9 Focus on science

9.1 Science in the curriculum

The important role assigned to science in the curriculum of Australian schools is evident from the broad exposure of students to the area during their compulsory years of schooling and the breadth of specialised subject options frequently available to post-secondary students. It is also strongly supported by way of expensive specialist teaching facilities and regarded as one of the key areas preparing students for post-schooling options.

Goal 6 of the ten Common and Agreed National Goals acknowledges the need “to develop in students an understanding of the role of science and technology in society, together with scientific and technological skills”. The role of science in the education of young people is apparent in the contribution it makes to the other goals of Australian education programs and to the ongoing personal, social and vocational development of students in the 1990s.

9.2 Comparing achievement in science – TIMSS

The background to the TIMSS is explained in Section 8 of this report. The existence of this survey is further evidence of the extreme importance with which achievement in mathematics and science is regarded internationally.

Science results

Performance by Australian students tended to be even stronger in science than in mathematics. Only four countries did better than Australia in the upper grade, and seven in the lower grade. Top performers were Singapore, the Czech Republic, Japan and Korea, and these were the only countries which achieved significantly higher than Australia in the upper grade.

At the upper grade, Australian students performed at the same level as 14 other countries including the United States, Canada and the top European nations apart from the Czech Republic. Results for the lower grade were similar, except that Australia was outperformed by a further three participants – Bulgaria, Slovenia and the Flemish educational system in Belgium.

Table 65. Science achievement – mean scores, TIMSS Population 2 (13 year olds), by country, 1995

Country	*Upper grade mean*	*Lower grade mean*
Australia	545	504
Austria	558	519
Belgium (Flemish)	550	529
Belgium (French)	471	442
Bulgaria	565	531
Canada	531	499
Colombia	411	387
Cyprus	463	420
Czech Republic	574	533
Denmark	478	439
England	552	512
France	498	451
Germany	531	499
Greece	497	449
Hong Kong	522	495
Hungary	554	518
Iceland	494	462
Iran, Islamic Republic	470	436
Ireland	538	495
Israel	524	_
Japan	571	531
Korea	565	535
Kuwait	430	_
Latvia	485	435
Lithuania	476	403
Netherlands	560	517
New Zealand	525	481
Norway	527	483
Portugal	480	428
Romania	486	452
Russian Federation	538	484
Scotland	517	468
Singapore	607	545
Slovak Republic	544	510
Slovenia	560	530
South Africa	326	317
Spain	517	477
Sweden	535	488
Switzerland	522	484
Thailand	525	493
United States	534	508

Source: ACER, *Maths and Science on the Line: Australian junior secondary students' performance in the TIMSS,* 1996

Table 66. Science achievement – TIMSS Population 2, by State, 1994

State	*Best estimate of mean score*	*State*	*Best estimate of mean score*
WA	562 ± 7	NT	539 ± 13
ACT	555 ± 11	NSW	518 ± 8
SA	550 ± 4	Tasmania	507 ± 12
Queensland	539 ± 7	Victoria	499 ± 8

Source: ACER, *Maths and Science on the Line: Australian junior secondary students' performance in the TIMSS,* 1996

Australian students performed particularly well in 'Physics' and 'Environmental issues and the nature of science', attaining some of the highest scores in the world on questions about the causes of sunburn and the unwanted consequences of introducing new species into an area. However, they had internationally low scores on some questions about atoms and molecules.

Overall, the top scoring State, Western Australia, achieved at a level between the two highest-scoring TIMSS countries, Singapore and the Czech Republic, while the Australian Capital Territory was comparable with the latter. South Australia was on a par with the next group of countries which included Japan and Korea. Queensland and Northern Territory students performed similarly to the relatively highly achieving Europeans, and New South Wales students' performance was equivalent to English-speaking nations like the United States, Ireland and Canada and European countries including Sweden, Germany and Russia. Tasmania performed similarly to Hong Kong and Norway, and Victorian students achieved comparably with students from Hong Kong, Norway, Switzerland, New Zealand, Spain and Scotland.

Australia was one of only six countries in which there were no gender differences in performance in both mathematics and science. However, as was the case in mathematics, students from low socioeconomic backgrounds and Indigenous students performed less well than others in the science test.

Teachers and teaching

TIMSS also gathered data from teachers and schools on curriculum and teaching practice, mainly by means of questionnaires answered by principals, teachers or students. This data included information on teacher characteristics – age and gender, qualifications and training, years of teaching experience, workload and so on – and on teaching practices and teachers' beliefs about their profession.

Nearly three-quarters of Australian mathematics and science teachers teaching 13 year olds were aged 30–49, with only five per cent aged under 30. Female teachers accounted for 42 per cent of the total. Australian mathematics and science teachers have taught for an average of 15 years, with the most common length of teaching being 20 years.

Half of the teachers surveyed had completed a Bachelor of Arts or equivalent degree in addition to teacher training and another quarter had completed a higher degree plus training. More males than females had postgraduate qualifications, while there were more females than males with no university degree but with 3–4 years of teacher training. Differences between States were minimal. In comparison with other TIMSS countries, Australian mathematics and science teachers were reasonably well-qualified, though in some countries (Belgium, the Czech Republic and the United States) nearly all teachers had a degree.

TIMSS teacher questionnaires also asked teachers about their attitudes to teaching as a career, with responses suggesting a low level of satisfaction among Australian mathematics and science teachers. Australian teachers ranked both primary and secondary school teaching relatively low on a list of preferred occupations, comparable only with ratings from Iceland and Slovakia (though 14 countries, including England and the United States, did not take part in answering this question).

In Australia, as in most countries, teaching was the career of first choice of at least 75 per cent of TIMSS Population 2 teachers, although approximately 50 per cent of the country's mathematics and science teachers would change to another career if they had the opportunity. Only New Zealand teachers showed similar dissatisfaction, at aproximately 58 per cent; European countries had figures in the range of 15 to 30 per cent. TIMSS also asked whether teachers believed that their work was appreciated by society and by their students. In all countries apart from Switzerland teachers thought their students appreciated their work substantially more than did society. Teachers from Australia, England and Latvia had the lowest level of confidence in society appreciating their work, at 20–25 per cent, compared with the Swiss high of 84 per cent.

9.3 Student outcomes in science – reports from the States

States provided a range of information directly relating to the performance of students in science, although the level of structured testing apparent in other areas such as

numeracy and literacy was not evident. As has also been the case with other subject areas, the varied nature and extent of the material provided has made direct comparisons between the States impossible.

The outcomes information provided, however, does suggest some overall trends in performance in science by particular groups of students. For example:

- in a contrast to the TIMSS outcomes, four of the five States reporting on gender in relation to outcomes in science indicated that the average level of performance by girls was higher than that by boys, while in the fifth State the relative performance levels were related to particular areas of the science curriculum;
- where they were specifically identified as a group for the purpose of reporting, Indigenous students, on average, performed below the level of other students; and
- students from backgrounds of particular socioeconomic disadvantage generally performed at a lower level than other students; but
- the extent to which attending an isolated school impacted on science performance was not clearly established at a national level.

National reporting from the independent school sector indicated that fewer schools participated in external assessment for science than for numeracy. Some use was made of task-weighted assessment and a number of schools responding used the results of that assessment to assist with developing student profiles. However, nearly 50 per cent of surveyed schools encouraged their students to participate in science competitions, an avenue also used by many government sector schools. The competitions available in science-related areas were more diverse than those for numeracy, ranging from chemistry to biology. The results from such competitions provided indicative feedback on the relative strength and comprehensiveness of a school's science curriculum, as well as celebrating individual students' understanding of science.

Summaries of the outcomes data, provided in varying degrees of detail by the various States, follow.

New South Wales

Specialist high schools showed the greatest improvement in School Certificate A grades for girls and boys in science. A higher proportion of girls and boys attending single-sex schools received A grades for science when compared to the overall State average.

Indigenous students and students from schools supported by the DSP received lower grades for School Certificate science than other students. Girls attending schools supported by the CAP received more A grades for science than the rest of the student population.

The majority of HSC students who undertook a science course elected to study chemistry, physics or biology. The most popular science course undertaken by girls was biology, while for boys it was physics. Students attending DSP schools and those in remote areas tended to choose biology and chemistry, while the Science for Life course was popular with Indigenous students. The majority of students attending CAP schools undertook either the Science for Life course or 2 Unit Biology.

Targeted groups generally performed at a level below the State average in science courses. Girls outperformed boys in almost every strand.

Victoria

Compared with other key learning areas, disproportionately large numbers of students were working at the lower end of the expected level in 1996. Very few students scored highly – at year 3 only 4.5 per cent scored at a level above that expected, compared with 15 per cent in English and nine per cent in mathematics. At year 5 as many as 35 per cent of students were working at a level lower than expected.

On average, students from language backgrounds other than English performed less well than other students, although the top ten per cent of these students performed as well as the top ten per cent of the total student population. Students attending DSP schools generally performed at a lower level than students in other schools. Indigenous students, on average, also performed below the level of other students, while students from isolated or rural schools performed at the same level as other students.

Queensland

Science is part of the common curriculum undertaken by students to year 10, at which level the vast majority of students were assessed in 1996 for the Year 10 Certificate. That assessment process indicated that 36.6 per cent of students were high or very high achievers in science, with only 6.3 per cent registering a very low achievement level.

Based on a five-point scale ranging from 1 (very limited achievement) to 5 (very high achievement), the mean levels of achievement for year 12 students undertaking studies in the science subject area were 3.23 for girls and 3.02 for

boys. Female students scored slightly higher than male students regardless of school contexts, such as isolation or socioeconomic disadvantage.

Both male and female students attending isolated schools and disadvantaged schools recorded lower mean levels of achievement than students in other schools, with isolation slightly increasing the gap in average performance levels.

South Australia

The 1995 results from Stage 1 and Stage 2 of the South Australian Certificate of Education (SACE) have been used as a basis for reporting outcomes in the science area for senior secondary students attending government schools. However, there was no system-wide data collected for science in years 1–10, on the basis of profile outcomes, on which to base reporting at those levels.

Data relating to Indigenous students and students whose language background was not English were considered to be unreliable, so have not been included. However, it was concluded that both participation and achievement in science subjects in the senior secondary years did increase as the socioeconomic background of students increased.

Across the total population of students attempting Stage 2 PES science courses, the mean scores for girls were higher than the mean scores for boys in all subjects except geology. However, in the lowest socioeconomic quartile this trend was reversed, with boys achieving higher scores than girls in all science subjects. This latter result is also in clear contrast to the mean scores across all PES subjects for this quartile, where the mean scores for boys and girls were the same.

In the Stage 2 School Assessed Subjects (SAS), the only significant conclusion that could be drawn from the data available was that, for almost all subjects, students from the lowest socioeconomic quartile tended to score less than the overall average. As a notable exception, the mean score for students from this quartile who studied environmental science, a subject not studied by any students from the highest socioeconomic quartile, was higher than that of the subject's overall student population.

Western Australia

In 1993, MSE testing showed that primary and lower secondary students attending government schools had difficulty in applying science knowledge. In terms of specific student groups, the 1993 testing also indicated that Indigenous students and those who were from non-English speaking backgrounds also generally achieved at a level below the State average in science. Boys performed at a higher level than girls in applying concepts and skills, while girls performed better in the Life and Living strand.

Concerns about the level of year 3 and year 7 performance revealed by that testing led the Education Department to establish the Science Project, an initiative detailed later in this chapter. MSE testing planned for 1997 will provide early data on the extent of changes in student outcomes.

Independent schools took part in a variety of external science-related assessments. In primary and junior secondary levels, use of the University of New South Wales Science Competition was common, while in years 11 and 12, the Royal Australian Chemical Institute (RACI) Chemistry Quiz and the Titration Stakes were both widely used. Most schools also undertook specific science-related assessments, some of them with the assistance of Curtin University.

Tasmania

An issue still being addressed in the government school sector was that of student learning outcomes. Schools were actively developing assessment, recording and reporting mechanisms for student learning outcomes in science. The science profile was being used to inform this process.

Australian Capital Territory

Reporting of student achievement in year 12 certificate science courses provided perspectives common to both government and non-government schools. In particular, while less than half of science subject enrolments in 1996 were from girls (47.5 per cent in government schools and 49.4 per cent in non-government schools), girls achieved significantly better than boys. In government schools, 68.3 per cent of the subject enrolments from girls resulted in A or B grades (49.7 per cent for boys) while in non-government schools, 64.3 per cent of science enrolments for girls resulted in A or B grades (57.3 per cent for boys).

The level of year 12 science enrolments by Indigenous students was too small to make valid comment and data for other equity target groups were not available.

9.4 Student participation in science courses

All primary students in Australian schools were exposed to science to some degree. A course in science was also a required part of the program undertaken by secondary

students to the end of year 10. Beyond that, however, the study of science was generally an option. Information provided by States in respect of participation in science mostly referred to students at senior secondary levels.

Despite its generally optional nature at senior secondary level, student participation in science was high. 1996 figures from States' accreditation authorities (see Table 67) showed that 64 per cent of all year 12 students undertaking tertiary-accredited subjects were studying at least one science subject. The percentage of students in science was below that for English (93 per cent), Studies of Society and the Environment (SOSE) (80 per cent) and mathematics (79 per cent). Other subject areas attracted only from 14 to 36 per cent of students. However, figures in Table 68 suggest a slight decline in the level of popularity of year 12 science subjects from 1991 to 1996.

New South Wales reported a decline in enrolments in science at year 11 from 67.8 per cent of students in 1995 to 62.7 per cent in 1996. On the other hand, year 12 enrolments in science courses increased slightly, from 64.8 per cent of students in 1995 to 65.2 per cent in 1996. For boys the most commonly studied science course was 2 Unit Physics, while for girls 2 Unit Biology was most common. Boys constituted 73 per cent of all physics enrolments, but only 34 per cent of enrolments in biology.

The trend of falling enrolments which first emerged in the early 1990s in physics and chemistry in the non-compulsory years of schooling continued. This appears to reflect student perceptions that science-based careers are not well regarded or rewarded in Australia.

Reporting from Queensland focused on participation in science by year 12 students, providing a perspective on the influence of gender, isolation and disadvantaged school status on that participation:

- 72 per cent of boys at year 12 undertook at least one science subject, compared with 64 per cent of girls;
- the rate of participation in science subjects was higher in isolated schools than in other schools, for both boys and girls; and
- the participation rate for boys in disadvantaged schools was lower than for other schools; for girls it was higher.

South Australia also confirmed the access of all students to science education, indicating that science was a required area of study in the compulsory years of schooling. At the post-compulsory level, science subjects formed part of the quantitative/experimental pattern of the SACE, along with mathematics and technology subjects. All students were required to complete a component of the quantitative/experimental pattern to successfully complete requirements for the certificate.

At the postcompulsory level, all government school students have access to the range of science subjects offered by the SSABSA on site, through the Open Access College, or through providers at other, nearby schools. From information provided about participation in a range of science courses, it is evident that in 1996, for example:

- significantly more girls than boys studied biology, at both Stage 1 and Stage 2, a position maintained across DSP and CAP schools;
- a higher percentage of boys than girls studied physics and chemistry, again at Stage 1 as well as Stage 2, the imbalance being somewhat greater for Stage 2 chemistry in CAP schools and for Stage 2 physics in both DSP and CAP schools; and
- a larger percentage of boys than girls participated in geology, with the exception of DSP schools, where girls constituted over three-quarters of all enrolments.

Based on a sample of ten Catholic schools, representing some 30 per cent of secondary schools with year 12 enrolments, South Australia reported that:

- 63.5 per cent of all boys and 75.4 per cent of all girls participated in at least one science course in 1996;
- the science participation rate for Indigenous students was much lower for boys, but was 100 per cent for girls; and
- participation by boys from language backgrounds other than English was also significantly below the average.

In Western Australian government schools, science enrolments in years 11 and 12 have declined over the last four years, particularly in year 12 human biology and geology, while enrolments in the non-TES (Tertiary Entrance Score) senior science course have almost tripled. There was a gender imbalance in most courses, with significantly more girls selecting biology and human biology, and boys favouring geology, physics, physical science and senior science. There was no significant gender difference in chemistry enrolments.

In Catholic schools, science enrolments in years 11 and 12 remained fairly constant, with the senior science course increasing in popularity. High participation levels were evident at senior secondary in independent schools, with students of both genders participating equally in chemistry, although boys predominated in physics.

Reporting from Tasmania indicated that in the post-compulsory years, nearly one-quarter of enrolled students (21 per cent) studied some form of science. A pre-tertiary course in science was undertaken by 13.1 per cent of students.

Data from the Northern Territory reflected much of that already reported from other States, with physics and chemistry being more popular with boys than with girls at year 12 and biology at both years 11 and 12 being far more popular with girls than with boys. The relatively greater popularity of year 11 chemistry with girls than with boys did not reflect the general position in other States. Participation rates for Indigenous students and students who were geographically isolated were less than from the total senior secondary student population.

The Australian Capital Territory reporting on participation by government and non-government students in science for the Year 12 Certificate in 1996 indicated that:

- 47.5 per cent of course enrolments in government schools were from girls, while the rate for non-government schools was 49.4 per cent; and
- 51 per cent of female students attempting year 12 did not complete a science course.

9.5 Curriculum time for the Science KLA

Although the integrated nature of the primary curriculum makes it difficult to generalise about time allocations to specific subject areas, a national study by the Australian Science, Technology and Engineering Council (ASTEC) found that between 45 and 60 minutes per week were allocated to the teaching of science and technology at primary levels. Limited State reporting indicated:

- the average time for Victorian government primary schools was 1.5 hours per week;
- the existing syllabus requirement in Queensland was one hour per week in years 1–7, although a new syllabus requirement will be a minimum of 1.5 hours per week, with significant additional discretionary time available;
- in South Australia, curriculum guidelines required a minimum of 100 minutes per week, but there was no official data on time allocations for science in the primary years in government schools, and anecdotal evidence suggests that actual time spent was less than 100 minutes per week in most classes. In Catholic schools the average time spent on science was in the order of one hour per week; and
- in the Australian Capital Territory, it was expected that 40–60 minutes per week would be allocated to science teaching in primary schools.

Time allocation for science subjects increased in junior secondary and tended to be greater still for courses at senior secondary, where students generally studied fewer subjects and the requirement to undertake practical laboratory work increased. States indicated that:

- the average for years 7 and 8 in Victorian government schools was 2.5 hours per week;
- in Queensland, a requirement of 180 hours over the three junior secondary years, with additional discretionary time up to a further 840 hours over the same period, was specified;
- in South Australian government schools, the average time allocated to science in 1996 was 200 minutes per week at year 8, increasing to 229 minutes per week at year 12; average time spent on science in Catholic schools was almost 210 minutes at year 8 and almost 255 minutes at year 12;
- in Western Australian independent schools, the time allocation by schools was mostly between 185 and 295 minutes per week; and
- secondary students in the Australian Capital Territory experienced 180 to 200 minutes of science per week.

9.6 Science initiatives and developments

Notable occurrences in science education in 1996 included the development of new curriculum, work towards establishing best-practice teaching methodologies and the establishment of teacher support networks. At a national level, students participated in a range of science competitions.

Science-related initiatives in the Catholic sector included a trial of a program published by the Australian Academy of Science, a project focused on children's use of technology and its impact on conceptual development, and a focus on the relationship between learning and assessment in science and technology. Independent schools used various approaches to increase student interest in science, including spending more time on science teaching, adopting a hands-on approach to science, exploring the links between language and science or the history and philosophy of science, and cross-level integration of science.

In Victoria, STEPS was broadcast to schools each fortnight via SOFNet, targeting students in years Prep, 1–2, 3–4, and

Science activities at Collingwood College, Victoria.

5–6 and their teachers. The broadcasts were accompanied by classroom support materials linked to the CSF, to assist teachers in the planning of their science and technology curriculum. In addition, a network of inter-related centres of excellence in science and technology education provided resources for the development of learning technologies across the curriculum.

The initiative with the potential to introduce the greatest change to science teaching in Queensland was the establishment of the Science Curriculum Development Project, an inter-systemic initiative of the Queensland School Curriculum Council (P–10) to design, develop and publish a science syllabus for years 1–10, supported by sourcebooks and initial inservice training materials. Statewide consultation has informed the development of a draft syllabus and the principles of the trial/pilot phase to occur during 1997–98.

Within the Queensland government schools sector there was a survey of science education in government primary and secondary schools, collecting a range of information to inform the development of curriculum and improve the quality of science teaching. In addition, the three key 1996 developments identified were:

- work on the development of the science syllabus for years 1–10, referred to above, which will involve 40 government schools in the trial/pilot phase;
- the formation of the Schools Animal Experimentation Ethics Committee, to help all schools to comply with regulations on the care and use of animals in schools; and
- addressing the issue of safety in science, the release of a reference manual and the inservice training of teachers, with focus areas including risk control and the control of hazardous substances in schools.

Some schools continued the development of their courses to emphasise analysis, interpretation and application, incorporating more complex reasoning and moving towards a more planned approach to science. Others were preparing for the changes to follow the development of the new science syllabus and the embedding of competencies in it. Changed emphases in science teaching in primary schools and increased linkages at the secondary level with TAFE colleges and universities also commonly occurred.

Support was provided through the Association of Independent Schools in Queensland (AISQ) for schools undertaking curriculum development to align their programs with the statement and profile. A number of schools developed outcomes assessment and reporting in science in line with the national profile. Most independent schools intend either to trial the new syllabus to be developed by the Queensland School Curriculum Council (P–10) or implement it when it is completed.

Significant achievements in science education in South Australian government schools in 1996 included:

- the establishment of the Science Reference Group;
- publications in science to support the implementation of the science statement and profile;
- two focus school programs, which began their first networking phase, sharing good practice with other schools using a train-the-trainer model;
- science professional development activities focused on the Energy and Change strand of the science statement; assessment, recording and reporting in science; and using student achievement information; and
- the development of the science curriculum exchange web pages.

While there was no specific system focus on science within Catholic schools in South Australia, individual schools undertook a range of initiatives, for example:

- developing teaching methods for middle school science, to include oral and group work and their assessment;
- including methodologies appropriate to the teaching of science to girls in the *National Action Plan for the Education of Girls 1993–97*;
- using new approaches in the teaching of science, including assessment of practical skills and procedures;
- participating in competitions and awards; and

- widening the use of technology – computers, CD-ROMs, the Internet, electronics, satellite delivery of science education programs and the encouragement of students in presenting projects using alternative media.

At the same time, changing trends in science education in Catholic schools were particularly evident in teaching strategies. Schools investigated a variety of approaches: single-sex groupings, learning teams approaches, small group work, rotation of classes amongst teachers, multi-age groupings, secondary teachers working with primary classes, and modelling by having females as the science teachers.

The major initiative reported by Tasmania was the use of NPDP funds to maintain networks of key teachers focusing on development of materials addressing specific curriculum areas and pedagogical issues. The framework for these materials was provided by the science statement and profile.

Evidence gathered through the school review process indicated that over 90 per cent of the reviewed schools had sound documented evidence of coherent and cohesive science syllabuses. Changed pedagogy was more evident in primary than secondary schools, but all types of schools were using a variety of strategies to improve student access to the curriculum, including widening the range of teaching styles, proactive efforts to ensure gender inclusiveness (ranging from teacher professional development to single-sex teaching groups), and consideration of the means by which special needs students could be integrated into the full science teaching program.

An issue still to be addressed is that of student learning outcomes, although, as a follow-up to the review process, schools are developing assessment, recording and reporting mechanisms for student learning outcomes in science. The science profile is being used to inform this process.

The identification of science as a strategic priority in Western Australia, the initiation of the Science Project and support from the broader science community have resulted in widespread implementation of Primary Investigations in schools, providing the State with an effective primary science program.

The Science Project was established to address needs identified in the 1993 MSE assessment for professional development and curriculum support. The project aimed to provide all schools with exemplary curriculum materials, establish an effective whole-school curriculum in primary schools, establish teaching methodology consistent with best practice, assist teachers to update their knowledge of science and its role in society, and establish networks of curriculum leaders to provide ongoing support for teachers beyond the life of the project. In developing new primary science materials and teaching approaches, particular attention was given to Indigenous students, early childhood students and isolated students.

The implementation of Primary Investigations in up to three-quarters of Catholic schools continued successfully and whole-school programs in science involved over 800 teachers, with clear improvements in teacher confidence and student enthusiasm for science.

Independent schools have made greater efforts in recent years to increase the participation of younger students and initiatives such as the Double Helix Club have proved effective. Trends in primary schools in this sector were toward ‘hands-on’ science and the use of science and technology studies to teach cooperative working and learning skills.

About two-thirds of responding schools focused on time allocations for science and a third identified specialist staff, professional development and teaching strategies as current issues. Schools pursued a range of initiatives, including Primary Investigations, life skills programs and new options such as marine studies. There was some feeling that science should encourage the development of positive values about the environment as well as knowledge and understandings.

Reporting from the Australian Capital Territory focused on the professional development opportunities provided though NPDP funding, as well as on the particular science opportunities provided through State and national science competitions and other special events with a science focus. The CSIRO, for example, through its Creativity in Science and Technology (CREST) program, offered opportunities for students in government and non-government primary and secondary schools to choose, organise and undertake their own experimental science or technology projects.

9.7 Emerging and continuing issues

The issue most commonly reported by the States was the need to improve the quality of science teaching in the primary years. Many primary teachers lacked confidence in teaching science, often because of their relative lack of background knowledge. Stemming directly from this lack of teacher confidence, the time allocated to science was often limited and the science activities undertaken not

always reflective of best practice. The need for more extensive professional development has been recognised and is expected to address many of the issues of teacher confidence in the science area in primary schools.

Professional development was identified separately as a key issue, particularly in areas relating to curriculum change and the application of the national statement and profile, key competencies, equity issues and teacher competencies. Science teachers associations, system science consultants and many science-oriented organisations provided professional development activities in 1996 in response to expressions of teacher need. Teacher participation ranged across government and non-government schools, metropolitan and non-metropolitan areas, teaching and non-teaching personnel and industry representation.

Within New South Wales government schools, the ageing of the teaching population was an issue which led to a focus on ensuring that pedagogy reflected best practice supported by current research. A professional development package launched by the Australian Science Teachers Association targeted these concerns.

The gender-biased participation rates in senior secondary science subjects were noted by a number of States and raised as an important issue by some of them. Nationally, boys outnumbered girls significantly in the study of the physical sciences (physics and chemistry) while girls still outnumbered boys in the biological and other sciences (see Table 68). There were also some tertiary concerns about secondary science which related to declining enrolments in the sciences at tertiary level.

A great deal of work has occurred and will continue to occur in all States in areas related to the science statement and profile. Student outcomes and the aligning of both curriculum and teaching and reporting practices with the science statement and profile were particular focus areas.

Among the other issues reported by States were:

- the specific inclusion by Queensland of the enhancement of student numeracy and literacy skills in its science curriculum priorities;
- in Western Australia, the supply of science teachers remained a concern, with senior secondary physics and chemistry being the most difficult to staff. The academic ability of students entering teacher education programs, most notably in the physical sciences, was also regarded as an issue requiring attention;
- South Australia reported that, in managing the eight KLAs, strategies for integrating more than one KLA into a topic without losing the integrity of the KLAs involved are a concern for teachers;
- South Australia also reported that key issues for senior secondary curriculum were the integration of vocational education into year 11 and year 12 curriculum and the design of courses to be inclusive of gender and Indigenous perspectives, the key competencies and collaborative learning, and science and society perspectives; and
- science education for Indigenous students remained an issue in the Northern Territory because of the differing paradigms between western and Indigenous science.

9.8 Impact of the national statement and profile

State reporting makes it clear that the science statement and profile have informed work undertaken in the development of science curriculum, but that they have still to be fully incorporated. At the minimum level the statement and profile were used to identify key areas or to establish a basic framework for in-school development. Others had proceeded much further along the path towards fully addressing the two documents in their courses. The variety of responses to the documents is exemplified below.

In New South Wales, the ‘outcomes in levels’ model inherent in the profiles significantly influenced the discussion about curriculum in science and was incorporated into the science teaching package produced by the Australian Science Teachers Association. However, this approach has also inspired some research into, and debate about, whether the levels really do describe a progression in learning for each of the designed strand organisers.

The new science curriculum under development for schools in Queensland has been based to a certain extent on the national science statement and profile. Outcome statements form the basis of intended student learning and for reporting on student achievement. The focus on students’ cognitive and conceptual development also reflected the spirit of the statement and profile.

In Tasmania, over 90 per cent of schools involved in the school review process in 1996 were addressing the national science profile. The most effective of these had mapped their curriculum to ensure coverage of the five profile strands in a sequenced manner, had identified units of work that address particular strands and were moving towards reporting student outcomes within this context.

Superintendents encouraged schools to undertake further professional development of staff in incorporating profile outcomes into planning and reporting.

Other reporting from Victoria, South Australia and Western Australia, in respect of non-government schools in each instance, gave a contrasting picture:

- Catholic schools in Victoria reported that the science statement and profile, along with professional development opportunities focused on those documents, were influential in changing teachers' thinking about science education;
- a significant number of independent schools in South Australia indicated that they investigated the alignment of their science curriculum with the nationally developed science statement and profile; over 70 per cent of sampled schools used the statement and profile to some extent for framing curriculum, but fewer than 20 per cent applied them to developing assessment procedures;
- two-thirds of Catholic secondary schools in South Australia and half the primary schools have implemented the science statement and profile, many of them in 1996; most schools only mapped their science curriculum against the science statement, but others have rewritten their curriculum in terms of the profile outcomes and some assess and report against the profile outcomes; and
- reporting from Western Australia suggested that less than 50 per cent of independent schools used the national framework in formulating curriculum or in assisting program development or assessment; where the national statement and profile were used, it was for the purpose of identifying key areas or establishing a basic framework for development by school staff.

9.9 Involving parents and the community in science education

Similar to the practices reported in respect of support for the development of numeracy, the involvement of parents and community organisations in the teaching and learning of science in Australian schools took many forms.

Some schools sought to involve parents to no greater extent than overseeing homework, supporting their children's learning, receiving school newsletters and conferring with teachers on occasional school visits. In a great many schools, however, participation was far more active and was an integral part of the teaching of science. Parents without specific science backgrounds were regular participants in such science-related activities as:

- providing supervision and facilities for excursions;
- attending parent seminars;
- discussion of topics and ideas with their children and becoming aware of science education through their children's involvement; and
- attending science week activities and science festivals.

Reporting from a number of States made it clear that parents and other members of school communities with backgrounds in science were highly valued as resources and role models for science students and were recruited to:

- promote the vocational relevance of science, increasing student awareness of science-linked careers;
- deliver guest lectures in their areas of expertise; and
- provide expertise and supervision in environmental activities.

The involvement of community groups was almost always in the context of active contribution to science teaching and learning. Universities, industry members and organisations, government departments and community organisations all assisted the development of science learning and teaching through:

- sponsoring activities such as science competitions, which were a part of science learning for many Australian students in 1996;
- providing additional teaching input by way of guest lectures and summer schools;
- supplying scientists to work with entire classes on projects in areas such as marine biology and environmental problems;
- supporting school science activities in fields such as minerals, plastics and petroleum; and
- placing students in science-related work placement programs, where they can learn and demonstrate skills and receive accreditation towards a TAFE module.

On yet another level, the entry by schools into events such as the international solar car challenge, signalled a milestone in efforts to relate aspects of science to contemporary social issues and to seek partnerships with business and industry in the teaching and learning of science.