experience

Combinations of junior, middle and senior school science taught by individual teachers			Number of teachers ² , followed by percentage of all respondents (%)	Average age (years)	Average number of years teaching experience
Junior school (yrs 7-8)	Middle school (yrs 9-10)	Senior school ¹ (yrs 11-12)			
			116 (9.6)	40	12
			227 (18.8)	40	11
			123 (10.2)	42	14
			51 (4.2)	39	13
			148 (12.3)	43	16
			247 (20.5)	44	17
			204 (16.9)	42	13
Total= 598 teachers	Total= 701 teachers	Total= 649 teachers	1116 (92.5)	42	15

¹ Four subjects only were included: Biology, Chemistry, Physics and Geology.

² The 91 respondents who taught only senior school science subjects other than Biology, Chemistry, Physics or Geology were not included in this table.

3.5.2 Demographics and qualifications of junior school science teachers

Nearly half of the respondents taught junior school science (Table 3.6) and 52% of this group were female, a significant difference to the overall gender distribution of the survey group (Chi-square: 10.71 P<0.01). The average age of those teaching junior school was the same as the group as a whole, but these teachers were on average slightly less experienced (13 years, compared to 15 years; Table 3.6).

The qualifications of the junior school science teachers were similar to those of teachers overall, with 61 per cent having attained a Bachelor of Science degree, 19 per cent a Bachelor of Education and 7 per cent a science-related degree. Twenty of the junior school science teachers held a Higher Degree in Science.

Biology and Chemistry were the predominant disciplinary backgrounds among the junior school science teachers (Table 3.7). Half the teachers held a major in Biology, while one-third held a major in Chemistry. Fifteen per cent had both qualifications. In contrast, only a minority of the teachers had studied Physics or Geology beyond first year (24% and 12%, respectively).

Sixteen per cent of the junior school science teachers had not studied any of the four science disciplines discussed beyond first year at university, and half of these teachers had not studied the subjects at university at all (Fig. 3.5a).

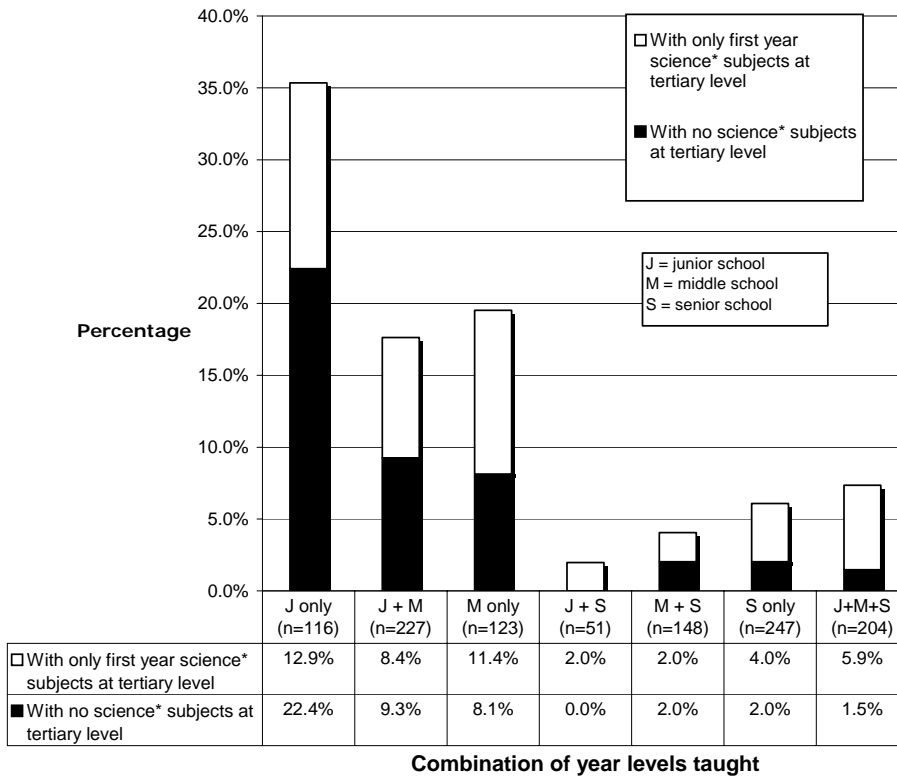


Figure 3.5a The percentage of teachers with either no tertiary science* background or no background beyond first-year study, presented as all, junior, middle and senior school science teachers.
 * 'Science' here refers only to the four subjects Biology, Chemistry, Physics and Geology.

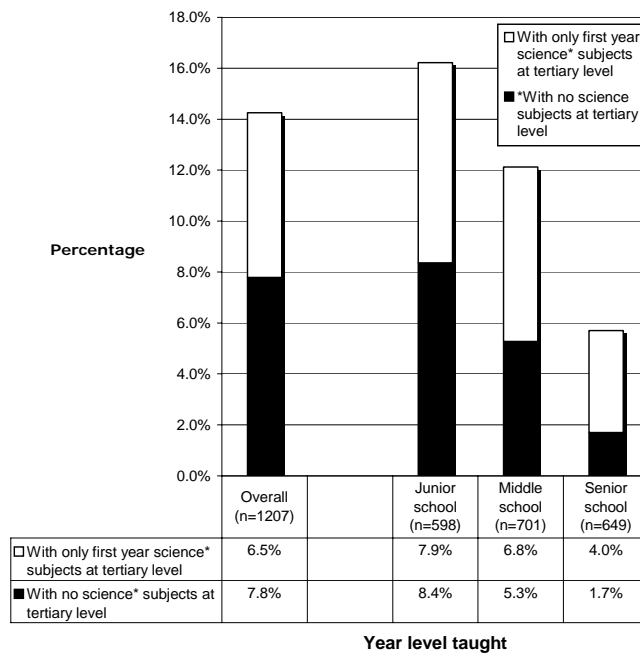


Figure 3.5b The percentage of teachers with either no tertiary science* background or no background beyond first-year study, presented by the combination of year levels taught.
 * 'Science' here refers only to the four subjects Biology, Chemistry, Physics and Geology.

Table 3.7 Disciplinary backgrounds of the junior school science teachers (n=598)

Highest level of university study completed	University subject areas			
	Biology %	Chemistry %	Physics %	Geology %
4 th year or above	13.4	8.4	4.3	1.8
3 rd year	36.5	24.2	8.5	6.4
2 nd year	8.5	17.7	11.2	4.2
1 st year	17.7	27.3	31.9	13.2
Nil	23.7	22.4	44	74.4

Nearly ten per cent of all respondents to the survey of teachers taught only junior school science (Table 3.6). The gender and experience profile of this group was significantly different to the national average. Females were over-represented (56%, compared to <47% overall; Chi-square: 3.87 $p < 0.05$) and almost one third of the group had been teaching for fewer than three years. Nearly one in four had not studied Biology, Chemistry, Physics or Geology at university (Fig. 3.5b) and a further thirteen per cent of the group had studied one or more of these subjects, but only to first year level.

3.5.3 Demographics and qualifications of middle school science teachers

The demographics of Years 9 and 10 science teachers closely resembled those of the sample overall (Table 3.6). The average age of these 701 respondents was 41 years and the average number of years they had been employed as teachers was 14. The gender distribution was 52 per cent male and 46 per cent female.

The qualifications of this group also most closely matched those of the sample overall (see Table 3.3). Nearly seventy per cent held a Bachelor of Science degree, and twenty per cent a Bachelor of Education. Another six per cent of the group held Bachelor degrees in other, science-related disciplines. Seven per cent had obtained a postgraduate degree in Science. The majority (88%) held either a minor or major in at least one of the following four subject areas: Biology, Chemistry, Physics or Geology. Almost half of middle school science teachers had a major in Biology, one third a major in Chemistry and just over 15 per cent a major in Physics (Table 3.8). Less than ten per cent of the middle school teachers had a major in Geology.

Twelve per cent of the middle school teachers had not studied any of the four science disciplines discussed beyond first year at university, and nearly half of these teachers had not studied the subjects at university at all (Fig.3.5a).

Table 3.8 Disciplinary backgrounds of the middle school science teachers (n=701)

Highest level of university study completed	University subject areas			
	Biology %	Chemistry %	Physics %	Geology %
4 th year or above	14.1	9.3	5.8	2.3
3 rd year	34.1	26.0	9.8	7.3
2 nd year	9.1	19.0	12.4	3.4
1 st year	19.0	27.5	32.1	13.7
Nil	23.7	18.3	39.8	73.3

3.5.4 Demographics and qualifications of senior school teachers

The 649 teachers of senior school Biology, Chemistry, Physics and/or Geology (Table 3.6) were typically male (58%) and both older (43 years of age) and more experienced (16 years experience) than those teachers who taught only Years 7 to 10. Nearly forty per cent of the teachers of senior school science did not teach science in junior or middle school, while another 31 per cent taught at all three 'year' levels (Table 3.6).

The age distribution for the teachers of senior school Biology, Chemistry and Physics is presented in Figure 3.6. Although the mean age of Chemistry teachers was just three years above the national average at 44 years of age, there were a large proportion of Chemistry teachers who would soon be retiring (Fig. 3.6). Geology teachers were on average the eldest, with a mean age of 47 years. However, this cohort was small and for this reason is not represented in Figure 3.6.

Most teachers in this group taught in only one of the four senior subjects investigated: Biology, Chemistry, Physics or Geology (Table 3.9). The most 'restricted' were the Biology teachers, 83 per cent of whom taught no senior Physics, Chemistry or Geology classes. In contrast, most Geology teachers were less 'specialised' in that they were also involved in teaching senior Biology, Chemistry or Physics.

The overall tertiary qualifications of this group was similar to the national average, with 65 per cent holding a Bachelor of Science, 14.5 per cent a Bachelor of Education and 7.5 per cent a Higher Degree in Science.

Nearly six per cent of the senior school teachers had not studied any of Biology, Chemistry, Physics or Geology beyond first year at university. Only eleven of this group (<2%) had not studied these subjects at university at all (Fig. 3.5a).

Number of teachers

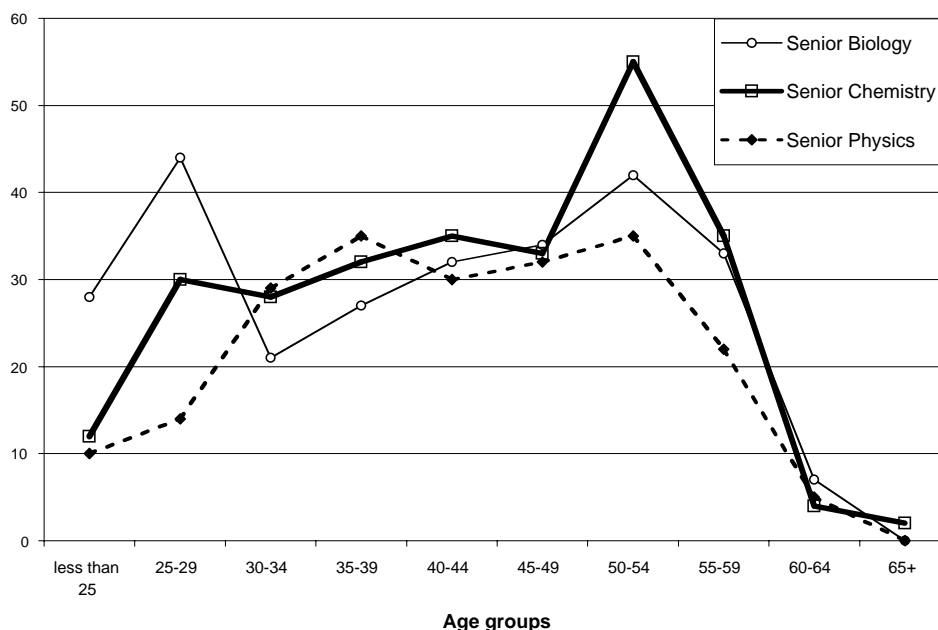


Figure 3.6 Age distribution of senior school Biology, Chemistry and Physics teachers.

The 'less than 25' and '65+' age groups have been adjusted to take account of the differing width of these age bands.

Table 3.9 Teaching responsibilities for teachers of senior school Biology, Chemistry, Physics and Geology

	Biology (n=255 teachers)	Chemistry (n=260 teachers)	Physics (n=209 teachers)	Geology (n=36 teachers)
Percentage who taught in none of the other three subject areas	83.1	66.2	74.2	30.1
Both Years 11&12 (%)	36.5	43.5	43.5	44.4
Year 11 only (%)	40.0	29.6	23.0	36.0
Year 12 only (%)	23.5	26.9	33.5	19.4

The teachers of Biology were the most highly trained in their specific discipline (Table 3.10). Eighty-six per cent held a major in Biology and 28 per cent had studied to fourth-year. Only four per cent of Biology teachers had no tertiary background in the subject.

Teachers of Chemistry also tended to have a strong background in the discipline, 73 per cent having a major in Chemistry (Table 3.10). As with the Biology teachers, very few teachers of Chemistry lacked any discipline-specific tertiary background.

Physics teachers responding to the survey were less highly qualified in the discipline than were the Biology and Chemistry teachers (Table 3.10). Fifty-seven per cent had a major in Physics, while one in four had not studied the subject beyond first-year at university.

Table 3.10 Disciplinary backgrounds of the senior school science teachers

Highest level of university study completed	Subject taught in senior secondary school							
	Biology (n=255)		Chemistry (n=260)		Physics (n=209)		Geology (n=36)	
	Year 11 % (n=195)	Year 12 % (n=153)	Year 11 % (n=190)	Year 12 % (n=183)	Year 11 % (n=161)	Year 12 % (n=139)	Year 11 % (n=23)	Year 12 % (n=29)
4 th year or above	31.3	27.6	22.1	24.0	23.0	28.1	17.4	13.8
3 rd year	49.2	56.6	52.1	51.9	35.4	33.8	21.7	13.8
2 nd year	6.7	4.6	14.7	13.1	17.4	14.4	4.3	3.4
1 st year	8.7	6.6	6.8	7.7	15.5	18.7	4.3	13.8
Nil	4.1	4.6	4.2	3.3	8.7	5.0	52.2	55.2

Geology teachers had the lowest levels of discipline-specific qualifications (Table 3.10). More than half of these teachers had not studied any Geology at a tertiary level. The number of teachers teaching Geology, however, is a very small proportion of the total sample.

The overall proportions of ‘suitably qualified’ science teachers

There is no single definition of the discipline-specific science background necessary for teachers of senior school science subjects. However, most of the heads of science departments surveyed defined a major in the discipline as the minimum satisfactory level of tertiary study. A smaller proportion believed that a minor was satisfactory. These results are discussed in more detail in Chapter 4.

If a minor in a subject is taken to be the base level of science desirable for teaching senior school science, then there appear to be significant shortages nationally in the number of suitably qualified Geology teachers (64% of Geology teachers having neither a minor or major in the subject) and Physics teachers (26% of Physics teachers having neither a minor or major in the subject) (Table 3.10). For Biology (13%) and Chemistry (12%) the proportion of not suitably qualified teachers was much smaller.

Alternatively, if a major in a subject is taken to be the base level of science desirable for teaching senior school science (see also Table 4.3), then at least twenty per cent of teachers in all four subjects areas were not adequately qualified to teach at senior school level. Biology teachers were the most suitably qualified group, with only one in five senior school Biology teachers having a minor or less in the area (Table 3.10). More than one-quarter of Chemistry teachers, 43 per cent of Physics teachers, and well over half of Geology teachers had not studied the subject beyond second year at university.

‘Other’ senior science subjects

Aside from the four senior science subject areas that this report focuses upon (Biology, Chemistry, Physics and Geology), there were a range of other science-related subjects offered across the country. For this reason, quite a large number of the teachers surveyed reported teaching senior school science and yet were not included in the preceding analysis. When the full range of senior science subjects are considered, more than two-thirds of all respondents taught at senior school level and almost a third of the all respondents taught only at senior school level. Of this group, 61 per cent were male. The average number of science subjects that senior school teachers taught was 1.8 (n=1447/816, range 1-7).

3.6 Summary

The 1207 respondents to the survey of teachers represent an estimated nine per cent of the nation's science teachers. Their average age was 41 years and the average number of years employed in the teaching profession was 15 years.

The majority of the cohort was university trained, and over half of the respondents held a Bachelor of Science degree. A further twenty per cent of the group held a Bachelor of Education, and a small proportion (5%) had obtained Higher Degrees in Science. Within their university degrees, the majority of teachers had studied Chemistry and Biology at some level at university. The discipline in which the largest proportion of the respondents had obtained the highest level of study was Biology, with a fifth of the respondents having studied this subject beyond third year at university.

Senior school Biology teachers were the group with the highest tertiary-level qualifications specific to their discipline. In contrast, one quarter of the senior school Physics teachers and well over half the senior school Geology teachers had not studied the respective subjects beyond first year. Ten per cent of the respondents taught Years 7 and 8 Science only, and nearly one-quarter of this group had not studied Biology, Chemistry, Physics or Geology at university.

Chapter 4: Staffing science departments – the issues for schools

This chapter examines the views of heads of secondary school science departments regarding the supply and quality of science teachers. It was assumed that at most schools the Head of Department would be in a good position to comment upon the availability of well-qualified teaching staff and so the project asked heads the following questions:

- Does your school have difficulty recruiting suitably qualified science teachers?
- Are there any science teachers at your school currently teaching in subject areas other than those for which they are qualified?

We examined how the respondents defined 'qualified' by asking them to specify the minimum level of university science study that they believed necessary for teachers of particular year levels.

Section 4.1 of this chapter describes the broad characteristics of school departments represented in the sample.

Section 4.2 examines the supply and qualifications of science teachers. In summary:

- Half of the department heads recognised a distinction between science subjects taught through university Science and Education Faculties. Although there are advocates for each, more heads favoured Science Faculties in terms of suitably preparing graduates for secondary school science teaching.
- There was near consensus that in order to teach senior year science subjects, secondary school teachers must have a strong background (an undergraduate minor or major) in the discipline concerned.
- Chemistry and Physics teachers were in short supply, but there was an adequate supply of Biology teachers.
- Filling short-term positions, such as the vacancies created when staff members take long-service leave, was a prominent concern for heads of science departments.

Related to the issues of teacher training and availability are the issues of attracting well-qualified people to science teaching in the first place, and subsequently retaining those people within the school system. These topics are explored in Chapter 5.

4.1. The profile of science departments represented in the dataset

4.1.1 States, sectors and ARIA locations of responding schools

Responses to the survey were received from the heads of 266 secondary school science departments. This represents ten per cent of Australian secondary schools, and a response rate of 42 per cent. Each of the eight states and territories were represented (Table 4.1).

There was no significant difference in the response rate between the states. However, representation by state does not directly reflect state population size due to the design of the sample, which was constructed to ensure adequate numbers of responses from the territories and smaller states (see Appendix 1). For example, for New South Wales fewer than four per cent of the state's schools were sampled (Table 4.1). In contrast, the Northern Territory, Tasmania and South Australia were all somewhat over-represented.

Included in the sample were the three recognised sectors of Australian schools: Catholic, Government and Independent. While both Catholic and Independent schools were well represented, more than half of the responses received were from Government schools (Table 4.1). This directly reflects the size of each sector nationally.

Table 4.1 Number of secondary school science departments responding to the heads of science departments survey, grouped by state and sector.

	Catholic schools	Government schools	Independent schools	Total number of schools	Percentage ¹ of schools in the state/territory
ACT	5	*	2	7	16.7%
NSW	8	16	6	30	3.6%
NT	1	13	4	18	37.5%
QLD	9	30	9	48	10.2%
SA	5	32	13	50	23.0%
TAS	3	21	6	30	28.0%
VIC	10	21	10	41	6.9%
WA	10	21	11	42	13.3%
Total number of schools	51	154	61	266	
Percentage ¹ of schools in the sector	10.6%	10.4%	9.1%		10.1% nationwide

*ACT Government declined permission for the involvement of government schools in this study.

¹ based upon ACER figures for the total number of schools in each state or sector

The location indices of schools in the sample loosely reflect the pattern of population distribution across the country (see Appendix 3). Most (82%) of the schools sampled are classified as either 'highly accessible' or 'accessible' under the ARIA system (see Appendix 2).

4.1.2 Size of science departments in responding schools

The size of science departments represented ranged from single-teacher departments (n=14) to one South Australian school with 30 science teachers (Table 4.2). The average was eight science teachers per school, and three-quarters of the science departments had no more than ten identified science teachers. These figures are fifty per cent higher than the estimates provided by ACER (Fig. 4.1). One possible explanation is that large departments are over represented in the dataset. Alternatively, the definition of 'science teachers' used by ACER and that applied by heads of departments might differ. It is worth noting that the concept of a discrete Science Department is not relevant in all school contexts. For example, the respondents from two 'very remote' Northern Territory schools commented that at their schools all secondary teachers taught all subjects.

4.1.3 Subjects taught at Year 11 and Year 12 levels in responding schools

Eighty per cent of the 266 schools responding to the survey taught year 11 and year 12 students. Five additional schools offered only one of the two senior years in 2004. Four of these schools were developing their senior school programs and offered only year 11, and the fifth was phasing out senior school teaching and therefore offered only year 12. Collectively, these 219 schools are referred to as 'senior schools' in the following analysis.

Table 4.2 Number of people teaching science at the responding schools, grouped by state and sector.

	Catholic schools		Government schools		Independent schools		average number of science teachers per school (by state)
	average number of science teachers per school	range	average number of science teachers per school	range	average number of science teachers per school	range	
ACT	11.75	8 - 15	*	*	8	4-12	10.5
NSW	7.88	5 - 10	6.13	2 - 9	9.2	4 - 15	7.2
NT	11	11	7.67	2 - 14	7.5	5-11	7.9
QLD	8.44	5 - 12	8.9	1 - 19	6.57	2 - 14	8.4
SA	10.80	8 - 17	7.35	1 - 30	6.54	1 - 20	7.5
TAS	6.33	1 - 12	6.71	1 - 14	5.50	1 - 15	6.4
VIC	13.22	2 - 27	13.55	1 - 29	8.78	3 - 19	12.3
WA	7.70	3 - 11	5.95	1 - 11	5.09	1 - 12	6.2
	average number of science teachers per Catholic school 9.5		average number of science teachers per Government school 8.1		average number of science teachers per Independent school 6.9		nation-wide 8.1

*ACT Government declined permission for the involvement of government schools in this study.

While there is currently no uniform national curriculum for Australian senior secondary school teaching (reviewed in Lawrence & Palmer, 2003), the curricula of all states and territories include the three core science subjects of Biology, Chemistry and Physics. In addition, most include 'Geology' or another earth-science subject (e.g. 'Earth Science' in Queensland and the ACT, 'Earth and Environmental Science' in NSW). Tasmania and Victoria are the exceptions, offering 'Environmental Science' but no distinct earth science subjects. In the following analysis, 'Geology' is used to refer to earth-science subjects, and therefore this category includes data from only six of the eight states and territories.

Most (80%) of the senior schools taught Biology, Chemistry and Physics at both Year 11 and Year 12. When each subject is examined individually the percentages are higher, ranging from 87 per cent for Year 12 Physics to 91 per cent for Year 11 Chemistry (Fig. 4.2). However, fewer than ten per cent of the responding senior schools offered Geology subjects. Differences in state curricula (i.e. the fact that Tasmanian and Victorian curricula do not include earth science subjects) were taken into account in the analysis for Geology. Insufficient demand from students was the most common reason given by heads of science departments for not teaching the full senior curriculum of their state or territory.

In contrast to the high proportion of schools offering senior Biology, Chemistry and Physics, eight of the 214 schools that taught both years 11 and 12 did not offer any of these subjects. The various reasons given included the size of the school ("cohort still too small") and the schools' philosophy ("some content matter in these subjects is against the religious philosophy of the school"; "courses offered are not suitable for use in the context of our school"). These eight schools offered either General Science subjects at senior years, science subjects by distance-delivery mode, or integrated science with other subjects.

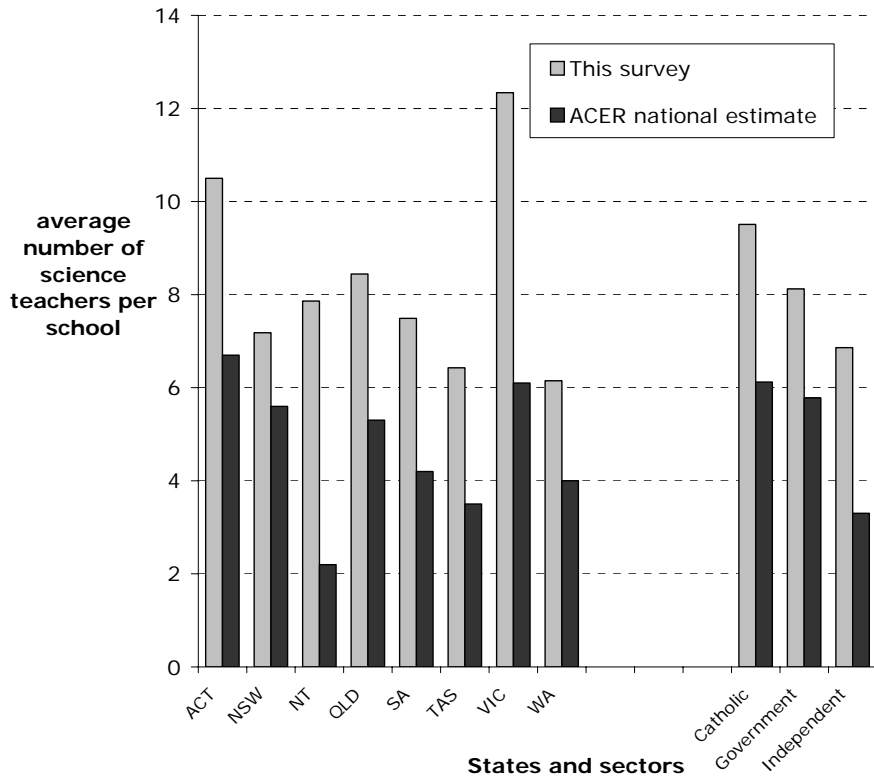


Figure 4.1 Comparison of the average number of science teachers per school in the dataset (this survey), and nationally as estimated by ACER, analysed by both state and sector.

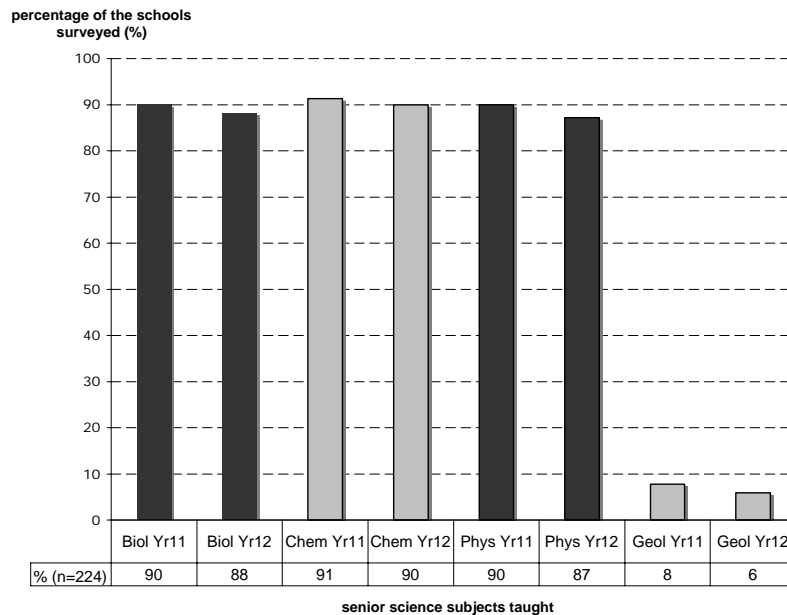


Figure 4.2 Percentage of schools teaching specific science subjects in senior years.
 Note: only schools with senior year enrolments are included [n=219], and both Tasmanian and Victorian schools are excluded from the analysis for Geology.

4.2. The 'supply and demand' of qualified science teachers

4.2.1 What constitutes an appropriate qualification to teach science?

There is no standard national qualification for admission to the teaching profession (reviewed in Lawrence & Palmer, 2003). Accreditation is managed by state-based authorities in the case of Government schools, and either sector-based authorities or the individual schools in the case of Catholic and Independent schools. Within the guidelines of individual states or sectors there is provision for accepting a diversity of backgrounds among accredited teachers. For example, in NSW the range of avenues advertised to aspiring science teachers include:

- a three-year bachelor degree plus a Diploma of Education (secondary), or
- a four-year Bachelor of Education (secondary), or
- a four or five-year combined degree such as Bachelor of Science/Bachelor of Teaching (secondary)

plus

- some degree-level science subjects. There is flexibility in the discipline area and year-level of study (DET 2004).

Therefore it is not surprising that the tertiary science backgrounds of respondents to the survey of teachers conducted by the present study varied significantly (see Section 3.4.1 and Table 3.3) – from no tertiary science studies at all to multiple majors.

This study canvassed heads of secondary school science departments regarding the most desirable preparatory training for science teachers. Their views were sought on university science subjects in terms of efficacy in preparing graduates for teaching science in schools. Specifically, those surveyed were asked if they made a distinction between science taught within Education Faculties and that taught within Science Faculties. They were also asked to specify the minimum level of formal science preparation necessary to teach at various secondary school year levels.

More than half of the heads of secondary school science departments made a distinction between the suitability of science taught by Education and Science Faculties, and nearly all of these respondents elaborated upon the nature of the distinction. Most (77%) declared a strong preference for teachers trained in Science Faculties. Typically, reference was made to the need for 'depth' in content knowledge:

... the teachers who have a Science degree have a much better Science knowledge while some of the teachers who did it in education faculty have very limited science knowledge

Students who come from an Education faculty often have less than adequate basic understanding of the discipline. They are OK for Yr 8 & 9 but Yr 10 plus is a problem in many instances

Science graduates complete their degree courses with a breadth of experience and understanding of science that is more than just "doing some science units" within an Education Faculty

However, a minority of heads of science departments (23%) expressed a preference for Education graduates. The general sentiment among these responses was that a Bachelor of Education provides a more appropriate preparation for teaching science, both in terms of classroom skills and general expectations of secondary school teaching:

I consider that the teachers that get their science training from an Education faculty have a better understanding of the science required by the students

Though unit(s) taught within a Science Faculty will prepare you content wise, those taught within the Education Faculty prepare you as a teacher (breaking down concepts to enable student(s) to understand them)

"Grad dips" are sometimes not in touch with the "real world" of teaching. Their expectations are often different

Heads of science departments favoured enhanced discipline-specific training for teachers of higher year science at secondary schools (Table 4.3). A clear majority (89%) believed that teachers of senior science subjects must have an undergraduate major in the relevant scientific discipline. There was near-consensus (98%) among the respondents that a teacher whose only tertiary science background is at the first-year level is ill-equipped to teach secondary school science beyond Year 10, and most respondents (82%) believed that such a background is also unsuitable for teaching Years 9 and 10. Half of the respondents, however, did state that such training adequately prepared teachers of junior school Science.

Table 4.3 Responses from heads of secondary school science departments to the question: *In your opinion, what is the minimum level of science that ought to be completed by teachers of various classes?*

Secondary school year level science	Desirable minimum level of science background for science teachers (university undergraduate studies) % n=257			
	Some first year subjects ¹ %	'Minor' in the discipline ² %	'Major' in the discipline ³ %	other
Junior school	53	34	11	2
Middle school	17	65	17	1
Senior school	2	9	89	0

Questionnaire options (specific wording):

¹ Some first year university units in the discipline

² Minor in the discipline (first year and more than one second year unit)

³ Undergraduate major or joint major in the discipline

4.2.2 How well is the current demand for appropriately qualified science teachers being met?

4.2.2.1 Overview

Nearly three-quarters of the schools surveyed reported some difficulty in recruiting suitably qualified science teachers. This response was consistent across all states and territories (Table 4.4). Twenty schools from 'remote' and 'very remote' regions (ARIA classifications) answered this question, and all twenty reported difficulty.

139 of the 194 schools that reported difficulty in the overall recruitment of science teachers also indicated that they experience problems in specific subject areas. This equates to more than half of all schools surveyed. However, only five Tasmanian schools reported subject-specific difficulties. This might be attributable to the fact that 70 per cent of the Tasmanian schools in the sample do not teach senior school and heads in these schools appear to have deemed the question regarding 'specific science subjects' not relevant to them.

More than half of the schools teaching senior school science subjects specified particular subjects for which they were having difficulty recruiting suitably qualified teachers. These results are presented in Table 4.5, analysed by state and by the major subject areas. Note that in this analysis only schools teaching senior year students are included and therefore the number of schools representing Tasmania is significantly reduced.

Table 4.4 Schools reporting difficulty recruiting suitably qualified science teachers
(proportion of the total number of schools surveyed by state / territory)

	Schools reporting difficulty recruiting suitably qualified:	
	science teachers overall ¹ %	science teachers to teach specific science subjects ² %
ALL SCHOOLS (n=266 schools)	73	52
ACT (n= 7 schools)	71	57
NSW (n= 30 schools)	73	67
NT (n= 18 schools)	78	61
QLD (n= 48 schools)	73	69
SA (n= 50 schools)	76	50
TAS (n= 30 schools)	83	17
VIC (n=41 schools)	63	54
WA (n=42 schools)	69	45

¹ Proportion of schools, by state, responding “yes” or “sometimes” to the question: *Does your school have difficulty recruiting suitably qualified science teachers?*

² Proportion of schools, by state, responding “yes” to the question: *Does your school have difficulty recruiting in particular science subjects?*

4.2.2.2 The demand for Chemistry and Physics teachers

Suitably qualified Chemistry and Physics teachers were in short supply nationwide (Table 4.5):

We have been trying to employ a second physics teacher for about five years with no success. [NSW; ARIA = ‘accessible’]

Physical sciences positions are always more difficult to fill than Biological [WA; ARIA = ‘highly accessible’]

School had few applicants for a senior chemistry position advertised two years ago [VIC; ARIA = ‘highly accessible’]

We currently have two ex-engineers taking up Physics teaching as our older teachers head for retirement [VIC; ARIA = ‘highly accessible’]

There was no difference between states (the lower percentages recorded for Tasmania are not statistically significant) or regions (ARIA). However, there was a significant difference between sectors, with Catholic schools experiencing the shortage of Chemistry and Physics teachers most acutely (Table 4.6).

4.2.2.3 The demand for Biology teachers

Contrasting markedly with the shortage of Physics and Chemistry teachers was the apparent abundance of qualified Biology teachers (Table 4.5):

... we have plenty of biology teachers

I have far more Biology teachers than classes

When teachers are 'on leave' there are few (if any) replacements in the areas of physics and chem. (there are plenty of biologists!)

Our teachers have predominantly Biology backgrounds – little pure Maths or Physics training

Table 4.5 Proportion of schools teaching senior school science that reported difficulty recruiting suitably qualified teachers in specific discipline areas.

	Schools reporting difficulty recruiting suitably qualified ¹ :				
	Biology teachers %	Chemistry teachers %	Physics teachers %	Geology teachers %	teachers of other science subjects ² %
ALL SCHOOLS (Biol, Chem and Physics n=219; Geol n = 172)	2.7	30.6	41.1	1.7	4.1
ACT (n= 7 schools)	0	14.3	42.9	0	0
NSW (n= 29 schools)	0	41.4	44.8	3.4	0
NT (n= 13 schools)	7.7	30.8	46.2	0	7.7
QLD (n= 45 schools)	0	42.2	53.3	0	4.4
SA (n= 44 schools)	2.3	29.5	36.4	2.3	0
TAS (n= 9 schools)	11.1	11.1	22.2	N/A	0
VIC (n=38 schools)	7.9	26.3	39.5	N/A	5.3
WA (n=34 schools)	0	20.6	32.4	2.9	11.8

¹Note that many schools (n=61) responded to two subject areas.

²Other science subjects, such as General Science and Psychology

Table 4.6 Proportion of schools teaching senior school science that report difficulty recruiting suitably qualified Chemistry and Physics teachers.

	Schools ¹ reporting difficulty recruiting suitably qualified:	
	Chemistry teachers (%)	Physics teachers (%)
Catholic schools (n = 46)	54.3*	67.4**
Government schools (n = 121)	27.3	35.5
Independent schools (n = 52)	21.2	30.8

¹Note that many schools (n=52) responded to both subject areas.

*Chi-square: 10.98 P<0.01

** Chi-square: 9.74 P<0.01

4.2.2.4 The demand for Geology teachers

Few schools expressed any difficulty in recruiting Geology teachers. Indeed in some schools there was a reported surfeit of geology-trained staff, and these teachers were therefore presumably taking classes in areas outside their main area of expertise:

We actually have a geologist on site, but there is no student demand

Have 3 Geos teaching at school [*from a school that does not offer Geology*]

Results from the survey of science teachers indicate that approximately one in four teachers had studied some Geology at university (Chapter 3, Table 3.4). However, only eight per cent of teachers surveyed held a major in the discipline.

The general adequacy of supply of Geology teachers may reflect the relatively low student demand for the subject (see also Fig. 4.2). One Head, however, offered an alternative explanation:

There are no qualified staff that generate the interest in Geology to make it "demanded"

Despite the fact that few schools reported difficulty recruiting Geology teachers, there were indications from the survey of teachers that this may not have held true for all schools. Half the teachers of Geology responding to the survey had no tertiary background in the discipline (see Table 3.10). This suggests that either some schools were unable to recruit suitably qualified teachers or a discipline-specific background was not deemed necessary for teachers of this subject.

4.2.2.5 Availability of teachers for short-term positions

A shortage of suitably qualified relief or casual teachers emerged as a common (n=35) and widespread problem:

Problems in covering classes if staff take leave or are ill (*QLD; ARIA = 'highly accessible'*)

It is very difficult to find well qualified teachers especially for short term temporary positions (*NSW; ARIA = 'highly accessible'*)

Usually it is difficult to replace teachers for short terms (*Victoria; ARIA = 'highly accessible'*)

At the moment a 7/8 teacher is on long service (leave) and the teacher filling in would rather not teach science, giving herself a (score of) 3/5 (*Tasmania; ARIA = 'moderately accessible'*)

Great difficulty in part-time science teachers because usually involves them teaching other learning areas as well (*Western Australia; ARIA = 'highly accessible'*)

4.2.3 Heads of departments' satisfaction with the qualifications of their existing staff

Generally, the heads of science departments were satisfied with the science qualifications of the staff teaching science in their schools, but the levels of satisfaction were markedly lower for junior and middle school science (Table 4.7).

The highest level of satisfaction was reported for senior school Biology teachers, reflecting the high, discipline-specific qualification level of Biology teachers reported in

Chapter 3 (see Table 3.10). More than 80 per cent of Biology teachers surveyed held an undergraduate major in Biology.

Table 4.7 Heads of secondary school science departments' levels of satisfaction with the science qualifications of teachers at their schools, presented according to subject.

Science subjects	Completely satisfactory %	Moderately satisfactory %	Unsatisfactory %	Total number of responses
Senior Biology	92.8	7.2	0	180
Senior Chemistry	88.0	10.4	1.6	183
Senior Physics	87.3	11.6	1.1	181
Senior Geology	73.3	20.0	6.7	15
Middle school Science	75.3	23.8	0.9	222
Junior school Science	66.2	30.5	3.3	210

Similarly, heads were highly satisfied with the qualifications of their Chemistry and Physics teachers (Table 4.7), despite the results from the survey of teachers that indicated that ten per cent of Year 12 Chemistry teachers had not studied Chemistry beyond first-year at university (see Table 3.10). This high level of satisfaction also contrasts significantly with the reported difficulties in recruiting suitably qualified Chemistry and Physics teachers (Table 4.5). This may indicate that the shortage of teachers in these disciplines had yet to fully manifest, and may become more critical in the future. Indeed, some heads express this concern:

It is getting harder & harder to get good quality Science teachers under the age of 30. In Physics & Chemistry the "pool" of good quality teachers is most certainly dwindling

Not so far, but we may have difficulties in the future

Stable staff has prevented this problem (recruitment) in some subject areas. When a vacancy has arisen, it has been a problem. We have been lucky. I can foresee future problems, and am aware of problems in other local schools

No difficulty recruiting yet ... However recruitment will be reduced once the baby boomers leave

The lowest level of satisfaction was with the qualifications of teachers of junior school Science. From the survey of teachers, the proportion that was 'qualified' by the majority definition of the heads ('at least some first-year subjects'; Table 4.3) was 85 per cent, comparable to that for senior year Biology teachers. There were, however, a relatively large number (n=50/593) of junior school science teachers who had not studied any of the four science disciplines discussed (Biology, Chemistry, Physics, Geology) at university (see Fig. 3.4a), and the heads of some of these particular schools were indeed among those reporting lower satisfaction levels.

4.3 Summary

Most heads of secondary school science departments defined the minimum qualification necessary to teach senior school science classes as an undergraduate university degree with a major in the relevant discipline. Far fewer believed that a major was essential for teaching earlier year levels. Half of the respondents were satisfied with 'some first year subjects' in science at university as adequate preparation for teaching Years 7 and 8, while most believed that a background in university science at second year level was necessary for teachers of Years 9 and 10.

Secondary schools had difficulty recruiting suitably qualified teachers for senior school classes in Chemistry and Physics. This was most acutely experienced when schools had short-term (e.g. six month) vacancies to fill. Most heads of secondary school science departments were satisfied with the qualifications of their teaching staff, but many suggested that replacing retiring staff would become increasingly difficult.

In contrast to the shortage of teachers with a strong background in chemistry or physics, there appeared to be no shortage of Biology teachers seeking secondary school teaching positions.

Geology was taught by a small number of schools, and so the fact that few heads seemed concerned about a shortage of teachers in this discipline is unsurprising. The predominant reason for schools not offering Geology was lack of demand from students rather than difficulty in staffing Geology classes with suitably qualified teachers.

Chapter 5: Retaining science teachers

This chapter examines the views of both heads of secondary school science departments and science teachers regarding the retention of science teachers within the secondary school system.

Section 5.1:

Why do people choose secondary school science teaching as a career? The project's survey of science teachers asked them to report on factors that motivated them in their career choice. Among other factors, enthusiasm for science and the rewarding nature of working with young people were both shown to be important elements. The survey results illustrate the range of factors that may influence the career decisions of people in the future.

Section 5.2:

Is retention of teachers a problem for Australia's secondary school system? Information from heads of science departments suggests that the retention of science teachers is a concern for many schools. Some groups of respondents to the study's survey of teachers were uncertain about their career plans, further suggesting that teacher retention is a significant policy issue. The study sought to discover why teachers might choose to leave the profession, inviting teachers to comment upon any factors that negatively affected their work. Long hours and low student engagement were two of the major concerns expressed by teachers in response to this question.

A logical question to flow from the issues covered in this chapter is: What could be done to attract more, suitably qualified people to the profession of science teaching? The question is explored in Chapter 6.

5.1 The factors attracting the teachers in this study to a career in science teaching.

Science teachers were asked what attracted them to a career in science teaching. They were given six options and an opportunity to list any other attractions. The responses are presented in Table 5.1. On average each teacher listed three separate factors and therefore the dataset is large ($n=3731$). Thirty additional responses are omitted from Table 5.1 as they did not readily fit into any of the dominant categories.

Perception of intrinsic rewards

More than one-third of the responses related to the personally rewarding nature of teaching, including the interaction with students (Table 5.1):

Always thought I wanted to teach, and love it [*teacher >19 years experience*]

I just like to be a teacher [*teacher <3 years experience*]

Kids gave me positive feedback about my teaching skills so that helped – even at uni, when (*I was*) tutoring or running pracs [*teacher <10 years experience*]

Making a difference to students that may not normally have 'decent' teachers [*teacher <5 years experience*]

To make a difference to students and the world [*teacher <3 years experience*]

Table 5.1 Responses of science teachers to the question: *What attracted you to the profession of teaching?*

		Frequency of responses (n=3731)	Percentage of responses %
Intrinsic personal benefits	Rewarding nature of the profession*	722	36.1
	Opportunities for social interaction with students and staff*	553	
	'Desire to teach' and other altruistic comments	73	
	Enjoyment of science*	791	21.2
Conditions of employment	Work conditions* (including suitability for working parents and ability to work from home)	605	16.2
	Job security*	592	16.2
	Transferability of skills (both to the career and to other careers)	12	
	Salary*	237	7.9
Other	Scholarship or superannuation scheme	59	
	No more desirable alternatives	41	1.5
	Parental or family encouragement	16	

* Option presented as a 'check-box' on questionnaire. The unmarked categories are derived from the written comments of teachers.

Work conditions, remuneration and scholarships

Nearly one quarter of the responses identified work conditions and monetary incentives as factors influencing career choice. Some teachers commented specifically about their perception of the pattern of the work year being suitable for working parents:

I have children and it's child friendly [*teacher <10 years experience*]

Opportunity to travel and teach

Initially: studentship, followed by four-year requirement to complete "bond". Later: job security. Now: the rewarding nature [*teacher ≥30 years experience*]

Initially the opportunity to attend university (i.e provision of a scholarship)

Job security

Another important factor cited was job security, with some teachers commenting that skills gained in teaching science were readily transferable to other careers:

Knowing that there was a shortage and that we were going to be "looked after", so that we stayed on [*teacher <3 years experience*]

Other factors

Just one per cent of teachers indicated that they had entered the profession as 'a last resort', and even fewer suggested that encouragement from their parents was an important factor.

5.2 Retention of science teachers in secondary schools

The study examined the retention of science teachers in several ways:

- The heads of secondary school science departments were asked if their schools experienced difficulty retaining science teachers [5.2.1]
- Teachers were asked if they planned to still be teaching in five years time. This data was then checked for correlation against a number of variables, including personal profiles (age, gender, teaching experience), school type (location, sector) and subjects taught [5.2.2]
- Teachers were asked to identify the more dissatisfying aspects of their work in an effort to uncover whether there were any issues of widespread concern or issues specific to particular subsets of respondents [5.2.3]

5.2.1 Retaining science teachers in secondary schools – the views of department heads

One-quarter of the heads responding to the survey said that retention of science teachers was a problem for their schools. The reason most commonly cited was the geographic isolation or the non-urban nature of their location:

Not being a 'big city' or a particularly attractive destination, teachers with experience tend to transfer out to more desirable locations (*QLD*; *ARIA* = 'accessible')

In a small community it is difficult to find suitably qualified and committed teachers willing to stay (*NT*; *ARIA* = 'very remote')

New graduates only want to stay in (*the*) country for 2.5 years, then want to move back to Melbourne (*VIC*; *ARIA* = 'highly accessible')

These views correspond with the finding that over half the schools surveyed from 'remote' and 'very remote' regions reported difficulty with staff retention (Fig. 5.1). In contrast, only 17 per cent of the heads from 'highly accessible' schools reported problems retaining staff.

A range of other reasons were offered by heads as explanation for their schools' difficulty in retaining science teachers, although the number of responses in each of these categories was small:

- stress and problems with student behaviour (n=10; e.g. "student discipline problems means high turn-over of staff")
- shortage of facilities and support for science teaching (n=7; e.g. "Lack of teaching resources in science", "lack of support [in technical preparation]", and "unpaid preparation hours")
- inability of the school to offer full-time contracts (n=4; e.g. "can get good teachers, but often on contract and system doesn't allow us to keep them")
- staff electing not to return after maternity leave (n=3; e.g. "a lot of recent teachers were women who leave to have children and do not return")
- promotion of 'good' teachers to non-teaching positions within the school system (n=3; e.g. "the best teachers get lost to classroom as they ascend the better-paid admin promotions")

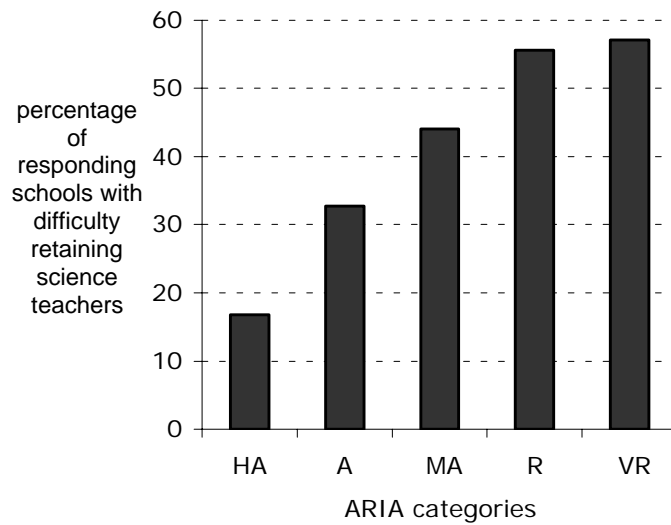


Figure 5.1 Schools reporting difficulty in retaining science teachers, expressed as a proportion of the total number of schools responding per ARIA category (HA = highly accessible; A = accessible; MA = moderately accessible; R = remote; VR = very remote)

While there was no significant difference between the states/territories in response to the question *Does your school have difficulty retaining science teachers?*, there was a difference between sectors. Government schools were far more likely to report difficulties (Fig. 5.2), with one in three heads of science departments responding *yes*. The reason most commonly cited by this group was the geographic isolation or non-urban location of their school ($n=21/54$), and 15 of these 21 schools are in ARIA categories ‘very remote’, ‘remote’ or ‘moderately accessible’. In contrast, only eight of the 51 Independent schools reported problems retaining science teachers, and there was no single, predominant reason given by the heads.

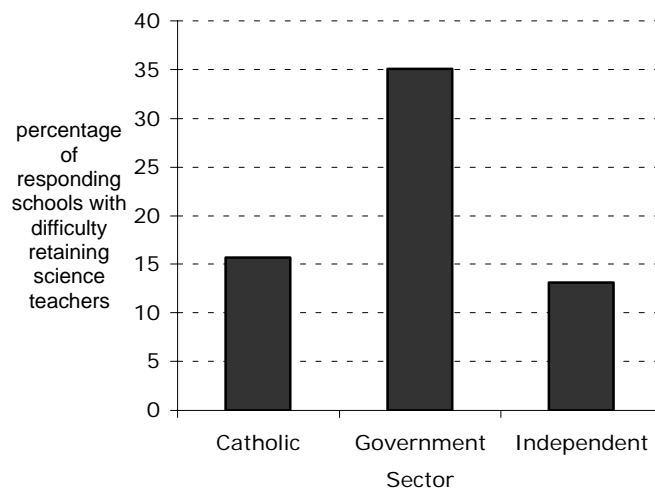


Figure 5.2 Schools reporting difficulty in retaining science teachers (proportion of the total number of schools responding per sector).

5.2.2 The career plans of science teachers in secondary schools – an overview

The supply of science teachers in the future will, in part, depend upon the career plans of those teachers currently in the system. More than half the teachers surveyed (53%) believed that they would still be teaching secondary school science in 2009 ('all' in Fig. 5.3). A small minority (16%) believed that they would have left the profession, and the remaining 31 per cent were undecided.

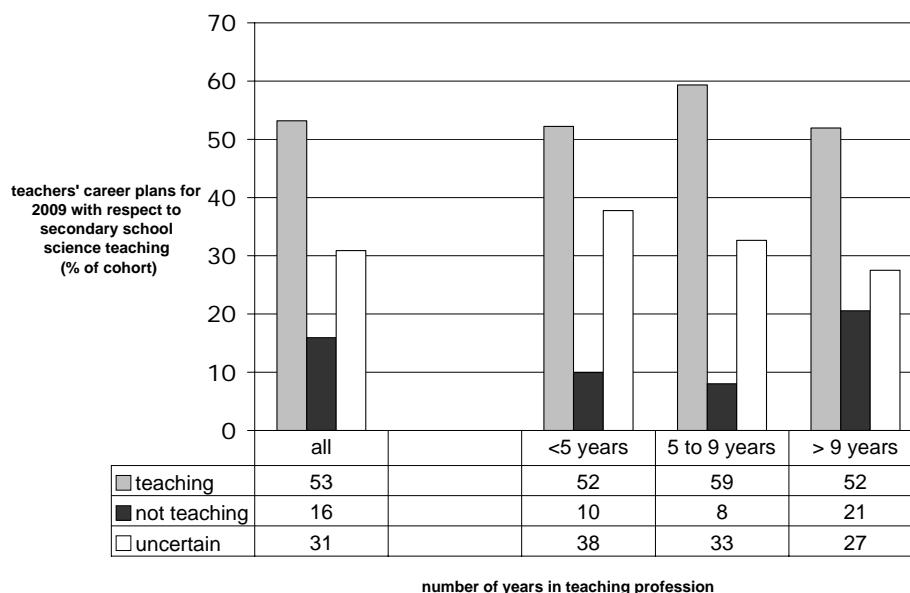


Figure 5.3 The career plans for 2009 of teachers responding to this survey, presented as a single cohort ('all' n=1180) and as three cohorts based upon years of teaching experience.

Teachers in the first five years of their teaching careers were less sure about their future plans than were the more experienced teachers (Fig. 5.3). Fewer were convinced they would leave the profession before 2009 (10% of 16% overall) but 38 per cent expressed uncertainty about their plans. These differences were statistically significant (Chi-square: 26.3 $P < 0.001$). There was no difference, however, in the proportion confident that they would be teaching in 2009.

In contrast, teachers with more than nine years experience were more likely than their peers to be planning to leave school teaching by 2009 (Fig. 5.3). This was due to the departure plans of more than one quarter of the most experienced (20 years or more) teachers.

5.2.3 Comparison of the profiles of teachers with different career plans for 2009

In considering the challenge of retaining secondary school science teachers in the system, it is useful to compare the profile of teachers with different career plans. In the following analysis, teachers responding to the survey were grouped into the following three categories. Those who were:

- planning to continue teaching for at least five years
- planning to leave the school teaching profession
- uncertain about their future careers.

Comparisons were then drawn between these three groups in terms of:

- personal profiles of the teachers (age, gender, years of teaching experience)
- location and sectors of the schools represented
- the senior year subjects taught by the teachers

Career plans and age, gender, teaching experience

More than half the teachers surveyed said that they planned to continue teaching science until at least 2009 (Fig. 5.3). Table 5.2a presents a description of this group. Eighty per cent of the group were under the age of 50 years and there was equal representation across gender. Most (65%) of the 40 to 49 year age group were in this category, while teachers 50 years of age or more were under-represented (36% of their age group).

In direct contrast was the demographic of the 16 per cent who expected to leave secondary school teaching by 2009. Table 5.2b presents a description of this group. These people were most likely to be experienced, male and at least 50 years of age. The group included an above average proportion of teachers with less than a minor in a tertiary-level Biology study. This was the only significant correlation between tertiary qualifications and career plans.

The remaining 31 per cent of respondents were undecided at the time of this study. Table 5.2c presents a description of this group. Half these people were under the age of 40. There was equal representation across gender.

Table 5.2a Profile of the group of 626 teachers who intended to continue science teaching until at least 2009 (age, years of secondary school teaching, and gender).

AGE	Less than 30 years 19.2%	30 – 39 years 26.6%	40 – 49 years 35.5%	50 years or older 18.7%
TEACHING EXPERIENCE	Less than 3 years 17.3%	3 – 9 years 24.8%	10 – 19 years 27.1%	20 years or more 30.8%
GENDER	Female 47.2%	Male 52.8%		

Table 5.2b Profile of the group of 188 teachers who intended to leave the profession before 2009 (age, years of secondary school teaching, and gender).

AGE	Less than 30 years 11.2%	30 – 39 years 13.4%	40 – 49 years 10.7%	50 years or older 64.7%
TEACHING EXPERIENCE	Less than 3 years 11.2%	3 – 9 years 12.3%	10 – 19 years 15.0%	20 years or more 61.5%
GENDER	Female 32.6%	Male 67.4%		

Table 5.2c Profile of the group of 366 teachers who were undecided about their career paths (age, years of secondary school teaching, and gender).

AGE	Less than 30 years 23.8%	30 – 39 years 24.6%	40 – 49 years 24.3%	50 years or older 27.3%
TEACHING EXPERIENCE	Less than 3 years 19.9%	3 – 9 years 27.3%	10 – 19 years 23.5%	20 years or more 29.3%
GENDER	Female 52.2%	Male 47.8%		

Career plans by location and sector

While there were no state or sector-specific differences in the career plans of teaching staff, there was an apparent difference between the sentiments of those teaching in more 'accessible' regions and those teaching in remote locations (Table 5.3). Compared to teachers in regions classified as 'highly accessible', teachers in 'very remote' regions were almost twice as likely to be planning to leave the profession before 2009, and the highest levels of uncertainty were recorded for the 'remote' and 'moderately accessible' groups. However, the total number of respondents for the remote regions was low and this difference is not statistically significant.

Table 5.3 Career plans of respondents to the survey of science teachers, analysed by ARIA category and presented as a proportion of total number of responses for each ARIA category

	Teachers' career plans for 2009 with respect to secondary school science teaching (%)			number of respondents (=100%)
	Teaching	Not teaching	Uncertain	
Highly accessible	54.3	15.2	30.6	870
Accessible	51.6	18.2	30.2	192
Moderately accessible	51.6	10.9	37.5	64
Remote	42.1	21.1	36.8	19
Very remote	40.0	28.6	31.4	35
Overall	53.1	15.9	31.0	1180

Relationship between career plans and subjects taught

Teachers of senior school Biology were significantly less certain of their career plans than teachers of other subjects (Table 5.4). Less than forty per cent of Biology teachers said they planned to be teaching in 2009 (cf 53% overall). Slightly more than half were uncertain about their future. These differences were highly statistically significant (Chi square: 82.82 P<0.001).

Table 5.4 Career plans of respondents to the survey of science teachers, analysed by subjects taught and presented as a proportion of total number of responses for each subject.

	Teachers' career plans for 2009 with respect to secondary school science teaching (%)			number of respondents (=100%)
	Teaching	Not teaching	Uncertain	
Junior school Science	53.8	16.0	30.2	582
Middle school Science	54.5	15.4	30.1	681
Senior Biology	39.2	9.3	51.5	365
Senior Chemistry	51.4	19.2	29.4	255
Senior Physics	60.3	9.3	30.4	194
Overall	53.1	15.9	31.0	1180

A higher proportion of senior year Physics teachers were planning to continue teaching for at least five years than were the teachers of any other subject. Correspondingly, the number of Physics teachers planning to leave the profession by 2009 was lower than the average. However, this difference was not statistically significant.

There was no correlation between the 'subjects taught' and career plans for any other subjects.

5.2.4 Work pressures and issues of concern to teachers

Given that one quarter of the schools in this study reported some difficulty retaining science teachers (5.2.1, above), and that almost half the teachers surveyed expressed uncertainty about their future career plans or were definitely expecting to leave teaching before 2009 (Fig. 5.3), it is important to identify any factors that cause dissatisfaction from the perspective of teachers themselves. The survey of teachers conducted as part of this study invited respondents to describe any negative aspects of their work and elicited responses from 94 per cent of those teachers surveyed. These responses were coded and analysed (Table 5.5), and form the basis of the following discussion.

Teachers' concerns fell into four broad category groupings;

- Teacher-centred:
aspects of the teaching role and its impact on teachers' lives beyond work.
- Student-centred:
issues such as student behaviour, attitude to learning and preparedness for secondary school.
- Governance:
decision-making beyond teachers' control, usually involving school, state or sector governance.
- Community attitude:
the attitude of the wider community toward both science and the teachers' role as science educators.

Table 5.5 lists the responses collected into each of these groups. The distinction between 'Teacher-centred' and 'Governance' is not absolute, and some of the categories (e.g. Low salaries) could be placed in either group. Note that many teachers commented upon multiple issues, and therefore the total number of 'responses' to this question exceeds the total number of teachers surveyed.

Workload issues

The most prominent issue for secondary school teachers was high workload. More than half the teachers surveyed commented that long hours, high administrative load or some other aspect of their job resulted in an overall workload or number of working hours that they considered too high. Such comments constituted 35 per cent of all responses to this open question (Table 5.5). Some teachers identified particular causal factors, such as large amounts of administration or marking, while other teachers made more general comments. The most common, single response of this type was a statement about 'long hours', with such a comment featuring in the responses of 29 per cent of the teachers surveyed.

Teachers really need to have their teaching loads decreased so that lessons do not deteriorate because of lack of preparation time
[teacher, >10 years experience]

Extreme number of hours have to put in 'out of hours' in order to complete job properly *[teacher <25 years of age]*

Demanding and ongoing nature of the 'at home' correction and preparation [teacher, >54 years of age]

Table 5.5 Responses of science teachers to the following question: *What do you see as the negative aspects of your job?*

		Frequency of responses	Percentage of responses (n=2646) %	
Teacher-centred	High workload	200	34.8	
	Long hours	345		
	High administrative load	187		
	High assessment load	110		
	Too much time spent on non-teaching activities (E.g. yard duty)	78		
	Teacher-centred	Low salaries	189	7.1
		Stress	82	3.1
		Inflexible hours and work year	24	0.9
		Teaching outside their area of expertise	18	0.7
		Isolated location of school	4	0.2
Student-centred		Inappropriate behaviour, lack of respect for teachers, lack of interest in learning and/or science	412	15.6
		Poor literacy and numeracy skills	37	1.4
	Governance	Changing or inappropriate curriculum	170	10.8
Other aspects of 'top-down' governance		115		
Insufficient physical resources and infrastructure		166	6.3	
Unsupportive environment of school, including both insufficient numbers of support staff and lack of collegial atmosphere		91	3.4	
Large class sizes		60	2.3	
Insufficient opportunities or encouragement for ongoing involvement in scientific research and professional development		53	2.0	
Concerns regarding 'duty-of-care' and risk of litigation		36	1.4	
Career advancement opportunities either lacking or selection procedures inequitable		26	1.0	
Lack of job security		27	1.0	
Community attitude		Science teaching undervalued by the wider community	152	5.7
	Insufficient cooperation from the students' parents	48	1.8	
Other		16	0.6	

Women were particularly dissatisfied with the large amount of work required of them as teachers. Fifty-four per cent of comments regarding workload issues came from women, despite the fact that women made up only 47 per cent of the teachers surveyed. This gender-bias was highly statistically significant (Chi-square: 18.3 $P < 0.001$). Of most concern to these women were long hours. One in three women surveyed were unhappy about the large number of hours that they were required to devote to their work as teachers:

Who's Teaching Science?

Meeting the demand for qualified science teachers in Australian secondary schools

The huge number of hours required for preparation and correction out of school time, including weekends and holiday (families resent this) [*female teacher, <30 years of age*]

High demand on time at certain times of the year – unrealistic sometimes – to the point where there can be no life outside school business for several weeks [*female teacher, <35 years of age*]

There were also differences in the experiences of teachers in different states and school sectors. Teachers from the ACT were more likely to comment about the impact of workload-related issues, while these comments were significantly less likely from teachers in Queensland and Tasmania. While statistically significant, these differences were not large (Chi-square: 15.85 $P < 0.05$).

Teachers from Catholic schools were the most troubled by 'high workload', while teachers from Independent schools were significantly less likely to make this comment (Chi-square: 12.0 $P < 0.01$). However, 'long hours' was more an issue for teachers from Independent schools, and less prevalent among comments from the Government school sector (Chi-square: 9.5 $P < 0.01$). Workload issues overall (i.e. including all aspects grouped in Table 5.5) were considered more an issue for teachers in Catholic and Independent schools than they were for teachers in the Government school sector (Chi-square: 7.6 $P < 0.05$). This may be due to an over-riding concern about student attitude prevalent in the Government school sector.

Student attitude and behaviour

A second major area of concern among teachers related to student attitude and behaviour. Grouped into this category were comments regarding student discipline problems, a perceived lack of respect from students, lack of student engagement with learning or a lack of student interest in science. Fifteen per cent of responses concerned these issues (Table 5.5), representing the views of more than one in four of the teachers surveyed:

Far too much time is wasted on discipline and classroom management rather than actual education [*teacher with >10 years experience*]

The need to deal with the inherent societal problems in a diverse student population [*teacher*]

As the years have gone by discipline has become much more difficult [*teacher with at least 15 years teaching experience*]

We are expected to be babysitters – can't make students accept their responsibilities, yet constantly reminded about their rights. What about ours? [*teacher, >25 years experience*]

Teachers are expected to do more and more – to be experts in social welfare, to deal with complex family dynamics of students ... and then to actually teach [*teacher*]

Concern about student behaviour and lack of student interest in science was most prominent among teachers from Government schools, rivalling 'workload' as the most common 'problem' facing these teachers (18% of all responses from this sector). Teachers working in Catholic or Independent schools were much less likely than their Government school peers to express these concerns. These sector-based differences were highly statistically significant (Chi square: 24.01 $P < 0.001$).

There was also gender-based difference in this response. Males were more likely to express dissatisfaction with student behaviour and attitude than were their female colleagues (Chi square: 8.45 $P < 0.01$).

Curriculum and other decisions of central governance

Ten per cent of responses reflected concerns about curriculum design or change, or other decisions that were beyond the control of individual teachers (Table 5.5). 170 teachers expressed dissatisfaction with either the constraints of the syllabus or the frequency of curriculum change:

(The) curriculum framework is totally ruining the creative nature of teaching science. Everything is too theoretical. I will not be teaching science next year because I am restricted and forced to teach theory and do less practical work which I love

VCE Biology units 1-4 have too much content. The students have to try to cram in way too much info. No time to talk about/discuss other issues/topics not directly related [*teacher <10 years experience*]

Change of science syllabus and philosophy every 5 years

Being expected to fix all of the problems in society by adding it to the curriculum

Too many new programs without assessment of their impact overall

More than 100 comments from teachers described concern with some aspect of the school system's bureaucracy:

The ability of administrators to: make the important trivial; the trivial important

Administration who put the "school" ahead of education and have forgotten how hard teaching is [*teacher >15 years experience*]

Increasing amount of bureaucracy, accountability and red tape, compared to time in the classroom

Very little reward but lots of criticism (*from*) bullying bureaucracy

There were statistical differences between states regarding concern over changing curriculum and school governance (Chi-square: 30.37 $P < 0.001$). The sentiment was particularly prevalent among teachers from Western Australian schools. These teachers represented just over ten per cent of respondents, yet they contributed more than 17 per cent of responses in this category.

Other issues of concern to teachers

Three other categories each included more than 150 responses. These were:

Insufficient physical resources

Fourteen per cent of teachers referred to problems caused by lack of equipment or other facilities, and some teachers stated that this frustrated their efforts to excite and engage students in the science classroom:

Resources in schools to teach science are poor

Lack of or poor ICT services [*teacher <3 years experience*]

Schools are behind in keeping up with technological changes: lack of funding is the main problem [*teacher ≥ 20 years experience*]

A highly significant correlation (Chi-square: 26.97 $P < 0.001$) was found across sectors: the majority of comments regarding lack of resources were made by teachers in Government schools (72%), while this sentiment was rarely expressed by teachers in Independent schools (7%).

Society's attitude toward science and science teaching

One in eight teachers expressed dissatisfaction with the extent to which the wider community valued the contribution of science teachers. Some teachers cited this as a factor in the low interest in science among science students. The sentiment was expressed equally by men and women across all school sectors.

Lack of respect and misunderstandings from the majority of the community

Community opinion of teachers as people who get heaps of holidays and work only from 9-3 (I wish!)

Lack of respect / appreciation for the occupation from students and society in general

Levels of pay

Sixteen per cent of teachers expressed dissatisfaction with their salary. Men were more likely to make this comment than were women (65% responses were from males; Chi-square: 9.60 $P < 0.01$) and teachers from Independent schools were more likely to make this comment than were their colleagues from the other sectors (Chi-square: 7.70 $P < 0.05$).

5.3 Summary

One-quarter of the heads of secondary school science departments surveyed reported difficulty retaining science teachers. This difficulty was most frequently reported by Government schools: more than one in three heads from Government schools expressed concern about their schools' ability to retain staff. Teachers themselves reported considerable uncertainty about their career plans. This was especially true of early-career teachers and Biology teachers. Nearly forty per cent of teachers with less than five years teaching experience and more than fifty per cent of Biology teachers were unsure if they would still be teaching in 2009.

The secondary school science teachers surveyed were attracted to the teaching profession for a variety of reasons, but most of these reasons related to a desire to share their enjoyment of science with young people. However, when asked if there were aspects of their jobs that they found unsatisfactory, the overwhelming response from teachers concerned the long hours and high workloads involved. In addition, lack of motivation on the part of students frustrated many teachers.

Chapter 6: Attracting suitably qualified science teachers

The study invited suggestions from science teachers and heads of science departments on ways to attract people to the profession of secondary school science teaching. Once coded, the data from the surveys amounted to more than two thousand responses from teachers and more than five hundred responses from department heads.

Many of the responses were suggestions and strategies for alleviating the work pressures that the group of respondents had experienced themselves (see Section 5.2.4). These suggestions included increasing salary, reducing workload and improving the status of teachers in Australian society. Reflecting these recurring issues, Tables 6.1 and 6.2 are structured around the same four broad themes introduced in Table 5.5 and Section 5.2.4, namely: Teacher-centred; Student-centred; Governance; and Community attitude.

Despite the recurrent themes in the responses, respondents appeared to distinguish between the questions of 'negative factors on their work' and 'ways of attracting new people'. This distinction was seen in the differing levels of importance placed on particular issues. For example, 'low salary' was ranked only fourth in importance with regard to personal dissatisfaction ('negative factors') among teachers (see Table 5.5), yet teachers viewed increase in salary as by far the most important factor in attracting new people to the teaching profession (Table 6.1).

Several of the suggestions from teachers and department heads align with recommendations from the recent review of science teaching commissioned by the Federal Government (DEST 2003b). For reference, these 'actions' are incorporated *verbatim*, where relevant.

6.1 Increased salary

More than half of the teachers and more than 60 per cent of the department heads surveyed believed that higher salaries would help attract more people to science teaching (Tables 6.1; 6.2). From both groups, this was the most common response and it was often the only response given. For example, nearly one in five heads made this and no other suggestion. Another 27 per cent of heads placed 'higher pay' first in their list of suggestions, an indication that they too believed it to be very important.

Table 6.1 Responses of science teachers to the question: *What could be done to attract other well-qualified people to science teaching?*

		Frequency of responses	Percentage of responses (n=2228) %
Teacher-centred	Increase salaries	679	30.5
	Reduce contact time and/or overall workload	109	8.9
	Allow more preparation time	55	
	Reduce administration load	34	
	Other ¹	44	2.0
Student-centred	Improve student behaviour	80	3.6
	Other changes to the student group, such as improved general literacy skills	23	1.0
Governance	Create more supportive school environment	180	8.1
	More opportunities for ongoing training and involvement in scientific research	131	5.9
	Improve resources and infrastructure	123	5.5
	Smaller class sizes	118	5.3
	Reduce 'political interference' and frequency of curriculum change.	111	5.0
	Create more attractive career pathways	82	3.7
	Provide more support for trainee teachers	80	3.6
	Offer more permanent jobs ie reduce emphasis upon short-term contracts	20	0.9
Modify the pre-service training requirements	40	1.8	
Community attitude	Improve the promotion of science, science teaching, and teaching generally to tertiary students and in the wider community	295	13.2
	Encourage parents to be more supportive of secondary school teachers	8	0.4
Other		16	0.7

¹This grouping includes such categories as: provide more flexibility in teaching times; reduce 'stress'; reduce time allocated to non-teaching activities (e.g. yard duty); offer greater incentives to work and live in rural and remote areas; improve superannuation.

**Table 6.2 Responses of heads of secondary school science departments to the question:
What could be done to attract well-qualified people to science teaching?**

		Frequency of responses	Percentage of responses (n=506) %
Teacher-centred	Increase salaries	167	33.0
	Reduce contact time and/or overall workload	19	8.1
	Allow more preparation time	17	
	Reduce administration load	5	
	Other ¹	13	2.6
Student-centred	Improve student behaviour	11	2.2
Governance	Create more supportive school environment	51	10.1
	More opportunities for ongoing training and involvement in scientific research	24	4.7
	Improve resources and infrastructure	27	5.3
	Smaller class sizes	27	5.3
	Reduce 'political interference' and frequency of curriculum change.	19	3.8
	Create more attractive career pathways	20	4.0
	Provide more support for trainee teachers	16	3.2
	Offer more permanent jobs ie reduce emphasis upon short-term contracts	10	2.0
Modify the pre-service training requirements	16	3.2	
Community attitude	Improve the promotion of science, science teaching, and teaching generally to tertiary students and in the wider community	62	12.2
Other		2	0.4

¹This grouping includes such categories as: provide more flexibility in teaching times; reduce 'stress'; reduce time allocated to non-teaching activities (E.g. yard duty); offer greater incentives to work and live in rural and remote areas; improve superannuation.

Many respondents (e.g. >10% of all department heads surveyed) expressed the view that salaries needed to be increased in order for the teaching profession to successfully compete with industry for science graduates:

Increase in salary. This is the determining factor. I know of many enthusiastic, excellent teachers who have left the profession due to better financial opportunities in other fields [teacher]

A person with a university science degree can find more lucrative employment, with more security and less stress, in other occupations [Head of science dept.]

Good physicists will not come to a profession where salary is so much less than what can be found in industry and does not have a clear career path within the subject. If they want to be physicists, why join a profession where their only chance of a career path is to do less and less physics teaching and more admin? [teacher]

Salaries more in line with science practitioners [Head of science dept.]

Both science teachers and heads of science departments expressed the view that higher salaries should be used to reward excellence in teaching:

Have a salary structure which reflects excellence in teaching rather than just years of service *[teacher]*

Higher wages for qualifications and skill as a teacher. DE&T need to restore Principals' ability to "skip" grad(uates) through levels/grades on basis of above. An excellent teacher is currently locked to the same pay scale as a mediocre one *[Head of science dept.]*

Schools should develop policies to "reward" good teachers. Salary should depend on "success" not "number of years taught" *[Head of science dept.]*

We note that these views from respondents align with recommendations from the recent DEST review of science teaching:

Action 29: Teacher career progression and salary advancement reflect objectively assessed performance as a teaching professional [DEST 2003b, p31].

Action 30: Recognition, including remuneration, for accomplished teachers who perform at advanced professional standards ... [DEST 2003b, p31].

Other suggestions for changing the salary structure also reflected dissatisfaction with the incremental increases based upon years of service:

Pay should be appropriate for higher order subjects at senior level *[Head of science dept.]*

Experience outside teaching should be taken into account so that an engineer/scientist should be given a number of years 'credit for industry knowledge/experience. This is not the case in Government schools at present *[teacher from Victoria]*

Higher starting salary for mature entrants to profession *[teacher]*

Increase top end pay rates ie after 10 years of teaching I'm still not at top of scale and top of scale is not noticeably different to first year teacher *[teacher]*

Increase salary. Not for beginners, necessarily, but the salary of teachers with ten years experience *[teacher]*

Teachers and heads of science departments from different states and territories, and from different sectors were equally convinced that salary increase was needed to attract more people to a career in science teaching, and there was no significant gender-difference.

6.2 Changing community attitudes toward science and teaching

One in four respondents to the survey believed that more people would be attracted to science teaching as a career if the profession was more highly valued by Australian society:

Acceptance by our society that teachers do an important job and that they do not work for short hours with long holidays [teacher]

Teachers need to feel valued by the employer and the community. I do not feel this is happening anymore [Head of science dept.]

Suggestions were made to promote both science and teaching as valuable contributors to society, and to promote science teaching among secondary students and tertiary science students:

Promote science work-experience by students [teacher]

A concerted advertising/awareness raising campaign to improve perceptions of the value of the profession would help [Head of science dept.]

Develop programs within Science Faculties in university where there are links between uni students and existing teachers [teacher]

Allow shadowing of present staff by interested parties [teacher >30 years experience]

I did an integration program as a part of my undergraduate studies involving working in state schools in classrooms. This encouraged me, and many of the other students in this program, to think about teaching [teacher <3 years experience]

I knew nothing of science teaching during undergraduate years. It needs promoting at universities for those doing Science [teacher >50 years of age]

The DEST review of science teaching also recognised a need for greater linkages between education and science faculties in universities:

Action 15: Close collaboration be developed between education and other (particularly science, agriculture and engineering) faculties at higher education institutions, with arrangements established for students in science, technology and mathematics-related non-teacher education programs to undertake teacher education units within their course packages [DEST 2003b, p20].

Some respondents linked community perception to salary or other aspects of teachers' work that the teachers surveyed had expressed dissatisfaction with:

Increase salary, which would improve status of the job and also serve to improve respect by students and the public for the position. This would also improve classroom discipline and attitudes. A big issue: that of status of the profession [Head of science dept.]

Female teachers and teachers from the Northern Territory were the groups most likely to suggest a need for greater public recognition of their profession (Chi-square: gender difference 4.09 $P < 0.05$; state difference 14.82 $P < 0.05$).

6.3 Workload issues

Nearly nine per cent of all responses concerned issues of workload. Suggestions included reducing contact teaching hours to allow more time for preparation and

reflection, and relief from some duties not directly involved in teaching science, such as administrative tasks and ‘yard duty’:

Increased time (*available, as this is*) required to do the job better/properly/correctly so that people enjoy doing it [*teacher ≥10 years experience*]

Science teachers should have lower allotments and more time to design and assess practical activities and promote individual student research programs [*teacher ≥30 years experience*]

A look at reducing the workload – it is huge in our school and in my last two schools. It is really difficult to “have a life” out of work in the term! [*Head of science dept.*]

I have taught more than 1000 Chem students (= the more academic students in school). How many went into Science Teaching? – maybe three. Why? They are observant and watch the crap I have to do: ground duty, ... etc..*[teacher]*

Removal of non-teaching “administrivia” (e.g. annual reviews) [*teacher*]

6.4 More supportive school environment

The comments and suggestions grouped into the category *Create more supportive school environment* were varied, but all referred to aspects of collegial support networks within schools:

Have something in place for special needs students and difficult students [*teacher*]

More professionalism from staff as a whole – more backup [*teacher >14 years experience*]

Good support network [*teacher*]

Increased team teaching [*teacher <3 years experience*]

Support new teachers in the profession [*teacher <3 years experience*]

Better provision of technical support in schools so teachers know they can focus on learning/pedagogy [*teacher ≥15 years experience*]

Several of the suggestions offered by respondents regarding additional support measures align with recommendations of the DEST review of science teaching:

Action 34: Teacher educators have continuing direct involvement in schools – including as part-time teachers, as mentors to beginning teachers, and as experts conducting or guiding action research – and education faculties and education authorities conjointly employ significant proportions those staff [DEST 2003b, p36].

Action 36: Beginning teachers receive appropriate professional support, including thorough-going induction and mentoring, and time to reflect on their practice [DEST 2003b, p37].

Action 52: Sufficient suitably trained paraprofessional staff be deployed in schools to support teachers in school-based non-teaching work [DEST 2003b, p49].

6.5 Ongoing professional development

Five per cent of respondents suggested that more people would be attracted to the profession of science teaching if they could be assured of opportunities to maintain some involvement in scientific research or industry:

Ongoing professional development opportunities. Many people feel that their knowledge in their field of expertise becomes stale *[teacher]*

Regular PDs that introduce new / improved practicals to use in the classroom *[teacher]*

I would like to do two-day workshops on how to teach certain areas of science (e.g. landcare, chemistry). My science minor at *(name of university deleted)* was a joke. I learned nothing. I basically teach science from my knowledge of what I learnt at school. My major area was PhysEd. I love physics, human biology but I am unsure of chemistry, ecology, land care areas. Workshops with lots of lesson plans, going through experiments (even simple ones) would be very useful. I have only had to teach science for three out of my ten years. You forget very quickly the tricks of the trade. Two-day courses in the holidays or in school time would be great *[teacher]*

Work exchange programs to bring scientist into schools and teachers to industry *[teacher]*

Job share opportunities in corporate or industrial sectors – ½ teaching, ½ working *[teacher]*

There are two types of Science teachers: 1. Teachers that teach Science, 2. Scientists that teach science. To keep and/or attract scientists, they should be part-time (80%) and the remainder *(of their time)* involved in research/study at uni or other institution or commercial enterprise *[teacher >20 years experience]*

The DEST review also identified a need for policy encouraging linkages between science teachers, industry and research:

Action 50: A national network of local and regional science clusters linking schools and teachers with science organisations, tertiary education institutions and industry organisations be created [DEST 2003b, p48].

Action 40: Opportunities be created through professional leave or other arrangements for teachers, especially of science, technology and mathematics, to gain relevant work experience in research and industry [DEST 2003b, p39].

Action 8: Scholarships and/or other incentives be provided to selected teachers to undertake advanced (including postgraduate) studies in science, technology and mathematics [DEST 2003b, p14].

Some teachers also suggested that teachers be encouraged to engage in research into the pedagogy of their discipline:

Time and opportunity to complete 'research' into Science Education
[teacher]

A related suggestion was included among recommendations of the DEST review:

Action 6: Scholarships and other incentives be offered to primary and middle school teachers to undertake studies to advance their knowledge and skills in science and mathematics teaching [DEST 2003b, p12].

6.6 Summary

Both teachers and heads of science departments believed that increased salaries were necessary in order to attract more, suitably qualified people to a career in science teaching. This contrasts with the low importance placed upon salary as a motivator for their choosing the career themselves, and with the fact that 'low salary' ranked lower than several other concerns that they had with their own working lives. Many respondents highlighted the need for schools to offer salaries that were competitive with industry if they were to attract Science graduates to teaching.

One in four respondents believed that the status of teachers was also an important factor. They proffered a range of suggestions for promoting science teaching, and teaching more broadly, among the general public and among tertiary science students in particular. A theme common to many of these suggestions was a desire by teachers for opportunities to retain, or obtain, research experience in their science disciplines.

The respondents' calls for assistance with non-teaching duties and their desire for stronger collegial support networks within schools suggest a rather negative perception of existing school cultures on the part of current teachers. Many respondents expressed the view that additional mentoring, paraprofessional support and team-teaching were necessary if more people were to be attracted to the profession of science teaching. These issues were also raised by the recent DEST review of science teaching (DEST 2003b).

Chapter 7: Conclusions

The findings of this study forecast increasing difficulties in the capacity of Australia's secondary schools to adequately prepare students in the principal physical sciences of physics and chemistry. There is a looming shortage of suitably qualified Physics and Chemistry teachers, a shortage already being experienced by some schools. Some of the indicators of this shortage are as follows:

- Teachers surveyed had, on average, much stronger backgrounds in the biological sciences than in the physical sciences. This was particularly true for younger teachers.
- In some schools the science teachers lacked the science qualifications desired by the head the department.
- Many schools reported difficulty recruiting Chemistry and Physics teachers.
- Many senior school teachers will be retiring in the near future. The teachers who specialised in senior school science classes were, on average, older than their colleagues. This was particularly true for senior school Chemistry teachers.
- Nearly forty per cent of early-career science teachers were uncertain about their plans to continue teaching.

Collectively, teachers had strong Biology backgrounds but limited grounding in Physics

More than half of the teachers surveyed had studied Biology beyond first year at university, and 45 per cent held a Biology major. Young teachers were even more likely to have a strong background in Biology. Among those teachers under thirty years of age, more than sixty per cent had studied Biology beyond first year at university and nearly half held a Biology major.

In contrast, less than thirty per cent of the teachers surveyed had studied Physics beyond first year, and only seventeen per cent held a Physics major. Only sixteen per cent of the teachers under thirty years of age had studied Physics beyond first year.

Some teachers lacked the desired minimum in science qualification

Both teachers and heads of school science departments expressed the view that science teachers need strong, discipline-specific qualifications in science. There was near consensus among heads of departments that first year tertiary study in a particular science discipline was an inadequate preparation for teaching that discipline in senior school classes. Yet this was the situation for many of the senior school Physics teachers surveyed. Twenty-five per cent had either no tertiary background in the subject, or had only studied it in first year. The qualifications of a further eighteen per cent fell short of the Physics major desired by most department heads.

There was a similar mismatch between the desired and the actual qualifications of many junior school science teachers. Virtually all the heads of departments surveyed expressed the view that junior school science teachers should have studied some science at university, and nearly half stated that first year study alone was insufficient. However, one in twelve of all junior school teachers surveyed, and nearly one in five of those teaching only junior school science, had studied no Biology, Chemistry or Physics at university.

Many schools experienced difficulty recruiting Chemistry and Physics teachers

Forty per cent of the responding schools reported difficulties recruiting senior school Physics teachers. The rates were significantly higher among Catholic schools, at 67 per cent. Chemistry teachers were also reported to be in short supply, with thirty per cent of all schools (and more than half the Catholic schools) reporting recruiting difficulties.

While generally satisfied with the qualifications of their existing senior school teaching staff, many heads of science departments expressed concern about their schools' ability to replace Chemistry and Physics teachers as they retire. Difficulties were greatest for

short-term vacancies, such as those created when staff took long service or extended medical leave.

Imminent retirement of 'baby boomers' will further exacerbate existing shortages

The largest age cohort among the teachers participating in this study was the 50-54 years of age class, followed closely by those between 45 and 50 years of age. This group includes many of the senior school science teachers, and teachers of senior school Chemistry in particular. Replacement of these teachers as they leave the system over the next five to ten years is an obvious policy issue.

Many young teachers were uncertain about their future career plans

This study has identified a high degree of uncertainty among early-career teachers about their future career plans. Among those teachers with less than five years experience, nearly forty per cent were unsure if they would still be teaching in five years time, suggesting that both current teachers and those entering the profession in coming years need increased encouragement to remain in the system. Policies and strategies aimed at improving the job satisfaction for these teachers are therefore critical if the staffing needs of schools are to be met.

Attracting and retaining suitably qualified science teachers

The findings of this study raise several options for consideration in attracting new, suitably qualified people to teaching science in schools:

- Encouragement for students enrolled in tertiary science degrees to incorporate education units into their study programs, with the belief that this would encourage more science undergraduates to consider a teaching career.
- Salary scales and structures more competitive with those offered by the industries that currently attract science graduates. Teachers and heads of departments alike suggested that experienced and well-qualified science teachers should be better recognised and rewarded for their expertise.
- Reduction in overall workload by means such as increased paraprofessional support staff to relieve science teachers from some non-teaching duties and assistance with the preparation and operation of practical classes.
- Opportunities for continuing involvement in research and/or applied science specific to their discipline. Possibilities raised by teachers included time release to undertake work in research institutes or industry, and more science-specific professional development workshops with the aim to keep teachers abreast of progress in their science discipline.

Attracting new, young graduates to careers in science teaching will not provide a complete solution to staffing science departments in Australia's schools unless those teachers can be retained in the system. This study invited teachers to comment upon any aspects of their work that they were dissatisfied with, and their responses suggest several areas of concern:

- The most prominent issues for teachers were high workload and long hours. These were of particular concern to female teachers with family commitments. One in three women surveyed were unhappy about the long hours required of them. Teachers in Catholic schools were significantly more likely to report concern over high workloads, while for those from Independent schools long hours was of most concern.
- Student attitude and behaviour were a source of concern expressed by one in four teachers surveyed. Male teachers were particularly concerned by the time and energy 'wasted' due to lack of student engagement and general discipline problems.
- Ten per cent of respondents expressed dissatisfaction with policy decisions beyond their control. Many teachers stated that repeated changes to the school curriculum were disruptive and not well planned.

- Many science teachers expressed the view that lack of time for preparing practical science classes and insufficient levels of physical resources were frustrating their efforts to engage and enthuse students.

Implications of the study's findings

The present study is a landmark in improving knowledge of the characteristics of people currently teaching science in schools across the nation and the immediate workforce planning issues associated with attracting and retaining suitably qualified people in this role.

On any reasonable assessment of the research findings, the picture is troubling. There are people teaching secondary school science who have low levels of academic preparation, if any, and the situation may worsen. Consideration might be given to new strategies for encouraging young people to consider science teaching as a career and for the opportunities for attracting people with appropriate science qualifications who are in early and mid-career and working in other fields. Part of the challenge is to raise the appeal of teaching and of teaching science in particular. The evidence from this study is that teaching science in schools is currently considered to be a less glamorous alternative to working in industry and certainly a less financially rewarding one. This problem may well be characteristic of the teaching profession as a whole, but is perhaps of particular significance in the field of science where the lure to work on leading-edge developments in other, well-resourced environments is apparently very strong.

The science teachers who responded to this study had a common love of science and a desire to share this enthusiasm with young people. This commitment appeared to be being tested for many. Imaginative solutions are needed for some of the issues and problems identified by this study. Australian universities have a major responsibility to ensure the nation has well trained scientists and a suitable level of scientific literacy within the community. This work starts in schools and with the training and development of the next generation of science teachers. For this reason, the higher education system should play a leadership role in initiating an analysis and discussion of the future supply of science teachers and the quality of science teaching well before a crisis point is reached.

Appendices

1. Selection of the schools to be surveyed

The Australian Council for Educational Research (ACER) provided us with a list of secondary schools, stratified by state, sector and socio-economic sectors and excluding schools that would not be representative of the majority of schools. This number of schools listed assumed that we would receive a 70 per cent response rate from the science teachers. This level was not received.

2. ARIA location information

The ACER supplied us with an Accessibility and Remoteness Index of Australia (ARIA) code for each school. The five categories within the index are: Highly Accessible (HA), Accessible (A), Moderately Accessible (MA), Remote (R) and Very Remote (VR). Each postal area is assigned an ARIA code, based upon Australian Bureau of Statistics (ABS) data, and each school was thereby assigned an ARIA code. Further information about ARIA can be found at <http://www.health.gov.au/ari/aria.htm>

3. Location of schools represented in the heads of science department survey

The number of schools sampled for each location (state x ARIA location)(Table A.1) loosely reflected the population size in that location category (Fig. A.1), but there were some exceptions. For example, in South Australia the population living in 'highly accessible' regions was slightly under-represented at the expense of the 'accessible' and 'moderately accessible' locations.

Table A.1 Number of secondary school science departments responding to the heads survey, grouped by state and location (ARIA) index.

	highly accessible	accessible	moderately accessible	remote	very remote
ACT	7	N/A*	N/A*	N/A*	N/A*
NSW	23	6	1	0	0
NT	N/A*	8	1	3	6
QLD	26	11	6	4	1
SA	28	11	8	1	2
TAS	16	9	3	N/A*	2
VIC	38	2	1	N/A*	N/A*
WA	28	5	5	1	3
Total	166	52	25	9	14
Proportion % (n = 266)	62.4	19.5	9.4	3.4	5.3

* No schools listed for this location in the state/territory

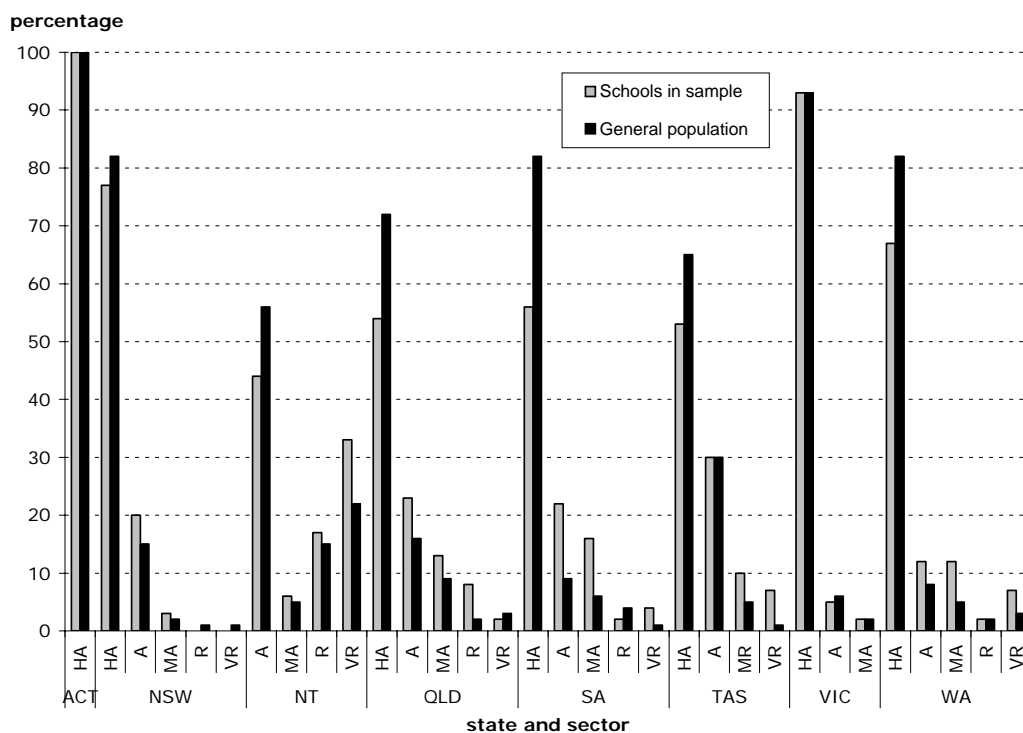


Figure A.1 Correlation between the state x location pattern of schools in the dataset, with population as percentage of the total of each (by state and ARIA index)

4. Pre-service teachers survey

The original design of this study included a survey of pre-service teachers studying Australian universities. The questionnaire was designed to reflect many of the questions that were asked of the science teachers. However, the questionnaire was completed by only twenty-three students at two universities, and therefore the results are not included in this report.

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