



**review of**  
**teaching and teacher education**

**Interim Report:  
Attracting and Retaining  
Teachers of Science, Technology  
and Mathematics**

**Committee for the Review of Teaching  
and Teacher Education**

**February 2003**

an initiative of

**Backing**  
**Australia's**  
**Ability**

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## **BACKGROUND**

One of the long-term strategies in the Government's \$3 billion innovation statement *Backing Australia's Ability*<sup>1</sup>, which was launched by the Prime Minister, is to increase the number of talented people who are attracted to teaching as a career, especially in the fields of science, technology and mathematics education. To implement this strategy, the Review of Teaching and Teacher Education, with a particular emphasis on science, technology and mathematics, was announced by the Minister for Education, Science and Training, the Hon. Dr Brendan Nelson MP. The Review's Terms of Reference are at Appendix 1.

An independent Committee, with representatives from school, university and industry sectors, was established on 8 August 2002 to oversee the Review. A broad-based Reference Group—made up of a wide-ranging and diverse group of individuals drawn from Deans of education and science, teacher professional associations of science, technology and mathematics, business organisations, parents groups, principals, teachers' unions, teacher education bodies, educational organisations and others—was established to assist the Review Committee by providing guidance on the issues raised during the Review. Details of the Review Committee and Reference Group are at Appendices 2 and 3. The Review Committee and Reference Group met separately on several occasions and held a combined meeting to discuss the final draft of this Interim Report.

The Review Committee's first Discussion Paper, *Strategies to Attract and Retain Teachers of Science, Technology and Mathematics*, was released on 5 September 2002, and accompanied by a national call for submissions. The Discussion Paper was intended to stimulate thinking about the issues relevant to strategies to attract and retain teachers of science, technology and mathematics, and provided an opportunity for parents, teachers, educators and all those interested in the teaching of mathematics, science and technology to contribute their ideas.

The response to the Discussion Paper was very encouraging, and the submissions provided a rich source of ideas and information for consideration. Submissions came from a wide range of organisations, including government and non-government school education authorities; most universities; teacher professional associations; industry, peak parent, principal, teacher and union bodies; as well as a diverse group of individuals. At the time of writing, a total of 143 submissions had been received. These submissions are listed at the back of this Report and are publicly available on the website hosted by the Department of Education, Science and Training (DEST) at [www.dest.gov.au/schools/teachingreview/sublist.htm](http://www.dest.gov.au/schools/teachingreview/sublist.htm).

A second Discussion Paper on innovation in Australian schools will be released shortly. Comments on that discussion paper will also be invited through a formal process of written submissions to the Review Committee. In accordance with the Minister's directive, a final report will be produced in mid-2003.



## FOREWORD

What became clear from the submissions and consultations to date is that teaching and teacher education is higher on the public agenda than ever before. There is a general consensus that this Review comes at a timely moment and that a convergence of factors occurring in the States and Territories will ensure that the Review has opportunities to institute important changes to Australia's school teaching and learning environment.

The emerging consensus among the education community is that issues related to the attraction and retention of teachers of science, technology and mathematics—the key theme of the first phase of the Review—are not isolable from the broader teaching and learning environment. The Review Committee took these views into account when preparing this Interim Report, which draws upon the wealth of information and thoughtful ideas and views contained in the submissions as well as broader education literature.

This Interim Report deals principally with attracting and retaining teachers of science, technology and mathematics. Recommendations have been held over for the final report, which will provide a comprehensive series of recommendations that address all aspects of the Review.

The Review looks forward to the completion of the current teacher supply and demand project being conducted by the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) which is examining the state of the teacher labour market in each Australian State and Territory in 2001, and will assess future teacher supply and demand. The Review also looks forward to the outcomes of the Review of Higher Education led by the Minister for Education, Science and Training, the Hon. Dr Brendan Nelson MP.

The Chair and Committee members thank the many knowledgeable individuals and organisations who contributed their observations and opinions through the submission process and through other consultations. In particular, the Committee thanks those on our Reference Group.

Sincere thanks are also expressed to Di Weddell and Dr Shannon Smith and all members of the Review Secretariat in the Department of Education, Science and Training who have been unfailingly helpful, who work cheerfully under pressure, and who have on so many occasions anticipated our needs.



Professor Kwong Lee Dow AM  
Review Chair  
20 February 2003



## **EXECUTIVE SUMMARY**

### **TEACHING AND LEARNING NEEDS OF THE KNOWLEDGE ECONOMY AND SOCIETY**

Australia is expanding its knowledge economy base built on the advanced skills, understandings and imagination of its people. Increasingly, the strength of our democratic institutions and our international success as a nation will hinge on the realization of the potential of all Australians.

In that context, the quality of our schools and, most importantly, our teachers is fundamental. Teaching is a crucial profession that requires talented, knowledgeable, enthusiastic and dedicated people. It is a matter of the utmost social importance that sufficient numbers of such people are attracted to, and retained in, the teaching profession. More than ever, coordinated planning and action by governments, employers, higher education institutions and the profession itself are required to ensure that enough high quality teachers are available to lead and facilitate the best possible learning for all our children. The Review was constantly reminded that quality teachers make a significant and lasting impression on peoples' lives.

For Australia to achieve its full potential as a highly successful knowledge-based economy and society, it will be necessary to raise the scientific literacy of Australians, to strengthen the foundations for world class scientists and innovators to emerge, and to support the development of a new generation of excellent teachers of science, technology and mathematics. Especially valuable will be the role played by high calibre teachers of science, technology and mathematics in developing the sound knowledge bases, competencies and capacities for creative and innovative thinking needed to secure our future well-being as individuals and as a nation.

There are a quarter of a million teachers with three and a quarter million students in Australia's schools. Broadly the supply of teachers has been sufficient to meet school needs across the country. However, in certain secondary specialisations—including physics, chemistry, mathematics, technology studies and languages other than English—significant recruiting difficulties exist in some rural and remote locations and in some locations within metropolitan areas. This situation may become more difficult in the second part of this decade.

Australia is likely to face significant losses of teachers through retirement, particularly at the secondary level, due to an ageing of the teaching workforce. Finding additional numbers of quality teachers, and preparing new professionals for teaching, to meet expected vacancies created by retiring teachers, will be a top priority.

While there are adequate numbers of primary teachers in Australian schools, more needs to be done to ensure that science, technology and mathematics is prioritised in primary schools and that primary teachers are effectively prepared and supported to ensure quality student learning in these areas.

Declining school student participation in science is a cause for concern. Study of physics, chemistry and biology at the Year 12 level declined over the last decade. The growth in participation in schools to Year 12 has been accompanied by a growth in the range of available subject offerings.

There are claims of schools narrowing subject offerings because of the unavailability of teachers with the required specialist skills and knowledge. Although the evidence is largely anecdotal, it is often claimed that a significant

proportion of teachers of science, technology and mathematics is not well enough qualified to teach in these specialist subject areas. The current work of the profession and education authorities on what constitutes professional standards will assist future debate of this contested issue.

Of concern in the medium to longer term is the trend for a lower proportion of teacher education students to undertake studies in physics, chemistry and mathematics. At a broader level, the age structure of the teaching force, with the potential for a high proportion of teacher retirements over the next decade, reinforces that there is no room for complacency in planning for a future supply of teachers. This is more compelling when one considers the different and flexible career expectations of young people who are unlikely to simply replicate the career behaviour of the current generation of teachers.

## **ATTRACTING TEACHERS OF SCIENCE, TECHNOLOGY AND MATHEMATICS**

An increased number of highly talented and motivated people need to be attracted to teaching, with this imperative particularly pronounced in the fields of science, mathematics and technology.

The evident increased interest in teacher education courses in the last two years is heartening. There also now needs to be more extensive exploration of additional means of selection for admission to teacher education. The objective should be to ensure the best fit between the outcomes of selection and applicants' suitability for the profession.

Public awareness and appreciation of teaching as a profession has to be raised. Aligning recruitment policies and practices with the interests and expectations of prospective teachers will become even more crucial. Tapping into prospective teachers' well-documented view of teaching as a socially valuable career, their liking of young people and their wish to help them succeed, is essential.

Financial incentives offered by employers, such as scholarships, arrangements to pay specialist teachers' accumulated higher education contribution scheme (HECS) debt, and assurances of employment (often in specified rural areas), have proved successful in drawing an expanded cohort of suitable people to teaching.

A broad and flexible view of the possible sources of teaching talent needs to be adopted. There is an emerging trend for those with suitable formal education and relevant life experiences, who are presently working in other occupations, to be attracted to teaching. Their interest needs to be encouraged and their transition to teaching facilitated. This may include the formal recognition of prior learning, implementation of appropriate fast-track teacher education, and the availability of commencing salaries at above the normal rate in recognition of previously acquired and relevant skills and experiences.

Greater attention should be focused on nurturing an interest in teaching among the large proportion of undergraduate students enrolled in science, mathematics and technology subjects who tend towards careers in other fields. This includes a strategic focus on the nature of teacher education courses and their effectiveness in the changing school environment.

There is a great deal of evolution and innovation in teacher education programs in Australia, but the predominant patterns of qualification remain; for secondary teachers, an undergraduate degree with substantial studies in one or more subject areas followed by a shorter period of postgraduate study of education and teaching method and; for primary teachers, an undergraduate education or teaching degree integrating subject study and studies of education and teaching method. There is continuing discussion about the appropriate balance of deep subject knowledge and advanced pedagogical competence required by teachers at the different levels of schooling.

Agreement on the critical importance of in-school experience (the practicum) was widely expressed. The high attendant cost to universities of running practicums is an issue that will need to be addressed. Greater cooperation between education and other faculties in the delivery of programs of teacher education is also required.

Emerging demographic trends and shifting social attitudes are affecting the way that new entrants and existing teachers participate in the education profession. Careers in teaching can be seen as careers in education more broadly. Teachers with their expertise in knowledge management will increasingly have opportunities to work in the broader education profession which supports the knowledge economy.

Similarly, continuing consideration ought to be given to enhancing the flexibility of course delivery to accommodate the diverse character, circumstances and needs of the prospective teacher education student cohort. For example, part-time, evening and other flexible delivery modes have further potential.

Starting salaries for teachers compare favourably with those available to graduates entering other occupations. Submissions saw greater HECS fees for prospective teachers of science, technology and mathematics as compared with teachers of other disciplines as disappointing.

Across the country, arrangements for workforce planning are varied and often uncoordinated. However a number of States and Territories have developed sophisticated teaching workforce planning processes. Better and more collaborative planning among all the key stakeholders needs to be negotiated and implemented because, in some States and Territories and for some systems, the projected teaching workforce needs of school systems do not formally inform the enrolment targets and shape of teacher education programs run by universities. Many key players contend that national data collection, analysis, coordination and brokerage relating to teacher supply and demand is required.

A formal professional standards framework can assist greatly in building teaching as a career of choice, and one well-regarded by the general community. Professional standards and teacher registration should be defining national features of the teaching profession in Australia. Significant work is underway towards the identification and promulgation of teaching standards and the eventual adoption of agreed frameworks across Australia will promote consistently high quality teaching and encourage public recognition of the character and complexity of teaching excellence. The adoption of standards will further enable the celebration and rewarding of that excellence. Momentum is also building for additional active leadership at the national level.

The introduction of portability arrangements would allow teachers to make seamless transitions between schools, school systems and State and Territory jurisdictions without losing salary, other work entitlements or standing.

## **RETAINING TEACHERS OF SCIENCE, TECHNOLOGY AND MATHEMATICS**

Too many teachers leave teaching in the first three to five years of their teaching careers, representing an excessive loss of talent. It needs to be borne in mind, however, that as with other occupations, there is an increasing trend towards movement 'in and out' of a variety of occupations. Episodic career change will be increasingly common in all parts of the labour market.

Greatly improved programs of support, induction and mentoring for beginning teachers need to become commonplace if successful transition to a continuing career in teaching is to occur. Here again there is need for continuing partnerships between universities and schools in guiding new teachers through the early, demanding period of their career.

Positive work environments, in which teachers feel valued and are able to fully engage students are crucial to student learning. The physical conditions within schools, curriculum materials, teaching loads, appropriate class sizes, access to and use of technology, access to appropriate in-service training and the opportunity for study leave and professional development increase teacher satisfaction and therefore retention.

The provision of high quality and pertinent professional learning and development opportunities will serve to rejuvenate, motivate and retain good teachers. Where possible, giving teachers the opportunity to gain experience in the broader education profession and other industries relevant to their teaching can reinvigorate and add new dimensions to teaching skills.

Effective school leadership, to build and maintain a supportive, friendly and positive school environment ensures more teachers remain in the profession. Perhaps the best means of improving teacher retention is through teaching that is lively with students engaged. Leadership that promotes a strong sense of purpose and a joy in learning shared between teachers and students creates environments where good teachers want to remain.

Considerable teacher time is occupied in attending to a wide range of non-teaching tasks. A range of roles for support staff, teaching assistants, non-teaching experts and community members within teaching and learning teams merits further consideration. Ways should also be found for more undergraduate and postgraduate tertiary students, particularly in science, technology and mathematics, to return to schools and support teachers and students in the classroom and laboratory. The teacher's role would be pivotal and such additional resources would support teacher expertise and student outcomes in and out of classrooms.

The present widespread practice of offering employment to teachers on a short-term contract basis is counter to the aim of fostering longer term commitment to teaching among beginning teachers. Lack of job certainty often drives new teachers to other employment.

After some ten years teaching, teachers' salaries plateau, remaining fixed thereafter unless the teacher seeks and gains promotion to another position (tending to remove them progressively from the classroom role they typically relish). This stasis can be a source of great frustration among experienced teachers and a reason many feel undervalued and look to other occupations.

The sheer size of the teaching force and the enormous cost to school systems of teacher remuneration results in a pronounced inertia in providing higher rewards for advanced teacher competence. However, as an essential part of the continuing professionalisation of teaching which must occur, avenues need be found to remunerate teachers who demonstrate ever more advanced competencies in the classroom.

## **THE WAY FORWARD**

Most of the approaches needed to better attract and retain teachers, and to reinforce the quality and standing of the profession, are already being implemented by one or more school systems and/or education faculties in Australia. The challenge is for these initiatives to be adopted more consistently and holistically throughout the country, and with the support of all stakeholders and participants, with the profession itself at the forefront of this drive.

To meet the individual and social imperatives of tomorrow's Australia, the scientific, mathematical and technological knowledge, confidence and competence of our young people must be further enhanced. Foundations for lifelong learning and higher participation in these areas must be prioritised.

Establishing and maintaining an adequate supply of quality teachers generally, and of good science, mathematics and technology teachers in particular, is a complex matter, requiring actions by a range of key players. With teaching occupying an ever more pivotal position in the knowledge economy and society, the imperative has never been greater for these stakeholders to collaborate and create robust partnerships to ensure the future supply of high quality teachers.

Within that setting of greater collaboration, cooperative planning to assure the needed supply of good teachers is fundamental. To underpin that planning, better and more comprehensive data, including that at the national, state and local level would illuminate the likely patterns of future supply of and demand for teachers and inform education policies and programs.

A national framework to support the new professionalism of teaching is required. A national framework will promote the consistent adoption of improved career paths for teachers, clear and specific standards for the profession, and portability of qualifications and entitlements. In turn, this will lead to greater acknowledgment of the need for professional learning and development.

The Way Forward points to the future. Recommendations around attracting and retaining teachers of science, technology and mathematics have been held over for the final report. The next Discussion Paper will explore a range of issues around developing an innovation capacity in Australia's school sector.

## 1 TEACHING AND LEARNING NEEDS OF THE KNOWLEDGE ECONOMY AND SOCIETY

### OUR LEARNING AND KNOWLEDGE NEEDS

Australia is expanding its knowledge economy base founded on competitive innovation systems, strong information and communications technology infrastructure, well-developed human resources and a productive economic framework. This shift is well underway and already knowledge-based industries account for roughly half of Australia's GDP.<sup>2</sup>

As recognised in *Backing Australia's Ability*, Australia's ability to remain internationally competitive over the next decade will depend to a large extent on the way in which it generates and uses knowledge. Australia, like many nations seeking to position its citizens to participate in the emerging global economy, is increasingly having to base its future on the emerging new science and industry fields such as bioinformatics, biotechnology, genomics, laser science, nanotechnology, micro-electronics—which derive from the enabling sciences of physics, chemistry and mathematics. The way this happens will in turn depend on the way in which research, development and innovation are supported.<sup>3</sup> Chief Scientist, Dr Robin Batterham, has described Australia's challenge:

We are presently in the middle of scientific revolutions in areas such as information and communications technology, genomics, biochemistry and nanotechnology that will change the way we live and work. The world stock of knowledge is doubling approximately every seven years, driven by the substantial commitment by the technologically advanced countries to invest in knowledge generations and workers of all kinds.<sup>4</sup>

The economic benefits of meeting these challenges are significant, and it is well understood that, even over a short period, increased involvement by Australians in the information economy could generate higher economic growth and increased employment opportunities. The Non-Ministerial members of the Victorian Council for Knowledge, Innovation, Science and Engineering argued that:

It is vital for the community to recognise that growth in employment and wealth creation depends upon further investment being made in the new industries to underpin economic expansion in the 21<sup>st</sup> century and continuing reinvestment in new technology in existing industries is essential if they are to remain internationally competitive.<sup>5</sup>

Australia's education system must be able to support this vision because a well educated and skilled workforce that embraces lifelong learning is essential for Australia to achieve its full potential as a strong economy capable of generating employment. This impetus places certain demands on Australia's education system to:

- **improve the scientific literacy of Australians** and create a well educated and skilled workforce that embraces lifelong learning;
- **equip Australia with world class scientists and innovators** in a range of disciplines able to take ideas through to successful application and commercialisation; and

- **enhance Australia's capacity to train, inspire and retain world-class teachers of science, technology\* and mathematics** who can in turn inspire and instil the necessary technical knowledge and critical and creative thinking skills in their students and achieve the previous two objectives.

A solid grounding in science, technology and mathematics is important for all Australian young people because rapid globalisation and technological change in the Australian workplace and society will demand such knowledge and abilities; because science and mathematics are important to everyday decision-making; and because the analytical tools of science and mathematics are primary foundations for lifelong learning. Information communications technology (ICT) is transforming communication mediums, accelerating the speed with which information is accessed, used and disseminated and at the same time transforming how information and knowledge is organised and therefore learned.

The Australian Academy of Technological Sciences and Engineering is of the view that:

... 21<sup>st</sup> century democracy demands scientific and technological literacy and understanding throughout the population. Ordinary people will increasingly be asked to make judgements about matters under pinned by science knowledge or technological capability. Those without a basic understanding of these matters will, in the future, be either disempowered or misled in exercising their democratic rights and powers within a technologically dependent society.<sup>6</sup>

In the words of the Australian Primary Principals' Association: "A sound education base is central to the future of the nation's most valued resource, the youth of Australia".<sup>7</sup> Australia needs to prepare a future generation imbued with a deep understanding of the enabling sciences, with the skills to learn and adapt to new circumstances and environments, and with a global mindset. It is crucial that all students have access to science, technology and mathematics that is engaging and of high quality.

There are views in the community that, in recent years, student interest in science, technology and mathematics has been waning:

The decline in the number of students completing examinable science subjects at upper secondary school over the last three decades has been widely documented ... Although this may be, in part, attributable to the increased availability of choice for students in subject areas that are more suited to their particular strengths, it is nevertheless a worrying trend, given the increasing numbers of science professionals and teachers required in this burgeoning age of new technologies. Perhaps even more importantly the science education system, as it exists, may be failing to capture the interest of our brightest students who would otherwise make enormous intellectual contributions to the future of Australian Science.<sup>8</sup>

Declining school student interest in science since the early 1990s—particularly in the study of physics, chemistry and biology subjects at the Year 12 level—is cause for concern and inconsistent with the knowledge needs of an advanced technological and democratic society. Between 1992 and 2001, enrolments in Year 12 biology decreased by 30 per cent, enrolments in Year 12 chemistry decreased by 23 per cent, and enrolments in Year 12 physics decreased by 22 per cent. This decline was sharper in the first half of the 1990s and enrolments plateaued midway through the decade.

For mathematics, overall Year 12 enrolments have changed little over the past decade. Between 1992 and 2001, enrolments in Year 12 mathematics decreased by three per cent; the decline was slightly lower midway through the decade and rose from that point.<sup>9</sup>

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\* While each State and Territory defines and interprets technology slightly differently in its curriculum, the following recent definition provides a useful encompassing view of technology education: *Technology is about the synthesis of knowledge, ideas and skills in the solution of identified problems and the development of innovative capabilities. In its focus on synthesis, design and invention it embraces creativity across the full spectrum of a student's learning. In a real sense, this synthesis places technology education as a significant integrating force within schooling. It is learning through practice. It is often practised through group or team activities with the objective of finding solutions that are culturally and environmentally informed* (AATSE 2002). In this document, information and communication technologies (ICT) refers to the technologies used by teachers across the curriculum as teaching and learning tools.

Yet schooling outcomes in science and mathematics by international comparison are generally encouraging. Australian secondary students perform well in terms of international comparisons of reading, mathematical and scientific literacy, as evidenced through the results of the Organisation for Economic Cooperation and Development (OECD) Programme for International Student Assessment (PISA) which assesses the reading, mathematical and scientific literacy of 15-year-olds every three years. Australia is amongst the highest performers in all three areas statistically, only being outperformed by Japan in terms of mathematical literacy, by Japan and Korea in terms of scientific literacy and by Finland in reading.<sup>10</sup> The strong performance is borne out in other studies. Outcomes of the Third International Mathematics and Science Study (TIMSS) during the mid-1990s show that in both mathematics and science, Australian students generally performed above the international average and often at levels not far below the world leaders.<sup>11</sup>

Overall these are encouraging results but they should not bring complacency. There are some areas requiring action which relate in part to ensuring that appropriate high-level outcomes are secured for all students. As a result of the PISA study, the Australian Council for Educational Research (ACER) identified a number of areas requiring action in order to ensure that appropriate high-level outcomes are secured for all students.<sup>12</sup> The main areas of concern are the poor performance of Australian boys in reading, the relatively low achievements of Indigenous students across all three domains, and the fairly wide dispersion of results between students from higher and lower socioeconomic backgrounds.\*

School participation rates in science, technology and mathematics also have a broad and far-reaching impact. The number of teachers of science, technology and mathematics depends on the number of undergraduates who graduate as teachers in these areas; and the number of undergraduates electing to study in these areas depends on the number of students at secondary school who participate in science, technology and mathematics. The potential effects this cycle can have was well described by Professor Alan Lindsay, Deputy Vice Chancellor, Academic and Planning, at Monash University:

Arguably, too few well qualified, committed and innovative teachers of mathematics, science and technology in schools has led to too few well prepared, confident and interested students entering higher education. Amongst those who do commence, retention is not high. This has obvious consequences for the number of graduates available to take up teaching. This has led to too few well-qualified, committed and innovative teachers ... and so on. This cycle cannot be overcome without long-term strategic policy and consistency of practice ...<sup>13</sup>

As noted by the National Council of Independent Schools' Association, the importance of "developing an interest from an early age in science, technology and mathematics" cannot be overstated, and that interest is first developed in primary schools.<sup>14</sup> However, the regularity and quality of science teaching in primary school is highly variable. According to Goodrum, in some primary schools, science is taught both as a specific subject and integrated into other curriculum areas, but in other primary schools, science is either not taught or poorly taught.<sup>15</sup> When it is taught well and on a regular basis, there is a high level of student satisfaction. The Non-Ministerial members of the Victorian Council for Knowledge, Innovation, Science and Engineering argued:

... there appear to be limited efforts to place classroom science in a real world context to make it relevant to every day life. There is continuing evidence of declining science participation rates among school children, and there appears to be no integration of any of this activity with sensible and realistic careers and course information.<sup>16</sup>

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\* In the context of this report, it is important to note that there was no significant difference between the scores of male and female Australian students in either mathematical or scientific literacy, and also that the relationship in Australia between socioeconomic status and student performance was stronger for reading literacy than for either mathematical or scientific literacy. ACER indicates that socioeconomic background alone does not determine outcomes—there are many students from lower socioeconomic backgrounds who achieve very high scores.

It appears that many primary teachers are assigned to teach mathematics and science but lack the expertise and confidence required to teach these learning areas, and may even actively dislike them.<sup>17</sup> Fritz observes: “The great majority of teachers who select a career in early childhood or primary school education have a personal preference for the humanities as opposed to the sciences. They often confess to feeling ill at ease with teaching science and technology”.<sup>18</sup>

The transition from primary school to secondary school is another critical juncture because students are introduced to a new teaching and learning environment, such as having specific teachers for each subject. There is strong evidence from the United Kingdom to suggest that the effectiveness of learning outcomes in primary school endure through secondary school, which reinforces the importance of quality teaching in mathematics and science at primary level.<sup>19</sup> Goodrum reports that post-primary students in Australia are generally enthusiastic when they initially enter junior secondary school, but that this enthusiasm is frequently not sustained beyond the second year.<sup>20</sup> Other studies have shown that at this stage, expectations of an interesting and challenging science curriculum in secondary school are not fulfilled and instead, students are faced with ‘chalk and talk’ style teaching rather than hands-on practical lessons.<sup>21</sup> It is at this stage that some students encounter feelings that science, technology and mathematics are too hard or are irrelevant to their everyday lives.<sup>22</sup>

A further critical juncture for students is at the transition from compulsory to post-compulsory schooling, particularly when making choices for Year 11 and 12 subjects preceding tertiary studies or entering the workforce. The Non-Ministerial members of the Victorian Council for Knowledge, Innovation, Science and Engineering argued that:

Student enrolments still include a core group who are passionate about science but there are many there just to meet pre-requisite requirements, keep options open or improve tertiary entry scores. Non-enrolments by those who could well have the capacity to be successful are due to poor experience in earlier years, gender differences, perceptions that it is ‘too hard’, peer and/or family pressures (or lack thereof), and lack of opportunity due to timetable blockages.<sup>23</sup>

Enrolments in science and mathematics in the final years of secondary school lead to subsequent tertiary education options for students. According to Monash University:

Notwithstanding considerable efforts to improve curriculum over recent years, upper secondary curriculum in mathematics and science, particularly for the ‘more able’, still tend to be designed as preparatory for higher education rather than offering knowledge which is significant, applicable and interesting in its own right. Ironically, too many students do not choose the very ‘futures’ for which these courses are designed to prepare them. We venture to suggest that were school mathematics and science designed to enthuse, inspire and equip students in and for their present lives, more would elect to continue their involvement.<sup>24</sup>

It is imperative that efforts are made to maintain, stimulate and enhance participation rates in the learning of science, technology and mathematics in Australia’s schools. This is necessary to ensure an adequate supply of school leavers able to undertake tertiary studies in science, technology and mathematics, and also to prepare a future generation that is scientifically literate. It is also necessary if Australia is to secure quality teachers.

Over the period 1992 to 2000, the total number of students in first-year undergraduate secondary teacher education courses rose by nine per cent. However, the number of students in first-year undergraduate secondary teacher education courses undertaking Science subjects declined by 29 per cent over that period, with the number of students in first-year undergraduate secondary teacher education courses undertaking Physical Sciences and Chemical Sciences declining by 62 per cent and 37 per cent, respectively, and the number undertaking Biological Sciences rising by 15 per cent. The number of students in first-year undergraduate secondary teacher education courses undertaking Mathematics and Computing also declined between 1992 and 2000, by 46 per cent and 26 per cent, respectively.

Based on current university preference trends at least, teaching is becoming a career of choice again. Notwithstanding the figures above showing declines in certain science subjects to 2000, anecdotal evidence

suggests that there are also increasing enrolments in science methods subjects and a similar improvement in the quality of those applicants. The apparent renewed interest in teaching is very encouraging, and the picture in relation to mathematics and the physical sciences may also be improving.

The Australian Council of Deans of Science “firmly believes that Australia’s future prosperity and independence requires a community which has a significantly higher level of scientific literacy than present. Teachers who know ‘what’ as well as know ‘how’ to teach are the key”.<sup>25</sup> Promoting a vision for teaching and learning needs to be grounded in the notion that teaching is an important profession at the forefront of social and economic change and one that requires specialised and highly valued skills and people. Learning today must be both lifelong and lifewide.<sup>26</sup> **Teaching and teachers are central to the knowledge economy and society.**

The changing context of teaching in the 21<sup>st</sup> century has many implications for influencing quality teaching and national capacity building in science and innovation. As knowledge becomes the underpinning element of society and the economy, teachers’ roles are shifting in substance and scope. As a result, strategic action aimed at securing quality teachers for Australian schools takes on new significance, particularly when there are now more career opportunities for people with skills in sciences, technology and mathematics, and when there are shifting expectations and attitudes relating to teaching as a profession and a career.

How Australia will fare in the future is very much dependent on how well it secures quality teachers in the next few decades. The overall outlook for continued maintenance and expansion of the science, technology and mathematics teaching force is not without its challenges. Australia’s profession of teachers—numbering a quarter of a million—particularly teachers of science, technology and mathematics, is ageing and faces competition from other sectors of the knowledge economy for a relatively modest number of graduates with science, technology and mathematics expertise.

## THE CURRENT STATE OF PLAY

Submissions from a variety of organisations and individuals provided a great deal of comment about attracting and retaining teachers of science, technology and mathematics in Australia’s schools, and identified a range of factors contributing to past, current and anticipated recruitment difficulties, including:

- the retirement over the next decade of a significant cohort of ‘baby boomer’ teachers;
- a gender imbalance, skewed towards a larger proportion of females, and falling rates of males;
- the relatively small numbers of teachers trained in the 1980s and early 1990s;
- difficulties obtaining teachers in regional and remote locations;
- aggressive recruitment of Australian teachers by overseas education systems offering relocation and teaching incentives; and
- losses of qualified teachers who either do not follow through into teaching or leave within the first few years.<sup>27</sup>

## Age and Gender Characteristics of the Teacher Workforce

Submissions identified that the ageing of the teacher workforce is a significant issue. Some State and Territory education authorities were of the view that they were unlikely to experience shortages in the short term but that there was likely to be greater demand in the medium-long term. The Western Australia Department of Education and Training was confident of maintaining the supply of teachers ‘in balance’ with demand, but that there would be challenges with the retirement of the ‘baby boomer’ cohort over the next 10 to 12 years.<sup>28</sup> Curtin University pointed to the fact that in Western Australia, the teaching area of technology and enterprise has been designated as a high risk area of shortage because 64 per cent of its technology and enterprise teachers are aged over 40 and 17 per cent are aged over 55.<sup>29</sup>

The Tasmanian Department of Education predicts that meeting overall demand in the secondary sector may become more difficult in 2006 and 2007 as a significant section of the teaching workforce begins to retire—as of June 2002 the average age of the Tasmanian teacher workforce was 43 years. A consequence of this will be high separation rates.

The Victorian Auditor-General found that 45 per cent of the Victorian State Government teaching workforce is likely progressively to retire over the next ten years, and that a substantial increase in the numbers of new entrants to the profession would be necessary to offset these losses.<sup>30</sup> The South Australian Department of Education and Children's Services acknowledged that ageing and retirement may lead to shortages of teachers of science and technology in the next five to seven years.<sup>31</sup>

Some 42 per cent of Australia's teachers are aged 45 years and over, and the teaching workforce is older relative to the rest of the workforce. Given the tendency of many teachers to depart the workforce around age 55, many may retire in the next decade.<sup>32</sup> The age structure of the teacher workforce varies between the primary and secondary sectors and varies significantly across States and Territories, with:

- the proportion of primary teachers aged 45 and over ranging from 40 per cent in Queensland to 53 per cent in South Australia; and
- the proportion of secondary teachers aged 45 and over ranging from 42 per cent in Queensland to 69 per cent in the Australian Capital Territory.<sup>33</sup>

With a large proportion of its workforce aged between 45–55, a potentially high proportion of Australia's government sector teachers may be eligible and decide to retire within the next 10 years. The extent to which retirements occur will depend on the success of any incentives offered to older teachers to remain in teaching. A significant factor is the nature of superannuation arrangements which, while they vary between States and Territories, generally encourage departure at the age of 55–60 years, although a number of these teachers may return on a casual basis. The picture is not so clear in the non-government sector, where superannuation and potential age retirements have different patterns to those in the government sector.

The ageing of the teacher workforce has potentially serious implications for schools because high levels of retirement from the middle of this decade will require effective means to attract increasing numbers to teaching in coming years, as well as effective means to retain teachers of all ages in Australia's schools. There is uncertainty about what will be the precise patterns of future retirements, such as whether they will occur in a concentrated pattern or be distributed across a broad age range over time.

Submissions also raised concerns about the gender profile of the teaching workforce. The numbers of female teachers in primary schools and secondary schools have increased over the last decade, and females now account for 79 per cent of primary teachers and 55 per cent of secondary teachers in Australia's schools.<sup>34</sup> It is desirable from the perspective of a diverse society that the numbers of male teachers increase in coming years, particularly in primary schools. This would allow our young children to see both men and women valuing learning and taking leadership in supporting the learning of others.

Another aspect to the gender profile of the teaching workforce is that while the numbers of female teachers have been rising overall, they have not been rising in secondary specialist areas such as science and mathematics. According to the Australian Council of Deans of Science, university enrolments in science, technology and mathematics are predominantly male.<sup>35</sup> More male teachers hold science qualifications (women only outnumber men in psychology) and men outnumber women by a factor greater than two-to-one in physics and chemistry. Moreover, a large proportion of male science and mathematics teachers are aged 45 or over, and their potential retirement from the middle of this decade will require effective means to attract increased numbers of teachers of these specialisations, particularly increased numbers of female teachers. The Tasmanian Department of Education will be addressing increased separation rates for secondary teachers of science and mathematics over the next few years by encouraging increased numbers of female secondary teachers of science and mathematics.<sup>36</sup>

## International Competition

Some submissions also expressed concern about potential losses of teachers to overseas education systems. A number of countries, including the United Kingdom, Hong Kong, Canada and the United States, recruit Australian teachers with offers of higher salaries and a range of incentives (including airfares, housing and rental assistance, training bursaries, bonus schemes, teacher tax credit, and exemption for repayment of student loans). There were views that this mobility appears to be particularly high in the areas of science, mathematics and technology education. It is estimated that from 1998 to 2000, almost 3,000 teachers left Australia, most of them presumably leaving to travel and teach overseas.<sup>37</sup> To date, these outward migrations patterns have been counterbalanced with similar numbers of incoming migrant teachers.<sup>38</sup>

Like other sectors of the economy, education is increasingly being exposed to global competition and, for teaching, a more global market place. Attracting and retaining teachers must be seen in this international context. Future workforce planning needs to take account of recent developments which suggest far more active international recruitment policies than in the last decade. Currently there are many United Kingdom and Hong Kong based recruitment campaigns actively seeking Australian teachers who are well trained and highly regarded internationally.

## Distribution of the Teacher Workforce

There were views that the issue of insufficient teachers of science, technology and mathematics are particularly acute in some metropolitan, regional and remote schools where teaching positions are not easily filled. State and Territory education authorities identified shortfalls in teacher supply, in specific geographic areas and in science, technology and mathematics curriculum areas. For instance, the New South Wales Department of Education and Training noted that: "Teacher supply difficulties in science, technology and mathematics in particular in geographically isolated and other hard to staff schools have become increasingly evident nationally ...".<sup>39</sup> The Non-Ministerial members of the Victorian Council for Knowledge, Innovation, Science and Engineering wrote:

Recruitment (supply) problems vary between schools and over time. Some parts of Victoria, including some suburban areas, have difficulty recruiting [science, technology and mathematics] teachers. Enrolments in some subject areas are cyclical, e.g. physics, which also appears to be looming as an area of significant teacher shortfall.<sup>40</sup>

The Association of Heads of Independent Schools of Australia claimed that "schools may not be able to offer higher level maths and science courses if they do not have access to teachers with appropriate qualifications and experience".<sup>41</sup> Similarly, Professor Elliott of the University of Canberra wrote:

The outcome of this situation is that many schools in hard-to-staff areas cannot get mathematics, science, technology or ICT teachers. Some manage to obtain teachers who would not be acceptable in more affluent areas because of their poor training, poor spoken English skills, and poor classroom management skills. Many of these teachers are teaching in schools where students are from NES [Non English Speaking] backgrounds, further compounding learning problems for students.<sup>42</sup>

The Queensland Board of Teacher Registration noted that difficulties have been experienced in retaining teachers in most regional areas and, in particular, that it is very difficult to retain teachers in their first five years of teaching in some regions.<sup>43</sup> The Isolated Children's Parents' Association of Australia made the point that the prevalence of multi-level classes and smaller class sizes in many regional and remote areas inhibits the employment of specialist mathematics, science and technology teachers in these locations—"the teacher student ratio is generally low, so there is little opportunity for specialist science, technology and mathematics teachers to be employed".<sup>44</sup>

There are regional and local aspects to teacher supply and demand, and they have different dynamics from the broader national picture. Australia has always had locations in regional areas and large cities where it has been difficult to attract professionals, and this situation has not been confined to the teaching profession. Long-time mathematics teacher, Rosemary Jacob, states: "Throughout my career there has always been a shortage of

mathematics teachers in the western world, a state which, in my view, will certainly continue in Australia until there is a drastic change in attitude towards the teaching profession and the status of teachers".<sup>45</sup>

## Quality Teachers

A number of submissions, like that from the Australian Academy of Science, expressed more concern about possible shortages of both well qualified and quality teachers of science, technology and mathematics.<sup>46</sup> Murdoch University claimed that "remarkably few schools have staff members with specialist qualifications in mathematics teaching beyond the bare minimum".<sup>47</sup> The Technology Education Association of Victoria describes the situation for teachers of technology:

We now have a critical shortage of qualified and quality teachers in the area at the secondary level, and a vast number of primary school teachers who have never been required to undertake any study relating to technology education ... It is our understanding that many schools are drastically reducing their technology programs and in some schools closing them altogether because they cannot find teachers. There are probably two issues here: A general shortage of technology education teachers; Finding quality teachers who have a comprehensive understanding of the technology learning area, the knowledge and skills involved, the design process that is central to it, as well as having practical hands on expertise.<sup>48</sup>

The Australian Mathematics Society argued that the supply of qualified mathematics teachers—especially new graduates—has been an on-going concern:

Put simply, the supply of mathematics graduates is grossly inadequate to meet the needs of business, industry, research and education in the foreseeable future. Further, the number of teachers of mathematics who are inadequately qualified for the level at which they are being asked to teach, continues to rise and represents a hidden shortfall of large but undetermined size. This is jeopardising the life chances of thousands of young Australians who are not being given the opportunity to participate in a technological society dominated by applications of mathematics.<sup>49</sup>

The Committee recognises that the teacher supply issue is more than just a quantitative one of having sufficient numbers of teachers in every classroom. It is also a qualitative issue. Teachers should be well-trained and have appropriate qualifications and experience. Teachers should also be highly-effective, and create an enthusiastic and inspirational learning environment.

It is fair to say that Australia's teachers of science and mathematics are better qualified than ever before. In a study of Year 12 teachers, 80 per cent of teachers of general science, biological science and physical/earth sciences had at least third-year tertiary level study, an honours degree or higher qualification in those areas. For Year 12 mathematics teachers, 70 per cent had undertaken mathematics studies to third-year tertiary level, or held an honours, Master or Doctorate degree. A further 10 per cent of teachers of these science and mathematics subject areas had two-year qualifications in their specialist subject discipline.<sup>50</sup>

The picture is less clear for junior secondary teachers of these areas.<sup>51</sup> There were also suggestions that the true extent of any shortage of teachers of science, technology and mathematics may be masked by the numbers of teachers without adequate specialist backgrounds teaching in these areas—that is, the numbers of teachers teaching 'out-of-field' hides true shortages.<sup>52</sup> The way in which schools are organised and operated, and how teachers are assigned to classroom duties may play a role in the nature and extent of this issue.

Determining what constitutes 'out of field' teaching, and how widespread is its use, is difficult to determine. At the heart of the 'out of field' issue is the use of such terms as qualified teacher, adequately qualified teacher and well qualified teacher. Different interpretations and approaches to this issue also make analysis complex. The Australian Science Teachers' Association believes it to be desirable that a secondary science teacher has a second-year tertiary qualification in the subject being taught.<sup>53</sup> Similarly, the Science Teachers' Association of Western Australia defines a 'qualified' senior secondary science teacher as one who has successfully completed second-year university units in the subjects they teach.<sup>54</sup>

The Federation of Australian Scientific and Technological Societies argues that senior secondary teachers should typically have a university major or higher degree in the relevant discipline.<sup>55</sup> The Mathematics Education Research Group of Australasia also states that a “well qualified teacher” should have “a strong theoretical and practical knowledge of school mathematics, including statistics, certified by formal qualifications”.<sup>56</sup> The current work of the profession and education authorities on what constitutes professional standards is likely to assist future debate of this contested issue.

## SECURING OUR FUTURE

The 2001 MCEETYA study *Demand and Supply of Primary and Secondary School Teachers in Australia*, found that teacher supply was broadly in balance across Australia for both primary and secondary sectors. It also found that there were recruitment difficulties in some secondary specialist areas such as mathematics, science and information technology and for schools in some locations in metropolitan areas and in some rural and remote locations. Noted also was that the age profile of the teaching workforce may result in greater losses due to retirement in the period ahead.<sup>57</sup> An assessment of national skills shortages in 2001 by the Department of Employment and Workplace Relations confirmed skills shortages in similar areas of secondary specialisation.<sup>58</sup>

This phenomenon is not confined to Australia. Other English speaking countries are experiencing similar trends in their teacher workforce markets, and New Zealand, the United States, the United Kingdom and Canada all have some recruitment difficulties in these same subject areas.

In the second part of this decade, Australia is likely to face significant losses of teachers through retirement, particularly at the secondary level, due to an ageing of the teaching workforce. Finding additional numbers of quality teachers, or preparing new professionals for teaching, to meet expected vacancies will be a top priority.

The number of teachers required will depend on three main factors—growth in the school system caused by changing demographics, changes to school retention patterns and student to teacher ratios. The school age population will not change markedly in coming years, although the number of primary school students will fall in the second half of the decade and the number of secondary students will rise at the same time. Again, the main requirement will be for secondary teachers, while the requirement for primary teachers is likely to change little, although this will vary from school to school and region to region.

The Review's earlier Discussion Paper *Strategies to Attract and Retain Teachers of Science, Technology and Mathematics* raised a number of issues and questions relating to the attraction and retention of teachers of science, technology and mathematics. The response to the Paper through the submissions, as well as an exploration of broader literature, provided a rich range of issues surrounding the question of how to attract and retain teachers of science, technology and mathematics. In the case of attraction, they included the need for effective and targeted recruitment policies and practices, attractive employment conditions, increasing the attractiveness of the teaching profession, and ensuring quality teacher education. In the case of retention, they included the use of induction and other support for beginning teachers, strong school-based leadership and team practices, the use of relevant curriculum and engaging pedagogy to enhance student learning, ongoing professional learning for teachers, and better career planning.

With current difficulties recruiting secondary teachers of science, technology and mathematics in some metropolitan, rural and remote locations in Australia, and with the likelihood that the number of secondary teachers required by Australia's schools will increase in the second part of the decade, it is critical to the future needs of Australia that effective ways can be found to attract and retain teachers of science, technology and mathematics. While there are adequate numbers of primary teachers in Australian schools, more needs to be done to ensure that science, technology and mathematics is prioritised at the primary level and that primary teachers are effectively prepared and supported to ensure quality student learning in these areas.

The following pages explore ways in which Australia can secure sufficient numbers of quality teachers of science, technology and mathematics in its schools, and thus meet the teaching and learning needs of the knowledge economy and society.

### **TEACHING AND LEARNING NEEDS OF THE KNOWLEDGE ECONOMY AND SOCIETY**

To expand its knowledge economy base, Australia needs:

- to improve the scientific literacy of Australians;
- to equip Australia with world class scientists and innovators; and
- to enhance Australia's capacity to train, inspire and retain world-class teachers of science, technology and mathematics.

Declining school student interest in science is a cause for concern. It is imperative that efforts are made to maintain, stimulate and enhance participation rates in the learning and teaching of science, technology and mathematics in Australia's schools.

Teaching and teachers are central to the knowledge economy and society. Australia needs to attract high ability students into teaching and provide them with effective and quality teacher education, particularly in science, technology and mathematics.

There are difficulties recruiting secondary teachers of science, technology and mathematics in some locations in metropolitan areas, and in some rural and remote locations in Australia. The number of secondary teachers required by Australia's schools will increase in the second part of the decade, as Australia's teaching workforce ages. Finding additional numbers of quality teachers, and preparing new professionals for teaching, to meet expected vacancies will be a top priority.

More needs to be done to ensure that science, technology and mathematics is a priority in Australia's primary schools.

Effective ways to secure and retain sufficient numbers of secondary teachers of science, technology and mathematics to meet the teaching and learning needs of the knowledge economy and society will be a top priority.

## **2. ATTRACTING TEACHERS OF SCIENCE, TECHNOLOGY AND MATHEMATICS**

The outlook for attracting people into the teaching profession is more optimistic than in the recent past. The quality of entrants to teacher education has improved dramatically in the past two years. Faced with a range of attractive career choices, more high achieving students are choosing education.

A number of elements influence why people are, or become, attracted to teaching, and specifically to the teaching of science, technology and mathematics. They include:

- flexible and effective recruiting policies and practices which promote the virtues of teaching and with attractive supporting mechanisms and incentives to assist prospective teachers with their preparation and deployment;
- positive perceptions of teaching as a profession and a career of choice in the eyes of the community and those who form the profession; and
- effective, relevant and quality programs of teacher education that prepare teachers to enter the classroom.

### **EFFECTIVE RECRUITING**

A range of recruitment policies and practices are being implemented by State and Territory education authorities for the purposes of attracting people to become teachers. The focus of activities differ somewhat, but they have the same common goal—to attract trained teachers to fill immediate vacancies in schools; and to attract and support people to qualify as teachers to meet future demand.

#### **Recruitment Campaigns**

A principal motivation for people to become teachers is one of altruism—teaching is perceived as a socially worthwhile and important career. People are similarly attracted to teaching because they like young people, want to help them succeed, and wish to contribute to society.<sup>59</sup> The National Catholic Education Commission agreed that the main motivation of teachers of science and mathematics was to work with children.<sup>60</sup>

Education authorities conduct a range of teacher recruitment activities focusing on these values, when attracting teacher education graduates who make themselves available for teaching immediately after graduating, or those considering a return to teaching. The recent New South Wales recruitment campaign promoted teaching as a rewarding career where an individual teacher could make a difference. Strongly promoted in the media, the campaign was supported by a shopfront, website and outreach program where recruitment officers provided advice about teaching as a career.<sup>61</sup>

Similarly, the Victorian Department of Education and Training recently ran a high profile public information campaign with the theme: “Become a teacher because ... teaching is one of the most stimulating and satisfying careers available today and one which has the ability to influence or make a lasting difference to so many lives”.<sup>62</sup> In Victoria alone, it is estimated that 2,300 new teachers will be required annually in government schools over the next few

years, including demand for qualified secondary teachers in a number of key learning areas including technology, information technology, science (particularly physics and chemistry) and mathematics.<sup>63</sup>

Attached to such recruitment campaigns is a range of supporting mechanisms and incentives to assist prospective teachers through their teacher training and preparation. For example, the Victorian Teaching Scholarship Scheme supports students to become qualified and teach in government schools through the provision of cash payments of \$3,500 and guarantees of ongoing employment in Victorian government schools.<sup>64</sup> In a similar way, the NSW Graduate Recruitment Program aims to attract outstanding graduates to New South Wales government schools.<sup>65</sup> In the case of independent schools, a range of similar incentives are used to attract teachers where “school authorities make decisions at the local level on advertising and recruiting”.<sup>66</sup>

While these generic campaigns and support activities attract sufficient numbers of teachers overall, it appears that different and targeted recruitment strategies may be required to attract teachers of science, technology and mathematics. It is useful to consider various sources of potential teachers of science, technology and mathematics. They include:

- mid-career professionals in other areas;
- science, technology and mathematics graduates;
- school leavers; and
- migrants.

### **Targeted Strategies**

Many submissions strongly advocated that motivated and capable individuals from professional and technical backgrounds with an appropriate undergraduate degree, such as scientists contemplating career changes, are a potential source of teachers. The Hon Alan Cadby, Shadow Minister for Higher Education and Training in Western Australia, described this potential source:

There is an untapped pool of potential teachers currently engaged in other professions. Lawyers, engineers, scientists, accountants—with the changing face of the workforce and greater fluidity between employment markets, many workers qualified in these and other areas have shown an interest in becoming a teacher.<sup>67</sup>

Colin McFayden, a chemical engineer, was one of those untapped pool of potential teachers currently engaged in another profession:

I am a chemical engineer with 27 years experience. I have an industrial background using maths and science continuously. I have considered changing careers to teaching so that I can pass on my enjoyment of maths and science subjects. I would recommend that the transition from industry to teaching be made more attractive and easy to occur.<sup>68</sup>

The New South Wales Department of Education and Training noted that “There are already clear pressures on schools to call on a wider pool of experience and qualifications than previously required”.<sup>69</sup> In supporting this concept, the IT Skills Hub noted in its submission:

Up skilling or retraining current industry workers is a valuable short-term proposal but in respect to its flexibility it also has merit as a longer-term solution to better matching the world of work with the world of learning. The mature aged entrant from the workforce will bring a view of the world that could be more diverse than that of those who have been in educational institutions of differing levels since they first started school.<sup>70</sup>

Recruitment strategies targeting mid-career professionals require responsiveness and flexibility in a range of areas through taking into account:

- prior skills and knowledge;
- costs of re-training and loss of income to undertake it;
- the need for different types of teacher preparation programs;
- greater levels of demand on mature-age students such as family commitments; and
- different expectations around salaries and remuneration.

The Mathematics Education Research Group of Australia proposed that:

Facilitating retraining of career switcher from industry could entail: 'one-year graduate secondary teacher education courses being made available; the use of some full time fee-paid scholarships with living allowances; the provision of other appropriate and part time courses with flexible off campus elements that recognise adults' current work, family and community commitments; and adequate ... school experience.'<sup>71</sup>

Some State and Territory education authorities have developed recruitment strategies which specifically target mid-career professionals and offer a range of appropriate incentives to support a mid-career switch to teaching. Education Queensland acknowledges the importance of "creating new pathways and avenues for mid-career transition to teaching" and the "use of differential starting salaries that recognises prior service in a related industry or service [and] facilitates ease of transition from existing career to teaching".<sup>72</sup>

The Western Australian Department of Education and Training has found that training wages and payment of course fees coupled with guaranteed placement in a school at a salary above beginning teacher level are very effective means for attracting mid-career professionals. The Department targets mid-career professionals from technology related fields and offers assistance with teacher training and through financial support.<sup>73</sup> In New South Wales, the Accelerated Teacher Training (ATT) Program provides opportunities for professionals to re-train as teachers of science (physics), technology and mathematics, and covers costs associated with university tuition and administration.<sup>74</sup>

Another possible source of teachers is final-year science, technology and mathematics graduates who may not have considered teaching or teacher education upon completion of their undergraduate degree. The Victorian Department of Education and Training has identified a strong trend in increased numbers undertaking post-graduate teacher education courses, and noted the opportunities for attracting graduates seeking to change careers through targeted recruitment campaigns.<sup>75</sup> This is premised on the likelihood that new teacher graduates are more likely to begin teacher preparation at the postgraduate level and come from an undergraduate degree in a non-education field. Indeed, the University of Melbourne indicates a recent and substantial increase in enrolments in their Graduate Diploma of Education.<sup>76</sup>

The pool of immediate science and mathematics graduates could extend to a range of other graduates, for instance of agricultural science or engineering. In this regard, the current accreditation and recognition restrictions in some States and Territories around Engineering graduates, whereby they are not considered to have sufficient science, mathematics or technology to be eligible to enter one-year post-graduate teacher education courses, should be addressed.<sup>77</sup>

Many State and Territory education authorities are already looking to new graduates as a potential source of teachers. The New South Wales Department of Education and Training offers pre-service scholarships to support students to become teachers of science, technology and mathematics, including covering Higher Education Contribution Scheme (HECS) liabilities, the provision of a training allowance and guaranteed appointment for a minimum three years to a school in a specific geographic area.<sup>78</sup> Similarly, the South Australian Department of Education and Children's Services' Early Targeted Graduate Scheme targets graduates of science, technology and mathematics.<sup>79</sup>

A large source of potential teachers are immediate school leavers. The New South Wales Department of Education and Training offers scholarships to encourage students to become teachers of technology, with a commitment to

accept an appointment to a school in specific geographic areas.<sup>80</sup> Suggestions were also made in submissions for targeting school leavers through outreach programs from university faculties, or through collaboration between universities and schools to recruit and prepare school leavers to become teachers.<sup>81</sup> Collaborative partnerships were strongly supported by the Non-Ministerial members of the Victorian Council for Knowledge, Innovation, Science and Engineering:

The wider context for [science, technology and mathematics] teacher recruitment includes the need to increase the value that the community places on science and technology, and the crucial role of young people in bringing about a major shift in community attitudes through improved scientific literacy. Businesses, research institutes and universities can play a more active role in ensuring that the pool of engaged and successful [science, technology and mathematics] students is increased over time.<sup>82</sup>

School leavers are also a potential teaching source for rural and remote communities—a ‘grow your own’ approach has merit because some individuals who are already members of a community are likely to return and remain there after they become teachers. Indeed, the Isolated Children’s Parents’ Association of Australia encourages students from rural and remote areas to pursue a career in primary teaching.<sup>83</sup> The Association of Heads of Independent Schools recommended that schools should offer scholarships, have scholarship holders undertake their professional experience at the school, and guarantee employment on successful completion of their course.<sup>84</sup>

Other specific mechanisms are used by State and Territory education authorities to recruit and deploy teachers to rural and remote locations. The New South Wales Government, through Beyond the (Great Dividing) Line, promotes rural teaching opportunities to pre-service teacher education students.<sup>85</sup> The Western Australian Department of Education and Training provides \$10,000 scholarships to final-year teacher education students to teach in areas of need, including science, technology and mathematics, in return for being contracted to the Department for two years in a rural school.<sup>86</sup> The South Australian Department of Education and Children’s Services has introduced a Country Scholarships Scheme.<sup>87</sup> In addition, most education authorities provide allowances that subsidise or offset costs for teachers in remote locations, including rental subsidies, relocation assistance and annual retention benefits in difficult to staff schools. Individual schools have also introduced incentives as a means of attracting teachers to regional locations.<sup>88</sup>

Another potential source of teachers identified in submissions is migrants who have the necessary qualifications for teaching science, technology and mathematics. It is estimated that there was an annual average of 2,244 migrants with teacher qualifications between 1998 and 2000.<sup>89</sup> The Australian Education Union recommended “the provision of intensive, high quality language and system-orientation courses for potential recruits from overseas with appropriate qualifications”, as well as facilitating the re-entry of Australian teachers who had been recruited to work overseas.<sup>90</sup> It is interesting to note that the submission from the School of Education at Murdoch University found that relatively few mathematics and science teachers have graduated from their short-term induction program for overseas-trained teachers.<sup>91</sup>

The amount of remuneration or salary offered to beginning teachers is an attractive feature of the profession. In relative terms, Australia’s teachers are well paid, particularly at the commencement of their teaching careers. Starting salaries for teachers compare favourably with the average graduate starting salary of \$35,000, and Australian commencing teachers’ salaries are above the mean of OECD countries.<sup>92</sup>

There is a factor unique to teachers of science, mathematics and technology—the differential HECS fees which apply to science, technology and mathematics units in university courses. Many submissions stated that the higher HECS fees which applied to science, technology and mathematics units was a source of disappointment and a disincentive to a career teaching in these areas, and that starting salaries for teachers with these qualifications are reduced when HECS debts are taken into account.

Some submissions suggested that the differential HECS fees for science, mathematics and technology students be removed where the students went on to undertake pre-service teacher education. Other submissions suggested that HECS debts be progressively waived as new teachers completed each year of teaching, as one way of reducing

the attrition rates among teachers in their first few years in the profession. The Western Australian Department of Education and Training has introduced an initiative that provides reimbursement scholarships for science teachers up to \$18,000 over three years to cover HECS fees.<sup>93</sup> The Committee notes that HECS issues were raised in the context of the Higher Education Review.

## **New Careers**

Emerging demographic trends and shifting social attitudes are affecting the way that new entrants and existing teachers participate in the education profession, and therefore the way that they need to be supported and retained. Careers in teaching can be seen as careers in education and as such open considerable opportunities in Australia and internationally for teachers in a knowledge economy where expertise in knowledge management will increasingly become a highly portable skill. The possibility that new teachers may have very different attitudes about work, career and life than the former generation needs to be considered:

Given that a significant number of careers today appear to have a relatively short life, 3–5 years, could it be that teaching is seen as committing people for too long?<sup>94</sup>

New attitudinal changes and career participation expectations are part of the changing pattern of the workforce. An emerging theme is that the post 1970-generation, now aged in their late twenties is actively shaping flexible careers. While they value the concept of a career, less of them connect a career to the traditional idea of a single full time permanent job for the term of a working life. They see jobs and careers as vehicles for advancement, that involve commitment and that offer personal fulfilment. Clearly this has implications for the way in which teachers will be developed and deployed within schools as they progress professionally. Many assumptions, including models of teaching as one career and a career for life, through to retirement, need to be re-considered in workforce planning.

There is every indication that the teaching profession will follow some of these trends. Indeed, a study of current teacher education students concluded that the “next generation of teachers will not replicate the past. They want flexible careers and are seeking personal fulfilment, commitment to themselves and advancement”.<sup>95</sup> The aspirations of these teacher education students are significant, giving rise to greater notions of flexibility and horizontal mobility in and out of different spheres of work and life. Their perspectives support the idea that traditional views of career, and therefore the management of careers, need to shift.

Some of these demographic and generational effects may be positive for teaching and education more generally. Rather than a teaching career being viewed as a whole of working life career, it should be acknowledged that many professions are now more mobile. For instance, there is anecdotal evidence that, for some, teaching is becoming a more attractive option as a second career as people leave their initial or first career. It is likely that State and Territory education authorities will need to further recognise and adapt to new attitudinal changes and career participation expectations of young people when planning around future workforce needs.

## **Meeting Future Teacher Demand**

Because more secondary teachers of science, technology and mathematics are likely to be required beginning from the second half of the decade, it is critical that sustained efforts to attract and recruit teachers are implemented. To be successful, new and innovative ways may be necessary to increase the numbers of teachers, especially of science, technology and mathematics, in Australia’s schools.

Current recruitment policies and practices, both general and targeted, are premised on a host of workforce planning activities that identify the numbers and potential areas of any demand for teachers, and develop means to address short, medium and long-term needs of State and Territory education authorities. For instance, Victoria’s Teacher Supply and Demand Reference Group brings together state-based stakeholders to address teacher supply and demand issues.<sup>96</sup> The New South Wales’ Joint Committee on Quality Teacher Provision brings together State and Commonwealth government and non-government bodies, and advises government on teacher supply and teacher

quality issues.<sup>97</sup> Similarly, the Tasmanian Department of Education is refining its workforce profiling and aligning it to teacher education needs, and notes that Tasmania is a net exporter of teachers to other States and internationally.<sup>98</sup>

Teacher supply and demand data that is disaggregated to the State and Territory, as well as the regional level, would inform policy makers about specific demand for teachers in specific geographic areas, and in specific subject specialisations like science and mathematics. The Association of Independent Schools in South Australia argued that “A national perspective (only) will not indicate the regional and State/territory differences that will emerge as a result of different demographic profiles”.<sup>99</sup>

Mid-career professionals, recent graduates and school leavers hold enormous potential for recruitment of science, technology and mathematics teachers. Improved identification of demand for teachers in certain subject specialisations like science and mathematics at the local and State levels, could lead to even more effective and targeted use of teacher recruitment campaigns.

The issue of attracting and recruiting teachers is complicated by the considerable number of individuals trained to become teachers who never enter the profession or those who leave within the first few years. Therefore, teacher recruitment policies and practices, and supporting mechanisms and incentives, will not alone address teacher demand if efforts are not also made to address the issues of teacher retention. These issues are dealt with later in this Report.

A national framework for identifying potential demand for teachers of science, technology and mathematics in some geographic locations would have the capacity to mobilise action at the local level through targeted recruitment and deployment strategies. The sentiment expressed by the New South Wales Department of Education and Training that it “is seeking to work cooperatively with the Commonwealth in relation to teacher workforce needs” was endorsed by a range of stakeholders and is welcome.<sup>100</sup>

## **A PROFESSION AND CAREER OF CHOICE**

To guarantee the attractiveness of teaching, it must be seen as a profession and a career of choice in the eyes of the community and in the eyes of those who form the profession. The notion of teaching as a profession needs to be re-articulated to raise its standing among the broad community involved in the education of future generations of Australians—not least students and parents. A number of submissions argued the imperative of teaching as a profession being revitalised.<sup>101</sup>

### **A New Professionalism**

Teaching may become a dominant profession of the knowledge economy. The Australian Council of Deans of Education promote a dynamic and mobile role for educators in the knowledge economy and note the career path alternatives for teachers:

... teacher training already has a high level of portability. Perhaps it should become more portable, and teacher training should be designed for what it is—a highly flexible and in-demand set of human attributes transferable right across the ‘knowledge economy’. An education qualification might take you into the private sector as a trainer, a team leader, a mentor or a mediator. It could easily take you for a stint overseas. It could take you into a job which is better paid than teaching, albeit perhaps with some lifestyle sacrifices. Rather than lament the fact that teachers leave for greener pastures, they need to be encouraged, even actively supported, to undertake further training and professional development, to change careers but also to return to teaching after they have worked elsewhere and to contribute the new knowledge and experience which they have acquired elsewhere. Explicitly designing teacher education programs for this kind of flexibility will enhance the status of those programs, and the profession.<sup>102</sup>

Enhancing and extending positive perceptions about the teaching profession contributes to making the profession more attractive. The Queensland University of Technology argues:

... the importance of learning and pedagogy is an excellent platform from which to move into many professional roles and organisations, so departure from the schools sector should not be interpreted as the end of a career—only a transition within a career as an educator. Such an approach will require a mindset change not only in the profession but also by the education employer agencies and teacher educators in universities.<sup>103</sup>

Within this frame of reference, attracting and retaining teachers take on a very different focus to the traditional view of teachers beginning, advancing and staying in a teaching career structure such as those that have evolved in Australia. In addition, positive perceptions about the teaching profession are fundamental to the attractiveness of teaching as a career to which to aspire. This view was advanced by a number of submissions. Continued success in attracting and retaining teachers, including teachers of science, technology and mathematics, will need to be built on an enhanced notion of the profession as a whole—a new professionalism.

The Australian Council of Deans of Education argued that teaching should “be seen in similar terms to professions such as medicine and that policy must aim to raise respect for, and the perceived importance of, teaching in the wider community”.<sup>104</sup> Many others support the notion of a strengthened profession, including the recent reviews of teaching in New South Wales.<sup>105</sup> This is important for those who seek to influence the quality of teaching in Australia and particularly to improve the teaching of science, mathematics and technology because it will not be enough to promote the attractiveness of teaching as a career without enhancing the attractiveness of teaching as a profession.

Vinson covered teaching professionalism in considerable depth in the *Inquiry into the Provision of Education in New South Wales*. Through public meetings and inspections of many schools across New South Wales, Vinson found that there is a strong feeling among the teaching community that there has been a loss of professionalism over the last decade. Vinson describes this as a ‘recurring theme’ throughout the Inquiry. The ‘professionalism’ that Vinson discusses is not focused on the way in which teachers go about their duties—it is more that their own sense of professionalism has been undermined through lack of professional support for their work and lack of respect from students, parents and the general community. Loss of professionalism had also arisen through deterioration in the level of remuneration received, relative to other groups, and in the working environment of teachers, including staff workrooms and facilities. Vinson concluded that there was a need for teaching to take steps to become a self-regulated profession and recommended, in line with Ramsey, that this would involve the establishment of a professional association for teachers, with clear terms of reference in relation to quality assurance and the ongoing development of professional standards and competencies.<sup>106</sup>

Submissions offered a range of suggestions about ways to raise professional aspects of teaching. These included:

- have a whole-of-government or national approach to issues around professionalism;
- develop standards of teacher professional practice;
- establish teacher registration and accreditation bodies;
- recognise the professional demands of teaching and focus on teaching as an intellectual rather than simply technical process;
- focus on the importance of learning and pedagogy in today’s information-orientated society;
- profile and promote the achievements of teachers and their students; and
- involve the profession directly in the promotion of teaching as a career.<sup>107</sup>

A major goal of any profession is to develop and improve its image by promoting its value, contribution and benefits—both as a profession and as a career for specialised and highly skilled members of the community.

Professional features, including commitment to quality preparation for entry into the profession and individual development throughout a career, professional collaboration and collective development, convey a recognisable, attractive and marketable role in society. These attitudes and approaches are essential to enhancing the attractiveness of the teaching profession, assisting potential new entrants to see teaching as a career of choice, and helping maintain ongoing commitment. Tim McMullen of the Sydney Catholic Education Office wrote:

In ensuring the continuing supply of high quality young teachers, it may be that the teaching profession itself will have to assume a significant degree of leadership. While governments will need to be pressured to improve teachers' salaries, working conditions and status, it will also be incumbent on teachers to contribute to the development of a stronger 'sense of profession'. This will need to be projected to the students so that more will want to join it, if only for a time; to the community so that they will see the need to ensure that it remains strong; and to the younger generation of teachers so that they maintain and build on the high standards of teaching achieved over the last fifty years.<sup>108</sup>

The teaching profession needs to be valued and respected and in turn to demonstrate its value to the broader community. Recognising and valuing the profession is a broad responsibility that resides with teachers themselves but also extends to a diverse range of stakeholders including governments, the education, arts, mathematics, science and technology communities, teacher employers, industry, parents and students. It can be developed through a series of actions which signal professional progress and development, and can create an environment in which teachers will encourage others into their profession.

Much is being done across Australia to enhance the teaching profession. Some States have established, or are establishing, bodies to formally recognise teachers as credentialed professionals, to develop professional standards and improve the status of the teaching profession. Two areas in particular are gathering national momentum:

- the formulation of a professional standards framework; and
- the widespread desire for a portability framework to provide a seamless transition for teachers between education jurisdictions.

## **Building Standards**

One of the most effective ways for teachers to pursue and achieve higher recognition and standing is to make explicit what their profession is about and what is important to it. Other professions employ these mechanisms to build public expectations about the relationship between the public and the professional. In the case of teaching, professional standards would present critical information about, and effectively articulate, the fact that teachers have specialised practical skills and techniques, underpinned by a body of theoretical knowledge, that achieves objectives highly valued by the community. According to Ingvarson:

Without standards, a professional body is defenceless. A demonstrated ability to articulate standards for high quality practice is an essential credential if a professional body wishes to be taken seriously by the public and policy makers. When placed on the table in forums with policy makers about reform and accountability, established professional standards are hard to ignore.<sup>109</sup>

The Australian College of Educators also proposed that an explicit set of standards would enhance the profile of the teaching profession, stating:

Whilst teaching is not a standards-free endeavour and most teachers have always understood the essential elements of high quality professional practice, much of this knowledge has remained at an intuitive level. Standards do help to make the knowledge and capabilities explicit—not only to professional colleagues, but also to students, parents and wider community. They also provide a means through which good teaching can be identified, celebrated and rewarded.<sup>110</sup>

For the broader community, professional standards can provide a window into the profession, building confidence and sometimes correcting perceptions. For potential new entrants to a profession, standards provide information about,

and give rise to more realistic understandings, of collegiate expectations. For the practitioner, professional standards help define their role, refine their development over time, and enable them to promote and share good practice. For a profession as a whole, standards sign-post, show-case and make transparent, the extent and scope of members' core competencies and responsibilities. A number of submissions made the link between teaching standards, professionalism and teacher status, including the Isolated Children's Parents' Association of Australia, which wrote:

Teaching needs to have its own standards for professional practice. This would do much to restore the public conception of teaching; make it something worth aiming for; give teachers a pride and purpose in what they are doing by encouraging them to keep building up skills; and aiming for further professional growth and development.<sup>111</sup>

There is a growing consensus among stakeholders that the teaching profession should develop its own explicit statement of professional standards. Moreover, there is a mounting national and collaborative movement towards bringing about the cultural shift necessary to make professional standards an integral part of the teaching profession. This impetus is strongly linked to the creation of conditions that support the achievement of the National Goals for Schooling in the 21<sup>st</sup> Century (the Adelaide Declaration) which include:

... a commitment to collaboration for the purposes of:

- Further strengthening schools as learning communities where teachers, students and their families work in partnership with business, industry and the wider community
- Enhancing the status and quality of the profession
- Continuing to develop curriculum and related systems of assessment, accreditation and credentialing that promote quality and are nationally recognised and valued
- Increasing public confidence in school education through explicit and defensible standards that guide improvements on students' levels of educational achievement and through which the effectiveness, efficiency and equity of schooling can be measured and evaluated.<sup>112</sup>

Establishing and maintaining professional standards should be central to any proposed strategies to attract and retain teachers of science, mathematics and technology.<sup>113</sup> Submissions from education authorities, professional associations and others emphasised the importance of professional standards and described the progress that is currently being made. The South Australian Department of Education and Children's Services argued that: "Professional standards, if associated with a system of assessment and accreditation, have the potential to refresh and enhance the competency and status of teaching as a career".<sup>114</sup>

Most education authorities are pursuing the development of standards. In some cases these standards are directly linked to teacher career structures and remuneration. From the perspective of education authorities, teacher standards development is emerging as a frame of reference for developing policies on teacher quality and performance benchmarks.<sup>115</sup> In this context, most States and Territories have established, or are establishing or extending, teacher registration boards or institutes and colleges of teaching which have capacity to support the development of professional standards. Many submissions advocated working towards a national consensus on these matters. The Australian Education Union supported, "Universal teacher registration, the development of teaching institutes and the insistence on the highest possible standards for teachers in qualification and performance".<sup>116</sup>

Several national professional associations have developed subject-based standards. The Technology Education Federation of Australia notes that the Australian Council for Computers in Education is conducting a project to define the relevant standards for teachers of senior secondary information technology.<sup>117</sup>

The Australian Association of Mathematics Teachers (AAMT) has developed *Standards for Excellence in the Teaching of Mathematics in Australian Schools* and is working towards establishing a mechanism for credentialing teachers against these standards as a means to acknowledging and rewarding highly skilled teachers. AAMT suggests

that these standards be used to establish and implement a standards driven professional development system for professional learning in mathematics.<sup>118</sup>

Similarly the Australian Science Teachers Association (ASTA) has developed standards which capture what highly accomplished teachers of science know and do. ASTA argues that these standards are a means for recognising and acknowledging the skills, expertise and experience that are linked to performance reviews and salaries and that “the furthering and implementation of professional standards for teachers is [also] seen as crucial to create career pathways that reward and recognise teaching excellence.<sup>119</sup> ASTA also sees benefit in using standards for mentoring, teacher education and professional development.<sup>120</sup>

Some initial work has also been undertaken on a proposal to develop a national framework for describing teacher ICT competency standards to inform the work of teacher education faculties and education authorities. This work acknowledges the key role of professional associations in the development, implementation and assessment of standards, and emphasises the need for a national framework for standards development in Australia.<sup>121</sup>

That parts of the profession have initiated statements of standards is a particularly welcome development, because a key success factor will be the extent to which teachers embrace these developments. The recent formulation of a common set of professional principles by a range of professional associations is particularly encouraging.<sup>122</sup> Projecting self-determination and balancing self-regulation with accountability and effectiveness are some of the challenges faced in any profession, and many submissions stressed the need for teaching standards to be developed and ‘owned’ by teachers. The Australian Association of Research in Education stressed:

The status of teaching cannot be resolved only by a professional standards movement that is imposed onto the profession. Professional standards must be developed, owned and mobilised by the profession. All professional standards should be grounded in a body of professional knowledge that has been developed by teachers.<sup>123</sup>

Given the need to develop a clear national framework, including the need to work through issues associated with generic, subject-based and performance-based standards, the achievements to date demonstrate that a growing part of the teaching profession sees value in developing professional standards and clearly link these with professional renewal and progress.

If collaborative, and if coordinated at the national level, and recognising education authorities’ responsibilities as well as the importance of ownership through professional associations, professional standards have the capacity to renew and extend professional structures, and enhance the standing of the teaching profession through community recognition and support.

The scope of any national framework is yet to be finalised. There are differing views as to how it should be constituted. Some organisations, like the Australian Parents’ Council, support a national professional standards body.<sup>124</sup> Others, like the Australian Council of Deans of Education, support a standards framework at the national level with allied mechanisms at State and Territory levels for teacher registration and training accreditation.<sup>125</sup> An earlier view of the Senate Employment, Education and Training References Committee was:

... that any serious approach to standards requires the establishment of a national professional teaching standards and registration body with the responsibility, authority and resources to develop standards of professional practice, to direct their application, to accredit pre-service teacher training courses and professional development programs, and to certify the quality and advanced standing of individual teachers.<sup>126</sup>

One of the necessary conditions for a national framework is an alignment of existing work to date. Commonwealth, State and Territory governments are well placed to assist in this process particularly to align emerging policy frameworks and build coherence and strategic purpose. The MCEETYA Taskforce on Teacher Quality and Educational Leadership is currently consulting with jurisdictions on the scope of a National Framework for Standards for Teaching, and a draft consultation paper argues that development of a national standards framework will:

Provide the Australian community with an authoritative, transparent and objective source of information about the elements of good teaching. It will make teachers' work more visible and promote the public image of teaching, contributing in turn to improved recruitment and retention rates. Such national recognition may well also promote international recognition of Australia's teachers.<sup>127</sup>

The valuable work achieved to date towards a national framework for professional standards is encouraging, and the momentum towards a national professional standards framework through MCEETYA is receiving strong support from stakeholders to ensure that the outcome also encompasses the needs of accountability and self-determination required by all.

### **Professional Mobility**

Another important area where a national professional approach is required relates to the capacity of teachers to be able to practise throughout Australia and specifically to take their professional qualifications and experience across education jurisdictions. As noted by the Faculty of Education, Health and Professional Studies, University of New England, currently registration and accreditation processes for teachers are "different for each State and often each system within a State".<sup>128</sup>

There are two aspects to the public standing and recognition of the qualifications offered by Australian universities in the initial preparation of teachers. First, each course is accredited by an Australian university under its self-accrediting powers established by individual State and Territory legislation. Other institutions of higher education have their courses accredited directly by State and Territory education authorities. These arrangements occur within the context of the national quality assurance framework established by the National Protocols for Higher Education Approval Processes endorsed by MCEETYA in 2000.

Second, many States or Territories have, or are presently developing, a direct influence and control over courses through registration bodies that determine whether a particular education program provides suitable preparation for first employment as a teacher. Queensland and South Australia have long established registration bodies. Tasmania and Victoria have recently enacted legislation to establish such bodies, and similar developments are occurring in Western Australia, New South Wales and the Northern Territory.

Unlike a number of established professions that have well developed self regulation or accreditation for membership, this has yet to happen in the teaching profession. As discussed above, this matter is under consideration by a range of bodies developing statements of national standards for the teaching profession and the work being undertaken towards a national standards framework.

Portability is a fundamental feature of most professions. There is an urgent need to make teaching qualifications and experience more portable to allow teachers to be mobile without losing salary, length of service conditions, career advancement status or any other entitlements. Indeed, there was strong support in submissions for national agreement about the portability of professional status and recognition to allow teachers who are mobile to continue within the profession.<sup>129</sup> For instance, the Australian Council of State School Organisations supports a national system because "an important outcome of this process will be that new teachers will have a nationally portable qualification".<sup>130</sup>

Differing professional experience requirements in initial education and employing authorities' requirements on commencement ought not to be significant factors in determining where teachers choose to start and develop their careers. Nor should they be determinants of whether a teacher chooses to stay in the profession if, for other personal and professional reasons, they are geographically mobile. This barrier to mobility may lead teachers to leave the profession or consider other careers. It may also be a barrier to teachers wishing to return to teaching. According to the University of Melbourne:

Teaching qualifications should be readily portable around Australia. Even minor variations, such as in the number of days of supervised teaching practice required, can be an important barrier to re-entrants to the profession who have relocated.<sup>131</sup>

The Australian Council of State School Organisations argued that portability between states through national teacher registration must be seen as a key element to keeping good teachers teaching nationally, rather than being tied to particular jurisdictions.<sup>132</sup> The Australian Education Union contends that both younger and experienced teachers might also be encouraged to remain in the profession “if greater portability of entitlements existed which allowed teachers to move around Australia but remain as a teacher maintaining salary position and status”.<sup>133</sup>

One of the attractive features of teaching, particularly among those choosing to undertake teacher education, is that it is perceived as highly mobile. One study found that, “for younger [teacher education] students a chance to move around and travel overseas with a transportable qualification” is significant.<sup>134</sup> The potential of this factor in attracting new entrants to consider teaching falls short when the reality of working as a teacher in Australia means that portability is hindered by diverse recruitment practices and employment requirements. When combined with the lack of highly visible professional bodies that can offer assistance to potential entrants, i.e., those outside the profession or outside of a jurisdiction, this diversity can be disabling for qualified teachers seeking to enter the profession or move within it.

Notwithstanding the recognition issues associated with teacher qualifications and experience, the principle of portability should be pursued for its capacity to influence positively the character and overall standing of the teaching profession. National collaboration in this regard would send an important signal to students, teachers and parents that the profession is developing and extending as a united and national profession.

For this reason, the goal of achieving portability in the professional structure of the teaching profession should be considered in the context of MCEETYA's work on the development of a national framework for professional standards. As an environmental factor with potential to enhance perceptions of the profession, it should also be recognised as a significant opportunity in the collaborative work of the various boards of teacher registration and institutes and colleges of teaching and national teacher professional bodies.

The development of national professional standards and portability frameworks should be fundamental structural features of the teaching profession. Both serve to build and enhance the professional status of teaching which is focused on attracting, educating, maximising and retaining high quality professionals. Renewing and extending the profession through development of professional standards and portability will serve to improve perceptions of the profession both from within and from the community as a whole. While they may need to be more fully considered by all stakeholders, momentum is developing for more active national management of these issues.

## **PREPARING TEACHERS**

Intending Australian teachers undertake a teacher preparation program run by a university or other institute of higher education. It is essential that the highest standards are applied to teacher education courses to ensure that high quality and well-prepared teachers enter the school environment.

High quality and relevant teacher education is extremely important because perceived attitudes about the rigour and extent of professional preparation provided by education, science and mathematics faculties, can do much to influence prospective candidates in their choice of teaching as a career. Two areas of teacher education are critical in this regard:

- pathways through, and participation in, teacher education; and
- effective and relevant teacher preparation.

### **Pathways and Participants**

Teacher education is provided through over 400 courses run by almost all of Australia's universities and some other institutes of higher education. In 2001, these programs produced over 11,000 new, qualified primary and secondary

teachers: 4,500 (32 per cent) were prepared for primary teaching, 5,250 (37 per cent) were prepared for secondary teaching and a further 1,800 (13 per cent) were prepared for teaching across the two sectors. A further 2,500 (18 per cent) were prepared for teaching at the early childhood, adult or some combination of levels other than primary-secondary teaching.

There is a large number of diverse programs of initial teacher preparation presently offered in nearly all of Australia's universities. To get an overview of what can appear quite complex alternative programs, it is best to see them characterised either as concurrent programs where the discipline or teaching subject content is taught in the same years as the education studies, the practical pedagogical learning and professional experience, or as end-on programs, where the education course follows the year(s) after the completion of the discipline subjects which are separately taught as an undergraduate first degree.

For preparing primary teachers, the most common pattern is a single four-year (full-time or equivalent part-time) undergraduate degree, most commonly styled Bachelor of Education. Other routes to primary teaching include what are called double degrees (two undergraduate degrees, taken concurrently, one of which is totally the discipline subjects, and the other totally in education, preparing for school and classroom teaching). The terminology varies, but may be, for example, a Bachelor of Arts or Bachelor of Science, plus a Bachelor of Education or Bachelor of Teaching, or an end-on pattern where a first discipline degree is followed by a Graduate Diploma or a Bachelor degree specifically preparing for teaching in primary schools.

For preparing secondary teachers, the most common pattern is to first complete an undergraduate degree in the discipline subjects (arts and science are the most numerous, but others include commerce, music, agriculture) and follow this with a course preparing for teaching (a Graduate Diploma in Education is the most common, but a longer course may be styled Bachelor of Teaching, or Bachelor of Education, and some two-year end-on courses are now styled Master of Teaching). New structures for initial teacher education, such as double degree programs, have been developing in response to new thinking about how best to achieve flexible preparation of teachers.<sup>135</sup> The double degree pattern is available fairly widely for secondary teaching, though the number of science and mathematics teachers coming from these programs appear to be small at this stage.

The science and mathematics content of the undergraduate primary education program is in many universities taught by the science faculty, though the entire program is taught by the education faculty in about one-third of cases. The usual requirement is two to four compulsory semesters of mathematics, and two or three compulsory semesters of science and/or technology. In the primary double degree programs, the science and mathematics content is universally taught in the discipline faculties. The science and mathematics content in all secondary programs appears to be entirely taught in the discipline faculties, though in all cases some innovative collaborations between the science and education faculties enhance the offerings for students, by bringing the two groups of specialists together.

The number of teacher education students specialising in science, technology and mathematics appears to be small. Research on projected secondary teacher education completions for 2001 indicates a relatively small number of the following specialisations—senior physics (four per cent), senior chemistry (six per cent), senior mathematics (seven per cent) and secondary information technology (four per cent).<sup>136</sup> The recent audit of the teacher labour market in Victoria concluded that technology, physics, mathematics and computer studies have the lowest numbers of expected graduate teachers.<sup>137</sup> Questions about the future supply of qualified mathematics and science teachers require further consideration.

The Committee is presently examining three trends which could impact in the future. There is clear support among employers, for increasing the balance of programs toward the end-on routes, especially for secondary teachers specialising in the upper secondary years. Second, in two states, the education component requirement is for not less than two years (though with accelerated offerings the programs are sometimes completed in 18 months). It is possible that the one-year Graduate Diploma may be seen as inadequate in covering the range of skills which are needed before 'registration' and first appointment. Third, a number of submissions are concerned that science

and technology are not seen to gain sufficient priority in primary teacher preparation. Some courses have minimal science and technology content, and students observe science and technology are given relatively low priority in some of the schools in which they practice. The Committee will address these issues more comprehensively in the final report.

The South Australian Department of Education and Children's Services proposes that in the delivery of primary science curriculum, the teacher should have completed a minimum of two years (or four semesters) of study including the development of conceptual understandings and, in a secondary setting, the minimum should be three years (or six semesters).<sup>138</sup> An important part of the conceptual understandings would include an understanding of the history and culture of Australia's Indigenous peoples. The Independent Education Union of Australia and many submissions made the strong point that every Australian student should have teachers who are knowledgeable in Indigenous studies,<sup>139</sup> obtained through a "teacher education which would improve the quality of knowledge and understanding for all Australian school students, Indigenous and non-Indigenous. It would certainly make for a better Australia".<sup>140</sup>

Other pathways through teacher education are available. Generally these are used as a means of attracting people who might otherwise not enter teaching and generally aim to do whatever any teacher education program does: convey good teaching practice; introduce teachers to classrooms; and provide an appropriate knowledge and skills base. In most cases, they are designed around mid-career professionals with industry or vocational experience. In addition, many are supported by State and Territory education authorities seeking innovative and flexible ways to attract people into teaching, such as by recognising prior learning and experience. As noted by the Queensland Deans of Education Forum: "there is no one model of teacher preparation that can purport to be the most effective way of preparing teachers".<sup>141</sup>

In many ways, these pathways are a response to the needs of a more demanding labour market and changing lifestyle needs, and this was borne out through those submissions which supported more flexibility in the delivery of teacher education courses, particularly for mid-career entrants, as well as students in regional and rural areas who are generally only able to study via distance education.<sup>142</sup> Other suggestions included increased flexibility in course delivery through part-time and evening courses; flexibility in entry and exit points, and flexibility in the recognition of learning pathways.<sup>143</sup> At the University of Newcastle:

... the 'Newstart in Teacher Education' program has been introduced to retrain as secondary technical and applied studies teachers former industrial workers, providing appropriate recognition of prior learning for existing qualifications and experience. The program commenced on a full fee basis for former Newcastle BHP Steel workers, with BHP funding the students. The program is also operating at Wollongong operating at a school site.<sup>144</sup>

Many universities have recognised the need for flexible delivery of teacher education courses and are prioritising their development in line with approaches being applied across university courses more generally. For example, Murdoch University offers off-campus teacher education programs which facilitate access to training by students in rural and remote areas.<sup>145</sup> The University of Western Sydney is prioritising the development of flexible course delivery:

Examples of flexible delivery have included the use of ICT-based platforms as the sole means or as supplementary forms of delivery; intensive short course mode, distance delivery using ICT and postal media, and evening classes and summer or winter subject offerings in undergraduate programs.<sup>146</sup>

Some submissions expressed concern about the quality of students undertaking and completing teacher education. In particular, links were often made between tertiary entrance scores and the quality of student teachers. While perceptions are that tertiary entrance scores required for teacher education are low, in the last two years the entry scores for teacher education have been steadily rising in response to greater demand.

Tertiary entry scores are not necessarily the only or most accurate indicator of suitability for teaching. For instance, some submissions argued that effective processes should be in place to ensure that applicants had the necessary

aptitude for teaching.<sup>147</sup> The Faculty of Education, Health and Professional Studies, University of New England, had concerns about applicants from business and industry:

There is a tension here regarding active recruitment of mid career professionals for the teaching profession. Just because individuals have been in a professional career does not mean that they have the skills and attributes to make a good teachers. Granting too 'easy access' of entry into the teaching profession devalues the skills and training of those who have undertaken traditional programs. It also contributes to a subtle undermining of the teaching profession by the false implication that "anyone can teach".<sup>148</sup>

Nonetheless, there is evidence that mid-career entrants to teacher education courses, who have been assessed using measures other than their Year 12 assessment, perform well in their courses and subsequent teaching. A range of indicators can be used to assess the suitability of applicants for teacher education. The Senate Employment, Education and Training References Committee noted the importance of prospective teachers' personal qualities, motivation, organisational ability and flexibility to ultimate teaching success.<sup>149</sup>

The Australian Teacher Education Association suggested that: "Those who have positive experiences of high quality teaching and contact with teachers who show commitment, enthusiasm and enjoyment of teaching are more likely to develop positive as well as realistic perceptions as a career choice".<sup>150</sup> Such information can be borne out through interviews, which have shown to be a useful component of selection processes. Indeed, the University of Tasmania was encouraged by research that found that interview ratings by academic staff of applicants for teacher education courses were accurate predictors of future practice teaching performance.<sup>151</sup>

### **Effective and Relevant Preparation**

Some teacher surveys report dissatisfaction about the standard and types of preparation received during teacher education.<sup>152</sup> What these studies illustrate is the importance of ensuring that teacher education courses are recognised for their high quality, their effectiveness, their relevance to the needs of potential beginning teachers, and that student teachers are given sufficient time in the classroom to master the needs of classroom teaching.

School-based reforms and technological advances in recent years have produced significant changes in the nature of what teachers do, and the last decade has seen considerable reform in the way schools are managed and manage themselves. These reforms have included increased devolution of employment policies, management functions and budgetary authority to schools. The dynamic and changing requirements of schools and teachers will always mean that teacher education course design and delivery includes ongoing re-evaluation, in order to better prepare student teachers for the classroom.

Quality teacher education is vital to the health of the teaching profession, and it is now well understood that teacher preparation and quality are closely linked to student achievement. As Jasman noted: "Teacher educators hold the practitioner knowledge of effective curricular, pedagogical and assessment practices that can shape the way in which new teachers are prepared for their work in the 21<sup>st</sup> century and support the development of existing teachers".<sup>153</sup>

Teacher education is intended to prepare students with a balance of pedagogy and content knowledge. While there is diversity within teacher education programs, they typically contain an even mix of subject discipline and pedagogical studies in undergraduate courses; although postgraduate courses, which usually follow an undergraduate degree in a subject discipline, typically focus exclusively on pedagogical studies. Deep understanding of content is strongly related to good student learning outcomes and teacher preparation gives students the opportunity to be confident and use their expertise in context. For instance, there is a strong correlation between the amount of mathematics a teacher takes in undergraduate study, how well that teacher knows mathematics and how well the students of that teacher perform in mathematics.<sup>154</sup>

Achieving the right mix between content and skills knowledge and the pedagogical skills necessary to teach science, technology and mathematics effectively is an on-going issue. Its importance is heightened by the advances in science, technology and mathematics that can cause foundation knowledge and skills to quickly lose currency.

Effective and on-going dialogue between the science and technology community, the teaching profession, curriculum developers and education faculties is essential in addressing this issue.

Submissions contained many references to the content and methods of teacher preparation, particularly how well teachers are prepared for the classroom through in-school practical experience. A common theme was the need for practical skills and experience to be a more integral component of pre-service teacher education courses.<sup>155</sup> The Australian Parents' Council captured the view of many respondents:

... there ought to be more opportunity for trainee teachers to undergo longer periods of practical work in schools. Reforms to teacher training should include a greater emphasis on in-school classroom training experience.<sup>156</sup>

While classroom and student management is dealt with differently in different courses, some submissions suggested that managing and directing groups of students towards learning was an incidental and minor component of some teacher education programs, and needed to be strengthened. There are good reasons for a re-articulation of practical experience in teacher education. In his recent examination of teacher preparation in New South Wales, Ramsey proposed a fuller integration of practical experience into educational programs for beginning teachers.<sup>157</sup> Similarly, the Australian Education Union argued:

There is a need to invest more in the practicum and allow for more time for teachers-in-training in classroom situations. As well, there is a need for increased investment in the time of supervising teachers to assist the student. This will provide more time and financial recompense for the supervising teacher and lead to greater levels of initial teacher confidence at the start of a career.<sup>158</sup>

Indeed, it is recognised that efforts need to be made to better articulate and integrate practical preparation with the theoretical preparation of teaching. The University of Notre Dame acknowledged:

A limited place in the pre-service program is reserved for in-school experience. There is a strong argument for this to be expanded in order to allow students to integrate the realities of school life and the work of the classroom teacher into the educational theory that underpins teacher education programs. This is an expensive option and difficult to deliver.<sup>159</sup>

Many universities have developed internship programs to facilitate the 'in classroom' preparation of student teachers. According to the University of Canberra, models of professional experience, such as teaching internships for pre-service teachers, also have the potential to close the gap between school and university perceptions and expectations of teaching. They argued that "Such programs could place professional experience as the central component of teacher education programs".<sup>160</sup>

At the University of Canberra, students in the fourth year of the Bachelor of Teaching (Primary) complete a 40 day internship in a primary school. In its Bachelor of Education program, the University of Queensland has an internship for the secondary and middle years of schooling. These interns carry a 50 per cent teaching load for a 10 week period and are mentored by appointed colleagues at the school.<sup>161</sup> At the Queensland University of Technology, all students in a new Bachelor of Education program will be placed in an internship in their final year, with students' teaching responsibilities scaled to accommodate their differing preparedness. The Queensland Deans of Education see internships as an important addition to the preparation of student teachers:

... induction as part of an internship program provides assistance in the transition to full time teaching but should not replace induction and mentoring support programs by employers for their beginning and other newly appointed teachers.<sup>162</sup>

The Australian Council of Deans of Education claimed that "the cost of teacher education is barely able to be sustained and will reach crisis proportions over the next few years without some further injection of funding".<sup>163</sup> The costs of teacher education courses, particularly the provision and administration of professional experience programs, are of particular concern to Education faculties.<sup>164</sup>

The Mathematics Education Research Group of Australasia recommended that State and Territory education authorities should provide more financial support for professional experience, arguing that: “Many Vice Chancellors consider teacher education courses to be relatively expensive, so course quotas are kept tight. There is one reason for this perception: the cost of the practicum ... The solution here is state-based financial support for the practicum”.<sup>165</sup>

A number of submissions recommended that teacher education courses should facilitate closer partnerships between teacher education institutions and schools.<sup>166</sup> The Australian Secondary Principals Association supported the case that “Schools needed to be significant “players” in the preparation of teachers”.<sup>167</sup> Shadow Minister for Education and Training in Western Australia, the Hon. Alan Cadby MP, advocated a full school-centred approach to professional experience.<sup>168</sup>

The Australian Catholic University supported the notion that practical experience should be jointly ‘owned’ by universities and supervising schools.<sup>169</sup> It may be necessary to better align the objectives of teacher education and school needs to achieve this goal. Nonetheless, as argued by the Australian Education Union: “There is also an opportunity to enhance the school-university partnership allowing for more time for school and university staff to work together and allow for interaction between the institutions”.<sup>170</sup>

Strengthening the linkages between discipline, education and curriculum studies within universities in order to develop well prepared teachers with high expertise in their content area as well as a thorough grounding in pedagogical practice was a key message from the submissions.<sup>171</sup> The Australian Council of Deans of Science advocated stronger partnerships between science, mathematics and education faculties to better develop appropriate programs and to market and promote teaching in science, technology and mathematics as a career.<sup>172</sup> From a practical point, collaboration between education, science and mathematics faculties is likely to enhance quality through maximising use of resources. Certainly more collaboration is going to be required between teacher education, science and mathematics faculties if in-roads are to be made to increase the numbers of students specialising to become teachers of science, technology and mathematics.

Whichever way they are configured, genuine partnerships between universities, governments and schools are essential to making teacher preparation courses, particularly the professional experience component, as effective as possible. Through partnering, those involved in teacher preparation at universities will improve the preparation of teachers for the classroom.

The lessons learned by teachers in preparation programs are powerfully reinforced in first teaching assignments. Appropriate bridging between initial teacher preparation and beginning teacher practice is a matter that universities and schools need to be actively engaged in. Professional experience, induction, mentoring and ongoing professional learning are all vehicles available to improve this engagement. They are important to making teaching more attractive to potential teachers and are a key factor in the retention of teachers, particularly in their initial years in the classroom.

## **ATTRACTING TEACHERS OF SCIENCE, TECHNOLOGY AND MATHEMATICS**

A number of elements influence why people are attracted to the teaching of science, technology and mathematics. They include:

- flexible and effective recruiting policies and practices which promote the virtues of teaching;
- attractive supporting mechanisms and incentives to assist prospective teachers with their preparation and deployment;
- positive perceptions of teaching as a profession and career of choice in the eyes of the community and those who form the profession; and
- effective, relevant and quality programs of teacher education that prepares teachers for the classroom.

The notion of teaching as a profession needs to be re-articulated to raise its standing among the broad community involved in the education of Australian school-age children.

### 3 RETAINING TEACHERS OF SCIENCE, TECHNOLOGY AND MATHEMATICS

Strategies and ways to attract both new and returning teachers are crucial, but they provide no assurances that teachers will be retained in the classroom. Increasing teacher retention through improvements to teaching experiences, teaching conditions and career pathways is important in this regard. One of the keys to understanding how to retain teachers of science, technology and mathematics is to understand what kind of professional environment is essential for teachers' success, enjoyment, satisfaction and quality of experience. There are four dimensions to the retention of teachers of science, technology and mathematics:

- the early years when students of teaching become teachers of students;
- school leadership, teams and engaging students;
- managing ongoing development as a professional; and
- following a career pathway as a teaching professional.

#### THE EARLY YEARS OF TEACHING

Some State and Territory education authorities anecdotally report high rates of separation early in teachers' careers.<sup>173</sup> This is possibly as high as 25 per cent within the first five years of teaching. In the United States, research has found that 29 per cent of all beginning teachers leave teaching after three years, increasing to 39 per cent after five years.<sup>174</sup> The Queensland Deans of Education Forum described what faces beginning teachers:

The transition from graduate to beginning teacher is a time of considerable challenge and vulnerability for first year teachers. ... The first years of employment is often a very isolating experience and a time of considerable stress and burnout. Many valuable members of the teaching profession resign and substantial teacher preparation resources are wasted.<sup>175</sup>

According to Khamis, "a teacher's first full-time position is critical in determining how long she or he will stay in the profession".<sup>176</sup> Many first-year teachers feel isolated when they take up their first posting. A survey of beginning teachers found that support in the first year is of critical importance. The experience of a Western Australian teacher is representative of the experience of many beginning teachers posted to regional and remote areas:

I went straight from high school into Uni, and straight from Uni into teaching. I have moved out of the city and lived in the country for the first time, moved away from my family and my friends, moved to a place I'd never even heard of before, and then on top of that starting this big scary job for the first time. I would have loved just once for someone to say, 'how are you going? Are you OK?' Not just, 'can you find the staff toilets, and can you find the books you need?'.<sup>177</sup>

Another teacher from Western Australia cited in the same survey expressed a similar view:

I had the chance to observe a really good science teacher who was just brilliant. The behaviour management was excellent, and everything was just so interesting. I thought to myself, I'd love to be like that, and have

the kids respond to me in the way they did for him. But I know that my classes are nothing like that. It often seems boring. But I don't know how to get to where he was, from where I am now. That's what I want in my feedback.<sup>178</sup>

## Induction

One of the best measures to assist teachers from the transition from teacher education to the classroom, and to ensure higher retention rates, is the provision of considerable support and guidance in the first years of their classroom-based career through a broad teacher induction program. Particular attention to the provision of support for beginning teachers in their first years in the profession is increasingly being adopted by education authorities, as a logical complement to preparation through teacher education and orientation to the school working environment. The Australian Education Union is of the view that:

... sound practices of induction and mentoring should characterise the beginning of a teaching career. This would entail:

- a well-planned mentoring relationship from the first day of a teacher's appointment;
- the provision of release time for both beginning teachers and their mentors;
- support mechanisms such as consultancy, group meetings of beginning teachers, interaction with training universities.<sup>179</sup>

A highly structured induction program in each school, which provides guidance and support, through the transition from novice to full-time teaching, is a key factor in making beginning teachers' transition to their new career a success. Induction programs can vary in terms of activities, content, participation, roles of universities and schools, formality and evaluation. Research suggests that the impact of induction programs for teachers can be positive, and there may be value in requiring induction programs to be accredited based on recognised standards of good practice.<sup>180</sup>

There are several outcomes that induction programs can be expected to achieve. One is an increase in the retention rate of promising beginning teachers during the initial years of teaching. Indeed, evaluations of induction programs show evidence of higher retention rates among induction program participants.<sup>181</sup> Several submissions supported the notion that the quality of induction plays a strong role in the decision of a new teacher to continue with teaching as a career.<sup>182</sup> Research suggests that beginning teachers who are supported with a formal induction program during their first year have increased job satisfaction and adjust better to the school community.<sup>183</sup>

Another outcome of good induction is an improvement in the knowledge, skills and performance of beginning teachers. Effective induction programs help new teachers to learn subject-specific issues in curriculum and instructional practices and create basic professional skills around effective communication and assessment, lesson planning, assessing student work and communicating with parents.<sup>184</sup> Literature presents evidence that, in other countries, well designed and supported induction programs assist greatly with neophyte teacher retention, especially in difficult to staff locations.<sup>185</sup>

As noted by the Queensland Deans of Education Forum: "Induction and structured mentoring should set the context for continuing professional learning".<sup>186</sup> Further, university participation in induction programmes would strengthen teacher education curriculum because it could encourage more integration of theory and practice, and tracking of teacher effectiveness. A challenge perhaps is to establish structures that enable universities to follow up with their graduates in order to assist their induction.

## Mentoring

Beginning teachers face the total complexity of classroom teaching from the very first day. A wide range of complementary and supporting activities can be used, and used to effect, as part of induction. One is through

utilising and enhancing mentoring practices. Mentors provide positive re-enforcement, guidance and understanding and are important in any profession. In New South Wales, teachers who retrain in science, technology and mathematics are provided with 12 months mentoring from an experienced teacher.<sup>187</sup> Some advocate a system where promotional positions are created for mature teachers who take on specific staff mentoring responsibilities—such mentor teachers might specialise in aspects of induction for trainees undergoing internships and for beginning teachers in their first three years of service.<sup>188</sup>

Some current mentoring practices in Australian schools are systematic and thorough. However, there are no established standards or structured training for those who mentor beginning teachers. Some guiding principles for mentoring would include:

- selecting mentors who meet the needs of individual beginning teachers;
- using appropriately prepared and trained mentors (universities and employers may be able to work together to establish structured training programs for mentors);
- making sufficient time for effective mentoring;
- providing effective mentoring for geographically and otherwise isolated beginning teachers; and
- establishing effective performance indicators and evaluation processes.

Another effective mentoring practice might be to use multiple mentors for different types of support. For instance, a beginning science teacher may need a teacher mentor to assist with classroom management, as well as a science mentor to assist with subject specific challenges. And if the new science teacher is the only science teacher in the school or in a regional or remote location, innovative approaches to using the Internet for networking with mentors might be provided. One way this is achieved in Western Australia is through the provision of on-line support programs for new graduates.<sup>189</sup>

Another practice is the use of supportive peer networks. Many new teachers can feel overwhelmed, so learning that their peers are going through the same kinds of experiences helps to create understanding that their difficulties are not an indication of their abilities or preparation. For example, such a peer network for beginning mathematics teachers might be facilitated by an experienced and highly competent mathematics teacher. Similar sources of support mechanisms might be found in teacher subject professional associations.

Other kinds of support given to beginning teachers might be through providing more varieties of teaching observation, and the use of technicians and other support staff. Gaining an appreciation of broader school life, in addition to appropriate teaching assignments, is also part of the challenge for beginning teachers.

Beginning teachers are usually expected to accept the same level of responsibility as veteran colleagues, rather than have a much more gradual introduction. In addition, beginning teachers may be given the 'least desirable and most difficult teaching assignments'. Their responsibilities are not generally introduced gradually and they are often placed in individual classrooms, without peer support. Such lack of support may quickly lead to lack of self-esteem and loss of self-confidence, and thus to stress and even early resignation.<sup>190</sup>

The Australian Council of State School Organisations recommended consideration of the use of a Scandinavian workload-sharing concept of a "phase in" for younger teachers, "phase out" for older teachers, whereby newer teachers are assisted on the learning curve, while those closer to retirement age can wind down but still make a contribution rather than leaving teaching abruptly, and have greater opportunity to act as mentors.<sup>191</sup>

Providing good support for beginning teachers requires an allocation, at the school level, of appropriate time and resources. Principals who acknowledge this when organising school timetables, can do much to ensure that beginning teachers have the opportunity to learn and develop in their first year of teaching. As one new recruit put it:

Our school has the rule that first year teachers don't take on any extra responsibilities. The first year is purely to find your feet.<sup>192</sup>

Well-planned and effective induction is one part of a comprehensive set of features to improve teacher quality and retain teachers in the classroom. Support of new teachers with concerns about student management, curriculum, parents' meetings and other issues is equally important. Coming to terms with school cultures and the many and varied roles of teachers in a school is an enormous challenge for all beginning teachers, and this needs to be well supported.

## **LEADERSHIP, TEAMS AND ENGAGING STUDENTS**

Positive work environments in which teachers feel valued and are able to fully engage students are crucial to student learning. The Australian Academy of Science notes several aspects about the school environment that are important to teacher satisfaction and therefore retention, including the physical conditions within schools, curriculum materials, teaching loads, the use of teaching assistants and other support staff, appropriate class sizes, access to and use of technology, access to appropriate in-service training and the opportunity for study leave and professional learning.<sup>193</sup>

In the areas of science, technology and mathematics, it is important for schools to devote sufficient physical and human resources to ensure that quality and effective teaching can take place and provide professional satisfaction to creative and innovative teachers. The Australian Parents Council was of the view that:

It appears from the findings of the PISA [Programme for International Student Assessment] study that the quality of teaching, teacher morale and school autonomy are aspects of school policy with substantial impact on reading, mathematical and science literacy.<sup>194</sup>

It is important to promote the well-being of teachers, personally and professionally, by fostering self-esteem and orientation to the school workplace. Indeed, a strong theme in the submissions was that professional and personal satisfaction were important to retaining teachers and improving the quality of their work. The Australian Association for Research in Education adopted the view that:

Given that the conditions of teachers' work are the conditions of student learning, employment conditions such as reasonable student-staff ratios, well resourced schools, supportive leadership, access to high quality ongoing professional development, recognition for innovation, supportive partnerships with parents, and university-school collaboration, all of which, together with a focus on student learning, are recognised as being conducive to quality teaching and student learning.<sup>195</sup>

Dinham and colleagues have researched over the last decade many aspects of the teaching profession and, more specifically, the question of teacher job satisfaction. These studies have shown that, for teachers, satisfaction lies in their ability to deliver their 'core business'—facilitating pupil achievement, their own professional growth and working with others. Dissatisfaction primarily lies in dealing with the 'system'—relationships with superiors and educational employers. Dissatisfaction is, however, on the rise, with teachers increasingly feeling that their efforts are not appreciated by students, parents and society in general and that they are now taking on a workload that was once primarily the domain of family and community.<sup>196</sup>

There are a number of reasons why people leave teaching other than for retirement or family commitments. These include dissatisfaction with teaching conditions, such as lack of resources or time to undertake all tasks and responsibilities, poor student behaviour, and the apparent indifference and criticisms of parents and the community. Having effective measures for managing student behaviour and building positive relationships with parents and the local community, and good school leadership practices are important to the teaching and school environment.

## Teaching Teams

The classroom relationship between student and teacher remains at the heart of effective pedagogy. The demands on teachers of student management were raised in many submissions, including claims that: "In many classrooms, management has replaced good pedagogy. Welfare issues and administrative requirements impact on the effective teaching of even the best [science, technology and mathematics] teachers."<sup>197</sup>

Teaching practices which improve classroom relationships, and finding ways to maximise time spent teaching have the potential to be productive for teachers. It might be timely to consider alternatives to current approaches to teaching science, technology and mathematics, acknowledging that many teachers have non-teaching administrative responsibilities which take them away from core teaching responsibilities.

Broad workforce planning models of the future may need to consider different classroom practices. One option to unlock the full potential of a school workforce and student potential may be through developing roles for ancillary workers such as teaching assistants to play a part within learning teams.

Teachers spend a significant proportion of their working time engaged in administrative and school organisational tasks that support staff could do equally well. More effective training and use of support staff would enable teachers to focus on consolidating good teaching practice and curricula.<sup>198</sup> According to Don Zoellner of Centralian College, there should be "greater use of para-professional staff in all facets of school work".<sup>199</sup>

The 2001 *National Report to Parliament on Indigenous Education and Training* reflected that: "Indigenous people regard it as important to have an indigenous presence in the schools their children attend".<sup>200</sup> In 2001, there were 1,764 Aboriginal and Islander Education Workers (AIEWs) in government, and 411 AIEWs in Catholic primary and secondary schools. As para-professionals, AIEWs play an important role in improving Indigenous student outcomes and developing strong relationships and linkages between schools and communities. This role can also provide a pathway into teaching for Indigenous people.

Many in the science and technology community proposed "funding schools to employ tertiary [science, technology and mathematics] students to assist [science, technology and mathematics] teachers in educational activities".<sup>201</sup> In the United Kingdom, the government responded to the Review of the Supply of Scientists and Engineers by introducing a major program to pay undergraduates and postgraduates, particularly in science, technology and mathematics, to return to schools during their studies and support teachers and pupils in the classroom and laboratory, with appropriate support and training to equip them to be effective.<sup>202</sup>

There are solid reasons for deploying high-achieving undergraduate and postgraduate students in classrooms. They have good recent understanding of the subject, they have recent experience of the classroom and they can be ideal peers and role models. Nola Shoring highlighted the Science/Technology Awareness Raising (STAR) program run by Murdoch University in Western Australia which involves graduate students in work experience in schools who act as mentors for secondary students. Undergraduate students with talent could also be a potential source of future teachers.<sup>203</sup>

The development of non-teaching experts in schools to raise understanding of what is involved in applying knowledge and doing real science has been suggested by the science and technology community:

Scientists and technologists, including engineers, could be funded by industry to undertake school placements, including mentoring teachers and students, and planning and managing integrated learning projects (similar to artists in residence).<sup>204</sup>

A range of roles for support staff, teaching assistants, non-teaching experts and community members within teaching and learning teams merits further consideration. The teachers' role would be pivotal and such additional resources would support teacher expertise and student outcomes in school and other learning environments.

## Effective School Leadership

The conditions surrounding teachers' work contributes to their motivation and their effectiveness as a teacher. For teachers, conditions in the school are likely to contribute to their sense of a productive and supportive environment in which to work. Of these, effective and supportive school leadership ensures that the school environment is hospitable and professional. It is well documented that teachers who find themselves in workplaces lacking these are likely to transfer to other schools or leave teaching altogether. According to the Western Australian Department of Education and Training:

Supportive leadership at the school level can have a real and positive effect on teacher retention. Research undertaken in Western Australia confirmed the importance of leadership at the school level, particularly from the principal and other members of the administrative team.<sup>205</sup>

As noted by the Australian Association of Christian Schools: "Invariably, good schools have good principals".<sup>206</sup> The importance of strong, appropriate leadership to teacher retention was also emphasised by the Association of Independent Schools of Queensland:

Effective leaders value the work of teachers and through affirmation of teachers and their work have an enormous impact on the retention of teachers in the education workforce. They provide opportunities for teachers to participate in collegiate and professional activities which ensure that teachers are confident and satisfied in the execution of their work.<sup>207</sup>

Principals and other designated school leaders generally have the flexibility to seek to achieve effective and efficient use of the school teaching workforce, including ensuring that existing skills and expertise is matched to the work required in the school, ensuring teachers are encouraged to practise to their full professional capacity, and ensuring teachers are encouraged to undertake professional development. In Victoria, management and responsibility for the selection of school staff and personnel management decisions has been devolved to principals.<sup>208</sup>

Principals and school leaders can also support teachers in their core task—enhancing student learning. According to the Australian Parents' Council:

Greater autonomy for schools, particularly in the recruitment and selection of staff could address local needs more effectively and lead to improved learning outcomes and better teaching morale, provided that resources are made available to support these responsibilities at the school level.<sup>209</sup>

Leadership, at various levels, is a feature of schools. According to the University of Adelaide, the most successful schools are those where "the school leadership establishes an academically-oriented learning environment and supports the collaborative involvement of teachers and parents, from all social and cultural contexts, in decisions about students' learning".<sup>210</sup> Promoting teacher partnership and communication with parents is also a function of school leadership, and teachers should be assisted with understanding parents and attempting to engage them in supporting the education of their children.

It is notable that there are programs in place to assist the development of effective leadership in schools. The Tasmanian Educational Leaders Institute, a joint University of Tasmania/government schools initiative, provides a compulsory professional accreditation process for school principals.<sup>211</sup> In Victoria, government school principals can undertake the School Leadership Development Program, which outlines the capabilities and knowledge essential for highly effective school leadership, provides a comprehensive and coordinated development framework for school leadership and promotes programs and activities which support school leaders at various stages of leadership and school development needs.<sup>212</sup>

Teacher-leaders are also important for successful in-school innovation. According to Education Queensland, teachers need to be recognised for the formative role they play in the development of their students, and thus there is a strong need for school leadership which respects the fundamental student/teacher relationship and creates teacher leadership opportunities.<sup>213</sup>

Leadership can also strongly influence the degree to which the whole school community accepts the importance and relevance of the areas of science, technology and mathematics and connects those subjects into the whole academic and cultural ethos of the school. According to the South Australian Department of Education and Children's Services: "School leaders, particularly in primary education, require a good understanding of qualitative components of the curriculum (i.e. science, technology and mathematics) and the implications for curriculum planning and resourcing".<sup>214</sup>

Beyond the classroom, there is a role for teachers who have recognised expertise and experience in particular subject areas, in mentoring and encouraging inexperienced teachers to remain in the profession, as well as taking on leadership roles in the broader community. According to the Queensland Board of Teacher Registration, "opportunities need to be provided for high performing teachers to develop a profile as role models: speaking tours, school visits, media work, etc".<sup>215</sup> Indeed, leadership roles can reward able and innovative teachers, without necessarily removing them from direct involvement with students in classrooms.

Good leadership also requires connecting schools to the wider community. All students, teachers and schools are part of a broader community including a global community. Connecting with such communities is a challenge for all. One way in which schools could (and do) connect with their community is through networking and building relationships with other institutions—universities, research institutes, industry, and science, technology and innovation centres.<sup>216</sup> Partnerships can also engage the community through the involvement of more non-teaching experts and community members in the classroom and at alternative sites in the community to work alongside the teacher, such as at Questacon, CSIRO Science Centres or Scitech.<sup>217</sup>

These science and technology centres provide a range of informal 'hands on' approaches to learning science and technology, which complement and enhance formal school learning. Their primary mission is to increase interest and participation in science and technology in the community through educational exhibitions and awareness-raising programs. According to Questacon, the objective is to motivate:

... students and teachers to adopt a more positive view of science and technology and which helps to develop a more conducive environment for science and technology learning in schools, for serious consideration of careers in science and technology, and for teacher development programs in science and technology education programs.<sup>218</sup>

Partnering with business and industry can enhance vocational learning and can play a significant role in the initiation of, and support for, innovation in schools, both in content and learning.<sup>219</sup> The benefits of partnerships can work both ways as the research sector, business and industry "have an interest in investing in the education system to prepare the technicians and technologists of the future".<sup>220</sup>

Partnerships can occur at a number of levels:

- they can exist for *ad hoc* communication and information exchange;
- they can be ongoing in nature, with experts advising on matters such as curriculum content, professional development and student programs;
- they can result in presentations in schools by guest experts; and
- they can formalise as sector exchanges, either as 'industry placements' or sabbaticals for teachers into industry or academia, or as expert secondments from academia and industry into teaching.

There was strong support in the submissions for transfers of teachers to and from industry and academia.<sup>221</sup> According to the Australian Council of State School Organisations: 'the availability of lateral transfers to industry and back into teaching without loss of entitlements is also essential, not only for the refreshing effect on an individual's career, but so that the teacher can remain up to date and bring current techniques back into the school'.<sup>222</sup>

Iona Presentation College proposed flexibility for teachers to move between schools, TAFE and industry. Further, the College emphasised the need to recognise existing skills when transferring between industry and schools.<sup>223</sup> Teacher professional associations also have an important role in linking schools and industry.<sup>224</sup> The Australian Mathematical Society maintained that:

The leadership in mathematics teaching must come from the discipline—the mathematical scientists, teachers and mathematics educators. Teachers need to feel they have connections with the discipline as well as education. The Society is devoting considerable effort and money in trying to improve teachers connections with new developments in the mathematical sciences and expects the newly create Australian Mathematical Sciences Institute to be able to take a lead in this work.<sup>225</sup>

According to several professional associations, effective leadership can create a culture that values teachers and teaching especially in the areas of science, technology and mathematics, and that learning in these areas thrives where they are broadly supported by leadership, while the opposite is true where they are not supported.<sup>226</sup> The University of Adelaide noted:

If teachers are to be attracted to teach science, mathematics and technology (and indeed all disciplines), then schools must have leaders who are able to create supportive and stimulating learning contexts for all teachers and students.<sup>227</sup>

Educational leadership is perceived to be fundamental to educational innovation and “successful school-based innovation tends to occur in response to a definitive educational need and as part of a clearly articulated vision on the part of a leader or leaders”.<sup>228</sup> Three particular aspects of school-based leadership are evident in successful educational innovation:

- leadership as a focused action, including strategic responses to crises, pursuit of an intrinsically motivated challenge, and facilitation and encouragement of the innovative ideas of others;
- leadership as culture building, including the recognition of extrinsic and intrinsic forces to align the school's vision, participants' values and innovative processes; and
- leadership as an organisation-wide process of learning, focussing on generating alignment between significant school elements, and developing a school-wide approach to pedagogy using the successful experiences of individual teachers and teams.<sup>229</sup>

Many submissions proposed that the diversity of the student population and the wider community should also be reflected within the teaching profession, if only to provide a wide range of role models for children.<sup>230</sup> The Queensland Board of Teacher Registration notes that one of the factors that contributes to difficulties in attracting and retaining teachers, especially in regional areas is “the relative homogeneity of teachers as a group (for example, in terms of their socio-cultural and socio-economic backgrounds and characteristics) compared with the heterogeneity of student populations in schools”.<sup>231</sup>

In Australia's multicultural democracy it is desirable that our educational institutions reflect the diversity of our people. This is particularly important in schooling where teachers are often regarded as role models for students and can be a key support for parents and communities. In relation to the teaching workforce in primary schools there is a large gender imbalance—in 2001, 79 per cent of teaching staff in primary schools were female.<sup>232</sup> In secondary schools there is not a marked imbalance across the board—in 2001, 55 per cent of teaching staff were female—but as outlined earlier in this Report, teachers of science and mathematics are predominantly male.

The House of Representatives *Inquiry into the Education of Boys* recognised that, whilst the quality of the teacher is more important than gender, it is desirable to consider measures to attract more males into the teaching profession. The aim would be to provide a balance of students' exposure to both men and women interacting in leadership roles and sharing authority.<sup>233</sup> The South Australian Department of Education and Children's Services suggests that gender balance should not only be confined to getting more males into the teaching profession, particularly in primary schools, but also encouraging females to specialise in science (physical), technology and mathematics, where the proportion of male teachers is high.<sup>234</sup>

There is an overall need to increase the number of Indigenous teachers and to ensure that all teachers are better prepared to teach students from a range of socio-cultural backgrounds. Several submissions pointed to a critical need to include Indigenous studies in undergraduate education courses: the Aboriginal and Torres Strait Islander Commission noted this was a recommendation awaiting action from successive reports including the 1991 Royal Commission into Aboriginal Deaths in Custody; and the Australian Education Union suggests such studies be a pre-condition to employment for all teachers in the public education system.<sup>235</sup>

There is also a more specific need to increase the number of Indigenous teachers with qualifications in science, technology and mathematics.<sup>236</sup> According to the Queensland Indigenous Education Consultative Body:

Indigenous students undertaking science and technology-based courses at tertiary level do so predominantly in the areas of the health sciences (nursing, primary health care, etc.) and/or the environmental sciences (landscape architecture, environmental studies, marine biology, etc.). These students rarely direct their efforts towards teaching, choosing instead careers in government, business, media or the arts.<sup>237</sup>

According to the Australian Association of Mathematics Teachers, “the under-representation of indigenous students in scientific and technological fields exacerbates this problem, and may well lead to a continuing cycle of Indigenous students not selecting these areas of study in senior secondary school”.<sup>238</sup> The Aboriginal and Torres Strait Islander Commission suggest that science, technology and mathematics curriculum should be built around concepts which are familiar or relevant to Indigenous students.<sup>239</sup>

Attention needs to be paid to raising the numbers of Indigenous teachers in Australia’s schools. In order to encourage Indigenous students to pursue a teaching career in the areas of science, mathematics and technology, the Queensland Indigenous Education Consultative Body recommends that incentives be offered to encourage Indigenous secondary students to pursue science, technology and mathematics, and additional incentives be offered for Indigenous students to undertake teacher education in the areas of science, mathematics and technology.<sup>240</sup> The 2003 New South Wales Pre-service Teacher Education Program for teachers of science, mathematics and technology will include at least 30 scholarships for Aboriginal and Torres Strait Islander people.<sup>241</sup>

## Engaging Students

Learning is central to the knowledge economy and a democratic society. Teaching students how to learn, discover, analyse and use information effectively is an important part of engaging pedagogy and relevant curriculum, especially in the areas of science, technology and mathematics.

A strong theme in the submissions was that the pedagogy required in classrooms was becoming more demanding. This was due in part to the complexity and rapid developments in content areas and in part to changing demands on the role of the teacher. Good pedagogy, as described by Monash University, is:

... dependent upon a sophisticated blend of content knowledge, knowledge of learning and learners, of the pedagogical issues pertaining to particular subject matter which is generally known as Pedagogic Content Knowledge (PCK), together with an understanding of the culture(s) of youth and schools. It relies on teachers who are broadly and deeply knowledgeable and sufficiently confident in their knowledge to be able to change and innovate.<sup>242</sup>

Pedagogy in the 21<sup>st</sup> Century is becoming increasingly complex and has shifted in paradigm from ‘*what* a student knows’ to also focus on ‘*how* a student uses that knowledge, and from ‘knowledge telling’ to ‘knowledge creation’.<sup>243</sup> In this new paradigm, the teacher is no longer the only source of knowledge, but a facilitator of learning.<sup>244</sup> Teachers have become ‘knowledge workers’ who require more comprehensive knowledge and skill sets than ever before, particularly in the area of ICT and on-line learning.<sup>245</sup> Indeed, education authorities are already using ICT, particularly for the remote delivery of curriculum to the classroom.<sup>246</sup>

Several submissions suggested that school mathematics and science curricula need to be made more relevant to the everyday world of students. The University of Adelaide submitted that issues related to curriculum and how subjects might be taught have traditionally been examined in relation to narrow subject definitions, and suggested that a major review of school science, technology and mathematics curriculum should be established to examine “how these disciplines interact and enrich each other”.<sup>247</sup>

Most State and Territory education authorities are engaged in continuous reviews of some or all elements of their K–12 curricula to include changes to content and pedagogy. However, although teachers are often consulted during these processes, curriculum reform and implementation tends to be “top down” and the changes involved can be perceived by teachers as a further burden on their work. While education authorities put considerable effort into involving teachers in curriculum change, the extent to which curriculum reform is implemented and actually becomes reflected in classroom practice remains problematic.

Goodrum found that the science curriculum in the States and Territories provided the basis for developing scientific literacy in all students as it focused on the development of broad conceptual understandings and provided an appropriate modern and progressive vision of the intended science curriculum. In terms of implementation at the secondary level, however, Goodrum concluded that there was “a gap between the intended curriculum of today’s science curriculum frameworks and the actual implemented curriculum”.<sup>248</sup> Goodrum found that science remained traditional, discipline-based and dominated by content.<sup>249</sup> In addition many of the learning support materials such as textbooks reflected traditional pedagogy, content and contexts, further limiting teachers’ ability to implement curriculum frameworks.

Submissions suggest that not enough science and technology, and to a lesser extent mathematics, is being taught in primary schools. Certainly it seems that the majority of primary teachers could have stronger grounding in science and technology and, to a lesser extent, mathematics. As a result, science and technology are often not prioritised in primary schools. The teaching of science and technology needs to be prioritised in the strategic plans of primary schools, particularly when there are pressures to focus on areas such as literacy and numeracy. Convincing school authorities and principals that science and technology curriculum be prioritised and finding ways for primary teachers to feel comfortable and confident teaching science remains a challenge.

The teaching of science, technology and mathematics at primary school is typically undertaken by generalist teachers. Primary teachers have generally undertaken pre-service courses in which mathematics/numeracy, science and technology have not been studied in any depth. As a consequence, when faced with teaching these subject areas may lack confidence. A number of submissions proposed the introduction of specialist teachers of mathematics and science in primary schools.<sup>250</sup> Others were of the view that the solution lay in enhancing the broadly based skills and confidence of primary teachers and building pedagogy content knowledge in science and mathematics. The Australian Science Teachers’ Association made the following recommendation:

Where a teacher with high science qualifications and/or experience is working in a primary school, a system needs to be established so that these teachers can assist and empower those teachers who lack skills, knowledge and experience. Primary teachers with science specialisation are best utilised as mentors and team-teachers in the regular teacher’s classroom. This will empower those teachers who are reluctant to take up science teaching. It will also ensure that science teaching is more easily integrated into the primary science classroom.<sup>251</sup>

The middle years also require attention. Australian results from the Third International Mathematics and Science Study revealed that Australian students’ attitudes towards science deteriorates markedly between primary and secondary education. When responding to the item “I enjoy learning science”, the frequency of disagree and strongly disagree responses increased from 22 per cent male and 19 per cent female middle primary students, to 32 per cent male and 37 per cent female lower secondary students. Almost 40 per cent of secondary students surveyed in this study reported that they never got excited about what they do in science. This suggests that the junior secondary school level is strongly in need of attention in terms of science, technology and mathematics pedagogy and curriculum.<sup>252</sup>

The mathematics curriculum also attracted criticism for its ability to inspire students and to equip them with the required mathematical thinking skills. According to A.G. Shannon, teachers of mathematics at any level “must love teaching and must love mathematics”, his main concern being “with their knowing some things well; with some appreciation of how mathematicians do mathematics (when there is no answer at the back of the book); and that they feel passionate about mathematics”.<sup>253</sup> The Mathematics Education Research Group of Australasia described the qualities of a well qualified teacher of mathematics as:

- having a love of mathematics arising from successful experiences in mathematics throughout primary and secondary education;
- having a strong theoretical and practical knowledge of school mathematics, including statistics, certified by formal qualifications;
- having strong pedagogical content knowledge appropriate for teaching specific content to the range of grade levels taught, as certified by appropriate methods studies and developed through experience, professional development and further studies;
- having up-to-date working knowledge of mathematical tools, methods and applications used in a wide variety of social, vocational and research contexts;
- having a strong understanding of how mathematical knowledge and skills apply to and should be used in all other key learning areas, and the capacity to convey this to teachers of other subject areas; and
- having attitudes and aptitudes to sustain learning about mathematics and its teaching throughout their careers, certified by engagement in professional development courses and activities that pertain specifically to their discipline.<sup>254</sup>

The technology curriculum attracted comment more for its broad nature than its relevance—technology can include a range of subjects including Home Economics, Design and Technology, Computing and Business Education. It was argued that the pedagogy for these subject areas should be reconceptualized to appeal to all students, particularly to distinguish technology as a subject distinct from the traditional manual arts subjects. The Australian Council for Education Through Technology was of the view that while States and Territories have or are establishing clearer directions for technology education through curriculum reviews, its implementation has been problematic due to a conflict between the revolutionary nature of the curriculum itself and its need to be implemented incrementally.<sup>255</sup>

The overall impression is that science, technology and mathematics need to be lively and contemporary and include effective pedagogy. Curriculum, according to the Western Australian Department of Education and Training, should: “allow for the development of teacher resource materials that demonstrate the links between pedagogy and subject specific content”.<sup>256</sup> Education Queensland concurred:

Content knowledge and understanding is very important but within the role of teacher, what is critical is the use of that knowledge and understanding to design and manage learning experiences that will interest and enthuse students ...<sup>257</sup>

Vocational Education and Training (VET) is addressing some these challenges. In 2001, nearly 95 per cent of schools with senior secondary school programs were offering vocational education and training and the number of students undertaking these programs was 169,809. The structured workplace learning component of VET courses is a clear example of embracing new learning contexts and providing students with opportunities for learning to take place in different contexts: in the classroom, on-line, in the workplace and in the community. As the submission from the Enterprise and Career Education Foundation noted:

The valued features of the learning process associated with structured work placement can be applied across the curriculum to revitalise interest and enthusiasm in all subjects. Transformation of school learning is less to do with ‘vocationalisation’ of school and more directly to do with rethinking how schools can best do their job.<sup>258</sup>

Given the strong relationship between good teachers and successful learning outcomes, it is important to focus on attracting and retaining high quality teachers who can effectively combine curriculum with engaging pedagogy in primary, middle and senior secondary schools. Moreover, it is also important to retain teachers who have the capacity to be passionate and remain passionate about their subjects, their teaching and their students; who have the capacity to inspire; and to become role models for their students.

## PROFESSIONAL LEARNING AND DEVELOPMENT

Teaching is a dynamic and lively profession. Being an integral part of the knowledge economy, teachers are lifelong learners with specific professional needs to be up-to-date with the content of their particular fields and with the developments about human learning. This goes to the heart of what is known as “lifelong and life-wide learning” which the Australian Council of Deans of Education describe as:

Lifelong learning means that education is no longer located at a discrete time of your life, your one chance to learn, a time when you learn things that are significant for life. Specific skills and knowledge learnt today may be obsolete in twenty years times or even five years time, and we will increasingly need to retrain and relearn throughout life.<sup>259</sup>

Professional learning opportunities improve teachers’ knowledge and skills, enhance the impact they have on children’s learning outcomes, boost morale and confidence, and facilitate career development. It is also linked to teacher professionalism. The School of Education, University of Queensland argued:

Ownership of one’s professional learning and the ability to form professional relationships and engage in ongoing professional dialogue with colleagues, underpins effective professional growth for teachers. This means that structures should be investigated that support and encourage teachers’ ownership of their own professional learning ...<sup>260</sup>

Professional learning provides a sense of teachers as active and alert professionals. As noted by the Australian Council of Deans of Science: “teachers are professionals who have needs for professional refreshment in their fields of expertise”.<sup>261</sup> Indeed, as the University of Western Australia acknowledged:

Pre-service education can no longer equip a teacher for their entire professional career. There needs to be systematic on-going professional development available to teachers, and universities can play a substantial role.<sup>262</sup>

The value to teachers of effective professional learning is not restricted to its potential to update their professionalism, their subject knowledge and pedagogical practices. The General Teaching Council for England says that teachers report “professional satisfaction of interaction with learners and the continuous process of development of learning” as a key factor in attracting people to teaching and keeping them in it.<sup>263</sup> Science teacher Peter Fox wrote: “Positive professional development experiences represent one way to help rejuvenate, motivate and retain existing teachers”.<sup>264</sup> According to Monash University:

Professional development of worth will increase a teacher’s expertise by building on content knowledge and how that content may be taught, enabling them to be flexible, innovative and thoughtful practitioners. It must be systematic, structured, sustained and recognised.<sup>265</sup>

Professional learning can improve teacher morale, contribute to teacher professionalism, reduce teacher isolation and, in this way, help to retain teachers in the profession. The Isolated Children’s Parents’ Association of Australia argued:

Some teachers experience ‘professional isolation’ due to lack of contact with and support of their peers. This is often the case in smaller schools where they may be the only mathematics, science or information technology teacher. The ability to access one’s peers through regular professional development activities would provide the opportunity to share ideas, concerns and issues. Networks need to be established and maintained.<sup>266</sup>

To remain effective, teachers require relevant, accessible and tailored professional learning opportunities. The view of the Mathematics Educational Research Group of Australasia was:

In order to retain teachers, attention to on-going professional development and support is essential, for many reasons. For example, it is not possible to attend to every necessary component of pedagogy in pre-service programs. New technological tools change both what is taught and how it should be taught, and close study of lesson content needs to be integrated with real teaching experience.<sup>267</sup>

Professional learning is especially valuable for teachers of science, technology and mathematics. According to the Australian National University:

In science, mathematics and technology, the pace of change and developments within the disciplines are such that, however talented and well-trained initially, teachers will quickly become disengaged from the innovation and excitement of their specialities ... In any solution to the problems which currently face science, technology, and mathematics education in Australia, the emphasis needs to be placed very firmly on ongoing professional development.<sup>268</sup>

In this context, professional learning around subject specific areas is particularly important. According to the Australian Science and Mathematics School:

What the rapid changes in science and mathematics imply is that it is no longer tenable to believe, if it ever were, that a qualification received at the start of a teaching career will keep a teacher current in these areas throughout their career, and in a position to bring to life the challenges and opportunities that they present. Subject specific professional development must be an essential part of teachers' working environment, linked with curriculum review and development.<sup>269</sup>

Primary teachers, in particular, require encouragement to access professional learning opportunities that raise their knowledge of science, technology and mathematics subject areas. This is important because primary teachers often feel pressured to undertake professional learning that assists them to meet community priorities in such areas as health, literacy and numeracy. According to the Western Australian Department of Education and Training:

Whilst most primary teachers have an excellent understanding of how students learn, they do not, as a general rule, have a good content knowledge of science, technology or mathematics. Primary teachers require specialist professional development to enable them to become confident teachers of maths and science ... This will enable them to provide a classroom environment that stimulates problem-solving and innovation.<sup>270</sup>

Frances Meeking, a teacher at Manjimup Primary School in Western Australia, described the benefit of professional learning to her:

I am currently employed as a Getting it Right Specialist Teacher in Manjimup WA. As such I am having extensive professional development in the area of primary school mathematics. I have learnt so much in the past year and, because I have a special position in the school, I get the chance to implement change to the pedagogy of teachers. I work with 8 teachers at a time which means that I am covering from K–3. Even in this short time we have been able to see quantum changes in the way teachers approach maths in the early years.<sup>271</sup>

Professional learning can take a number of forms and be provided by a range of education providers. Professional learning can be accredited, linked to career progression, voluntary, compulsory, and vary in quality and format. It can also be employer-provided or self-initiated. Different types of professional learning can include:

- professional development for teachers who lack the appropriate qualifications to teach a particular part of a curriculum in their own subject area or a related one, e.g. maths education for a chemistry teacher, or photonics for physics and science teachers;
- refresher courses for qualified former teachers who now want to return to teaching (possibly sponsored by schools with funding support);

- incentives for travelling teachers to return to Australia, including recognition of overseas experience, and;
- serious funding support to schools to allow effective mentoring by senior teachers.<sup>272</sup>

Teaching 'out of field' in secondary schools was an issue raised by some submissions. The nature and extent of this practice across secondary schools needs further examination. At the heart of such claims are the qualifications and skills of those teachers teaching 'out of field'. The Western Australian Department of Education and Training suggests that if teachers are required to teach outside their specialist area, they should be assisted by their employing authority to gain the necessary qualifications through professional learning.<sup>273</sup> The Australian Mathematical Society also proposed re-training for teachers teaching 'out of field':

If they do not have adequate qualifications to teach at the level they are being required to teach this must be addressed. This includes many primary teachers who may have graduated without sufficient content knowledge but may have excellent teaching skills. Retraining must be done over time and allow teachers to reach a level of qualification that is appropriate for the level they are being asked to teach.<sup>274</sup>

The University of South Australia suggests that professional development to update the teaching and content knowledge of teachers moving outside their original specialisation can be done through a school-based model where release time to attend university courses, and highly accomplished teachers to act as mentors and provide support are available.<sup>275</sup>

State and Territory education authorities have a range of initiatives in place to support teachers' professional learning needs. For instance, Victoria's School Innovation in Science Professional Development Program is designed to facilitate whole school change in science teaching and learning through professional development for primary and secondary teachers.

Professional learning opportunities can also be built on partnerships with the science and industry communities:

Schools could be funded on a partnership basis to release [science, technology and mathematics] teachers for work placements alongside scientists, engineers, technologists and technicians in industry and research organisations; the duration of placements would be determined by the nature of the placement (hands-on laboratory-based experience or an informed transfer of knowledge by the teacher about [science, technology and mathematics] at the placement location), the expected benefits to students and the funding model.<sup>276</sup>

Education Queensland's Centres of Excellence in Science, Technology and Mathematics provide training for teachers to help them maintain currency of knowledge and skills, and do this in partnership with universities, industry and the community.<sup>277</sup> Victoria's Teacher Release to Industry Program places Victorian government school teachers in an industry setting for up to 40 weeks, with benefits for both school and industry. A teacher submitted that, "This program has proved to be professional development, second to none".<sup>278</sup>

The Australian Science and Mathematics School, which is a partnership between the South Australian Government and Flinders University, is another model that is predicated on the science, industry and business community being involved directly in the process of translating what they know into the classroom context and teachers being engaged in real learning contexts.<sup>279</sup>

Professional learning is also used to increase the attractiveness of re-entry for teachers who have been out of the classroom for some time. New South Wales provides re-training for existing and retired teachers in secondary teaching areas of technological and applied studies, mathematics and science (physics) including university study, mentoring support and school placements.<sup>280</sup> Western Australia provides science rejuvenation programs to returning teachers, in partnership with professional associations.<sup>281</sup> Victoria offers Online Science programs for teachers who work in remote locations or are unable to attend face-to-face professional development sessions.<sup>282</sup>

The Commonwealth has identified mathematics/numeracy, science and information technology among the priority areas for its Quality Teaching Programme (QTP), which provides funds to school authorities for professional

development of teachers with over ten years of practical experience, teachers re-entering the workforce, teachers of Indigenous students, teachers in rural and remote areas and teachers in disadvantaged urban schools. The University of South Australia noted that recent initiatives taken in each State and Territory under the QTP “have built significantly on previous Australian and international research on effective professional development which is respectful of teachers’ existing expertise and creating collective challenges for professional renewal”.<sup>283</sup>

Teacher professional associations also make a significant contribution to the availability and provision of professional development opportunities for teachers. The Queensland Board of Teacher Registration noted that: “Teacher professional associations currently provide a range of professional development activities focusing on discipline knowledge, curriculum and pedagogy”.<sup>284</sup>

Many teachers are likely to make individual decisions about the types of professional learning they need or want. Some may wish to upgrade their skills or knowledge in a particular area because, as noted by the South Australian Association of Independent Schools, “Teachers in general have a strong commitment to professional development and a willingness to learn new methodologies”.<sup>285</sup> Other teachers may undertake professional learning that will enhance their career transition through the stages of beginning teacher, accomplished teacher, highly accomplished teacher and educational leader.

Whatever the nature and objective of the professional learning, the benefits of teachers having ownership and professional responsibility for their own personal learning is well-understood. Caldwell notes that there is currently little incentive for teachers to undertake professional learning, especially in their personal time, and argues that these issues need to be addressed.<sup>286</sup> According to The University of Melbourne, “a key to any professional remaining committed in their work is professional development (especially self initiated), a degree of autonomy and recognition of their expertise and achievements”.<sup>287</sup>

It is important to note that the learning requirements of education authorities and individual teachers are not mutually exclusive. For example, Education Queensland take the approach that “teachers are able to take responsibility for their learning as individuals and members of teams within a framework that aligns to school and system priorities”.<sup>288</sup> Moreover, professional learning will be a requirement for maintaining registration in some jurisdictions. For instance, “the College of Teaching to be established in Western Australia, will require teachers to undertake ongoing professional development to maintain their registration as a teacher”.<sup>289</sup>

Ingvarson argues that professional learning should also be seen for its capacity building benefits at several levels. Professional learning should build individual teacher capacity to obtain knowledge and skills necessary to provide quality student learning. Professional learning should also build collective capacity for a strong and accountable profession, including through broader issues related to professional standards and career structures.<sup>290</sup>

The professional needs of teachers require acknowledgment and active management by individual teachers, school leaders, professional bodies and state and territory education authorities. This is because relevant and effective professional support for teachers’ professional learning and development improves the impact they have on children’s learning outcomes, increases skills, knowledge and confidence, and maintains existing and creates new career pathways.

## **CAREER PATHWAYS**

Highly qualified individuals already in, or about to join, the teaching profession have career aspirations which need to be understood, respected and managed. For many teachers, the type of opportunities for career advancement and flexibility are key motivations for entering and staying in the teaching profession. As a result, it is recognised that teachers develop over their careers and seek career pathways that provide personal and professional satisfaction. They also require recognition because “teaching is a profession about which the public has high expectations”.<sup>291</sup>

Practices that encourage and reward excellence in classroom practice, and encourage expert teachers in classrooms can address retention and attraction issues, as well as raise the status of the profession. Here, flexible career and employment structures that recognise and reward advanced teaching skills are very important.

## Recognition and Remuneration

As in many other professions, maintaining career advancement opportunities and rewards is a challenge for employing authorities. It is well understood that one of the more attractive features of teaching is that beginning teacher salaries compare favourably with most other professions. However, teaching can become less financially attractive the longer a teacher remains in the profession. “Unless teachers opt to seek administrative appointments, the salaries of classroom teachers do not rise after eight years in the profession”.<sup>292</sup> In 1998, the Senate Employment, Education and Training References Committee Inquiry into the Status of the Teaching Profession noted the impact of this compressed salary scale:

In this respect the teaching profession compares unfavourably with many other professions which have both extended salary scales and more opportunities for promotion at the ‘coal face’.<sup>293</sup>

In relative terms, Australia’s teachers are paid quite well at the commencement of their teaching careers, on both a national and international basis. Starting salaries for teachers compare favourably with average graduate starting salaries, and Australian teachers’ salaries were above the mean of OECD countries, both in terms of commencing salaries and after 15 years of experience.<sup>294</sup> Salaries in government schools commence at an average of \$36,000 and, at the top end of the classroom teacher scale, salaries range from \$47,500 to \$58,000. Additional benefits may include superannuation, leave entitlements and provision of professional learning.

Submissions highlighted the importance of recognising teachers’ work more broadly, and linking remuneration and rewards to appropriate recognition, as important to retaining teachers. A number of elements were raised:

- while commencing salaries are well-paid compared to some other professions, salaries plateau quickly and there is little opportunity for increased remuneration through career progression, especially at the mid-level;
- opportunities for increased levels of remuneration are in management positions, and to some degree this removes skilled teachers from the classroom;
- remuneration rewards longevity of service and experience rather than being linked to higher or further qualifications, or to performance;
- salaries do not recognise the diverse range of skills and expertise gained by teachers, especially in non-curriculum but increasingly essential areas such as behaviour management;
- salaries for mature-age recruits often do not recognise prior work and non-teaching experience;
- little provision is made for permanent part-time employment, more flexible hours of work and job sharing;
- portability of entitlements should allow teachers to move around Australia but retain as salary position and status;
- that salary structures should be reviewed to ensure that there is a clear and attractive path to encourage people to remain in teaching.<sup>295</sup>

Another related aspect to retention of teachers are the conditions or basis by which a teacher is employed. The Victorian Department of Education and Training found that cessation rates in the 25–29 year age group have fallen since ongoing tenure became the standard mode of employment.<sup>296</sup> This would suggest that permanency or ongoing tenure can positively influence teacher retention. Don Zoellner of Centralian College argued:

Teachers must be offered permanent positions early in their career. One reason so many leave early is that they are on medium to short term contracts with little job security.<sup>297</sup>

The favourable starting salaries for teachers may be a less significant factor in retaining teachers, particularly given the age profile of teachers, whereby the majority have been in the profession for some time and have already reached the highest salary increment. When combined with a compressed salary scale that rewards teachers on the basis of length of service, and promotion out of the classroom into management of schools, few financial incentives remain for career progression.

Caldwell and Roskam argue for the need for more flexibility in government schools to allow devolution of responsibility for appointment of teachers to schools, greater reward for high quality teachers and removal of structural limitations built into salary scales by industrial awards. In return, teachers would be expected to meet standards of accreditation and re-accreditation that would match the best in other leading professions.<sup>298</sup>

State and Territory employing authorities have worked to improve career structures, such as by creating mechanisms for career progression and flexible employment conditions. For instance, the Western Australian Department of Education and Training has created a career pathway for teachers wishing to remain in the classroom using a financial incentive of approximately \$7,000 per annum additional salary.<sup>299</sup> Employers are also packaging the range of incentives they provide in different ways in order to attract and retain teachers in rural and remote locations. Attractive packages for employable teachers can include incentives such as additional training and development, reimbursement for certain dental and medical treatment, vacation travel expense, and rental subsidies. Teaching can no longer be seen only as a localised state-based profession but one where professional teachers will seek an employment package that best suits their individual needs.

There are some realities that need to be taken into view that will not see radical changes taking place in the short to medium term. The teaching workforce is one of the largest of all workforces in Australia. In 2001, there were 249,629 teaching staff employed in all schools.<sup>300</sup> Budgetary realities for government and other employers mean that addressing some of the issues surrounding remuneration are considerable. This is not specific to Australia, it is a worldwide phenomenon. Any change to remuneration would need to be sustainable within this context and, as with other career professions, would need to be integrated with performance and reward systems.

For the teaching profession this could mean systematically aligning recognition and performance structures with remuneration. This could produce significant financial gains for highly accomplished teachers and stronger encouragement for beginning and developing teachers. An overarching objective would be to maximise the impact of the investment in teaching on student learning outcomes. This may be achieved through making a stronger connection to professional standards.

Submissions strongly suggest that poor remuneration can lead to job dissatisfaction and that improved remuneration would encourage teachers to stay in the profession. However, remuneration itself is not necessarily the only or most important point of dissatisfaction. As discussed elsewhere in this report, there are a range of factors that impact on teacher satisfaction. Therefore attitudes to remuneration need to be considered along with other factors important to attracting and retaining teachers.

Retention of teachers, however, goes beyond questions of remuneration. Many younger people are now making career decisions on the basis of quality of life and family responsibilities, rather than merely financial rewards and status. Moreover, new visions of careers are developing, whereby a job is no longer seen as a lifetime commitment, particularly now that there are more career opportunities for people with high demand skills such as in the sciences, technology and mathematics.

## **RETAINING TEACHERS OF SCIENCE, TECHNOLOGY AND MATHEMATICS**

Effective retention objectives can be met through:

- supporting new teachers in their initial years of teaching through induction, mentoring and other support mechanisms;
- providing a school culture that is team-based, has strong leadership, and encourages and supports teachers' abilities to use effective curriculum and engaging pedagogy;
- professional learning that improves teachers' knowledge and skills, enhances the impact they have on student learning outcomes, boosts morale and confidence, and facilitates career development; and
- providing flexible career and employment structures that reward advanced teaching skills.

These objectives allow teachers to focus on their core teaching responsibilities, and on enhancing student learning outcomes. Such a professional environment is essential for teachers' success, enjoyment, satisfaction and quality of experience—keys to retaining teachers of science, technology and mathematics.

## **4. THE WAY FORWARD**

### **RAISING SCIENTIFIC LITERACY**

The overall scientific literacy of the general community has important implications for lifelong learning, for the status of teaching and for encouraging people to consider teaching as a worthwhile career. In a society which has come to take scientific and technological progress largely for granted this is not easy but possible ways forward include:

- encouraging students to participate in science, technology and mathematics in post-compulsory schooling;
- rethinking classroom practice to make science, technology and mathematics more relevant and engaging, particularly in the middle years of schooling;
- focussing career counselling to encourage school students with aptitude to pursue careers in teaching and in science, technology and mathematics;
- extending the teaching of science and technology at primary schools;
- ensuring that teachers are acknowledged for their high quality pedagogical skills and deep content knowledge;
- supporting a culture of innovation and leadership in schools;
- creating communities of schools to harness and exchange resources and expertise; and
- connecting schools and community and industry-based science education centres.

### **EXTENDING PARTNERSHIPS**

Partnerships involve the commitment of time and certain resources but they can bring enormous benefit to Australia's education and science communities. Successful partnerships need to be built:

- between education, science, mathematics and technology research and teaching areas within universities to ensure appropriate pedagogic and content knowledge, to share resources, and to influence university planning in order to improve teacher education courses;
- between universities and schools to improve the relevancy and currency of school-based teaching practice, to ensure effective induction for beginning teachers, and to enhance ongoing professional learning;
- between governments, schools and scientific and technological communities to diversify approaches, improve the relevance of curriculum and teaching, and provide career models for students; and
- between schools, parents, local communities and industry.

## **BUILDING THE CAPACITY OF THE PROFESSION**

The teaching profession needs to develop through a supporting and flexible national framework. A new professionalism would include improved teacher career paths, effective teacher education, sustained professional learning, the development of professional standards and other support mechanisms, including:

- more opportunities for career-long professional learning both in discipline and pedagogy to encourage, support and improve student learning;
- improving induction and other support mechanisms for beginning teachers;
- making more effective use of teaching assistants and ancillary workers to give professional teachers the opportunity to focus on core teaching and learning;
- ensuring teacher education is effective and relevant; and
- establishing a national framework for professional standards, and determining an appropriate role for these standards in recognition of teacher professionalism.

## **PLANNING FOR THE FUTURE**

The issues around teacher supply and demand relate to the availability and utility of data, and to the effectiveness of planning and recruitment strategies by employers. Possible ways forward include:

- better national and disaggregated data on school student participation and teacher education participation, particularly in the sciences, technology and mathematics;
- strengthening cooperation between employing authorities and universities to ensure teacher education understands and meets the needs of schools;
- sharing effective teacher recruitment, incentive and retention strategies;
- seeking Australia-wide agreement on portability provisions;
- actively developing career paths for teachers and recognising prior and in-service learning;
- improving the conditions of teaching and learning environments; and
- improving understanding of the workforce needs of the future and examining flexible practices and planning including seeking future teacher professionals from a more diverse pool of potential applicants.

## **THE WAY FORWARD**

The Way Forward will be to:

- Raise scientific literacy
- Extend partnerships
- Build professional capacity; and
- Plan for the future

The Way Forward points to the future. Recommendations around attracting and retaining teachers of science, technology and mathematics have been held over for the final report. The next Discussion Paper will explore a range of issues around developing an innovation capacity in Australia's schools sector.

## LIST OF SUBMISSIONS

1	Glenda Murray
2	James S Page
3	Australian Association of Mathematics Teachers Incorporated
4	Jill Finch
5	Malcolm Solomano
6	Peter Fox
7	Frances Meeking
8	Commerce Queensland
9	Chad Gallaher
10	Rosemary Jacob
11	Peter Best
12	Peter Lennox
13	Sr Barbara Bochat
14	Professor A. G Shannon
15	Betty Jacobs
16	Tim McMullen
17	Iona Presentation College
18	Colin McFayden
19	Nola Shoring
20	Neville Hatton & Alan Watson
21	Douglas Whitton
22	Australian Catholic University
23	Barry Hardy
24	Association of Independent Schools of South Australia
25	Don Zoellner
26	Australian Society for Educational Technology
27	Dr Warren Beasley
28	Wayne Muir
29	Alan Watson
30	Mathematics Education Research Group of Australasia Incorporated
31	Australian Mathematical Sciences Council
32	Charles Sturt University

33	Neil McLennan
34	University of Adelaide
35	Leonie Stott
36	Australian College of Educators
37	Confidentiality requested
38	Ivan Chester
39	Science Teachers' Association of Victoria
40	Dr Penelope Webb
41	Curtin University of Technology
42	Henry Condon
43	Women in IT Tasmania
44	Australian Academy of Science
45	Australian Council of Deans of Science
46	Faculty of Education, Deakin University
47	Technology Education Association of Victoria
48	Isolated Children's Parents' Association of Australia (Inc)
49	Australian Education Union
50	Board of Teacher Registration, Queensland
51	The Hon. Alan Cadby MP, Shadow Minister for Education & Training, Western Australia
52	IT Skills Hub Pty Ltd
53	Education Queensland
54	Design and Technology Teachers Association of WA
55	Australian Science Teachers Association
56	Faculty of Biological and Chemical Sciences, University of Queensland
57	School of Education, University of Queensland
58	Association of Heads of Independent Schools
59	Confidentiality requested
60	Australian Association of Mathematics Teachers Inc (second submission)
61	Confidentiality requested
62	School of Mathematical and Physical Sciences, James Cook University
63	Dr Allan Harrison
64	Faculty of Education, Queensland University of Technology
65	Queensland Deans of Education Forum
66	Faculty of Education and Creative Arts, Central Queensland University
67	University of Technology, Sydney
68	School of Mathematics, University of New South Wales
69	Council of Private Higher Education Incorporated
70	Aboriginal and Torres Strait Islander Commission
71	University of Sydney
72	University of Canberra
73	Edith Cowan University

74	Debra Turley
75	Dr Robyn Ewing
76	National Council of Independent Schools' Associations
77	University of Notre Dame
78	Dr Barry Golding
79	Australian Mathematical Society Incorporated
80	Home Economics Institute of Australia Incorporated
81	Queensland Indigenous Education Consultative Body
82	Murdoch University
83	Australian Association of Research in Education
84	University of Tasmania
85	University of Melbourne
86	Australian Council for Education Through Technology
87	Faculty of Education, Health and Professional Studies, University of New England
88	Minerals Council of Australia
89	University of Western Sydney
90	Australian Association of Christian Schools Incorporated
91	Monash University
92	Lorraine Tran
93	Australian Parents Council Incorporated
94	Australian Teacher Education Association
95	Association of Independent Schools of Western Australia Incorporated
96	Professor Alison Elliott
97	Genevieve Loughnan
98	La Trobe University
99	The Association of Independent Schools of Queensland Incorporated
100	Australian Computer Society
101	Christian Heritage College
102	Western Australian Department of Education
103	Anne Forbes
104	Engineering Employers Association South Australia
105	Australian Council of English as a second or other language Association
106	Technology Education Federation of Australia Ltd
107	National Catholic Education Commission
108	Questacon—The National Science and Technology Centre
109	Australian Science Education Research Association Ltd
110	Australian National University
111	Association of Independent Schools of Victoria
112	Non-Ministerial members of the Council for Knowledge, Innovation, Science and Engineering, Victoria
113	Australian Council of State School Organisations
114	University of South Australia

115	Lutheran Education Australia
116	Department of Education (Tasmania)
117	Australian Science and Mathematics School
118	Confidentiality requested
119	University of Newcastle
120	Professor Tim Brown
121	Catholic Education Office, Parramatta
122	University of Western Australia
123	The Institution of Engineers, Australia
124	Department of Education and Training, Victoria
125	Dr Vilas Jayanthi
126	Robert Lutton
127	University of Ballarat
128	Australian Council of Deans of Education Incorporated
129	Gerald Daly
130	Andrea Foster, Craig Haran, Sandra Robinson and John Arton-Powell
131	Independent Education Union of Australia
132	National Tertiary Education Industry Union
133	Science Teachers' Association of Western Australia
134	CSIRO Education
135	Karen Wade
136	Erica Jolley
137	Enterprise and Career Education Foundation
138	Australian Secondary Principals' Association
139	Australian Academy of Technological Sciences and Engineering
140	Kathleen Partridge
141	New South Wales Department of Education and Training
142	Australian Primary Principals Association
143	South Australian Department of Education and Children's Services

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## APPENDIX 1

### TERMS OF REFERENCE

#### Review of Teaching and Teacher Education

The Prime Minister in launching the Government's Innovation Statement *Backing Australia's Ability* in January 2001 announced a range of measures to pursue excellence in research, science and technology and to build an even more highly skilled workforce. In this statement the Prime Minister announced a number of initiatives for immediate implementation and a number of strategies for longer-term implementation. One of the major long-term strategies announced was to:

... ensure that talented people are attracted to teaching as a career, especially in the fields of science and technology education, teaching and teacher education will be reviewed, in consultation with State and Territory Governments.<sup>301</sup>

To implement this strategy, a Review Committee will be established to conduct a review of teaching and teacher education. Particular emphasis will be placed on the fields of science, technology and mathematics. The review will focus on teacher work force needs in these areas in the short term and skills teachers need to build a culture of continuous innovation in Australia's Schools in the longer term (2012).

The review will:

1. Build upon comprehensive work that analysed teacher supply and demand undertaken by the then Commonwealth Department of Education Training and Youth Affairs (DETYA) under the auspices of MCEETYA;
2. Draw upon recent literature and initiatives to describe the teaching skills needed to develop a culture of lifelong learning and innovation in Australia's school students;
3. Explore the impact of innovative pre-service and in-service education programmes on the development of teachers' pedagogic practices to enhance their students' appreciation and capacity for learning, creativity and innovation, with particular emphasis on the fields of science, technology and mathematics;
4. Map current skills and propose strategies for equipping teachers with the knowledge and skills to create an innovative learning culture amongst their students;
5. Examine leadership practices that attract and retain teachers, especially in the areas of science, technology and mathematics;
6. Produce an interim report, by end 2002, on strategies to attract and retain science, technology and mathematics teachers in Australia's schools; and
7. Produce an innovation action plan for the school sector, by mid 2003. This action plan will encapsulate a shared understanding of the school exit outcomes necessary to equip school graduates for the knowledge economy and society. The action plan will consider the current situation and future scenarios.

## APPENDIX 2

### REVIEW COMMITTEE

Professor Kwong Lee Dow AM—Chair  
Deputy Vice Chancellor (Students & Staff)  
The University of Melbourne

**Ms Elizabeth O’Leary**

Executive Director  
Catch 22 Asia Pacific

**Dr Peter Tannock**

Vice Chancellor  
University of Notre Dame

**Ms Helen Paphitis**

Principal  
Salisbury High School

**Mr Ken Rowe**

Retired Principal  
Frankston High School

**Professor Anne Edwards**

Vice Chancellor  
Flinders University

**Dr Ian Paterson AM**

Retired Headmaster  
Knox Grammar School

**Professor Janet Greeley**

Executive Dean  
James Cook University

**Mrs Jill Healey**

Principal  
Flinders Christian Community College

**Professor Steve Dinham**

Chair of Teacher Education, Pedagogy  
and Professional Development  
University of New England

**Mr Phillip Kiely**

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Chair, Enterprise & Career Education  
Foundation

**Mr Stuart Hamilton AO**

Secretary  
Department of Education and Training, Victoria  
(August–December 2002)

**Mrs Marianne Nicholas**

Science Teacher, Walkerville Primary School  
Recipient, Prime Minister’s 2002 Prize for  
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### REVIEW SECRETARIAT

**Department of Education, Science and Training**  
Di Weddell—Manager

Susan Smith

Shannon Smith

Marie Hird

Scott Lambert

Steve Neal

Millennia Pullen

Margaret Carruthers

Robert Fleming

## APPENDIX 3

### REFERENCE GROUP

Ambassador, National Indigenous English Literacy & Numeracy Strategy	Ms Naomi Anstess
Australian Association of Mathematics Teachers Inc.	Mr Steve Thornton
Australian Chamber of Commerce & Industry	Mr Joe Moore
Australian College of Educators	Mr Jim Cumming
Australian Council for Computers in Education	Ms Cathy Crook
Australian Council for Education Through Technology	Mr Brian Webberley
Australian Council of Deans of Education	Professor Terence Lovat
Australian Council of Deans of Science	Professor William McGillivray
Australian Council of State Schools Organisations Inc.	Ms Julian Golby
Australian Curriculum Studies Association	Professor Alan Reid
Australian Education Union	Mr Denis Fitzgerald
Australian Parents Council Inc.	Ms Josephine Lonergan
Australian Principals' Associations' Professional Development Council	Mr Don Zoellner
Australian Science Teachers Association	Mr Peter Russo
Australian Society for Educational Technology	Mr Ian Thomas
Business Council of Australia	Ms Maria Tarrant
Federation of Australian Scientific and Technological Societies	Ms Jan Thomas
Independent Education Union of Australia	Mr Patrick Lee
IT Skills Hub	Ms Deirdre Mason
Mathematics Education Research Group of Australia Inc.	Ms Judy Mousley
MCEETYA Teacher Quality & Educational Leadership Taskforce	Mr Paul Leitch
MCEETYA Teacher Quality & Educational Leadership Taskforce	Dr John Roulston
National Catholic Education Commission	Dr Michael Gaffney
National Council of Independent Schools' Associations	Ms Audrey Jackson
Technology Education Federation of Australia	Mr Ralph Leonard

## END NOTES

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