CHAPTER TWO

THE CONTEXT OF RURAL AND REGIONAL EDUCATION IN SCIENCE, ICT AND MATHEMATICS

2.1 INTRODUCTION

> Schooling should be socially just, so that students' outcomes from schooling are free from the effects of … differences arising from students' socio-economic background or geographic location.
>
> (MCEETYA, 1999)

> By age 18, each young person residing in rural or remote Australia will receive the education required to develop their full potential in the social, economic, political and cultural life of the nation.
>
> (MCEETYA Task Force, 2001, p. 7)

These quotes lie at the heart of a firm belief in equality of educational opportunity for students living in all parts of Australia. The first is taken from Goal 3 of *The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century*. The second, written in a similar vein, is a vision statement from the *National Framework for Rural and Remote Education*. As clearly enunciated in these guiding documents, the principle of equality of opportunity, regardless of economic and social changes, remains central as a stated position of Australian education.

Education in rural and regional Australia has been the subject of numerous studies concerned with a wide variety of issues and conducted from different perspectives. Rather than duplicating these studies, the SiMERR National Survey sought to build upon the foundation established by this research to identify and investigate in greater detail those rural and regional issues related specifically to science, ICT and mathematics education.

This chapter provides a context for the National Survey by identifying and discussing these issues. The first section, *Images of rural and regional Australia*, considers the changing social, economic and educational context of rural areas. The next three sections, *Professional and social issues for rural and regional teachers*, *Demand and supply of science, ICT and mathematics teachers*, and *Strategies to address recruitment and retention problems*, look more specifically at the major concerns of education providers and rural teachers.

The sections titled *Students living in rural and regional Australia* and *Indicators of rural student achievement in science and mathematics,* examine what is understood about rural students' experiences, aspirations, attitudes and learning outcomes. These sections are followed by *Rural and regional ICT education,* which looks at student achievement in ICT subjects as well as their access to and use of ICT. A *Summary of rural influences on educational outcomes* completes the literature review.

2.2 IMAGES OF RURAL AND REGIONAL AUSTRALIA

For most of last century rural Australia represented an idyll; Slessor's country towns peopled by Lawson's rugged heroes and heroines with their dry humour, strong loyalties and sense of fairness. While few Australians may have subscribed to this as a realistic image, we were in general content that there was enough substance to the myth, and if the heroes were thinner on the ground than we might like, at least the character of rural Australia, and in particular the passion for equity, were still strong.

Over the last twenty years that image has taken a battering in the public consciousness. When rural Australia is in the headlines today, it is because of bank closures and foreclosures, chronic drought and urban drift, poor telecommunications, and troubled health services. The fair go seems to have gone and equity is now discussed in an entirely different context altogether.

This image, like the idyll, is inaccurate. Much of rural Australia today is vibrant, dynamic, and in some cases, increasingly cosmopolitan. While there is a steady drift to larger centres, many rural areas are growing – with some even experiencing a boom as city folk look for a 'sea change' or 'tree change'.

Nevertheless, it is true that the overall complexion of rural Australia has changed. The country has developed a more open, less protected, national economy through reductions in trade barriers and assistance programs, deregulation of the financial system and labour market, and privatisation of government utilities and services (Squires, 2003). A consequence of this shift has been an acceleration of structural change in rural areas. Corporate rationalisation has indeed led to closures of banks and other infrastructure institutions in many small towns, in some cases to the point that schools have come to be seen as the main enduring institution and hence, a focal point for the community.

There has been a diminution of the traditional employment opportunities that attracted and retained adults in rural communities. Furthermore, job options for school leavers have changed in nature and scope. Census and other data reveal that income levels for rural communities are well below those in metropolitan cities, with Squires (2003, p. 27) reporting that average household incomes in about 80% of Australian rural towns and municipalities are at least 10% below the national average. In almost half of all rural areas, average household incomes are 20% or more below the national average.

There has also been a demographic change. Whereas about 54% of Australia's population in 1900 lived in rural areas, near the end of the 20th century this proportion had dropped to 21% (Squires, 2003, p. 26). Dellitt (1998) warns that unless more people are encouraged to conduct online businesses from rural locations, the decline in rural population is likely to continue. One consequence for rural communities of this demographic change can be what Squires (2003, p. 31) describes as 'the absence of a critical mass of people of a similar age, or life stage or gender or common interests.'

These changes have had consequences for school education in rural Australia. The current trend toward cost-efficiency and consolidation of resources means that the viability of some smaller rural schools is being questioned (Hammer, 2001). Restricted access to education, especially higher education, has been identified as a critical factor in 'the increasing social exclusion of many rural young people' (Alston & Kent, 2003, p. 15), resulting in their being 'shut out of the global marketplace and limited to local labour market opportunities'.

Nevertheless, there are growing indications that education in rural and remote areas of Australia has begun to receive more attention in recent years. The two quotes introducing this chapter are indicative of this trend. In addition, there appears to be a renewed recognition of the valuable economic and social contributions made by rural communities to the nation's output and wellbeing (MCEETYA Task Force, 2001, p. 4).

The decision by the federal government to provide establishment funding for the National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia (SiMERR) at the University of New England in July 2004 is another indicator of government concern. In turn, the SiMERR National Centre has developed hubs at universities in each state and territory to create SiMERR Australia, a cohort of researchers and educators committed to identifying and addressing concerns in these subject areas. The vision of SiMERR Australia is to work with rural and regional communities to achieve improved educational outcomes for all students in the areas of science, ICT and mathematics, so that:

- Parents can send their children to rural or regional schools knowing they will experience equal opportunities for a quality education
- Students attending rural or regional schools can realise their academic potential in science, ICT and mathematics
- Teachers can work in rural or regional schools and be professionally connected and supported.

Clearly, a deeper understanding of how best to address the particular needs of rural teachers, their students and their communities will allow for a more effective and efficient response from governments and other relevant support and service agencies. The results of the SiMERR National Survey provide a critical way forward. The survey, guided by the earlier research reported here, provides the necessary empirical basis for state, territory and national governments to make policy and funding decisions.

2.3 PROFESSIONAL AND SOCIAL ISSUES FOR RURAL AND REGIONAL TEACHERS

2.3.1 Advantages of teaching in rural schools

In his review of public education in NSW, Vinson (2002) acknowledged the many positive features of rural schools. Indeed, a number of researchers have identified the advantages of teaching in a rural environment. Boylan, Sinclair, Smith, Squires, Edwards, Jacob, O'Malley and Nolan (1993, p. 112) found that teachers perceived these benefits to include quieter, safer lifestyles with less crime and other problems that affect big cities. The teachers also felt that rural centres offered smaller, more caring communities, healthier lifestyles, and an abundance of clean, open spaces. Country communities were also considered to be good places to raise children.

More recently, Arnold (2001, p. 34) concluded that rural schools are often a focal point of the rural community. They are commonly seen as a community resource and an economic strength. Arnold also found that smaller class sizes allow for more individual attention, the staff members are often younger and more accepting of educational innovation, and student-teacher relationships are generally very positive.

In addition, the Isolated Children's Parents' Association (ICPA, 1999, p. 16) pointed out that the experience of teaching in an isolated area could help a teacher become more adaptable, confident and independent. However, the ICPA acknowledged that the value of this positive

outcome may be diminished if professional experiences are not recognised and rewarded at system level, for example, through transfer and promotion criteria, for professional advancement.

Sher (1991, cited in Yarrow, Ballantyne, Hansford, Herschell & Millwater, 1998, pp. 7-8) warned that some barriers to attraction and retention in rural and remote areas are the result of 'myths' about life there. To counterbalance this he suggested that 'rural education has the potential to be a wonderful laboratory for educational innovation and improvement.' The implication is that teachers may experience a sense of achievement, recognition and control over their own professional lives that will itself be an incentive to teach in such schools.

2.3.2 Disadvantages of teaching in rural schools

High among the disadvantages for teachers working in rural and regional schools is the feeling of isolation. Boylan et al. (1993, p. 112) identified the chief disadvantages faced by many teachers on their appointments to rural areas. These included:

- a dearth of cultural activities
- the 'tyranny of distance', of having to travel long distances
- the lack of employment opportunities for their spouses and their own children
- the more limited availability of health facilities (e.g., specialists) and sporting facilities.

The Isolated Children's Parents' Association maintained that 'attracting and retaining qualified teachers to many isolated rural and remote areas is an increasing problem once their own children reach secondary level' (ICPA, 1999, p. 15). They cite the observation of one farming family from the Eyre Peninsula in South Australia that 'principals always make sure that they are transferred from here prior to their children commencing secondary education' (p. 31). Understandably, teachers' appreciation of the value of education means that they want good quality access to opportunities for their children. That they look for this elsewhere reflects their beliefs about the quality of education available at their current posting.

There are conflicting beliefs about the characteristics of rural and remote students. It has been claimed that the advantages of teaching in rural and remote schools are that students are less difficult to manage and that student-teacher relations are more positive than in city schools (e.g., Arnold, 2001). On the other hand, the ICPA (1999, p. 17) has expressed concern that discipline problems are common in many remote schools, even to the extent that parents fear at times for the safety of their children.

These contrasting points of view suggest that solutions to the challenges of attracting and retaining teachers will need to address the specific challenges associated with some individual communities as well as the broader concerns that affect all or most rural and remote schools. The ICPA also conceded that some small communities can be 'extremely insular' (ICPA, 1999, p. 11) and that this could lessen the motivation and aspirations of children living in them, adding an extra dimension of challenge for teachers in such communities.

Whether these findings, mainly from 1990s research, remain relevant today is worthy of further investigation. Also important is the issue of their significance to teachers making decisions about appointments in rural and remote areas, and those deciding to relocate to larger centres.

Professional isolation and morale of teachers

As indicated above, a critical theme running through much of the literature on rural education is that teachers and principals commonly experience professional isolation. Herrington and Herrington (2001, p.1) pointed out that geographic and professional isolation associated with rural areas occurs across all service professions, with 'teachers, doctors, dentists, nurses … equally at greatest risk of leaving their profession in those first critical years in country placements'. The authors believe the consequences of isolation go even deeper. They see the attraction and retention of human service professionals and para-professionals in rural and regional Australia as a significant problem affecting the very sustainability and social cohesion of rural communities.

Social and professional isolation can be exacerbated when young teachers placed in rural and remote schools are living away from home for the first time. Squires (2003) listed the physical aspects of isolation as access to services, difficulty in travel, and demographic changes (especially a lack of like-minded people), along with such psychological aspects as feelings of disempowerment (or low self-efficacy) and differences in values, attitudes and aspirations. It is these features that may help explain why Cresswell and Underwood (2004, p. 8) commented in their analysis of the PISA 2000 survey that 'principals from schools in outer regional areas reported the lowest levels of staff morale'.

In her study of rural teachers' morale and efficacy, Young (1998) found that teacher morale varied within and between schools, indicating the importance of taking into consideration both the individual and the collective staff morale of a school. She also concluded that teachers' morale appeared to be a 'useful indicator' of an effective school. Squires (2003, p. 35) highlighted the importance to staff morale of school-community relations, arguing: 'if the school perceives its community to be depressed and unresponsive, or its prospects to be poor, or its attitudes to be negative, the reactions of school personnel are likely to be less enthusiastic and committed.'

The MCEETYA Task Force (2001, p. 13) acknowledged that 'the fundamental capacity of a rural or remote community to build a learning environment will vary significantly throughout Australia'. This means the challenges are greater in some communities than others, so rural and remote schools ought not be seen as a single, uniform entity. What is clear from the report is the affirmation that schools can play a vital role in educational capacity building, particularly in remote Indigenous communities.

Since frequent teacher turnover has a deleterious effect on a school's 'institutional memory' (e.g., of successful practices, of community dynamics) it seems essential that retention be investigated fully and successfully. Boylan and McSwan (1998) reported that two key issues identified by teachers considering remaining in rural and remote schools were opportunities to engage in professional development activities and the availability of curriculum support personnel. For example, Sharplin's study (Roberts, 2005, p. 49) found that lack of contact with other teachers in their subject area was a major concern of first-year teachers.

A lack of sufficient relief staff in many rural and remote communities is cited (e.g., ICPA, 1999, p. 17) as contributing to teachers' discontent and professional isolation, as it means that they are unable to avail themselves of opportunities to attend professional development days and other forms of face-to-face sharing and knowledge enhancement. This becomes particularly unfortunate, and potentially very stressful, for teachers in one-, two- or three-teacher schools. These teachers often miss out on the chance to share practices and ideas with

colleagues concerning across-school perspectives and administrative responsibilities that can help address concerns related to 'curriculum overload' that many teachers appear to feel.

While the provision of online professional development and networking opportunities should help to address these concerns, Roberts (2005, p. 50) warned that reliance on information technology alone might *increase* teachers' sense of professional isolation. This arises as it may further reduce teachers' already limited face-to-face contact with colleagues – unless 'network meetings, tutorial support and conferences' complement these on-line activities.

In his NSW inquiry, Vinson (2002, p. 107) found compelling evidence 'of the special difficulties and associated costs faced by country teachers in accessing professional development opportunities.' He recommended that rural teachers receive a significantly higher per capita professional development allocation than their city-based counterparts in recognition of the view that, while online communication will help to diminish professional isolation, many teachers, like many of their students, wish this to complement rather than replace face-to-face contact. One objective of the SiMERR National Survey was to determine whether teachers in other states and territories also experience these 'special difficulties', and if so, how they were being addressed.

Several researchers (e.g., Millwater, 1996; Yarrow et al., 1998) have extended this notion of personal contact. They recommended a collaborative approach to the content and processes associated with the practicum component of initial teacher education undertaken in rural and remote schools. They based their suggestion on the grounds that it will encourage

> … reflective and interactive teaching practices (and) … will involve teacher-mentors and student-interns working together to develop and improve relationships with students and the wider community.
>
> (Yarrow et al., 1998, p. 10)

The implication is that teacher education faculties within universities can contribute to school renewal and the minimising of rural teachers' professional isolation. At the same time university staff can benefit from tapping into the insights and experiences of practising teachers in rural and remote areas. Such practices may be enhanced by the development of better links between schools, and between schools and their rural communities.

In the report of their research project on social capital in rural communities Kilpatrick, Johns, Mulford, Falk and Prescott (2002, p. xii) recommended that 'both government and independent schools in rural areas should be encouraged and supported to develop further linkages with each other, with rural and other industry, and with community groups.'

Because of its current accelerating growth in both accessibility and capacity, and its potential for new forms of interaction, ICT will inevitably be part, and possibly a major part, of the solution to teachers' feelings of professional isolation. The extent and nature of this need to be the focus of current and ongoing research in Australia and elsewhere. Nevertheless, Herrington and Herrington (2001) have outlined some of the features of professional development websites that may reduce the sense of isolation.

However, the Human Rights and Equal Opportunity Commission's (HREOC, 2000) finding that teachers in rural and remote areas often had no formal training in ICT is a cause for concern, if still the case. This is an issue that needs to be clarified. The lack of familiarity with

the technology may be the reason why online conferencing has been reported to be underused in Australia (Dellitt, 1998). Mentoring has been mooted (e.g., Yarrow et al., 1999) as a strategy that could help to overcome some of the problems faced by beginning teachers. Determining the optimal mix of online and face-to-face forms of mentoring is an issue for further investigation, as is the question of what kind(s) of 'expert' can assume the mentor role most effectively.

Professional isolation is often cited as the major concern of teachers in rural and remote areas, and an important factor in their reluctance to remain long-term in rural schools (Roberts, 2005). A detailed understanding of what this means to teachers, and science, ICT and mathematics teachers in particular, may be the key to the overarching problem of attracting teachers to rural schools.

2.4 DEMAND AND SUPPLY OF SCIENCE, ICT AND MATHEMATICS TEACHERS

> Most states and Territories reported difficulties in filling two types of vacancies: those located in rural and remote areas (and in some locations within metropolitan areas as well) and for certain specialisations – with mathematics, science and ICT vacancies specified as "hard to fill in all states and territories".
>
> (MCEETYA, 2003, p. 20)

This quote highlights the scope of the problem faced by rural schools in trying to fill teaching vacancies in science, ICT and mathematics. While the statistics are not currently available for 2005, it is generally believed the situation is now worse than it was in 2003 as the large cohort of teachers trained in the late 1960s and early 1970s approach retirement age.

This section takes up this issue by considering three aspects related to demand and supply. These are the national context, attraction and retention of teachers, and international trends.

2.4.1 The national context

The national situation concerning demand and supply of teachers in these subject areas is difficult to quantify. There is plenty of anecdotal evidence about shortages in certain subjects in certain areas of Australia. However, there is difficulty in gaining up-to-date data about staffing in all three subjects from all states and territories. A further problem is that official figures do not always reflect the actual staffing situations in particular schools. The situation is made even more confusing by reports of teachers being expected to teach outside the area in which they were trained. Nevertheless, some studies in Australia have managed to collect data on the issue.

The Committee for the Review of Teaching and Teacher Education (2003a, p. 80) reported that the 2003 National and State Skill Shortage Lists (generated by the Department of Employment and Workplace Relations) identified national shortages in the second half of 2002 in the secondary subject areas of manual arts, mathematics, physics/chemistry and general science. More specifically, the report identified specific national shortages in rural and remote areas.

In their recent survey of secondary science teaching in Australia, Harris, Jensz and Baldwin (2005) found that 30% of sample schools reported difficulty in filling vacancies for chemistry teachers, while 40% reported difficulty recruiting suitably qualified physics teachers. Catholic

schools were most affected by the shortage of suitably qualified senior-school chemistry and physics teachers.

Harris et al. (2005) also found a high level of disillusionment among science teachers about remaining in the profession, and discovered that a large proportion of respondents teaching Years 7 and 8 students in Australian schools do not have any university science in their professional qualifications. Whether these findings vary according to geographic location was not explored by Harris et al. (2005). However, given the lack of properly qualified teachers, and the short supply of science teachers in rural areas, there is a suspicion that unqualified teachers are more common in rural areas. Clarification on this issue is an objective of the National Survey.

The situation with mathematics teachers seems even more fraught, with a recent survey by the Australian Secondary Principals' Association (*Review of Teaching and Teacher Education*, 2002, Submission No. 138, cited in Skilbeck & Connell, 2003, p. 33) revealing that 67% of Australian schools in the sample had experienced difficulty in finding sufficiently trained mathematics teachers. Furthermore, they found that '56% of sample schools (and 92% of remote sample schools) indicated they anticipated some loss of curriculum offerings due to teacher shortage during 2003' (Skilbeck & Connell, 2003, p.33).

One consequence of requiring teachers to teach science and mathematics, despite their lack of suitable expertise and training, is the lower likelihood that they will be seen as enthusiastic role models. Further, such teachers may be ill-equipped to give advice on careers in science and mathematics (Federation of Australian Scientific and Technological Societies, 2002). The net effect on students can be a negative image of science and mathematics that may become entrenched.

Three emerging trends appear to be affecting the availability of teachers of science, mathematics and ICT particularly in rural areas, suggesting that the current difficulties could become worse. These are the aging teacher workforce in Australia, the gender trends and related subject specialisations of teachers being trained, and the urbanisation of education with fewer teachers, especially beginning teachers, having experience in rural schools.

Aging teacher workforce

The age structure of the Australian teaching profession is another source of concern in that a sizeable proportion of its members, already aged over 50, may retire in the next five-to-ten years. Two particularly relevant aspects of this looming exodus are that it:

> … is particularly the case for males, and males supply a significant proportion of teachers in certain teaching specialisations, notably maths, science and ICT. Further, census data indicate the national teaching workforce has a bimodal age structure – there are large numbers of teachers aged under 35, and significant numbers aged over 45. However, there are limited numbers in the 35-45 age range, which will cause a major gap in the 'experience' of the teaching workforce as older teachers retire.
>
> (MCEETYA, 2003, pp. 4-5)

In the report of their survey of secondary science teaching in Australia, Harris et al. (2005, p. ix) also expressed concern about this trend among science teachers. They noted: 'the age profile for (science) teachers shows a bulge of 'baby boomers' in the 45–54 year age bracket,

that is particularly prominent for males.' The science teachers in their sample had, on average, been teaching for 15 years, though the mean of 17 years' experience for males was five years higher than that for females. While those teaching in 'highly accessible' and 'accessible' areas had an average period of service in line with the national average, 'teachers from less accessible locations had taught for only 11 years on average' (Harris et al., 2005, p. 6).

Gender and subject specialisation

Gender differences in preferences of teaching specialisation have become an emerging factor to consider. The proportion of female secondary teachers in Australian schools is increasing, in line with overseas trends. New female teachers are specialising more in the secondary subject areas, and the percentages of female teachers in secondary schools is approximately equal to that of males and appears to be rising. This situation is very different in the primary sector where the ratio of female teachers to males is about four to one.

The important point for secondary schools is that the incoming female teachers tend to specialise in the humanities and languages rather than difficult-to-fill subject areas. While new male secondary teachers favour science, mathematics and ICT, 'the numbers of males undertaking teaching qualifications has declined in recent years' (MCEETYA, 2003, p. 5)

An urbanised workforce

A national census-style survey of teachers in Australian schools (Department of Education, Science and Training, 2001) found that the majority of teachers spend most of their careers teaching in metropolitan and city schools. Moreover, the study reported that only 10.5% had ever taught in an isolated community, with the majority of these teachers spending less than five years in these communities. Of greatest concern, however, was the finding that 'teachers aged 21 to 30 years were least likely to have taught in these schools' (DEST, 2001, p. 7).

This last finding highlights a possible tendency for new teachers to be called upon to fill the vacancies in difficult-to-staff metropolitan areas. Once the lifeblood of rural and regional schools, it is possible that the most capable and better qualified of these new teachers may never find their way into rural schools. This emerging situation needs to be monitored carefully.

2.4.2 Attracting and retaining teachers for rural schools

Attracting qualified teachers is a significant challenge facing rural areas; retaining them is even more critical. While these two issues are clearly linked, it appears that the incentives and disincentives associated with teacher attraction differ in some ways from those linked with teacher retention.

Major barriers (Lunn, 1997, cited in Yarrow et al., 1998, p. 6) in the *attraction* of teachers to rural and remote areas were found to include:

- a negative perception of teaching as an attractive and viable career
- the improved employment prospects in urban schools in time of teacher shortages, especially for subject specific and specialist teachers
- a predominance of students from urban-suburban environments in teacher preparation courses
- a decline in the numbers of students from rural and remote areas entering teacher preparation courses

- the personal and professional considerations of experienced teachers, particularly couples, residing in metropolitan or large provincial centres that dislocation to a rural or remote areas incurs
- a lack of personal and professional incentives to accept a teaching position in rural and remote areas.

By way of comparison, major barriers (Lunn, 1997, cited in Yarrow et al., 1998, p. 6) to the *retention* of teachers in rural and remote areas were identified as:

- the desire or need to return 'home'
- lack of professional advancement
- dissatisfaction with teaching and/or living in rural and remote areas
- lack of appropriate incentives to retain teaching personnel in rural and remote locations
- the selection of teaching personnel for appointment to rural and remote areas.

In the case of secondary science, the survey conducted by Harris et al. (2005) confirmed that many of these issues have still not been adequately addressed. The authors reported that more than 50% of the 'remote' and 'very remote' schools surveyed reported difficulty in retaining staff. They noted that isolation and geographic disadvantage were most commonly cited as the reason for lack of retention. Figure 2.1, reproduced from Harris et al. (2005, pp. 31–32), shows that, in contrast, only 17% of those from 'highly accessible' schools reported difficulty in retaining science teachers.

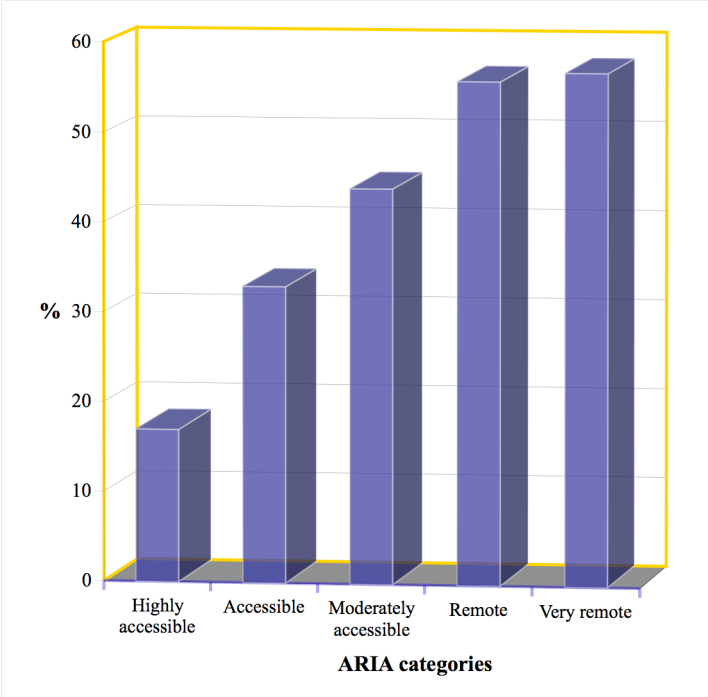

Figure 2.1 Schools reporting difficulty in retaining science teachers, expressed as a percentage of the total number of schools responding per ARIA category (adapted from Harris et al. 2005, pp. 31–32)

When considering career plans Harris et al. (2005, p. 35) noted several important findings. In particular, they found that science teachers in 'very remote' areas were almost twice as likely as those from 'highly accessible' areas to be planning to leave the profession by 2009. Those in 'remote' and 'moderately accessible' regions expressed the highest levels of uncertainty

about remaining in teaching. However, the numbers of respondents in the remote categories were low and the differences not statistically significant, leaving this an issue that warrants fuller investigation.

At the time of writing, similar data for mathematics and ICT teachers were not available. Hence, an objective of the National Survey was to generate data about geographic differences in staffing in science, ICT and mathematics at the primary and secondary levels.

2.4.3 International comparisons

The shortages in science, ICT and mathematics teachers identified by the Committee for the Review of Teaching and Teacher Education (2003b), among others, have prompted education authorities to look at ways of rapidly increasing supply to meet demand. In the past, shortfalls in qualified teachers have been met through overseas recruitment, but this appears to be more difficult in the current world situation.

It seems that other comparable countries are in a very similar situation concerning the demand and supply of teachers of science, ICT and mathematics. Indeed, our supply problems could be exacerbated if other countries seek to attract Australian teachers as part of their own solution to teacher shortages in areas such as science and mathematics. For example, secondary teachers of mathematics, science, and ICT 'continue to be in great demand' in New Zealand, with vacancies 'more likely to occur in rural and minor-urban areas' (MCEETYA, 2003, p. 33). A policy of overseas recruitment of teachers to meet demand in these areas was stated as a 'likely option' in an official New Zealand report (Ministry of Education, 2002).

In the USA the Secretary of Education outlined 'the critical need for teachers in curriculum areas such as mathematics, science ...' (MCEETYA, 2003, p. 32). This quote foreshadows a worsening US problem as a result of heightened emphasis on science and technology education, increasing student enrolments and rising teacher retirements (Committee on Science, Engineering and Public Policy, 2005).

A study of teacher demand and supply in British Columbia (Grimmett & Echols, 2001) found shortages of physics, chemistry and biology teachers in all areas, but particularly in rural schools. These findings supported those revealed earlier in the Survey of Canadian School Boards on Demand/Supply Issues, which reported that among the 19 subject areas surveyed, the most critical shortages were in science specialisations (Canadian Teachers Federation, 2000, p. 2).

In their OECD country background report on the United Kingdom, Ross and Hutchings (2003) noted evidence of teacher shortages in mathematics, science and technology, and in particular expressed concerns about shortages of chemistry and physics teachers (2003, p. 34).

Clearly, the literature suggests that finding qualified professionals to teach mathematics and science in many countries is becoming more difficult. The problem appears worse for rural schools. It is compounded in situations where administrators are willing to consider recruiting individuals without appropriate qualifications or skills. Ideally, rural teachers are expected to fit in with the school, take a leadership role in the community, and stay in the job for the long-term. They should be certified to teach more than one subject or grade level, capable of teaching students with a wide range of abilities in the same classroom, prepared to supervise extracurricular activities, and able to adjust to the community (Collins, 1999). These expectations are demanding and it is doubtful they can be fulfilled using unqualified, inexperienced teachers.

2.5 STRATEGIES TO ADDRESS RECRUITMENT AND RETENTION PROBLEMS

This section examines the strategies to address recruitment and retention suggested in the literature. Because of the complexities involved, research conclusions can sometimes appear contradictory. This section is divided into three parts, the first of which concerns a number of incentives to encourage recruitment and retention of teachers. The second part considers the role of teacher education for rural placement, and the third outlines specific strategies for recruiting science/mathematics teachers.

2.5.1 Incentives to encourage recruitment and retention of teachers

All of the key studies in this area have recommended that some system of incentives should be put in place in order to successfully recruit and retain teachers in rural areas. For example, the Human Rights and Equal Opportunity Commission inquiry (2000) recommended a package of incentives that would redress financial and personal disadvantage in order to attract and retain experienced professional staff for an optimum period of five years.

Incentives recommended by the Australian Education Union (1999, p. 4) include the introduction of a remote teaching service award covering the 'real costs of living in these communities', while the Education Alliance (2004, p. 6) supported a similar approach by suggesting that governments 'develop higher salary structures in rural systems'.

Most studies acknowledge that financial packages only address part of the problem. In view of the apparent importance of teachers' perceptions of school-community relations, it also seems that more could be done to make newly appointed teachers feel welcomed into the community of which they are to become a member. Some newly appointed teachers have commented on the lack of any information packages about, and welcoming events in, the community they have joined (Kenyon, Sercombe, Black & Lhuede, 2001, p. 40). In fact, the issue of how well teachers are prepared for living and teaching in rural and remote areas is central to the attraction and retention debate, and is discussed in some detail later in this chapter.

As a balance to calls for incentives, Boylan (2003, p. 5) offered a warning that some staff recruitment incentives, such as a guaranteed transfer to a preferred location, 'can lead to increasing turnover rather than increasing staffing stability'. Boylan (2003, p. 5) also cited Watson and Hatton's (1995) conclusions that 'incentives are not very effective in improving the quality of teaching', especially where the deficit approach is a response to some urgent need 'and often implies short term expediency'. The key point here is that effective planning requires a long-term emphasis and one that addresses the *qualitative* implications of staffing decisions, not just the quantitative criterion of filling all vacancies.

Finally, as well as considering the nature of incentives to encourage teachers to work in rural areas, there should be attempts to minimise disincentives. An unintended consequence of the move from seniority-based to merit-based promotion within education systems seems to be that teachers perceive the new approach as disadvantaging those who take up rural appointments. The reason for this lies in the perception that subsequent returns to metropolitan teaching positions may not be readily available, let alone assured (Roberts, 2005).

If the vision that Vinson (2002) and others described as the 'community strengthening and capacity building roles of country schools' is to be realised it seems imperative that teachers, principals and school executives in rural and remote schools be chosen on the basis of their capacity (knowledge, skills and desire) to assume such broadened leadership responsibilities.

2.5.2 Teacher education and rural experience

> (Teacher Education) is mostly carried out in large, metropolitan institutions and draws heavily on an international culture of intellectual endeavour, research and experience, even in the ordering of the practical component of training.
>
> (Skilbeck & Connell, 2003, p. 20)

Skilbeck and Connell pinpoint a fundamental issue concerning teacher education in Australia today, namely, it has a predominantly metropolitan character. Support for this view may be found in a recent survey by the Rural Education Forum Australia (Halsey, 2005, p. 4) which reported that no Australian university involved in teacher education requires its students to undertake pre-service teaching experience in a rural school.

The lack of systematic and effective preparation of teachers in Australia to teach in rural and remote schools has been reiterated over the past two decades (e.g., Gibson, 1994a; Yarrow et al., 1998). In their earlier review of the literature on teaching in rural and remote schools, Yarrow et al. (1998, p. 5) noted that *all* significant studies advocated some sort of specialised training.

Cooper and Hatton (2003) pointed out that rural people working in many professions often have to be more multi-skilled than their urban counterparts. For teachers, this may mean being able to teach across the primary/secondary divide, or in subject areas beyond their zone of expertise. Cooper and Hatton argued for an initial degree that focuses on all grades of schooling as one way of preparing teachers more adequately for the challenges and opportunities associated with teaching in rural and remote communities.

One joint initiative of the Queensland University of Technology and ICPA resulted in a program of student-teacher practicum placements across rural and remote parts of that state. This has been implemented so that the student-teachers (the majority of whom are from Brisbane) may gain first-hand experience of teaching in small schools and of living in rural and remote communities. An encouraging outcome of this venture has been that many of the participants have subsequently 'applied for and accepted appointment in rural and remote communities' (ICPA, 1999, p. 14).

However, Boylan's (2003) survey in 2002 of the 11 major teacher education institutions in New South Wales found that only two universities included a rural education subject in their concurrent initial teacher education program (compulsory in one case but as an elective in the other). Furthermore, only two universities offered such a subject (as an elective in both cases) in their end-on secondary program.

Gibson and King (1998, cited in Boylan, 2003) conducted a national survey of 27 universities to document the level of pre-service preparation provided for prospective rural teachers. From this work and an earlier study (Gibson, 1994b) the following deficiencies in their preparation for rural teaching were identified:

- pedagogy of multi-age classes and multi-age group strategies
- strategies for managing lower grade students in multi-grade classes
- rural classroom organisation and small school administrative responsibilities
- accessing appropriate and sufficient resources
- strategies for engaging in successful community interaction

- developing an understanding of community dynamics that influence the teaching-learning environment
- strategies for dealing with value clashes
- isolation
- developing supportive communication and interaction networks with colleagues, consultants, support groups or friends
- teaching experiences in rural schools and their communities.

(Boylan, 2003)

In a similar vein, Boylan (2003, pp. 2-3) cites Yarrow, Herschell and Millwater's (1999) conclusion that rural-oriented preparatory programs for teachers needed to include: strategies for teaching in multi-age classrooms; developing an understanding of and a sensitivity to the cultural differences, values and mores of country towns; appreciating and using the nature and extent of community involvement in school life; and participating in rural practicum experiences. Further, the need to prepare teachers for the challenge of teaching multi-age and multi-level classes was a common inclusion in such analyses (e.g., Higgins, 1993).

A recurring recommendation (e.g., Roberts, 2005) is that universities involved in teacher education should collaborate with state and territory education departments to develop and implement specialised preparation programs for rural teaching. One instance of such collaboration has been the 'Beyond the Line' program introduced by the University of New England in New South Wales (Boylan, 2003).

If part of the solution is to attract into teaching more people who have grown up in rural and remote communities, then attention needs to be given to how best to achieve this. One pertinent observation here is the HREOC inquiry's finding (cited by Roberts, 2005, p. 19) that:

> Training in the community by distance mode, with short residential on-campus programs, is the preferred option for many rural and remote trainees. It is cost-effective and avoids family and community disruption. Other benefits include a commitment to working in the local community on the part of the trainee which means enhanced stability of staffing in rural and remote schools and the opportunity for local children to be taught by community members.

2.5.3.Strategies for recruiting science, ICT and mathematics teachers

It is clear that a number of strategies have been suggested for attracting and retaining teachers in general to rural and remote areas. However, few studies at the national level have addressed the specific problem of recruiting science, ICT and mathematics teachers.

Skilbeck and Connell (2003, p. 31) identified three programs at the state level. Western Australia developed a scheme to pay university fees of science graduates entering teaching. The Northern Territory offered student bursaries for priority subject areas such as special education, ICT, science and mathematics. New South Wales offered retraining programs for accredited teachers for targeted specialties. There has been no evaluation of these programs to date.

At the national level, the DEST Quality Teacher Programme, which commenced in 2000, was designed to support the updating and improvement of the knowledge and skills of teachers re-entering the workforce, and casual teachers in the subject areas of mathematics, science and ICT in schools (MCEETYA, 2003, p. 25). In addition, in 2002 the Australian Government

made available 2,000 new fully-funded places under its 'Backing Australia's Ability' initiative. Of these, 280 new places (increasing to nearly 770 places after four years), or 14% of those available, were allocated to innovative teacher education programs specialising in the teaching of mathematics, science and information technology (Skilbeck & Connell, 2003, pp. 41–42).

The Federation of Australian Scientific and Technological Societies (2002) recommended that HECS liabilities for teachers should be at the lowest rate irrespective of discipline, i.e., differentials that act as another disincentive for prospective teachers to undertake science and mathematics degrees should be avoided. This seems particularly pertinent for students from rural and remote areas since the cost involved has been cited as a factor in their lower rate of university attendance (e.g., James et al., 1999).

In conclusion, concerns about teacher recruitment and retention in the fields of science, mathematics, and ICT are not (with the possible exception of teaching ICT) a recent phenomenon. These claims have been part of a general concern, expressed over several decades, about staffing difficulties and turnover in rural schools. Nevertheless, this ongoing concern has yet to produce definitive, detailed solutions, despite some pertinent and helpful research endeavours. While noting that several previous reports and other investigations have made many similar recommendations about how to attract and retain teachers in rural and remote areas, and how to improve the life chances of their students, Roberts (2005, p. 58) still found that 'there were significant gaps in the research and existing government reports which need to be addressed'.

2.6 STUDENTS LIVING IN RURAL AND REGIONAL AUSTRALIA

2.6.1 Student perspectives and aspirations

While not wishing to downplay the difficulties associated with schooling in some rural areas, it is important to avoid presenting a deficit view of life in rural Australia. Research focusing on rural and regional education issues highlight the many positive experiences of students and their teachers. For example, Alloway et al. (2004, pp. 124–125) commented favourably on the degree of 'street savvy' and resulting confidence displayed by many of the rural students who participated in their study. It is also important to recognise that the research reported here does not describe all students in all rural areas.

Nevertheless, young people in rural and remote areas are particularly vulnerable in the face of economic restructing. Consequential demographic and community changes have been identified in several sources (Ainley & McKenzie, 1999; Kenyon, et al. 2001; Spierings, 2001). Alloway et al. (2004, p. 2) noted that this vulnerability is compounded by the educational disadvantage experienced by young people in some areas of regional Australia in terms of access to schools, suitable curricula, and higher education and training programs.

There are conflicting messages in the research on rural students' aspirations. On the one hand, a study of the higher education choices of Australian students in Years 10–12 (James et al., 1999) found that, compared with urban students, rural and remote students are:

- less likely to consider that a tertiary education offers any benefits
- less likely to believe that their parents want them to go to university
- more likely to view tertiary qualifications as irrelevant to their employment aspirations

- more likely to believe that their families cannot support them going to university
- more likely to consider that the cost is beyond their resources.

On the other hand, Alloway et al. (2004, p. 263) concluded from their more recent focus-group interviews that rural students differed little from their metropolitan peers in their aspirations and expectations for their futures. In contrast to the previous study, rural and regional students seemed to have recognised 'the need in newly emerging knowledge-based economies and information societies for further education and training'.

There has been a growing trend for young people educated in rural communities to be under-represented in post-compulsory education (Lamb, Dwyer & Wyn, 2000, p. viii). Further, young people with rural backgrounds are:

> over-represented in what Kilpatrick and Abbott-Chapman (2002) call 'the most disadvantaged labour market group' – those who have not participated in post-school training and who have been unemployed for more than 25 percent of the time since leaving school.
>
> (Alloway et al., 2004, p. 30)

This situation is exacerbated in many rural and remote areas by the lack of local access to secondary schooling (especially in the senior years) and to post-school education and training.

The study by James et al. (1999, p. 84) on 7000 rural students' higher education aspirations and access found that a larger proportion of rural students with low-to-medium access to universities intended to enrol in general science, health science and agricultural science courses, while urban students were more inclined to take courses in law, engineering, surveying, computing, and business (see Table 2.1).

Table 2.1 Intended field of university study, by student location (James et al., 1999)

	Rural			Urban
Intended field of study	**Low Access**	**Medium Access**	**High Access**	**High Access**
Agricultural science	8.3	7.0	5.1	1.4
Architecture/Building/Planning	3.5	2.2	2.7	4.2
Arts/Humanities/Social science	19.0	20.6	25.2	19.6
Business/Administration/Economics	15.3	12.7	15.1	17.9
Education	10.6	14.9	11.2	9.8
Engineering/Surveying/Computing	11.6	9.8	10.7	14.9
Health sciences	15.6	19.0	15.0	14.9
Law/Legal Studies	3.5	3.5	4.9	6.7
Veterinary science	2.8	2.2	2.2	3.0
Science	9.6	8.2	8.0	7.5
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Low access: more than 300 kilometres from a university; Medium access: 151-300 kilometres from a university; High access/rural: less than 150 kilometres from a university, and home postcode classified as rural; High access/urban: less than 150 kilometres to a university and home postcode classified as urban.

One implication of this finding for the present study is that students from rural areas undertaking university study are proportionally more likely than their urban counterparts to become involved in many science-related careers and thereby contribute to scientific endeavours.

2.6.2 Student diversity

Students in rural and regional areas have similar needs and concerns to their city cousins. Consequently, they require similar services and support systems. This is particularly the case with regard to student diversity in learning. This can take the form of access to specialised programs in literacy and numeracy as well as support for students with learning difficulties, programs for those who are gifted or talented in certain subject areas, or special programs and activities for Indigenous students.

The Human Rights and Equal Opportunity Commission (1999) noted the importance for many remote community children to have access to early literacy programs. Alloway et al. (2004) supported this view on the basis of research evidence that revealed the significance of literacy competence for all forms of educational success, including school completion, higher education entry and likely employability. Hence,

> … the lack of access to early childhood education can be identified as a potential disadvantage for rural children, and as a factor likely to affect young people's aspirations and expectations.
>
> (Alloway et al., 2004, p. 31)

Because of their size, many rural schools do not have ready access to the expertise needed if children's specific learning difficulties or disabilities are to be diagnosed early and accurately (ICPA, 1999, p. 21). This scarcity of expertise for diagnosis is mirrored in the limited access to treatment when a disability is apparent. The ICPA reports that rural and remote students identified as requiring speech therapists, occupational therapists or physiotherapists do not have local access to these services on a regular basis. In remote areas, it is often the case that there is no access at all.

Likewise, the identification of gifted children is often left to chance. In general, specific expertise is not available to confirm or challenge teachers' initial subjective judgements through the use of IQ tests or other standardised measures of academic potential. Research in rural NSW (Chaffey, Bailey & Vine, 2003) showed that academically gifted Indigenous children are highly likely to become 'invisible underachievers', and misperceived by teachers as 'average students', unless very specific objective methods are used to reveal their true potential. Indeed, Chaffey's research demonstrated that *most* Indigenous students may be underachieving markedly, regardless of their level of academic potential.

In contrast, a survey of rural and remote schools in the United States (Colangelo, Assouline, Baldus & New, 2002) reported that students in smaller schools indicated a greater sense of belonging. Teachers in smaller schools reported that it was much easier to work together to create individualised instructional plans for students with special abilities and interests. They felt they were less hampered by rigid bureaucracy and large enrolments and had more time to spend on students as individuals.

On the other hand, difficulties identified by Colangelo et al. (2002) included lack of, or much more limited access to community resources, including museums, libraries and mentors. Moreover, the relative scarcity of gifted students in a small population can result in their

experiencing social isolation and loneliness. The curriculum options for these students, especially in the form of advanced courses, are also more limited because of smaller student cohorts in schools.

Likewise, teachers in rural areas may find it difficult to access professional development to help them teach gifted students. This can increase feelings of isolation in teachers who are trying to develop new ideas and skills. The recent production in Australia of a professional development package (Gross, MacLeod, Bailey, Chaffey, Merrick & Targett, 2005) on teaching gifted and talented students provides one example of how ICT may be used to lessen professional isolation.

In their research on the attitudes of Indigenous students in Western Australia to schooling, Richer, Godfrey, Partington, Harslett and Harrison (1998) found their students generally had a positive attitude to their schools and their education, but were much less positive about their teachers. Nearly 60% disagreed with the statement 'I like the teacher', 37% disagreed with the statement 'my teacher cares what happens to me', and 34% disagreed that their teachers encouraged them to continue their education. In addition, about one in five agreed that 'most teachers pick on me at school, while 12% thought that 'the teachers gang up on me'.

The low participation rate of Indigenous Australian students in post-compulsory schooling, and in higher education and training, is well documented (Kenyon et al., 2001; Yunupingu, 1995). Reasons suggested for this include Euro-centric curricula, language difficulties, and an absence of Indigenous role models (Kenyon et al., 2001). Feelings of racism and prejudice were also found to be factors inhibiting Indigenous students' aspirations and expectations for their futures, including their access to further education and training, and to employment (Kenyon et al., 2001). Lester's (2000) research in NSW described the strong influence of racism, and racist perceptions and attitudes, on the educational and employment aspirations of Indigenous young people.

One of the findings emerging from analysis of the PISA 2003 results was that Indigenous students were over-represented in the lower categories of achievement (Thomson, Cresswell & De Bortoli, 2004). As one step toward addressing this issue, the Vinson Inquiry in New South Wales recommended that trainee teachers who have a commitment to Aboriginal education be identified and nurtured, with a view to their being placed in schools with high numbers of Indigenous students (Roberts, 2005, p. 21).

However, a more common recommendation (e.g., HREOC, 2000, pp. 78-81) is that all teachers be educated – through initial teacher education and also through professional development once in the service – to understand, respect and adjust their teaching to accommodate Indigenous culture, history, languages, aspirations and learning styles. The extent to which teachers currently feel comfortable with such expectations and confident about their ability to act upon them, given the resources and support currently available, requires exploration.

2.6.3 Parent perspectives

It is useful to look at these background issues through the eyes of the parents. Secondary schooling is particularly challenging for many parents. Its demands often exceed the capacity of supervising parents to provide appropriate support. In the cases where children are engaged in home-based distance education this problem is often exacerbated. For those students who do attend a rural school many find their subject choices restricted because of the school's small size or the lack of teacher expertise in specific subject areas.

Even where it is possible for parents to send children to larger centres for education there are implications for the rural schools they leave. Preston (1999) argued that 'middle class flight' (e.g., sending rural students to boarding schools) lessens the attractiveness of rural and remote schools. Hence, 'the importance of improving the quality of schooling so that the local school is a reasonable choice, rather than assisting those who want to choose schooling elsewhere to leave the district' (p. 8).

Vinson (2002, p. 104) noted that financial disparities were a source of rural inequality and that this adversely affected:

> Parents, teachers and students in the Inquiry's country consultations spoke as one about the additional expenses they incurred, compared with their city counterparts, in fulfilling basic educational requirements.

The alternative for parents is having children board away from home in order to attend larger urban secondary schools. This option remains costly despite government recognition of the need to provide supplementary financial support (e.g., through the Assistance for Isolated Children's Scheme). With recurring droughts undermining rural sustainability this option becomes impossible for many, and a difficult burden for most parents residing in rural and remote parts of Australia.

International influences, such as the rising cost of fuel, can also affect distance education indirectly, as in cases where a generator must be run for extra hours to accommodate radio- and computer-based access to school. Learning through traditional forms of distance education, such as correspondence, can be difficult for students who are not fluent readers, and for those whose supervising parents have had very limited schooling themselves (Preston, 1999).

The HREOC (1999) report concluded that distance education was adequate for the primary years of schooling but not for the secondary years. Whether innovative forms of online interaction and presentation of learning material can fully address this aspect of teaching remains to be determined.

2.7 INDICATORS OF RURAL STUDENT ACHIEVEMENT IN SCIENCE AND MATHEMATICS

This section examines two important issues. The first is the relative underachievement of rural students in science and mathematics compared to their capital city peers. Data are becoming available that allow a quantifiable interpretation of the issue. The second concerns the factors research suggests might contribute to the disparity in academic achievement, and how these factors helped guide the framework of the National Survey.

2.7.1 Geographic variations in achievement

The significant variations in the academic achievement of students in different parts of Australia may not be a recent phenomenon. Nevertheless, evidence of this variation has gradually emerged in recent decades (e.g., Cresswell & Underwood, 2004; HREOC, 1999; Jones, 2002;). Of particular relevance to the National Survey are the results of the National Numeracy Benchmarks (MCEETYA, 2006) and the international tests associated with the Programme for International Assessment (PISA).

The National Numeracy Benchmarks are agreed minimum acceptable standards for numeracy at particular year levels. Figure 2.2 shows the percentages of students in Years 3, 5 and 7 in different parts of Australia achieving these minimum standards in 2004.

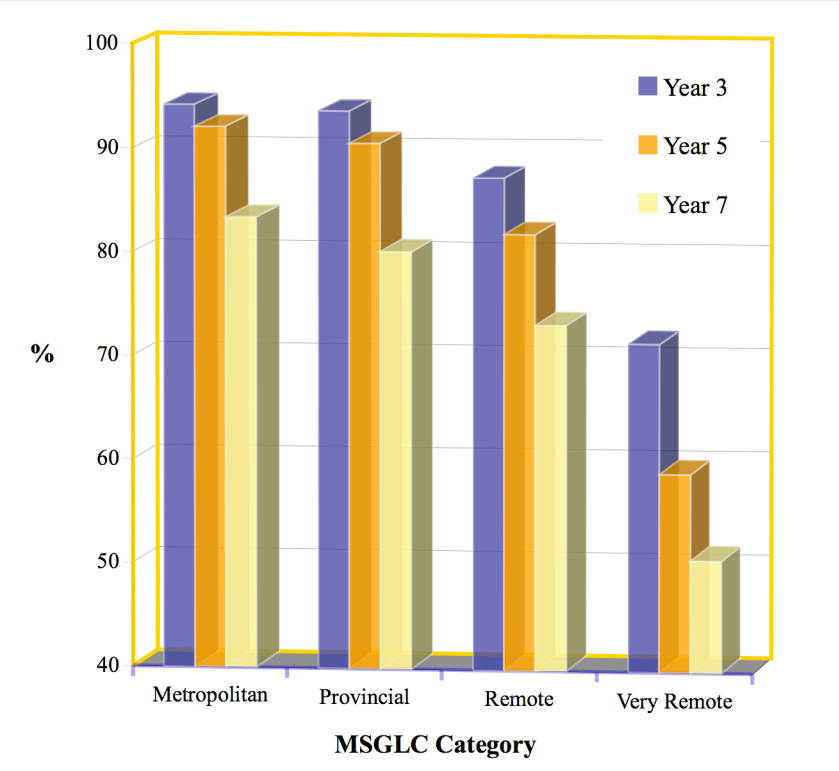

Figure 2.2 Percentages of Year 3, 5 and 7 students in different MSGLC categories achieving the National Numeracy Benchmark in 2004 (adapted from MCEETYA, 2006)

The figure displays a pattern whereby the percentages of Year 3, 5 and 7 students achieving the benchmark decline with remoteness/accessibility of school location[2]. To some degree the relatively lower proportions of remote students achieving the benchmark may be influenced by the significantly lower percentage of Indigenous students achieving the benchmark (MCEETYA, 2006), though information about the extent of any interactive influence is not yet available.

PISA conducts regular surveys of the mathematical and scientific literacy of 15-year-old students in a range of countries. The 2003 survey involved approximately 276, 000 students from 41 countries, including over 12,000 in Australia (Thomson et al., 2004). In general, Australian students performed very well in mathematical literacy, scientific literacy and problem solving, achieving results that placed them in the top five countries in each area. However, a closer analysis revealed that the performance of Australian students varied significantly with their geographical location.

School location was categorised according to the MCEETYA Schools Geographic Location Classification (MSGLC), the same classification system used in the SiMERR National Survey[3]. Thomson et al. (2004) reported the PISA results in terms of the broadest three categories: Metropolitan, Provincial and Remote Classification.

[2] MCEETYA notes that the small number of Very Remote students tested means that measurement uncertainty is relatively high for comparisons involving this group (MCEETYA, 2006).
[3] See Chapter One for explanation

Figure 2.3 shows that in mathematical and scientific literacy, students in metropolitan schools outperformed those in provincial schools, who in turn had a higher mean achievement than students in remote areas. According to Thomson et al. (2004), all of the differences between regions are statistically significant. By comparison with the OECD mean score (500), the performance of students in metropolitan locations was on average about one quarter of a standard deviation higher, while performance of those in remote areas was below the OECD average.

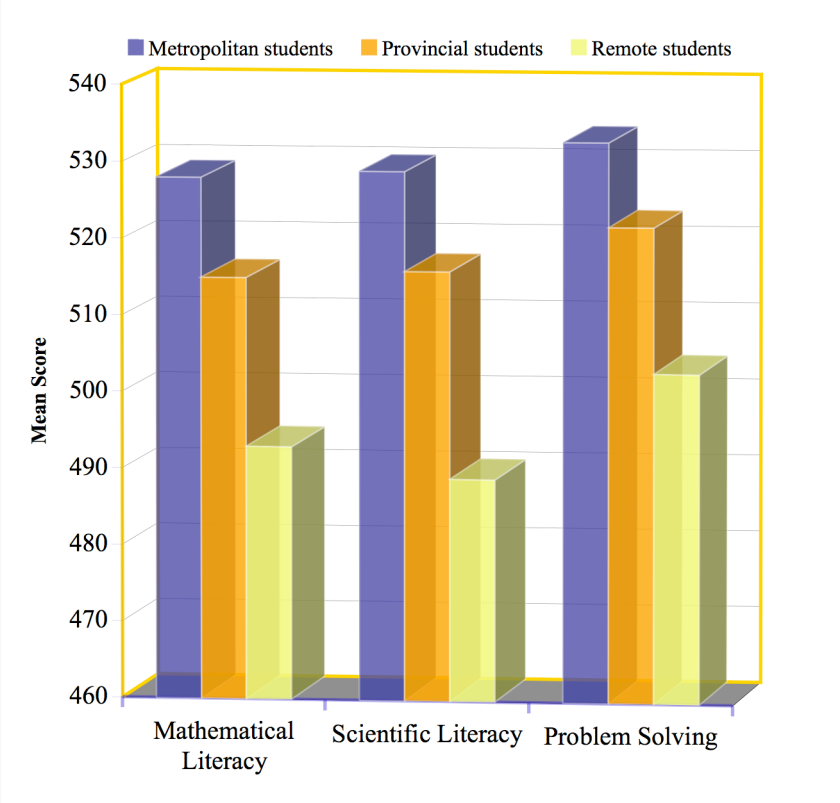

Figure 2.3 Mean scores of Australian students from different locations in the PISA 2003 tests of mathematical literacy, scientific literacy and problem solving (adapted from Thomson, Cresswell & De Bortoli, 2004)

The authors also noted that Indigenous students were over-represented at the lower levels of performance in mathematical and scientific literacy, and under-represented at higher levels.

This pattern is consistent with that reported in PISA 2000. According to Cresswell and Underwood (2004), one explanation for the regional differences in scientific literacy suggested by school principals was the availability of science resources. The implications were that the availability of such resources declined with distance from a major city and that this adversely affects student academic performance. This is an important issue to be explored in the National Survey.

PISA 2003 also tested problem-solving skills of Australian students, and Figure 2.3 reveals the same pattern of regional variation. Thomson et al. (2004) commented that this was an interesting finding since problem solving would not be expected to be as dependent on resources as mathematical literacy might be.

2.7.2 Consequences of poor teacher retention for student outcomes

Alloway et al. (2004, p. 160) reported that when expressing opinions about the quality of schooling in rural and remote communities, students and teachers most often focused on issues relating to the availability of specialist teachers, the range of subjects from which students could choose, the high turn-over of teachers and, invariably, the quality of subject offerings.

Alloway et al. (2004) found that Year 10 students in remote areas were concerned about the quality of teaching they experienced, and how this affected their learning. For example, students in one remote Western Australian school commented that they 'get the worst teachers up here'. These students were also aware that their teachers were often teaching in subject areas for which they were not qualified (Alloway et al., 2004, p. 160). The authors added that students' concern about the lack of sufficient specialist teachers was linked to their anxiety about doing well at school. This was most evident in grades where there were competitive examinations that might determine their further education or work opportunities.

The conclusions of Alloway et al. (2004) are consistent with the view expressed by Elliott (2002, p. 6) in her submission to the Committee for the Review of Teaching and Teacher Education. Elliot was concerned that many schools in hard-to-staff areas cannot get mathematics, science, technology or ICT teachers. Some schools employ teachers who 'would not be acceptable in more affluent areas because of their poor training, poor spoken English skills, and poor classroom management skills'.

Smaller class sizes and multi-level classes in many regional and remote areas can also work against the employment of specialist mathematics, science and technology teachers in those areas (Isolated Children's Parents' Association, submission no. 48, cited in Committee for the Review of Teaching and Teacher Education, 2003, p. 68).

These conclusions are generally based on qualitative data from sample sites (14, in the case of Alloway et al, 2004), or anecdotal evidence. One aim of the SiMERR National Survey is to quantify the availability of specialist science, ICT and mathematics teachers in different parts of Australia, and determine the extent to which teachers in different areas are required to teach outside their areas of expertise.

2.8 RURAL AND REGIONAL ICT EDUCATION

Much of the previous discussion has concerned science and mathematics education. There is little existing literature on the challenges associated with teaching ICT to students in rural and remote areas. Previous findings that are pertinent tend to relate to access, infrastructure and technical support issues, but are often anecdotal. Learning about ICT and learning with ICT are both crucial concerns if community regeneration and the full potential of rural students are to be realised.

2.8.1 ICT resourcing and support

In their study of resourcing of Australian primary schools, Angus, Olney, Ainley, Caldwell, Burke, Selleck and Spinks (2004) found numerous complaints that ICT support is seriously under-resourced. For example, schools generally do not have staff with appropriate expertise when networks or servers fail – this affected teaching programs adversely. Furthermore, these necessary support services 'are not always available locally, especially in the case of rural schools', and hence 'delays of several weeks during term time are common and longer periods are not uncommon' (Angus et al., 2004, p. 33).

The nature and adequacy of access remains an issue in Australia. For example, Vinson (2002) reported a widely expressed concern in rural NSW that the Internet does not work efficiently in many rural regions. While acknowledging that attempts were being made to address this problem, Vinson noted that prolonged delays in accessing web sites frustrated the work (and temperament) of students and school staff. Similar concerns were voiced in the Human Rights and Equal Opportunity Commission's (2000) report.

Because of its current politicisation in Australia, it seems likely that ICT access will be a major focus of government attention in the immediate future. The MCEETYA Task Force (2001, p. 5) highlighted 'improvement in user affordability (as) the major challenge that must be met in order to fully capitalise upon the revolution in online learning that is taking place'.

However, the extent to which everyday resource issues – such as the availability, speed and reliability of Internet access and ICT servicing and technical support, and the adequacy of science laboratories and materials – are currently problematic for teachers in rural and remote schools has not been examined in detail. This warrants a fuller investigation. Only five years ago the Human Rights and Equal Opportunity Commission (2000, p. 3) cited cases where IT infrastructure was inadequate and where 'repairs can take an entire term to effect'.

The 2001 Census data revealed that less than 10% of Indigenous Australians had access to the Internet at home, compared with 30% of non-Indigenous Australians, and that this low figure 'declined with distance from the major urban centres' (Daly, 2005, p. 1). The use of community facilities to promote access has been recommended, particularly for remote areas, one implication being that more community online access centres need to be established, along with training in their use.

Cresswell and Underwood (2004) reported that the learning of students in remote areas was hindered by a shortage of educational resources. Unfortunately, they did not provide details of which resources this involved although their comments did not seem to apply to computer access: 'students in Remote/Very Remote areas responded that there was never an occasion when they had no access to a computer at school' (p. 6). Resourcing problems, actual or perceived, have the potential to act as disincentives and hence to affect teachers' willingness to remain in rural schools, so it is important to investigate this aspect of education in rural and remote areas.

2.8.2 ICT for distance learning

ICT is a globalising force, as well as an enabling one (Alloway et al., 2004). However, the Human Rights and Equal Opportunity inquiry concluded that distance education 'is not suitable for all students and cannot be relied on to ensure effective educational access for every isolated student' (HREOC, 2000, p. 43), on the grounds of differences in students' learning styles and expressed preferences. Roblyer's (1999) research supported this view. It found that for some students, control over pace and timing of learning was more important while for others interaction with other students and the teacher was seen as paramount.

Yet, it was asserted at a public meeting in Bourke, NSW, that isolated students are well suited to take advantage of information technology 'because of their independence and responsibility' (HREOC, 2000, p. 92). This is a claim that invites empirical investigation, not only because of the opportunities it may create, but also to resolve the contradictory views it exposes.

There is a finding that students who have high self-efficacy for self-regulated learning tend to attain higher levels of achievement (Zimmerman & Martinez-Ponz, 1992). Hicks (2002) found

support for his hypothesis that there is an improvement in academic achievement for rural school students who learn through distance education. ICT education seems one domain that should not suffer unduly from being taught largely online to rural students, though this remains to be demonstrated.

2.9 A FRAMEWORK FOR THE SIMERR NATIONAL SURVEY

A number of important themes have emerged from this review of the rural education literature. The most prominent include staffing difficulties, particularly in science, ICT and mathematics, pre-service preparation for rural teaching, professional isolation, school resourcing, student disadvantage and underachievement, student and parent aspirations, and perceptions of the quality of rural education.

Nevertheless, there are gaps and inconsistencies in the literature. In some cases there is conflicting evidence on these issues (e.g., Arnold, 2001). In others, the conclusions relate only to particular states or territories (e.g., Vinson, 2002) or apply to education generally, rather than science, ICT and mathematics education specifically. Moreover, the data that informed these conclusions were in many cases from the 1990s. The need for up-to-date, nationwide data on these themes provided both the motivation and framework for the SiMERR National Survey.

Finally, it is worth reflecting on a statement made by the chair of the Committee for the Review of Teaching and Teacher Education, Kwong Lee Dow (2003b, p. 8):

> Australia's future lies in its potential as a knowledge-based economy and society–one built on the knowledge, intellectual capabilities and creativity of its people. To achieve this potential, it will be necessary to: raise the scientific, mathematical and technological literacy and the innovative capacity of students; strengthen the education system that provides the platform from which world class scientists and innovators emerge; support the development of a new generation of excellent teachers of science, technology and mathematics teaching.

As the federal, state, and territory governments move to take up these challenges, it is critical that the particular needs of rural and regional areas are considered, and that the principle of equality of opportunity for students and teachers remains central as a stated tenet of Australian education.