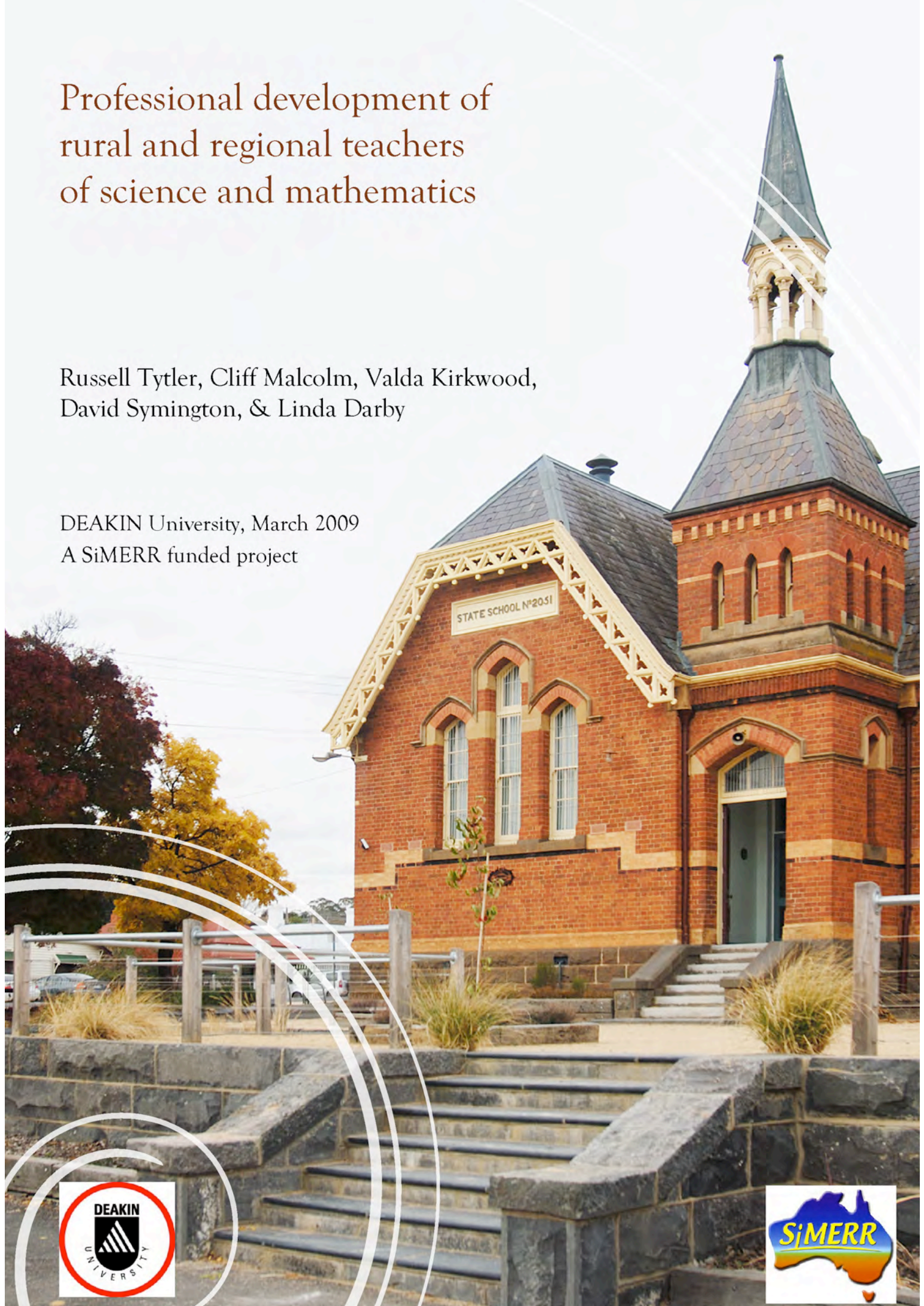# Professional development of rural and regional teachers of science and mathematics

Russell Tytler, Cliff Malcolm, Valda Kirkwood, David Symington, & Linda Darby

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STEME Research Group
Re-imagining futures in Science, Technology,
Environmental and Mathematics Education

SiMERR

Front cover design: Lorena Carrington

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Dedication

The key figure in the planning of this study and the gathering of the data was Professor Cliff Malcolm. Cliff on returning to Australia from South Africa, where he had made an outstanding contribution to education generally, and science education in particular, joined the team at Deakin and was delighted to be able to lead this study because of his commitment to people living in rural areas. Sadly soon after returning he found that he had cancer. However, following surgery and chemotherapy he was able to visit schools around the state to gather the data for this study. This was a wonderful experience for him as he was always a passionate learner and he loved to hear of what the teachers in these schools are doing. He returned from his travels full of enthusiasm to ensure that their stories are told.

The spread of cancer to his spine meant that he was never able to complete the task, but to the end he loved to talk about the people he had met and the insights that he had gained. In dedicating this work to his memory we hope that we have done justice to his vision for the study and the data that he gathered.

We have decided to include below several extracts from tributes written by colleagues at the time of his death to complete our tribute to this outstanding educator and person.

He understood what was needed to advance Black South Africans and his great intellect was such that he could make it happen. His internationally funded research projects gave so many that important and necessary lift - intellectual & personal in a culturally sensitive way. The respect and love which so many South Africans gave to Cliff was clear evidence that he was a great cause for good. (Dr Warren Beazley)

Cliff thought fast, and seemed to write even faster. In both forms of communication he made connections that constantly left the rest of us wondering how his mind could be so broad and profound at the same time. It was a trap to agree to do some writing with him, because his part would be done before I had barely begun. The many people who for years read his letter from South Africa, as the first and often the only part of LabTalk, will know these qualities. He had an amazing gift, over his eight packed years in South Africa, of seeing in persons and situations he encountered the potential their story had for opening our eyes to things in Australian education that needed a critical eye rather than our passive acceptance. (Emeritus Professor Peter Fensham)

He was integral in opening new doors for me, both in my mind and professionally. He lifted the bar of my educational experience, was driven to perfection and was an amazingly warm man; a professional relationship was also a personal one. This was quite new to me at the time. His gift to the education community worldwide is immeasurable and he touched so many real people along the way. I am honoured to have known Cliff and had the opportunity to work with him. (Brigitte Glasson)

I worked with Cliff at the Victorian Education Department and at Curriculum Corporation. He was the most enthusiastic educator I have known. His passion for science education engaged both teachers and students and he radically altered the traditional approach to science teaching.

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I will most remember him as a wonderful person with immense generosity of spirit. (Susan Mann)

I remember him saying, when we were discussing some national science initiatives, that everyone is asking the wrong question - we shouldn't be asking how the curriculum can serve future scientists and users of science, rather we should be asking what science education can do for the country and all its people. How will it make Australia a better place? (Professor Russell Tytler)

Report of a study of professional development of rural and regional teachers of science and mathematics in Victoria

Executive Summary

This research was carried out under the umbrella of the SiMERR project. The aim of the study was to explore the following questions:

- What are the provisions for professional development in science and mathematics for teachers in rural and regional schools in Victoria?

- How is professional development provision perceived by the teachers, school leaders, and Regional Project Officers charged with responsibility for the provision of professional development in science?

- What are the issues related to the provision of appropriate professional development to science and mathematics teachers in rural and regional schools in Victoria?

The data were gathered by interviews with six Regional Projects Officers and 44 principals and teachers from seven rural Victorian schools. The data were analysed qualitatively, with themes emerging as the researchers identified common issues and circumstances in the data.

The interviews revealed a generally positive attitude to teaching and learning and community life in these rural schools, with good relations between teachers and students, parents, and the local community, and general agreement about a number of aspects of rural life both for students and teachers. Teachers were generally very positive about relations with their colleagues.

The interviews revealed a number of significant inputs into the professional development setting for these schools and teachers. A number of state government initiatives were acknowledged and featured strongly in teacher reporting, including the requirements to keep up to date with the current state curriculum (VELS) and pedagogical framework (POLT), programs run by the regional offices largely centred on new departmental initiatives, and projects and workshops undertaken as part of the Innovation and Excellence cluster initiative, which was the most recent professional learning program supported by the Department. While principals and schools acknowledged their responsibilities to keep abreast of system-wide developments, they discharged this responsibility in their own ways, depending on the school context.

Professional development opportunities created by Commonwealth Government projects were alluded to, in the two schools which had been involved. There was a range of professional development activities provided by other agencies such as environmental centres or industry bodies, but the major other providers were the science and mathematics teacher associations, mainly through conferences. These were generally well regarded, but a number of difficulties were identified as for rural teachers.

Principals were in general both committed and strategic in arranging appropriate PD provision for staff, and a number of approaches to professional development were identified within these schools which were effective to varying degrees. Approaches largely initiated by the school leadership included:

- Mentoring, which was felt to happen most effectively when it was informal;

- Professional learning teams, which might focus on generic issues but which a number of science and mathematics teachers found minimally relevant for their own needs, preferring a focus on subject specific professional learning;

- Employment of consultants, which often led to enjoyable workshops but was limited because of the difficulty of effective follow up;

- Visits to local schools, to consult with others teaching perhaps the same VCE subject;

- Whole-school staff in-services, which seemed to work particularly well for primary schools when all teachers were committed to the same issue, but which for secondary schools sometimes focused on generic issues that did not capture the allegiance of science and mathematics staff. This strategy included sharing of information from the internet;

- Discipline based activities such as KLA meetings, which were highly regarded because of their collaborative nature and the opportunity to work through initiatives over time.

Approaches which were largely initiated by individual teachers included:

- Conversations and working with colleagues generally, which was felt to be very important as a source of advice and shared initiative;

- A range of individual initiatives including event attendance, or time off to explore new ideas;

- The taking up of new initiatives and challenges based on a variety of inputs;

- Gathering of information and advice from family (*My dad's a scientist*), local community members, or teachers from other schools;

- Undertaking formal qualifications, although this was uncommon;

- The use of resources such as books or the internet.

Generally, the data indicated commitment by both principals and teachers to ongoing professional learning, and quite complex pathways along which this might occur, with responsibility being shared at various levels of the school. However, a number of issues emerged that militated against effective professional learning for these teachers of science and mathematics in rural settings. These included:

- Factors limiting opportunities for professional growth in an area of specialisation, mostly of concern to secondary teachers. These include the small size of the schools with the resulting small number of professional colleagues and the limited professional learning discussions arising from this, and difficulties in attending conferences and participating in other professional development opportunities off-site. These difficulties include unavailability of relief teachers, distance from major centres where the activities were scheduled with implications for travel, and accommodation and time costs attending events.

- Limitations to the effective use of technology due to lack of technical support in rural areas.

- Secondary teachers teaching 'out-of-field' creates particular challenges for professional development provision as they are more inclined to seek professional development in their own field, while their need for professional development in the 'out-of-field' area may be great.

- Due to pressures to meet system demands and to use resources such as time and money most effectively, school based professional development focuses on generic issues at the expense of discipline based professional learning.

The authors argue that professional growth involves being part of vibrant discourse communities, and for teachers of science and mathematics this will be three fold, consisting of other teachers of science and mathematics and subject based experts, the school community (teachers, students, leadership), and the community outside the school more generally. It is argued that there is a greater need to engage rural teachers in interactions with the subject based group, to get the balance right. It is also argued, on the basis of current trends and recent research, that the local community can also be a powerful source of professional discourse in science and mathematics, particularly in rural communities, and effective ways of tapping into this resource need to be found.

The implications of the study, for school systems and professional organisations include:

- the need to adequately address the demand for subject specific professional development for rural teachers of science and mathematics, particularly in secondary schools;

- the need for professional associations and other providers of professional development for science and mathematics teachers to pay attention to the circumstances of teachers in rural and regional schools;

- the need to prioritise the provision of technical support in rural schools to enable teachers to effectively use technology for their professional development needs;

- the need for funding models for professional development to take better account of the issues faced by rural and regional schools in adequately meeting the professional development needs of their teachers; and

- the need to strategically establish, support and bring into balance the different discourse communities implied by an active and effective professional learning culture for science and mathematics teachers in rural schools.

Introduction

Background

Researchers in science and mathematics education at Deakin University have a particular focus on learning in rural and regional schools. They have been working alongside teachers in rural and regional schools over an extended period of time within a number of projects, for example, the Science in Schools Project (Tytler, 2007; Tytler & Nakos, 2003), various projects under the SiMERR banner (www.une.edu.au/simerr/projects , http://www.deakin.edu.au/arts-ed/education/simerr/), and a study of exemplary ASISTM projects (Tytler et al, 2007). The knowledge and experience of the group suggested that it would be most worthwhile at this time to conduct a study of the provision of professional development for teachers of science and mathematics in Victorian rural and regional schools.

In addition there have been a number of reports (for example, Harris & Jensz, 2006; Harris, Jensz, & Baldwin, 2005) that have drawn attention to the factors that have particular relevance to rural and regional schools, for example shortages of specialist teachers in science and mathematics leading to the use of teachers whose specialisation is in another field to teach these subjects.

Further impetus for the study was provided when Professor Cliff Malcolm joined the group. Dr Malcolm had a strong commitment to rural education and had been conducting significant work in rural areas in South Africa while on the staff of the University of KwaZulu-Natal.

While a great deal can be learned from the literature about effective professional development, and a brief survey of relevant literature follows, most of the literature concerns exploration of the most effective methods of conducting teacher professional development. By contrast the study reported here was designed to gather data on the impact of particular factors operating rather than to answer the big questions about teacher professional development itself. There are significant changes occurring in rural and regional communities. Further, initiatives taken at both state and commonwealth level have particular relevance to the teaching and learning of mathematics and science. For example, at the Victorian state level there has been the operation of the Innovation and Excellence Clusters some with an emphasis on science and mathematics, and at the commonwealth level there has been the DEST funded ASISTM scheme which has provided significant funds for initiatives in mathematics and science involving non-school personnel. Also, the Science, ICT and Mathematics Education in Rural and Regional Australia (SiMERR) project has spawned initiatives in all states.

Literature on teacher professional development

Whilst this section of the report does not attempt a comprehensive review of the literature on teacher professional development, the brief overview that follows aims to identify major themes and issues relevant to this study. There is a great deal of consensus in the literature about the areas in which teacher professional development is important and about the characteristics of effective teacher professional development programs.

The nature of successful approaches to teacher professional learning.

There have been some major studies conducted in Australia seeking to identify factors which contribute to successful teacher professional development (for example Ingvarson, Meiers & Beavis, 2005). Syntheses of the findings of such studies have been able to identify general criteria for success. For example, the Mathematics Education Research Group of Australasia (MERGA, 2007) suggests that the following propositions are supported by the research literature:

- Teachers can progress their own learning through reflection (e.g., Smith, 2006, 2007; Llinares & Krainer, 2006)

- There is benefit from teacher release time to work in teams to develop and reflect upon lessons (e.g., White, 2006; McDonough & Clarke, 2005; White, Mitchelmore, Branca & Maxon, 2004; Goos & Bennison, 2004; Anderson & Bobis, 2005; Sullivan, Mousley & Zevenbergen, 2004; Isoda, Miyakawa, Stephens, & Ohara, 2006)

- Teachers conducting action research on their own practice within postgraduate education qualifications can have significant benefits (e.g., Anderson & Bobis, 2005; Goos, Stillman & Vale, 2007)

- Teacher learning has been found to be more effective when spread over time with opportunity to put ideas into practice then reflect on this rather than when provided in 'one-off' sessions (Anderson, 2005; Carroll, 2005; Handal, 2004; Yates, 2005)

- Large learning gains have been found to occur in classes where teachers were involved in large scale research projects in partnerships with university educators over time (e.g., Cheeseman & Clarke, 2005, 2006; Hunter, 2005; Brown & Renshaw, 2006; Callingham, 2005; Irwin & Britt, 2005)

- The support from the school administration has been shown to be critical to the success of teacher professional development (e.g., Bobis, Clarke, Clarke, Thomas, Wright, Young-Loveridge & Gould, 2005; White, 2006)

The literature reveals that there are further issues to be considered when thinking about teacher professional development. For example, Tytler et al (1999) drew upon data from two substantial Australian teacher professional development projects, with the Mathematical Association of Victoria and with the Science Teachers' Association of Victoria, to argue that teachers' professional development needs change over time, and proposed a developmental framework for conceptualizing teacher professional development needs. This framework is included as Attachment 1.

In the context of this current study of teacher professional learning in science and mathematics, the question of the relevant mix of generic versus subject specific professional learning provision is important. Research has shown that generic-based professional learning opportunities cater for only part of the teacher's professional needs. For example, subject-specific mentors have been shown to be more effective in US science teacher induction programs due to the specific support they can give in the areas of instruction, running practical activities, and planning, as well as support to incorporate "science as inquiry" and the "nature of science" into their teaching (Luft, 2008). Grossman et al. (2004) further highlight the importance of providing external sources of subject-matter expertise when supporting reform efforts. They assert that the extent, and availability, of subject-specific instructional leadership has an effect

on the degree to which teachers incorporate reform ideals into their practice: "how teachers and administrators respond to and implement subject-specific policies will vary considerably, depending largely on their own knowledge of and beliefs about the subject in question" (p. 12).

The role of subjects in defining teachers' work and identity

Secondary schooling in Australia is based on a departmental model. Teaching occurs through subjects, and teachers usually refer to themselves as teachers of specific subject areas. Historically, subject specialisation developed in the US education system between the late 1800s and early 1900 (Hargreaves, 1994), resulting in the "emergence and institutionalisation of the academic department" (Siskin, 1994, p. 38) in high schools. Departmentalisation remains one of the main differences between primary and secondary education in Australia.

With the establishment of specialised subject areas, secondary teachers increasingly came to see themselves as part of a "subject community", and tended to separate themselves from other subject communities (Goodson, 1993). Curriculum development became overtly subject-centred to the extent that, in the US, concerns were expressed through The Norwood Report of 1943 (quoted in Goodson, 1993) that "subjects seem to have built themselves vested interests and rights of their own" (Goodson, 1993, p. 31).

Over the years, the term "subject" has been applied at a number of levels: as a school examination category, a title for a degree or training course, and as a department within a school. Goodson (1993), claims that the

> "subject" is the major reference point in the work of the contemporary secondary school: the information and knowledge transmitted in schools is formally selected and organised through subjects. The teacher is identified by the pupils and relates to them mainly through her or his subject specialisation. (p. 31)

Departments act as more than administrative units (Siskin, 1994); they also serve as the primary site for social interaction, professional identity and community, they represent strong boundaries dividing the school, and they influence decisions and shape the actions of individual teachers. According to Siskin, these departments are distinguishable and determined by "realms of knowledge" (p. 5). These realms of knowledge are more than just adjectives or labels for organising the school; "these subjects give departments their very reason for being" (p. 153). The knowledge is recognisable so that understood differences between realms of knowledge construct boundaries that draw people together around a common interest. Therefore, subject departments

> are not just smaller pieces of the same social environment or bureaucratic labels, but worlds of their own with their own "ethnocentric way of looking at" things. They are sites where a distinct group of people come together, and together share in and reinforce the distinctive agreements on perspectives, rules, and norms which make up subject cultures and communities. (Siskin, 1994, p. 181)

Research has shown that a teacher's identity and work are organically bound up in what teachers know about their subject (see, for example, 1982). Teachers describe themselves in accordance with what they know:

> to know a particular subject means that I know something in this domain of human knowledge. But to know something does not mean to just know just anything about

> something. To know something is to know what that something is in the way that it is and speaks to us. (van Manen, 1982, p. 295)

The subject matter is arguably the defining element of the culture of a subject (Siskin, 1994). Stodolsky and Grossman (1995) claim that the content provides the context for the secondary teacher, not just in terms of the subject matter to be taught, but in the ways teachers think about learning, assessment, and their roles as teachers (see also Grossman & Stodolsky, 1995; Siskin, 1994; Stodolsky, 1988).

The subject, the subject matter, and personal histories in relation to the subject, are defining elements. This was demonstrated through Little's (1995) research into schools that challenged the traditional school structure around subject departments, where it was found that subject allegiance remained high as teachers used subject expertise for maintaining the status of the subject.

Siskin (1994) also found that teachers tended to talk not only about themselves but also about others in terms of their specific subject area as a way of conveying information about their work. What mattered for teachers involved in Siskin's study was "not simply *that* they teach, but *what* they teach" (p. 155, emphasis in original). Disciplinary background is revealed through a teacher's choice of words, how they structure an argument and their goals for teaching and learning.

Further, pedagogy is influenced by an inextricable link between the way teachers see their students and the subject: teachers understand what students need in order to make the subject matter have meaning, therefore, "teachers understand and value their subjects for what they offer students, and understand their students through the metaphors and assumptions of the subjects" (Siskin, 1994, p. 158). Pedagogical knowledge is tied to how the teacher understands the knowledge of the subject. Conversely, the content knowledge of teachers as representations of the epistemology of the subject is transformed in a way that meets the learning needs of students. This refers to "pedagogical content knowledge" (PCK), as described by Shulman (1986).

Shulman introduced "a new model and set of hypothetical domains of teacher knowledge"(Gess-Newsome & Lederman, 1999, p.3). He described seven facets to a teacher's knowledge base (Shulman, 1986, 1987):

- content knowledge, which includes knowledge of concepts and facts, knowledge of the substantive structure of a subject, or the way concepts inter-relate, and knowledge of the syntactical structure of the subject, or the operating rules relating to how knowledge is generated and validated in the subject;

- general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject matter;

- curriculum knowledge, with particular grasp of the materials and programs that serve as 'tools of the trade' for teachers;

- pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding;

- knowledge of learners and their characteristics;

- knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures, and

- knowledge of educational ends, purposes, and their philosophical and historical grounds.

PCK emphasises the inextricable link between teachers' knowledge of pedagogy and content. Today, research on the interaction between content and pedagogy provides valuable insight into discipline- and interdiscipline-specific pedagogies, including what is possible and appropriate for teaching domain specific content (see, for example, Gess-Newsome, 1999; Loughran, Berry, & Mulhall, 2006; Loughran, Mulhall, & Berry, 2004; Mulhall, Berry, & Loughran, 2003). Aware of Shulman's intention to draw attention away from generic pedagogical research, Morine-Dershimer and Kent (1999) broaden this definition by drawing on studies in classroom organization and management, instructional models and strategies, and classroom communication and discourse. They make the point that, in reality, "it is literally impossible for a teacher to implement pedagogical knowledge in the absence of content. Similarly, we would argue, it is literally impossible to teach content effectively without using pedagogical knowledge and skills" (p. 42).

Clearly, the literature indicates that the subject cultures to which teachers affiliate themselves can strongly influence how they teach, and therefore, their professional development needs.

Generic versus subject-specific pedagogical description and policy

In recent years, various curriculum models underpinning Australian state education systems reflect a re-thinking of the purpose and role of the "subject". These models are informed by research focused on a contemporary view of the purpose of schooling that has generated, and reported on, a shift in the way pedagogy is conceived, particularly in the middle years of schooling. This section outlines some of the arguments and counter-arguments involved in this debate about the integrity of "the disciplines" as pedagogy is removed from the context of the subject.

Gardner (2004) states that disciplines are "the best answers that human beings have been able to give to fundamental questions about who we are, physically, biologically, and socially" (p. 233). They are distinctive in terms of moves, genres, syntax and content, the mastery of which takes time. However, historically, research in teaching and learning has regarded subject matter disciplines in varied ways: "as the organizing framework for investigation and implementation" (Shulman & Sherin, 2004, p. 135); or as secondary to "generic principles of instruction that could transcend disciplinary boundaries" (Shulman & Sherin, 2004, p. 135). The result was that content areas nearly disappeared from research into professional development at various points in history. Today in the US, Gardner (2004) sees disciplines as being threatened by "facts, which are discipline-neutral subject matter, and which serve as just a textbook convenience" (p. 233), and by "interdisciplinarity, which often ignores and obscures disciplinary differences" (p. 233). These pressures are evident in the Australian context where, in many classrooms, specific content is the focus of instruction, and where the notion of interdisciplinary approaches to broad scale and localised curriculum development are being explored.

There was considerable evidence leading up to 1996 of student dissatisfaction with school, especially with what was being offered in the middle years (Anderman &

Maehr, 1994; Beane, 1990; Sizer, 1994). For example, in a Victorian inquiry, Hill, Holmes-Smith and Rowe (1993) noted a decline in the engagement of young adolescents in secondary school compared with their engagement at primary school. There was mounting evidence to support a change in direction of curricula and syllabi that recognised the unique needs of middle-years students.

The current reform in the middle years of schooling reflects a modified emphasis on subjects where the purpose of the subject matter is as the context for delivering an alternative curriculum concerned with "many of the communicative, expressive, thinking, affective, moral and social experiences which can provide students with impetus to their holistic development as young adults" (Arnold, 2000). Arnold states that middle school curricula and syllabi should "reflect integrated approaches emanating from collaboration between teachers of different subjects and between the teachers with their students" (p. 4). The New Basics curriculum model trialled in Queensland represents such an integrated framework for curriculum, pedagogy and assessment (see Matters, 2001, for a review of the New Basics trial), and signals a move towards generic description of pedagogy. The framework incorporates Productive Pedagogies, derived from Newman's construct of Authentic Pedagogy, and Rich Tasks that allow students to "display their understandings, knowledge and skills through performance on trans-disciplinary activities that have an obvious connection to the real world" (Matters, 2001, p. 2).

Given a growing trend towards generic descriptions of pedagogy accompanied by advocacy of professional learning provision based around such generic formulations, it is important to understand how the subject cultures play a role in determining both pedagogy and professional learning needs. This is particularly so considering the number of teachers, particularly in rural areas, who find themselves teaching science and mathematics without having specific training in these discipline areas through their pre-service qualifications. Teaching out of field is a growing reality in many secondary schools. For example, research has shown that the future junior mathematics teacher is likely to be a female biology graduate (Harris & Jensz, 2006). While this in itself is not problematic, the move from one disciplinary way of knowing, thinking and acting requires both a shift in teachers' thinking and being, and support through professional learning that acknowledges this.

A further tension framing professional learning provision that potentially affects teachers of subject disciplines is that between the promulgation of knowledge about new curriculum arrangements and system policy provision — the distribution of knowledge of a technical nature — and the provision of support for the professional growth of teachers. At a deeper level, teachers as professionals need support to develop their own approaches to teaching, to update disciplinary knowledge, and to gather support from colleagues in furthering their pedagogy. The two views of professional learning represented here are on the one hand top down, or delivered information about current systemic arrangements, or new approaches to teaching and learning, and on the other hand support for the teacher as a self motivated professional to make decisions about their own professional needs and journeys. Hoban (1997) argues that we need to strike a balance between these approaches – what he terms 'inside/outside' approaches. Hoban (1997, p.11) observes that:

> These professional development models draw upon both the knowledge that teachers have generated from their experiences and the knowledge of others to promote a 'community of discourse'. …There are two aspects of teacher learning

underpinning these models—personal reflection by the participants and the introduction of alternative views to provide participants with different perspectives on teaching and learning. Consequently, teachers' *inside* perspectives are complemented by teacher research from *inside* and educational researchers' and other *outside* perspectives. Features common to these models include shared control of the agenda and the contribution of ideas from participants with a rich variety of perspectives.

The balance between these approaches will be part of the analysis in this study.

Part of the backdrop to this study is the School Innovation in Science project (SIS) which involve hundreds of Victorian schools from 2000 to 2004, and in which some of the schools and teachers surveyed in this study had participated. A number of papers arising from SIS (Tytler, in press; 2007; 2005) have examined the effectiveness of the science learning team as a driver of professional learning for teachers, and argued the importance of local ownership of teaching and learning initiatives.

The particular needs of rural teachers

Of particular relevance to the study to be reported here is the report of the SiMERR National Survey (Lyons et al., 2006a). The Survey was conducted by the National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia at the University of New England and involved gathering survey data from teachers, parents and carers across all states and territories of Australia.

The Survey included a section on professional development of teachers and gathered a great deal of valuable data. The summary of the findings with respect to professional development, are set out in Table 1. Reference back to these findings will be made throughout the data analysis for this study.

Several points need to be made about the National Survey as they relate to this study. The first is that the response rates to the survey were relatively low in Victoria. The report suggests reasons why this was so. However, the issue for the current study is that it would be of benefit to gain further insight into the situation in Victoria.

The second point to be made is that the National Survey places greater emphasis on the expressed needs of the teachers than on what schools and school systems are currently doing to provide professional development for teachers. In the study to be reported here it was determined to explore in some depth what schools and the government school system are doing about this critical issue.

Further, The National Survey covers the Government, Catholic and Independent school systems. In this study it was decided to restrict our enquiries to the Government school system. The reason was that there had been a large-scale professional development activity, the School Innovation in Science initiative and its mathematics and technology sequels, operating in that system.

Alongside the National Survey there was a series of case studies produced by teams in each of the states and territories (Lyons et al., 2006b). The data for the Victorian case study was generated by conducting three focus groups, one of teachers, one of students and one of parents, in each of six rural schools. Teacher professional development was one of the topics dealt with in the teacher focus groups. There was a further focus group of Regional Project Officers (RPOs). The RPOs had been supporting school and teachers with professional development provision and as

critical friends, as part of the School Innovation in Science initiative and its mathematics and technology sequels.

Arising from the analysis of the data gathered in these focus group meetings questions were raised by the researchers which were considered worthy of further examination. Amongst these was one concerning teacher professional development, '*What modes of professional development are best able to support science, ICT and mathematics teachers in rural (and especially remote) areas?*' The study being reported here is an attempt to address this question, and to provide insight into the particular circumstances framing professional learning of rural teachers, that underpin the statistics reported in the Lyons (2006a) survey.

Table 1

The findings of the SiMERR National Survey with respect to professional development for teachers

Professional development needs of primary teachers	1. There is a strong need for opportunities to develop their ICT skills and to help them cater for special needs and gifted and talented students.
	2. Primary teachers in Remote Areas are significantly disadvantaged in terms of accessing professional development opportunities such as mentoring, release time for PD and collaboration with colleagues. Teachers in Metropolitan schools have a considerably lower unmet demand for in-services in mathematics and science than teachers in other areas, particularly those in Remote Areas.
	3. There appears to be a need to develop or improve structures to support mentoring of teachers in remote schools.
	4. Primary teachers in remote schools, and schools with a high proportion of indigenous students feel professionally isolated. In particular there is a need for professional development to help these teachers cater for special needs and gifted and talented students, for more financial support to cover costs of professional development, and for strategies to ensure that classes are covered in their absence.
Professional development needs of secondary science teachers	1. Science teachers in general see the priority areas for professional development as being release from face-to-face teaching for programming and other collaborative activities, and more effective communication with educational authorities.
	2. Science teachers need professional development opportunities to help them cater for the diversity of students in their classes.
	3. The need for professional development opportunities increases substantially with distance from Metropolitan and Provincial Cities.

	4. Science teachers in remote schools feel professionally isolated when it comes to opportunities to contribute to syllabus development. Teachers in Metropolitan Areas have more opportunity to mark/moderate external science examinations.
	5. Science teachers in schools which have a relatively large proportion of Indigenous students have a substantially greater need for a range of professional development activities, particularly those which would help them cater for student diversity.
Professional development needs of secondary ICT teachers	1. ICT teachers see the need for release from face-to-face teaching for collaborate activity as the highest professional development priority.
	2. ICT teachers see a need for intensive on-the-job training.
	3. There is no significant relationship between professional development needs of ICT teachers and distance from a metropolitan city.
Professional development needs of secondary mathematics teachers	1. Secondary mathematics teachers see a high need for professional development to teach higher-order thinking skills, to improve classroom management and to develop alternative teaching methods.
	2. There is strong need for release from face-to-face teaching for unit programming and more effective communication with education authorities.
	3. Mathematics teachers see a substantial need for professional development opportunities to help them cater for student diversity in their classrooms.
	4. The professional development needs of mathematics teachers do not vary as much with location as do those of science and primary teachers.
	5. Mathematics teachers in schools with substantial proportions of Indigenous students require more professional development in student management, alternative teaching methods and strategies to cater for student diversity than do those in schools with fewer Indigenous students.

Research questions and methods

Objectives of the study

This study employed a qualitative, interpretive methodology to explore the current nature of professional development provision for rural teachers of mathematics and science, and to ascertain these teachers' perceptions of their professional learning needs. The purpose of this study was to explore the following questions:

- What are the provisions for professional development in science and mathematics for teachers in rural and regional schools in Victoria? and

- How is professional development provision perceived by the teachers, school leaders, and Regional Project Officers charged with responsibility for the provision of professional development in science?

- What are the issues related to the provision of appropriate professional development to teachers in rural and regional schools in Victoria?

Research design

Gathering the data

It was decided that the data would be gathered by interview rather than by survey. Whilst recognising that survey methods would allow a larger sample to be studied, it was believed that at this stage in our knowledge it would be desirable to operate within a more open structure which would increase the possibility of all of the relevant issues emerging. We also intended to gain insights into the perspectives of teachers and schools 'on the ground', concerning professional learning needs and provision.

The interviews were all conducted in the work place of the interviewees. The interviews were recorded, with the permission of the study participants, and the interviews transcribed.

A significant issue to be addressed in determining the methods to be employed was the choice of sample. The decision was made to begin with interviews of the Regional Project Officers (RPOs) who were located in the Regional Offices of the Victorian Department of Education. These people were appointed with the specific brief to provide professional development in science and mathematics as part of the extension of the Science in Schools Project which had been developed in Victoria and operated in many schools across the state.

All of the RPOs located in the non-metropolitan Regional Offices were approached to participate in the study. There were some difficulties due to personnel changes. However, 6 interviews were conducted. It needs to be noted that one of those interviewed was now the principal of a primary school in a country town after a number of years as an RPO, and another had responsibility for both country and metropolitan schools.

At the conclusion of the interview each of the RPOs was asked to suggest schools in which there were positive things happening in relation to professional development for science and mathematics with a view to selecting from these for the main study sample. Attachment 2 is part of the transcript of one of the RPO interviews to illustrate this process.

A selection of schools was made from those recommended by the RPOs bearing in mind the need to keep a balance between primary and secondary schools, between rural and regional schools, and the time constraints of the study. In each school the decision as to who would be interviewed was made by the school principal, whose decisions were influenced by staff availability on the day(s) of the visit. The study team wish to acknowledge the extent to which both principals and teachers went to great lengths to ensure that the data gathering was as extensive and representative as possible within the constraints.

Table 2 sets out details of the schools visited and the teachers interviewed.

The interviews were based on an interview framework (Attachment 3) but there was a great deal of flexibility to allow the local issues to emerge and be explored. Each interview took approximately 1 hour and they were all conducted by one of the study team, Professor Cliff Malcolm.

Table 2:

Schools visited and teachers interviewed

School	Type of school	Brief description	Teachers interviewed
Bellbird	**Sec**	This is a small school – 160 students and 22 teachers. The local community has some 'traditional fine wool' farmers, but also an increasing number of low SES families/ singles who come for cheap housing, and proximity to a regional city.	**Principal and 5 teachers**
Eagle	**Pri & Sec**	This is a P-12 school, in a remote farming area. There are about 260 students. Most of the students come to school by bus. The school has first rate buildings and owns a farm, where they do some cropping and run sheep. The breadth of programs is remarkable considering its size.	**Principal and 6 teachers**
Goshawk	**Pri**	The school has an enrolment of approximately 95 students and services the stable yet diverse populations of a small historic township as well as surrounding rural areas. The school is also the Hub school for a 1.4 teacher rural school, with a current enrolment of 15 students, situated 15 kilometres away. The school is used by many local community groups and enjoys a high level of parental support and involvement. It promotes a warm, friendly and welcoming environment.	**Principal and 5 teachers**
Mudlark	**Sec**	The college is a small rural college with a student population of 418, a very friendly atmosphere and considerable pride in its 40 years of serving the town and the surrounding communities. It enjoys a close working relationship with the adjacent Primary School. The college also enjoys an excellent relationship with all its neighbouring primary schools.	**Acting Principal and 6 teachers**

		The district has relatively high rainfall and so the major industries are dairying, grazing and vegetable growing.	
Nightjar	**Pri**	The school with 250 students is located in an industrial town with a population of 14,000 with several other large towns nearby and so there are 7 primary schools & 2 secondary colleges within 10km. The school's parent body includes some low SES families. The school has taken significant steps to make the school a community centre particularly for parents with a room set aside for their use.	**Principal and 7 teachers**
Osprey	**Pri**	The school, located in a predominantly dairy farming area, has a roll of 25. There is another primary and a secondary school within 10 kms. VELS is being implemented in innovative and integrated programs connecting science and drama, for example, supported by a successful external funding application.	**Principal and 2 teachers**
Yellowtail	**Sec**	The college has 423 students. The town, with a population of about 6,000, is set in a farming area adjacent to the Murray River. There is a single primary school in the town and there is a smaller sister town with a primary school across the river in NSW. The water access has enabled the area to develop into a popular holiday destination. Involvement with their cluster in an ASISTM project has provided directions for these curriculum areas into the wider community.	**Principal and 6 teachers**

Analysing the data

Initially all the interview transcripts were read by two members of the study team who identified broad themes around which the analysis should proceed. These themes related to the broader, system-wide context in which professional development was occurring; the types of professional development strategies that had been employed; and the issues around the provision of appropriate professional learning opportunities. The framework developed from this analysis, covering context, strategies and issues was used to revisit the transcripts and identify representative quotations from the interviews which illustrated aspects of the context, the use of a particular strategy, or an issue impacting on the provision of professional development. This structure, and the fidelity of the analysis supported by the evidence from transcripts, was then tested and refined in the process of writing by the other members of the team.

Interpreting the data

While the data are extensive with extended interviews with 50 people, it needs to be recognised that, excluding the data from RPOs, the school data comes from only three

secondary schools, one P-12 school and three primary schools. Further there are significant differences between the schools. For example, one of the primary schools is a relatively large school in a regional city while another is a very small school in a rural hamlet. Again, it needs to be noted that these were schools recommended to the researchers as illustrations of schools with successful professional development in science or mathematics.

There is no sense, therefore, in which one can generalise to the broader population of regional and rural schools. Rather the data must be seen of indicative of issues which are relevant to professional development of teachers in these schools, and the types of approaches which are being adopted in some schools to address the professional development needs of the teachers in science and mathematics. However, it has been possible to check some of the trends suggested by these data against those found in other studies and reported in the literature. This does make it possible to have some confidence in the validity of the inferences proposed.

Presenting the findings

As indicated earlier the data set for this study comprises interview transcripts. The reporting of the findings of this study will be done in three sections. The first relates to the context in which the schools are operating as identified by the interviewees, the second deals with the professional development strategies currently being employed and the participants' perception of their value, while the third identifies issues for the professional development of teachers in rural areas.

Quotes are used to illustrate the main themes emerging from the data and in some cases variation within the themes. The interpretive nature of the methodology and in particular the loosely structured nature of the interviews makes it inappropriate to refer to percentages of teachers or schools representing particular views, but where possible the prevalence of these perceptions and views is referred to.

Findings of the study

The findings section begins by describing the context in which the schools are operating their professional development programs. The first two subsections set out information gained from the study participants about aspects of the local context - the local communities and the school populations. The following subsections deal with two aspects of this context — the local context, and the wider professional development setting — which are seen by the study participants as relevant to the professional development issue.

The local context

The nature of the community

Most of the comments about the local communities in which the schools were sited were made as background to the issues for teachers working in those communities. There were several schools, however, in which the teachers talked about the active role that the school was playing in the community.

Smaller rural communities, because of their size, are perceived to be more friendly and co-operative with the education of the children.

> The kids and the teachers and the parents are all a bit more laid back. And that makes it. Yep, they're more, … everyone's on board, so to speak. You're not - there are a

few who aren't on board. But that's everywhere you go. But it's just a very tiny community and everyone's very willing to help out and that makes such a good school, I think. It makes a school even better, having support of, like school goes hand in hand with home. You need that. (P/N)

I've got lots of parent support. Parents are very involved in, well, when we've done the energy breakthrough, parents were very involved. I had a parent come to every science class. So they knew what the kids were talking about, what they wanted to do with the push cart each time, and because the kids didn't have the expertise to actually do the welding and that, they would take it off and either do it themselves or that, and bring back the next little piece done. (F/O)

I think those (school/community) partnerships really do work in terms of the schools just more connected to the community. They're obviously connected by the kids and the parents but when they get involved with a local industry, or the CFA, or the paramedics, or something, whatever it is, they see themselves as being more relevant. (C/RPO)

However, it would wrong to give the impression that this level of involvement ran across the entire communities. It was pointed out that the possibility of cheaper housing in some of these smaller rural communities made them attractive to people escaping higher rents in the city and that these people were not always integrated into the community and linked to the school.

I think to some extent that's happening more in some of the smaller communities, because there is a change in population, where housing and access to housing is cheaper than in the cities, so there are people moving into the country who would have stayed in the cities in the past. (O/RPO)

As indicated earlier there was one school in particular, a primary school in a regional city, which was working extremely hard to build community around them.

They're good people but their backgrounds and life experiences are different from a lot of ours. And they love the kids. They make some strange decisions, against a background of generational poverty…..We have a high proportion of parents help at the school, and we offer many different ways for parents to help. …….I run a Craft, Cuppa, Chat. I got a grant last year. It's to skill parents. We've gone to Bunnings, and we've looked at how to operate power tools, how to plaster a wall, pottings and a herb garden, and painting. And I've come back and run scrap-booking and card-making, and painting and color and design and we're really upskilling our parents and empowering them in that way…….. Yes it takes the community and the school-community to raise the child……And we need to locate adult mentors if you like for the kids in our school. If we could extend that it would make a big difference. (R/N)

The nature of the school population

The people interviewed referred to both the students and their colleagues as part of presenting a picture of the context in which they worked. The comments about students were positive suggesting that generally their attitudes made teaching in these schools more pleasurable. This finding repeats one of the findings of the Victorian focus group survey (Tytler, Mousley, MacMillan, Marks & Tobias, 2006)

So the kids are very good here. There's a great learning culture here. The kids are actually here to learn. And that makes it really pleasant to be here. They love to learn. So, yeah, that's probably the biggest plus about this school. Instead of having to worry about discipline all the time and that's a big plus. I think the size has a lot to do with it. I've been in a school where there's … there was fourteen hundred students. There's

> only four hundred and thirty here. So, you know, after two or three years, you do know nearly every single student….. As I said, because you can actually teach. (P/M)

> ..it's a beautiful town, kids are, kids are lovely, you have great, you have, you can have great relationships with the kids and their families. (J/Y)

> At a school like this, I mean, we've got a small percentage that, you know, a bit like feral kids, um, but we don't have any really nasties, so, a new teacher to the school can come in and really concentrate on getting themselves established in their area, which will build confidence, which will also help discipline. (M/Y)

School climate is important in enabling professional development from colleagues, especially for teachers in the early stage of their career. In all of the small schools visited the relatively small size of the school was seen as important in creating a learning community amongst the teachers, again echoing the Tytler et al (2006) survey findings.

> I've learnt how to work definitely more as a team member because it's been a more tight knit community. In that sense of having to be… and being able to ask for help, it's been easier to ask for help and it's not … like a big drama. It's like: 'Yep, we can help.' And, anything that you need, it's just there. It's not a hard resource to get. And just even finding and sharing resources, um, like L, who's in five-six, she did have three-four at one stage, years ago, but she had units of work that had worked that could help us with our new units. Yeah. Just little things like that, and just getting new ideas from people. (C/G)

> I think the small size of the school is positive in terms of exchange of ideas and just working collaboratively with other teachers. Yeah, I think it is. Yeah, it's very positive really. I think there's a sense amongst teachers here that it's a good place to be, and that probably feeds into … professional learning a little bit. (R/M)

Where there is a small school it is possible to involve all of the staff in curriculum projects which provide professional development for them.

> And I think, what made it sort of work so well here for us is that, it wasn't me going off to a professional development a long way away and, ah, coming back and saying how good it was and we should do it, we actually were able to organise it so that every single person on staff, and then later on our volunteers and parents, have been down to see a model, um, of the, ah, garden and the kitchen program and so that meant that we all knew. …I think we went three times. (C/G)

The interview data suggest that the climate within smaller schools (and most rural schools are small) is conducive to both informal professional development and projects in which the whole school staff can participate and from which they can all learn. This is consistent with advocacy in the literature for school based professional learning approaches involving cooperation between teams of teachers. It seems that rural schools provide a supportive environment for such cooperation, in this case involving members of the local community also.

The wider professional development setting

The foci of the study are the issues surrounding professional development and how these are addressed in individual rural schools. However, these schools are part of a school system and are operating within a state and national context, and so to understand the thinking and actions of school principals and their staff members one needs to have some insight into the context in which they are operating. We will present in this section insights into what the interviewees reported on initiatives which

create the context for professional development, with regard to the nature and history of PD provision in these schools.

We will start with State Government initiatives. The Victorian Department of Education and Training introduced in the years leading up to the study a number of major initiatives which applied across all schools in the system.

Victorian Essential Learning Standards (VELS) and the Principles of Learning and Teaching P-12 (POLT)

One of these initiatives was a recent change to the state curriculum framework within which all schools develop their own curriculum, the Victorian Essential Learning Standards (VELS). The structure of VELS includes key disciplinary based content, but its innovation has been to promote generic skills and attributes as a requirement within each subject area. A second was an initiative focusing on a generic formulation of classroom pedagogies, the Principles of Learning and Teaching P-12 (POLT). There was an expectation within the Department's Regional Offices that schools would make the implementation of these initiatives, VELS and POLT, key drivers of professional development. This was very evident in the interviews with the RPOs who were locate within the Regional Offices of the Department which had a delegated authority in this regard.

> The professional learning agenda is kind of set, to get their heads around POLT and VELS, and the 'must haves' of teaching. (J/RPO)

> The big shift came from the centre with Melbourne running out the VELS etc, the new reporting regimes, and flagships strategy one, that became the sort of preferred, well, gospel if you like, to be taught and told, and everything else sort of got pushed to the side. (L/RPO)

> But the plan is really an overall plan, rather than looking at individual subjects. The priorities that come from the Department generally are curriculum on a general level, addressing key priorities of the Department, under the flagship which is looking basically at VELS and the Principles of Learning, and the concept of improving teaching strategies, but there's not that, sort of, key expertise provided for individual KLAs. (O/RPO)

However, whilst there was some comment by principals on both of these initiatives as factors to be considered when planning professional development they were not as dominant as one might have expected from the comments of the RPOs.

> Another way that we are fairly blessed by our size: Every Tuesday is staff meeting day, and we alternate between a general information-sharing meeting, and a curriculum meeting. Often our curriculum meetings are organized into small groups, and individuals present and so on. So that's another important vehicle, our curriculum committee (well, it's not a committee really: it's the whole staff). In a staff of 20, that's a pretty effective means of professional learning as well. If you're talking about the new VELS system, whereby we are supposed to assess on thinking skills and those sorts of things, the way we have communicated that is largely by individuals on staff making presentations about what they do, and how they assess. (Principal, B)

Again while teachers acknowledged the need to address the introduction of VELS and POLT, there was no school in which they were reported as the drivers of the professional development agenda. Rather, VELS seemed to be viewed as speaking only to curriculum organisation.

> We've got a curriculum committee now, like we didn't have any coordinator and now the school has set aside a coordinator this year: mainly to work on the VELS and try and coordinate this VELS together, for the reporting system and things like that. I suppose we were a bit slow off the mark with that because of the change in Principals. (C/E)

The data suggest a strongly decentralised system with schools firmly in control of their agenda for professional development. Whilst schools accept their responsibility to respond to both VELS and POLT they determine for themselves the manner in which this is done, including PD planning. Whilst the administration of the Department makes it clear that schools are required to respond, it is within the schools that the decisions are made concerning the way in which they will meet the challenge. The Regional Offices of the Department, whilst not directing the professional development agenda in relation to these, and other initiatives, do however offer support for professional development.

The school system's regional office

There is regional support available for professional development. This involves programs offered by the region to which schools can send representatives and the possibility of regional staff running on-site programs for individual schools or clusters of schools.

> You've got a Senior Education Officer (at A) and two professional staff, one in charge of student services, the other one in charge of curriculum. So there is a curriculum network there. They call it TOP, the on-site program. They'll come around and run PD in your school, or in another school around the place. So if I've got something I think is important, I ring up and say "How about you run such and such at BSC". (Principal/B)

The RPOs indicated that the emphasis within the regional offices was to address the professional development needs arising from major initiatives generated by the head office of the school system. In addition to VELS and POLT, these included at the time a new reporting system and programs to address the issue of bullying within schools.

> …..bullying was our big issue at our Monday night staff meeting and we had a regional resource person and she came out and did a very good 'show and tell' and talk and discussion, and we could have gone on for some time. We tried to stop it at 4.30 but teachers didn't end up going until about 5. So a lot of the PDs come to us. (R/E)

It was pointed out that these were issues relevant to the whole teaching force and that the Region was not playing a significant role in the provision of professional development within specific subject areas. Because of the emphasis within the regions on servicing these generic initiatives coming from head office, the RPOs, who had been appointed to provide support in the areas of science, mathematics and technology, found themselves limited in opportunities to provide professional development in these areas.

> My priority is to try and remain within the confines of science, maths and technology. But because the Region has this general school improvement policy, which is at the broader level, people like myself are involved in working with schools on a range of programmes. (O/RPO)

> In my work, I'm limited by Departmental policies. And the move has been to quite focussed work in schools and with schools. You know, the standards of best practice in Teaching and Learning, the 7 Key Elements of Professional Learning are definitely on the agenda. (J/RPO)

The emphasis within the Regional Offices was clearly on providing support for the major initiatives of the System. However, it was clear from interviews both with schools and the RPOs themselves that the Regional Officers are seen as providers of support to schools as required, rather that as the overseers of the implementation of these initiatives.

Innovation and excellence clusters with appointed cluster educators

The state Department of Education introduced the Innovation & Excellence initiative in 2003. It was phased in over three years and funding was supplied to groups of schools that joined together in "Clusters". By 2005 all Victorian government schools were a part of one of 247 clusters across the state. An Educator was appointed for each Cluster, usually someone who was removed from the classroom and given the full time role of developing educational programs that would improve student learning. Initially the project was aimed at the Middle Years. However, the importance of leading change in teaching practice and improving student engagement and student outcomes has resulted in its extension from P - 12.

The initiative was to go over three years, so Phase 1 Clusters were effectively complete in 2006. At the end of 2006, the government announced the project would run for a further twelve months, with funding provided to meet Educator wages only. This initiative finished at the end of 2007 and so was operating at the time of the data gathering.

The interviews revealed that the clusters featured significantly in the teachers' thinking about professional development. Further, the focus of such activity varied significantly across the clusters. For example, there were clusters focussed on the discipline areas of mathematics and/or science, others on issues such as the education of boys, others on the implementation of a number of government initiatives and policies, while yet others explored local issues.

> There are eight schools in the cluster, ranging from a small school of twenty- five students, a primary school, and us being about four hundred here. And, certainly, we've really now got some strong collegiate networks and strong networks around professional growth. (S/Y)

> I've probably been pretty lucky here. They've had a fair focus on maths, with P, the Innovations and Excellence Educator. He's here, and he sort of runs the Cluster as well. But he's been doing a lot specifically with maths especially for the secondary, but for the cluster as well. (J/B)

> So, basically the cluster got funding for the Success for Boys, so now we're going to bring it into our school environment. (R/Y)

> …he's working across our three schools B, A and E in Innovation and Excellence and the tag is sort of changed a little bit. He's now really running with this assessment across the VELS and managed to get teachers into some very fancy, good software that was made by another teacher in a school up north, in terms of assessing, recording and working out where the kids are, under this new VELS assessment. (R/E)

> We went to a guy in R called J and that was early this year in February. He was excellent. He wasn't specific subject so much as about setting up a good culture in the school. (J/O)

The response of teachers to the professional development offered within these clusters was equally varied. Many of the PD activities involved both primary and secondary

teachers. The data would suggest that some of the topics worked better across the primary/ secondary school divide than others. For example, in some of the places where the focus was on the discipline there were indications that it was difficult to meet the needs of all of the teachers simultaneously.

> Most of it tends to be primary school-based which becomes quite frustrating. It's not clear straight away because I've been to many PDs where, although some of it's relevant, and it's nice to know what the primary schools are doing, when you've got the majority of the day spent on telling or informing primary school teachers, you know, what's the best way to teach the kids how to do long division, it becomes quite frustrating. (J/Y)

However, even when the content of the professional development activity is not seen as particularly relevant to a teacher they can use the opportunity for some networking beyond the school with apparent benefits.

> Well, I find I can't implement them in Further Maths in year twelve, or year eleven Math Methods, which is what I'm teaching this year …….so we do a little bit of communication with people at R, we've gone to PDs there and I've actually got to give them a call and see if there's a teacher over there who could come over here and do a PD for us coming up on some new technology that's out that they've been using. (J/Y)

> So, I got to know them and I feel comfortable ringing them up and saying, 'What about this? What about that? Do you mind sharing this?' I wouldn't have had that opportunity otherwise. (L/G)

The value of the cluster professional development activity would also appear to depend in part on the stage a teacher is at in their career.

> I suppose, being fresh out of Uni, a lot of the stuff is revisiting for me, like the thinking skills. And with the POLTs, and data charts and Venn diagrams, it's stuff that I have already been using. And then I'm doing formative assessment and rubrics but again it's really just reflection for me except that I'm using rubrics now as an inquiry process. (D/E)

There was quite a lot of positive comment about visiting experts that the clusters were able to organise to contribute to the professional development activity within the clusters.

> What he's been trying to do is get in a number of guest speakers that were maths specific, in terms of engaging students, and new ways, or maybe rehashing old ways, of getting kids interested, and being effective, I suppose. We've had C, who's fairly high up in the maths world. We've had I, and we've just had recently M. So we've had those three, all this year. Yeah, so that's been very helpful for us. (J/B)

> …..he came over and spoke to the cluster meeting in R. We all went. We all felt it was a really worthwhile day to the point where after we finished and we had the big day and usually we'd had it after, you know, days like that but we all went up to E and sat down and said, 'Here are the strategies that we can take from today and we can use at the school'. So that was really good. (J/O)

While there was much positive comment about the professional development activities within clusters there were some criticisms, apart from those already raised. However, these seem to be general issues and not specific to the activity organised by the cluster. For instance, one teacher complained that there was insufficient time to follow up on ideas, another suggested that there were not sufficient resources, while

another claimed that she found the meeting difficult because she didn't know the others at the meeting.

> Some of it can be good, but unfortunately with the content that we need to cover you just don't have the time to go through that sort of stuff. (J/Y)

> Obviously if they're serious about resourcing, they need to provide at least the compulsory work here, at the school, and certainly within the cluster. (B/B)

> We had some PD with the Primary school and everyone was like, 'Oh, hi Mary, hi such and such, hi such and such.' And, like I have no idea who these people are, and I was pretty shy and unfortunately there was very little coming the other way. (J/Y)

As is obvious from the above, it is difficult to generalise about the impact of professional development within clusters. However the data do suggest that an important issue is the selection of a topic by the cluster which can be seen by both secondary and primary teachers as relevant to their work.

Two issues emerge from this discussion of the efficacy of the cluster model for supporting effective professional development. One relates to the need to generate a critical mass of teachers to collaborate on a particular professional learning issue, and while the cluster clearly makes this more possible than if PD was organised within a single school, in many respects the linking of primary and secondary schools was unhelpful in allowing a focus on significant teaching and learning issues germane to all teachers involved. The choice of focus was critical in this respect. The second issue relates to the competing needs of government on the one hand, committed to rolling out new programs and approaches, and teachers on the other hand with their own specific professional learning needs that may not be coincident with the government focus at the time.

Commonwealth Government initiatives e.g. ASISTM

The Commonwealth department responsible for school education has undertaken a major initiative in the areas of science, technology and mathematics education known as the Australian School Innovation in Science, Technology and Mathematics (ASISTM) project. This has been identified in a study of exemplary ASISTM projects (Tytler, Symington, Rodrigues and Smith, 2007) as something which has resulted in significant professional learning for teachers involved in the various projects. In the interviews for the present study teachers in two of the schools have been involved in ASISTM projects and discussed it as part of their consideration of professional development opportunities.

Projects involved getting experts/consultants from outside the school to provide learning experiences for the students and often for staff themselves. Teachers were very positive and explicit about the professional learning that flowed from these projects.

> Also what we've done as part of ASISTM, we've linked up with the Region, and B has been sensational. The staff has really appreciated his input, and you can see that when he comes and meets with them, he's bringing real stuff to the table, he's not just talking theoretical stuff that may not help them. Because teachers at the end of the day are saying: We want stuff that makes life easier for us, we don't want to be given extra work, or to be hearing stuff that isn't relevant to us. Because their time's too precious to be sitting in meetings or hearing stuff that isn't relevant. (P/B)

> So, in terms of my professional development, being thrown in to being a leader for a project has, I think, made me capable of a lot more now than what I was. I think I

> could professionally handle taking on a different job that involved managing a lot of people. I think,whereas before my skills were probably average I'm better now. Yeah, so it was really good. (R/Y)

It would be wrong to suggest, however, that all of the staff in these two schools had the same view of the ASISTM project. In one school there were some quite critical comments and in the other many of the staff never mentioned the ASISTM project, which suggests they did not see it as a significant professional development opportunity. It seems probable that the nature of the ASISTM initiative was such that it involved only some staff and some of the curriculum, and/or was seen as an add-on and not part of the mainstream curriculum.

> The ASISTM project last year was a bit of a battle, because it was seen as an add-on. A lot of last year was trial and error, and I think we learnt a lot. (P/B)

References to ASISTM were the only indications of the Commonwealth Government being seen as a major supporter or provider of professional development activity.

Initiatives from professional, government, community and industry bodies

There is a range of bodies with a commitment to providing PD programs to support teacher professional learning. Prominent amongst these are the professional associations, such the Science Teachers Association of Victoria (STAV) and the Mathematics Association of Victoria (MAV), and the universities. These are primary sources of subject specific PD. Study participants also mentioned other bodies that either provide professional development programs for the teachers or they organise programs for students which result in teacher professional development. These included the environmental centre CERES, the RACV (Royal Automobile Club of Victoria), and the Minerals Council.

While there were those who were critical of the activities offered by the professional associations, the STAV and MAV were generally recognised as providing valuable professional development opportunities for teachers, mainly through their annual conferences. These opportunities are mostly for individual teachers, in contrast to the initiatives described above. However, there were significant limitations on the possibility of teachers in these schools availing themselves of these opportunities, such as cost, distance and finding replacement teachers during term time. Risks associated with travel to Melbourne, and time away from family were also mentioned.

> And the disadvantages, the obvious ones I guess are distance…Well when you factor into your PD petrol money and accommodation. Yeah, and you've only, you're allocated $300 for the year; well the last PD I went to was $260. That was just to get in the door. Which was quite expensive, so now my PD for the rest of the year, I've got to be cautious of. Which is why, you know, doing PD amongst yourselves becomes, well not the preferred option, but almost the compulsory option. (M/Y)

> Our big issue is cost to do lots of things. We see lots of great things, but they are often in Melbourne, … so um, ah, that is prohibitive. I mean we have sent people to Melbourne, but, ah, and then with replacement CRTs. Like, as a principal, I find that I have to be the replacement, often. (Principal /G)

> I used to go to the Biology conference every year, the Melbourne one, but the last two years it's been held at La Trobe Uni. I went last year. Took three hours to get there. And it was, I really have to say, the worst one I've ever been to. (P/M)

There were positive comments about interactions with universities through the ASISTM initiative which had led to professional development.

> The ASISTM project as a PD, as a professional learning thing is fantastic. Fantastic. Because, because I got to go to the uni and see Prof K. He's great. And like I got to do things and experience things, like bridge building. Then I went to see bridge building at the uni because they had an open day there, and we invited students from here. We offered a free bus, through the grant. About a month later, I brought the resources in here, and we had our own bridge building competition as part of a year seven transition day. So the truth is I learnt a lot. (R/Y)

The other potential professional development providers were mentioned infrequently. There did not appear to be widespread recognition of their offerings except where individual schools were wishing to pursue a particular topic or approach, such as the development of a program around a school garden.

Professional development approaches

The interviews revealed that, as has already been implied, the significant decisions about professional development are made at the school level rather than at the Department's Head or Regional Offices, although the funding for the activity, which determines the extent of such activity, does come mainly from the centre. At the school level there is a tension, and a balance struck between the leadership of the school and the individual teachers with respect to planning and provision of professional development activity. In the following sections we will identify the strategies used by a) the school leaders and then b) the individual teachers, before returning to the question of this balance.

Strategies used by the school leadership

Mentoring

Mentoring of teachers is advocated as a powerful way to support teachers and improve classroom processes (Barber & Mourshed, 2007), and has become increasingly common in school systems generally. In Victoria, mentoring of new teachers is a formal requirement through processes, set up by the Victorian Institute of Teaching (VIT), which are designed to move provisionally registered teachers towards full registration as formal recognition of their competence within the profession.

The National survey (Lyons et al., 2006a, 2006b) found that there appears to be a need to develop or improve structures to support mentoring of teachers in remote primary schools.

In the schools visited we found both formal and informal mentoring of early career teachers. The generalisation that can be made is that teachers in the early years of their career experienced the support that they needed. There were however, a few exceptions, but this seemed to relate to individuals rather than the school climate generally.

> I felt like I wasn't valued for what I could offer to the school and I wasn't supported as a new teacher, as other new teachers were. (D/E)

While there is a formal process to establish these mentoring schemes in Victoria, from the interviews the major determinant of supportive mentoring relationships would appear to be the general climate of support created within the school. In most of these

schools the teachers were not dependent on the formal process because there was a supportive climate in which they could seek help from staff generally.

> I think it comes from the top down – they're very approachable, the principal and assistant principal. That probably helps. And just the mood of the staff a little bit. That's been a huge help for me – every one of the leading teachers I feel comfortable to go to, and they'll help me through and give me a little bit of advice. (S/B)

> She's sort of my mentor person that's helping me because she's quite into the interactive whiteboard. She's the person I could turn to, and perhaps the technician, but he hasn't been here much lately. I find I have a fairly good rapport with her, so you actually pick up. I think it's a two-way street. I'm helping her a bit with her with the literacy work, and she's helping me. (C/M)

Responses to the formalisation of mentoring processes were mixed. There were some complaints about the time consuming nature of this formal process. Others were critical of the idea of appointing mentors when the pair match may not be appropriate, and had a view that the concept of mentoring was restrictive.

> But for the young teachers now, with the VIT it's been formalized, which can be a pain, in that it's gone too far and added work on. (P/B)

> I don't like mentoring. I like the notion of coaching and also mentors tend to be appointed. I think mentoring has a place, and the way that we try to use it here is that when you're appointed a mentor, they're a nuts and bolts person. So, if you want to know how to use the photocopier, if you want to know how to do this, how to do that. A coach has got a teaching and learning purpose. A mentor, as I said, is a functional nuts and bolts [support]. (J/M)

However, it would be wrong to leave the impression that there was not some support for the formal process itself, particularly from the beginning teachers.

> The school established a good mentor, that I was able to go to and he sort of lead me through it, which was good. (S/B)

Most of the schools visited were relatively remote and small and there was evidence that the staff members develop stronger relationships than is frequently found in larger urban schools. This would appear to make the mentoring process relatively independent of formal processes. The interview data suggest that mentoring, particularly informal mentoring, is alive and well for most of the beginning teachers in these rural schools.

Professional learning teams

In some of the secondary schools across-curriculum learning teams (PLTs) have been set up to enable teachers across disciplines to work together and learn from each others' strengths. Such activity is congruent with the VELS which encourages the development of across curriculum engagement. The nature of such PLTs is such that they focus on broader, rather than subject specific issues.

> Well, you've got to nominate a focus for your professional learning team thing for second semester for yourself. Building rapport with the kids or getting the kids to be more comfortable in class or something like that. And then I have to, following discussion, try something in the classroom. Actually do a bit of action research. And then report back to the group on that. (C/M)

In this instance there was variability in the success of the teams, depending on how well the focus was matched to teachers' professional learning needs and interests.

> What we found last year was that some of the PLTs ran very effectively, but others, where staff lacked the specific focus, they didn't. For example, one of our PLTs was on assessment and reporting. Staff that didn't have another one to go into went into that one, so what came out of that was some very productive learning, but not with as high a focus as what we would have liked. I think it was that they didn't cater for staff individual needs. They catered for a perceived school need, but you must be able to match the personal and the school need. (J/M)

While some teachers find it useful, these broader based professional learning initiatives are not universally valued by science and mathematics teachers. Some see greater value in working with people from their own subject discipline.

> I don't know, I guess, there's not a lot of connection sitting next to someone who teaches some totally different subject. It's sometimes difficult in those meetings because maybe it would be more valuable to be in your KLA group, like your Science group. I think there's probably more value in that, because already, the bond, and they want to make your group as good as possible, is already there. So when we're broken up into groups from all over the place, it does I guess make you wonder the purpose of it all. (R/Y)

Shulman's (1986, 1987) categories of general pedagogical knowledge and pedagogical content knowledge would suggest that there is a place for such Professional Learning Teams to operate effectively and, as has been indicated, there is encouragement within the current curriculum framework, VELS, to look at cross-disciplinary approaches. However, the data here indicate that in action the success of such activity will depend upon the teams finding a topic of relevance to all of the participants in the team. It may be that teachers' readiness for such activity could depend upon their stage of development as a teacher, and their ability to translate general into subject specific principles.

Employing consultants

All schools reported experiences in which consultants had been brought in to conduct professional development for the staff. In some cases the consultants were identified because they could address an issue of concern to the school. However there were also reports of situations where the consultant introduced staff to issues which had not really been seriously considered but which then became a focus.

> The staff from this school were blown away from this guy and the way he communicated his message and basically he was an AP in a secondary school, assistant principal in a secondary school. So he often had to deal with discipline and welfare issues, boy problems, and he sort of sold himself as that, after 30 years of teaching he finally worked out what you needed to do. And he said that leadership was the main ingredient, boys are always looking for a leader, the classroom teacher is going to be showing that leadership or someone else within the classroom is going to be showing that leadership. (J/RPO)

Again, however, the value of such consultants depended on the particular needs of individual teachers. There were negative comments about some of the work done by external consultants in that the ideas were seen by individual teachers to be lacking relevance.

> When I first started as a teacher, pd used to be 'done to us', and I know I became very cynical about it after a short period of time, especially if I didn't see the relevance of it. As I said earlier, a lot of it for teachers is whether it's going to make life easier. One of the things I remember was classroom management, a whole lot of things, and

maybe one or two rubbed off on me, but a whole lot of it wasn't relevant, wasn't going to work for me. (P/B)

A number of teachers criticised this approach to PD on the basis of its lack of embeddedness in school planning and implementation processes. The issue of motivation was also raised with teachers arguing that unless there was follow up it was likely that much of the value would be lost.

> ……poverty education, she was very, very good. But once again, following that all the staff said they enjoyed, they enjoyed the day, and yes they all got a little bit of… sort of knowledge and information out of it. But once again, when it had finished, she'd gone and there's no follow up. In terms of um… staff being able to follow through with questions or possible activities and that type of thing. And that's when we stopped our cluster days. (J/M)

> It's fine to have a professional development person, and you all nod and say that's okay, but then there's no pressure on you to implement change. But if you know that that person is going to come back in three months time and say "Well we did this last time; what have you done with it?", there's a little encouragement to persevere with change. (S/RPO)

The data indicate that consultants can have their place within a professional development program but the success of using them will depend upon the acceptance of the consultant by the staff, the relevance of the topic to the staff, the arrangements made for the implementation of the ideas, and the necessary follow up. In a working environment where the teachers feel under constant time pressure there will be no appreciation of the use of consultant who is not able to add value in the short term to the work that the teachers are doing. The work of such consultants is most valuable in association with ongoing action at the school.

Visits to local schools

Visiting other schools was nominated by principals and teachers as an effective means of providing relevant professional development.

> I'm also very comfortable with teachers, teaching VCE for the first time, or even teaching junior subjects for the first time. They come and see me: 'Oh, look, there's a teacher over in L. who's got a program or whatever.' 'Okay, when do you want to go? We'll provide you with CRT replacement, we'll support that.' Because, I think that's a great professional development activity. Because… the expert is so close and you start to build a relationship with the person. You call them up: 'I'm having a problem here.' They're there for you. (Principal/ M)

However there are practical impediments to this.

> It's often suggested "Why don't you go and have a look what they're doing in H, or in N?". But, in practice, you can't do that. It's all well and good to say that, but like I've got two VCE subjects this year and we don't have hundreds of CRT teachers available here. If I go and say 'I'm taking the day off next week to go to… whatever'. It just doesn't always work. In time I'm quite sure that if you pushed it a little bit, they'd give you the time off to do it. But then you don't always get a qualified teacher to come and replace you. So, if I leave my year twelve IT class, they would just flounder for the whole time I'm gone. So you just can't take those days off. (L/E)

It would appear that, if the practical issues which limit the use of this strategy can be overcome, there is support for this approach to professional development. It would appear to be of particular importance to secondary teachers in small rural schools because they have limited people with subject expertise in their own school. However,

these are the schools where the practical problems such as finding replacement teachers are very significant.

Whole school staff in-services

There is a great attraction for the leaders of small rural schools in having topics around which professional development can be arranged for the whole school staff. At the time of the study there were a number of initiatives from the State department which lent themselves to professional development activities in which the entire teaching body could be engaged. Most significant amongst these were VELS and POLT which have implications for teachers across the entire curriculum. In addition there were topics such as 'bullying' and 'the education of boys' which also have implications for the staff collectively and individually. It is not surprising therefore that the leadership in each of the schools visited used whole staff in-services as a significant professional development strategy.

> …like most of our professional development would be done on site in those big areas, those big government issues that are going on. With all the teachers in the computer room the other night, we pushed that and gave them some information first hand to get them started and get them going. (R/E)

> I think everyone needs more training on it (VELS). And I don't know if it's just I've been out of the country for two years, but even when I ask people, it's not that clear when they explain it. I think they're quite good but for me they're a bit too like wishy washy. (G/Y)

> Yeah, because I guess what I was thinking was that in past years my professional development focus has really drifted away from the subject. Just it seems to be more emphasis, more pressure to be looking into things like POLT and student management strategies and what have you. So I guess the last five to seven years I've found that the professional development focus has been much more methodology sort of based, rather than subject specific-based professional development. (R/M)

Primary schools would appear to be more successful with whole-of-school professional development activity as generally each teacher is responsible for all curriculum areas and within primary schools there is greater acceptance of integration of studies as proposed in the VELS documentation. The primary schools visited showed impressive use of whole-of-school professional development and learning focused on student learning across the curriculum, and systemic implementation. In many cases this revolved around internal planning processes.

> We team plan together which gives a day to plan together at the end of each term, and we put down what we're going to do for a term and where we're going to go. The planning's got quite good actually, even with maths. So, we've since done that and changed over from CSF to VELS. We've slightly changed our planning since that in-service as well. I think you do change and I think with us it's been a trial and error. We keep changing it as we find what works. (J/N)

Some principals encourage staff to use the internet to further the professional learning of the whole staff.

> I know a colleague of mine who starts every staff meeting with a reading or discussion led by a staff member. For the teacher, it's a chance to get on your own soap-box. When it's your week, you can present a short paper, which you could have got by jumping on a blog somewhere, and pulling down the discussions, whatever. So it's a chance to say "Here is some professional reading I'd like you to do, and for ten minutes, I'm going to lead discussion on that reading". So every staff member is

> timetabled into that, and it's now embedded into that school's culture. And it's only ten minutes. You know, it's supposed to be an A4 page, not 3 or 20 pages: "Here's a brief reading, and let's discuss how that impacts on our school." It's a way of getting the bigger picture, the wider world of best practice, without having to drive 100 km. (S/RPO)

There are indications however that sometimes whole staff professional development is seen as utilising time which could be better spent in developing expertise in a more personally relevant field.

> At the moment, there's some talk for us to do some PD in regards to ICT. I've been asked along with another person to maybe do a five-day course. ….And then we'd have to teach ten other people. I don't mind the idea, but the truth is, I would much prefer to hone my own skills in Physics, or spend time learning to be, like learning techniques to teach differently. (R/Y)

The evidence is therefore that whole-school in-servicing is a much used strategy in the schools visited but that a number of teachers questioned its relevance for themselves, given the limited PD resources available and their need for professional learning of greater personal relevance.

Discipline based activities eg. Key Learning Area (KLA) meetings

Meetings of staff engaged in teaching each curriculum area are part of the ongoing life of secondary schools. The activity is viewed as professional development for the staff involved. The comments of the teachers interviewed indicate that these meetings meet many of the criteria for effective professional development activities, for example,

- teachers can progress their own learning through reflection;

- there is benefit in working in teams to develop and reflect upon lessons; and

- teacher learning has been found to be more effective when spread over time with opportunity to put ideas into practice then reflect on this rather than when provided in 'one-off' sessions.

> We do probably use our science meetings in many ways as an informal PD, because we all raise issues. We're currently writing a new unit. That gets discussed at science meetings…when someone's picking up a new subject, then a lot of that involves a lot of informal PDing. (K/M)

> So we have our KLA meetings. Every three-four weeks, whenever the science meeting, where we all get together and… discuss… the new initiatives and get things rolling. We're - one good thing about the science department here is - always looking at our curriculum, and making sure it's relevant to the students that we're teaching at the moment - their interest, make sure it's up to date and current. That it's, you know, you talk about situations and examples that they know about - that are actually affecting a lot of their lives, so… [We're also] Identifying your strengths and your weaknesses, formulating plans of action, and so on.

> It does [work] because … I mean… I find myself personally, probably the biggest area that I lack in, is actually getting feedback from my students. You sort of run out of time sometimes, especially at VCE. You're so determined to get them through the course and get them ready for the exam. But, it's been good, coz that's what we've been focusing on at senior science, is to get feedback from our VCE students. I've got nineteen at the moment. Yeah, definitely [with nineteen you've got to organize it], so the survey's have been good. They've given me a lot of feedback on areas that I now know I'm doing quite well. (P/M)

A significant issue for Heads of Science at small secondary rural schools is the dependence upon staff whose first curriculum area focus is not science.

> The only concern I have with the KLA team, is probably one, a couple of staff that are mostly Maths, so then they don't get the opportunity to really come to our KLA meetings and sometimes I think they're falling behind……I mean, we still have a strong team with the three or four that are left. But to have that extra person would mean you knew they were doing the same sort of work. And they'd share resources, and they could present their lessons on the projector, and have high quality lessons. (R/Y)

The interviews revealed that in the secondary schools the KLA team meetings meet many of the criteria for effective professional development as there is ongoing activity with the opportunity to try ideas in the classroom and reflect on the outcomes with colleagues. The fact that in small schools teachers are likely to be teaching in several learning areas and so are unlikely to be so intimately involved in each of the areas does place some limitation on the effectiveness of this form of professional development activity. It is likely that the people who miss the activity because it is not their main teaching area are those who could benefit most from the professional development opportunity.

One of the advantages of subject specific, school based PD, as described in the quotes and commentary above, is that it is built around a focus on curriculum planning and classroom approaches to teaching and learning which can be trialled and discussed as an ongoing learning process. For primary schools this school based, project based PD can involve the whole school, but for secondary teachers it is necessarily restricted to staff in the disciplinary area.

Staff member initiated professional development

The interviews revealed a significant level of professional development activity initiated by the staff members themselves and that such initiative is encouraged by the school leadership.

> I guess it's not a formalised teacher-learning process as such, it's a teacher led and teacher directed own personal learning that they take on themselves, and the staff certainly work well together in that sort of process.(Principal/O)

The activities described ranged from the very informal, such as corridor conversations about teaching/learning issues, to undertaking formal education programs. While there is no single pattern emerging, the teachers interviewed were conscious of their need to continue to learn and their personal responsibility for that learning.

> Let's say for a start I'm extremely choosey about what professional development I go to: some of them are not productive. Basically, I go expecting to learn something new, and in the end, to some extent I already know what they're telling me. I find that quite common. I find the best ones are ones I can pick out and target myself. That's generally going to see other teachers in other schools, or other subject areas. It's not the large conference things. (J/B)

> …. probably every five years or so you're looking for a new challenge. You sort of take something on. You get on top of it to some extent, well hopefully you get on top of it. And you look to the next challenge. And, I think that sort of revitalises you in the classroom. Otherwise you'd get pretty stale, so I guess that's been sort of the prime objective, and then of course you have the interests and the needs. (C/M)

> I took three years leave without pay and worked around the district, around Victoria and went to various schools on short term contracts and so on, which was good. And I see that as PD. That was a big thing for my professional learning. (M/Y)

Conversations with colleagues

Throughout the research, interviewees commented on the importance of conversations with their colleagues. While meetings, both of whole staff or key learning areas, facilitated conversations, many commented on how valuable conversations were often "catch as catch can" chats, in corridors, staffrooms, or classrooms. Such conversations were often needs-based and focussed on finding solutions, for example, to a current learning situation or a practical challenge.

> There's a couple of very good maths teachers in this school. I don't see myself in that light, but …… we have lots of discussions about, you know, how it's taught, and what are good things to do. If I have a difficulty, I go to X and say: 'Look, you know, I'm not doing this very well, or what would you suggest, or the kids seem to be having a problem with this or a misunderstanding'. So I think we do have conversations. (L/G)

There is recognition that in rural schools with limited staff numbers there is not necessarily the range of experience that there is in bigger staffrooms. As a consequence advice is sometimes sought from colleagues at near-by schools, family, members of the community, or from others further afield via email. Closer relations established through system/state/national initiatives have supported rural colleagues by helping develop wider networks.

> But, my own development's always been conversations with people across a broad range of learning areas. Probably [works] not as well here as this is only my second year here. Probably not as well here as at T, where I worked before, mainly because most of the staff here are a similar age, you deal, I deal with my learning area. Whereas in T, … you seemed to have a, there's certainly a bigger spread of age groups in the staffing. And just teaching ideas, new ideas coming from younger staff helps. (P/M)

> I'm also very comfortable with teachers, teaching VCE for the first time, or even teaching junior subjects for the first time. They come and see me: 'Oh, look, there's a teacher over in L who's got a program or whatever.' 'Okay, when do you want to go? We'll provide you with CRT replacement, we'll support that.' Because, I think that's a great professional development activity. Because… the expert is so close and you start to build a relationship with the person. You call them up: 'I'm having a problem here.' They're there for you. (Principal/M)

> My Dad's a scientist too, so I speak to him sometimes about scientific issues... (D/E)

> Then there's email to a teacher: Look I'm doing forces and I'm having trouble; I need something that's a Wow! Have you got any ideas? Yeah, and having trade experience, I've worked with people in the community. (D/E)

The evidence gathered suggested that there are both advantages and disadvantages of working in schools in rural areas. There appears to be a strong sense of community amongst the teachers, which facilitates open discussions about professional matters. However, on the down side there is a reduced range of people with whom professional conversations can be initiated. This latter issue seems to be more significant in the secondary schools where teachers often do not have opportunity to share expertise with people in their specific discipline.

Undertaking formal qualifications

There was a perception by some that formal degree programs could contribute to professional learning.

> I'm still going, doing a Master's in Education. And I'm doing a Graduate Diploma in Hazard Management, Health and Safety, at the University of B. It's all summer school. I do one unit per semester. I'm working on leadership, the Sergiovanni model, which has five categories and all of my PD has to link into those five categories, and at the end of five years, I'm able to go to tick tick, tick, tick, tick, so everything fits into a plan. You know, I want to be a leader; I want to be part of the leadership team….(D/E)

However, very few teachers mentioned this as a category of professional learning. The opportunity to complete formal qualifications would appear to be of limited significance to the teachers interviewed. This may be related to the isolation of the schools.

Use of resources for personal professional development eg. books, internet

The teachers identified ways in which they personally draw upon available resources such as books, journals and information on the internet to build their professional competence.

> and because you're isolated … you tend to get in lots of books or ideas out of lots of books……so when I go to conferences I pick up the pamphlet, have a look around at the resources and thinking 'What is there available?' (C/E)

Information technology has changed the sense of isolation for many teachers.

> Look the beauty of technology now is that there really are no isolated schools anymore. Just every school in the region now has got a 2 meg. pipe and so they can have access to emails, whatever is on the internet instantly, so there's no sense of isolation anymore. (C/RPO)

> So there's that sort of side of it as well that needs to be improved. There's a lot of internal professional learning. Yeah ICT that's my interest, I'm not very good at it I don't think, still a lot to learn. But I love it. (J/O)

Lack of familiarity with the technology is still a barrier to the use of the internet for such purposes by some teachers.

> I haven't used online as much as I should. I know other staff, they're there. It's just the time factor. And, I suppose I haven't been brought up with the internet. I haven't used it as much as other people. Not as technology. I found you can waste a lot of time. ….I probably don't use it as much as I should. (C/E)

While there is recognition of the internet as a potentially valuable resource for professional development there are still barriers to its effective use. One is the lack of expertise in its use amongst some staff members. Further, as will be detailed in the final section, there is a lack of the necessary technical support in rural schools.

Teacher professional learning for rural communities and schools

The findings to this point have indicated the context in which the schools were developing and implementing their professional development programs, and the range of strategies being employed. In this final section we present the issues which emerge as impacting on the provision of professional development for teachers in these rural schools.

Availability of relief teachers

This was a major issue raised by those interviewed, particularly the secondary school teachers. The lack of availability of people able to teacher senior secondary school science, ICT and mathematics significantly reduces opportunities for teachers working at this level to participate in professional development activities which fall within school time.

> But then you don't always get a qualified teacher to come and replace you. So, if I leave my year twelve IT class, they would just flounder for the whole time I'm gone. So you just can't take those days off. (L/E)

> ….probably the other disadvantage is recruitment… of staff. … availability of CRTs, so that you can release people to do professional learning. (J/Y)

Distance from centres providing professional development

This was an issue often raised by the study participants. There was frequent reference to the fact that so much professional development activity, such as the annual conferences of the Science Teachers Association of Victoria and the Mathematics Association of Victoria, is conducted in Melbourne. The study participants raised a number of implications of the distance from centres where professional development activities are happening. There is the obvious one of the cost of travel and accommodation. However, the time factor away from family was also mentioned as was the risks associated with travel at night in regional areas.

> And we can send a few people to that, but it's going to cost $200-300 for the conference, and two CRT days is another $450, plus transport and accommodation: it costs over $1000 for one person. And that one person by herself, you know, has a good time, but one person by herself can't change the school. (S/RPO)

> I mean, professional development in science is really only conducted in Melbourne. And those opportunities are less and less available. ….And to get to Melbourne is a fairly hefty drive, and I understand why no-one does it, why only beginning teachers go. (B/B)

> Travelling late at night there's always the worry of hitting a kangaroo. Yeah there's kangaroos out here, and even one kangaroo can damage your car and kill yourself, so it is a worry. (R/E)

> You just cannot be going to Melbourne for three hours. And that's why I'm doing my master's in education. I'd have liked to have done it in leadership, but they don't do it in blocks, its three hours here and three hours there, and I can't get to that. (D/E)

The size of the schools

There are a number of matters which arise from the size of the school. While, as has been referred to earlier, the data suggested that the friendly, positive climate within the smaller school aided learning from one's colleagues, and the nature of the student body made on-site professional development possible, there are less desirable aspects of being a staff member in a smaller school. There is, for example, greater likelihood that secondary teachers will have to teach outside their fields of expertise.

> Trouble with a little school too, we'll sometimes have teachers who aren't in their area of expertise, but if they're a good teacher they sort of learn with the kids anyhow. Do you know what I mean? (R/E)

Again, since the schools attempt to provide all that larger schools offer to students the tasks that need to be done are shared amongst a smaller group of people and so each

person bears responsibility for a number of aspects of the school's life. Teachers will commonly be required to carry responsibilities early in their career, for instance subject co-ordination, which would not normally be expected at that stage of their career.

> Um, ... other disadvantages in a small school are, I think more and more it's hard to be just a teacher, it's hard to just do your job, you're expected to do more. Like, for example, you know, network administration person, year ten coordination, and still teach twenty lessons a week. Um, and there's others in the school that are doing similar things. You know, I'm not by myself. So... more jobs shared amongst smaller amount of people, which is an advantage for new people, for the experience, but a disadvantage ... um, because the more years you teach the more and more you're expected to do. (M/Y)

> Again, because we're a small school, everyone has an extra responsibility, so everyone's pretty busy. (P/B)

However, the multiple responsibilities, while widely acknowledged, were also portrayed as a positive for staff as they have the opportunity to learn from these positions of responsibility, an opportunity that they would be unlike to have in a large school.

> Yeah, I mean, it's good being in a small school to get these opportunities. If I were in a big school, I'd probably be a teacher concerned just with my own. And I suppose in one way, you'd spend a lot more time with your own preparation and assessment. (S/B)

In smaller schools, although the climate may be supportive and friendly, there are fewer people with whom teachers are able to interact at a specialised professional level.

> I think that it's a small school, like this is an advantage and disadvantage, but you don't have a lot of people to bounce ideas off. (G/Y)

Small schools obviously have less physical resources than larger schools and this can impact on the experiences of the teachers and the students. As one of the RPOs commented:

> I think financially, they just don't have the equipment for starters. So whenever you talk about (professional development activities) the first question to ask is 'Oh do you have any funding?' Cause quite often when you come in with a box load of sort of junk, they still see it as a difficulty, whether they want to buy all this stuff etc so that's one of the big issues I think. It's simply resourcing these things. (L/RPO)

Competition between schools

A matter raised by only two of those interviewed was that of competition between schools which are relatively close together having a negative impact on the degree of co-operation between schools in various areas including the provision of professional development.

> They'll ring me and say can we do it, and you spread the word around a little cluster of schools. Instead of having 3 teachers there, you might have a dozen. There's already a great camaraderie among them because they are so far apart they're not really competing for students and so they can cooperate well with each other.

> Often it's harder to get schools to aggregate their staff for efficient delivery of PD because they are together. I've got the classic example. We've got 3 schools within

> 15 kilometres of each other but can I get them together to share resources? No! (C/RPO)

Technology and technology support

A significant issue for the teachers interviewed was the provision and support of technology. This has implications for teaching, as the teachers recognized the quantity and quality of resource material available to them on the internet if they have appropriate equipment and technical support, and for professional development where again they realize that, given the right circumstances, they are able to access professional development from the internet.

> There's great resources out there. But, I think, you almost have to go to pretty much all internet for your lessons. I think you have to make a conscious decision that you are going to try and target ICT, and have a lot of ICT in your class. Then do you have the facilities? Do you have a projector and everything? I find that it's just a fairly big thing to do properly. I certainly do use a bit of computer in showing them animations, but not probably as much as I could. I just think it's just more work and the course is tight. Unless it's already there some way and easy to access, I just think it's a lot of hard work to get these lessons up and running. (R/Y)

Technology support people are more often than not multi-committed people with full-time teaching loads, or serving several schools, or having other school responsibilities which mitigate against helpful support.

> I'm not even sure what our time allowance is for our lab technician, but our lab technician is also the camps person, that goes on all camps and excursions. She's great at her job. But, it's been two weeks. She's been out for the whole two weeks kind of thing. And then if they need her in the library, she has to go to the library. I just find that sometimes it'd be nice if ... you know, we could... (G/Y)

> Everyone assumes that you know how to fix it or do something with it. You might be their computer technician. So, you look after the network, but you also look after, well we've got a hundred PCs here and we've got fifteen or sixteen whiteboards. I'm not really sure the number now. And, fifteen or twenty scanners, half a dozen printers. And, the expectation is that you can not only operate them proficiently and show everybody else how to operate them, but that you can also repair them and maintain them and look after them and do all that sort of stuff. (L/E)

> And, I think coz everyone has basically played with a computer, that they, that they think they've got an appreciation of what's involved in it. And I don't think they really do. Oh, teachers will often say 'Oh, can you burn me off a couple of discs of…' 'I need it, it's a text we're using for VCE.' It might be a media study on something and they want a film copied three times. And I dunno if you've ever burned a DVD? It takes a long time……I do pretty well every lesson preparation at home. I do all my correction at home. Because I don't get any time here to do any of it. (L/E)

> We've got a technician who's been… he didn't know much about it, he certainly has tried … He's just a technician that's contracted out and we get him for two hours a fortnight. And we share him with W, the other campus. So it's a pretty full on…Yeah, it's a hard one. It's beyond me….some of the stuff that he does. Um, I can help. I'm not, I mean, they say, they joke that I'm the guru, but really I know very little more than what the other girls do. (L/G)

> So the expectation is that I run PDs after school to show everyone how to use it. Least it's okay, but, then there's no PDs for me to show them … for showing me how to do it. Yes, so you just, you just do it. (L/E)

In order to keep up-to-date schools often go ahead and purchase ICT equipment/gadgets without any consideration to any professional development, let alone quality professional development:

> I think with technology and learning, there's a lot more emphasis on acquiring gadgets. And that, um, and, there's gotta be more emphasis on quality and PD for staff…..I did read, um, someone who'd done some research into technology and he said nearly everyone makes the same mistake. You've got $100 000, you don't spend, say, $30 000 of it for PD, because for $30 000 you can buy another twenty computers. So you buy the computers. But you still don't train anyone how to use it. And they, everyone seems to have it around the wrong way. (L/E)

The demands of the job can leave little time and energy for elective professional development activities

> I just missed that the TEAC conference last week, which was disappointing because I've never missed it. The school-community was busy with education week and I had a lot of visitors coming in. Again, using the outside community, I had a wood turner from the wood guild came in and demonstrated the wood lathe. And with food, we brought the kinder kids and the Year 7's mentored them. They took one student each and taught them how to cook, and they all made healthy snacks and then we had a big party. And not an additive or coloring or, you know, in place. It was a very positive day. You have to weigh up. I've missed my PD, but…. I have my networks and they all rang me and said why weren't you here, and they sent me some of the presenters' notes. And if there's anything that takes my fancy I'll get in contact with that presenter, and maybe there'll be another PD to do that. (D/E)

> And just a comment, during my teaching rounds it didn't strike me that teachers are interested in it. Yes. It was never brought up as such. And it didn't strike me that they were interested in talking science outside of school. And I now understand why. It's too hard a task you know. You're just exhausted. If it wasn't such a taxing exercise, then you might be little more willing to offer up time to establish that sort of network or contribute to it, or participate in it. (B/B)

Discussion

Trends in professional development provision

This particular study was not intended to present a comprehensive picture of professional development issues for teachers of science and mathematics but rather, as part of the broader SiMERR project, was designed to identify the specific needs of these teachers in rural and regional schools. It is informative therefore to begin by comparing the findings of this study which looked only at schools in rural areas with those findings of Kenway et al (1999) who, as a result of an extensive research project in Australia looking at the issue of teacher professional development, suggested that schools now operate in environments characterised by:

- various modes of planned decentralisation, that is, there is no single or pure model of devolution,

- a proliferation of different types of provision and providers,

- scarce funds and multiple demands for and on such funds,

- the fact that market forces and choice are constrained by state priorities and guidelines and by different levels of resources in different schools,

- an intense push for schools to use new information and communication media, and

- the enhanced role of the school principal in guiding teachers' professional development.

In relation to the first point made by Kenway et al (1999), in the schools visited it was evident that the professional development activity, although significantly influenced by state priorities, was decentralised being determined largely by the leadership of the schools and the individual teachers within the schools. While the school system made it clear that schools were to take up VELS and POLT and other initiatives, the ways in which schools responded to the professional development demands of these requirements were quite varied. It does not appear that distance from the head office is the reason for schools being free to respond in their own way: the local arm of the system head office, the Regional Offices, were providers of professional development support on request rather than managers of the process. The system looks to the school leadership to take responsibility for the professional development of the staff within that school.

The second issue made in the Kenway et al (1999) report indicated that education systems were operating in such a way as to throw up a proliferation of different providers of professional development. While reference was made in this study to a range of providers there was not a lot of use of their services in these schools. In part, this would appear to be related to cost. A number of the interviewees indicated that the cost of private consultants was too great for the schools to be able to use them, partly due to the distance of the schools from Melbourne. However, a more significant factor appeared to be that frequently school personnel saw the use of external providers as inappropriate because follow-up, critical to the success of any professional development activity, was not easily arranged. The overall impression gained was that in most cases schools were not only taking responsibility for determining the purpose and focus of the professional development but were also carrying out most of the activity using their own resources.

The issue of funding, the third issue raised by Kenway et al (1999), is a critical one for these schools. The interview data indicated that cost was a major determinant of what professional development activity was undertaken. For all professional learning activities, apart from those run by the schools themselves, these schools appear to be at a disadvantage to those in metropolitan areas. Attendance at seminars and conferences becomes much more expensive due to the costs of travel and accommodation, and to bring experts to the schools is also much more expensive for the same reasons. Teachers indicated that the limiting funding available forced them to make choices which meant that they were not able to participate in some programs which they saw as important for their own professional growth.

The fourth claim of Kenway et al (1999) is that state priorities and guidelines and different levels of resources in different schools constrain market forces and choice. Both of these factors, as has already been argued, do influence decisions and limit choice. However, the data point to the finding that school leadership responds as best as they can to these challenges and exercise a great deal of initiative in attempting to provide appropriate professional development for staff. Further, many of the teachers themselves, although recognising the constraints, were overcoming the constraining factors through their own initiative.

Kenway et al (1999) claim that generally there is an intense push for schools to use new information and communication media, and this is certainly true for these schools where the possibilities of the technology to contribute significantly to both the effectiveness of the school and the professional development of the teachers is recognised as even more significant than for metropolitan schools. However, while the study has illustrated some ways in which the technologies are contributing to teacher professional growth, the more significant finding is the extent to which insufficient technical support limits the positive contribution that it could make to these school communities.

With respect to the role of principals, the findings of this study are entirely congruent with that of Kenway et al (1999) that the school principal is a critical figure in guiding teachers' professional development. In each of the schools visited the principal was shown to be providing the main leadership in determining the school's approach to professional development.

Thus, when the findings of this study are contrasted with those of a broader study it becomes clears that there are some distinctive issues which our study has identified for schools in rural and regional areas. These relate to the constraints imposed by distance and accompanying expenses, lack of technical support, and the contraints imposed by size which affects the ability to form a vibrant, discipline based professional community. The findings suggest that, while teachers in these schools do enjoy some benefits there is a need for special provision for these schools to assist them to overcome the unique issues they confront.

Subjects and subject cultures and their role in rural professional learning

Consistent with other research, this study has shown that subjects and subject departments act as the locus around which secondary teachers will gather, collaborate, develop identities, and support each other (see, for example, Darby, 2008; Siskin, 1994; Stodolsky & Grossman, 1995). In particular, teacher identity is grounded in their knowledge and appreciation of the subject. At the same time, their view of the subject is linked to their knowledge of what it means to teach it. As knowledge of how and what to teach grows, so does teachers' confidence and sense of themselves in relation to the subject. A socio-cultural framing of identity describes teacher identity not as fixed, but as an ongoing process of becoming (Beijaard, Meijer, & Verloop, 2004) and where context plays a crucial role (Beijaard et al., 2004; Connelly & Clandinin, 1999). The modern self, according to Giddens (1991), "is not something that is given…but something that has to be routinely created and sustained in the reflexive activities of the individual" (p. 52). From this perspective, the becoming of a subject teacher is a continuous process of identity construction that takes place as the teacher interacts with and reflects on their professional and personal experiences. Participation within a range of discourse communities is therefore vital, but this can be difficult in rural locations.

The problem specifically for the "untrained" or developing mathematics or science teacher is, therefore, not simply a lack of content knowledge, but has to do with how they are supported to develop a sense of self in relation to the subject. Efforts to improve mathematics and science teaching should be premised on the understanding that an aesthetic appreciation for the subject is a critically important adjunct to developing conceptual and pedagogical knowledge. It is therefore imperative that teachers have access to professional learning opportunities that focus on subject-

specific renewal and support. The implications of teaching in rural communities make this imperative even more critical, given the limitations on the variety of professional learning opportunities available, including contact with colleagues who might assist teachers in understanding the content, practices, values and artefacts associated with the subject culture.

Teacher professional learning as participation in discourse communities

There are other ways in which the unique issues that rural and regional schools must address can be explained. We suggest that they can be more clearly seen by proposing a model of teacher discourse communities as the framework from which to consider teacher professional learning.

The key point to be made in presenting this model is that professionalism is invested in the teacher, and each teacher during their professional life will strive to grow within their profession by continuing to learn the ideas and practices underpinning it. These ideas and practices are fundamentally situated in the discursive practices of science and mathematics teachers, which shape and draw on developing thinking in these specific fields, but also draw on discursive practices within the discipline itself, within school education more generally, and within the community regarding schooling. Figure 1 suggests that teachers need to be part of three distinctive but important discourse communities if they are to function effectively and grow professionally.

Figure 1:

Teacher professional learning discourse communities
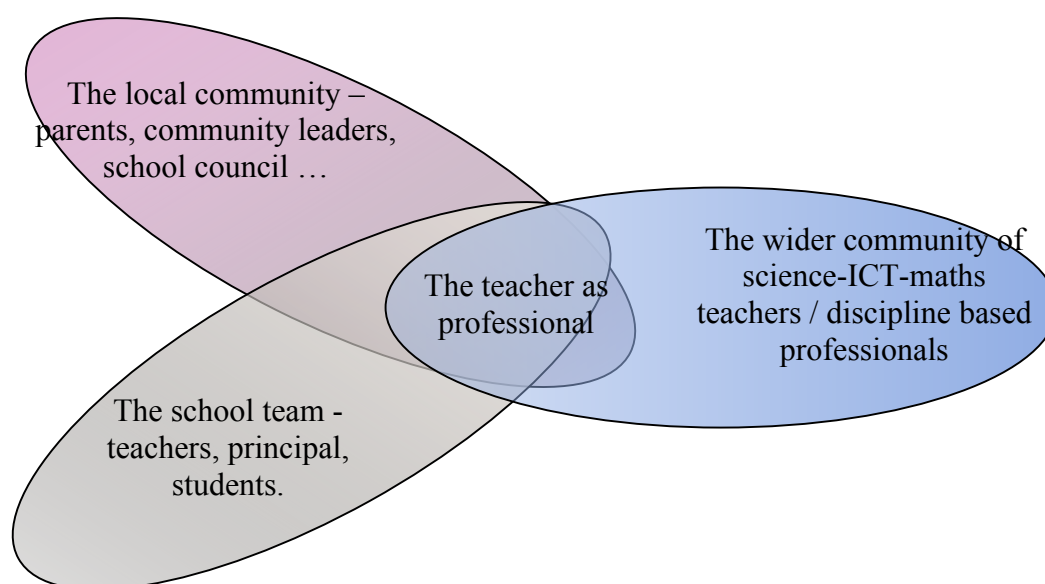
The school community is central to the teacher's life. Early in their career it is important that teachers have access to mentoring from colleagues within the school. Further, the ongoing discourse within the school community will be important in ensuring that the teacher develops expertise in many of the abilities required of the effective teacher. In general the schools visited for this study had a climate that supported mentoring activity. The only constraints would appear to be that the number of colleagues within a school may be quite limited and, for secondary teachers, the restricted range of expertise within the school.

However, it is imperative that the teacher has access to the community of professionals sharing their discipline base. Opportunities to share with colleagues through professional associations, such as the Science Teachers Association of Victoria or the Mathematics Association of Victoria, or on a less formal basis through the internet, are important for professional growth. As indicated earlier, prior research has led to the recognition of various forms of knowledge to the effective teacher. Most of these, for example knowledge of learners and their characteristics, or knowledge of educational ends, purposes, and their philosophical and historical grounds, are common requirements across the teachers within a school. However, this is not the case for all teacher knowledge. It is recognized that pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, will require teachers to interact with others working in the same discipline field. This is a particular issue for the teachers in rural secondary schools. In the primary school each teacher was expected to have the requisite pedagogical content knowledge.

As has been illustrated by the data, it is more difficult for teachers in the rural secondary schools to maintain this dialogue. Within their own school there is a limited pool of colleagues with the same specialisation. Also, as been demonstrated, there are significant barriers, such cost and finding replacement teachers, associated with

attending the seminars and conferences where teachers are able to communicate with their professional peers. The internet does provide an important avenue for such dialogue and, as the data has shown, teachers do utilise the opportunities that exist. It is important that thought be given to ways in which the technology can be used more effectively to meet this need.

Crossing the boundaries between subjects can be seen as a cultural border crossing for teachers (Aikenhead, 2001; Aikenhead & Jegede, 1999) in the same way as it is for students. Negotiating this boundary can be difficult for the out-of-field teacher who has limited background and aesthetic understanding (Darby, 2008) of teaching the subject. Unfortunately, for some of these out-of-field teachers, there is limited access to people who might be seen as *culture brokers* (Stanley & Brickhouse, 2001) who play an important role in assisting them with their border crossing. The head of department and other subject teachers may assume this role, but some teachers receive little support, particularly in small schools in rural and remote locations where there are no other teachers to participate in subject-specific professional dialogue or where professional development is not readily available or only deals with generic teaching and learning issues.

Some of our other research (Tytler et al, 2008) has increased our awareness of the possibilities of teacher development through discourse with the local community. Our studies involving school-community linkages around the school science program has shown how teachers have learned a great deal from scientists, engineers and technical officers practicing in the community, or from university colleagues, when jointly focussed on providing meaningful learning experiences for students. For example, in an ASISTM project it was reported that one of the teachers had mastered the techniques used by the scientists who were assisting with the project to the extent that he was able to take over the activity and had become a leader for the schools in their science program. In the present study one of the teachers referred to the extent to which she had grown professionally through her involvement with people outside the school system. However, such activity, and consequent professional learning, was not widely reported in this study. This third discourse community, we would suggest, is potentially powerful for teachers in rural schools but is at this stage underutilised.

Teachers draw strength from their different discourse communities, and in rural areas particularly these need to be recognised and built upon in conceptualising professional learning provision. Attention needs to be paid to developing these communities within the school and local community, and across networks of schools.

Conclusions

This research has addressed the questions posed at the beginning of the study. It has described a great variety of approaches through which professional learning occurs , many of which have particular strengths or weaknesses in rural settings. It has exposed a range of issues that are very significant for rural and regional schools and which need to be addressed. The remedy for some of these could be found in an injection of funds, for example to meet the costs necessary to provide greater access to conferences and seminars in Melbourne. Others, however, admit to no such straightforward solution. For example, if rural schools are not able to find replacement teachers so that staff can participate in during-term activity off-campus, what alternative forms of arrangement can be made to enable them to continue to enhance their pedagogical content knowledge? Increased networking, and greater use of

modern communication technologies is one possible strategy to address this issue. We have proposed an increase in school/community linkages as one way in which this can occur. There will not be a single answer. However, we believe that our study has identified this as a critical issue for school systems to address.

The study has particularly pointed to the tension between generic foci for professional development as against more subject specific foci, and the way this is a particular issue in small rural schools where there does not exist a critical mass of subject specialist teachers. It argues that more attention needs to be given to subject discipline based professional development particularly given current and looming shortages of these teachers in rural schools. The importance of subject, and subject culture, as the backdrop to the sense of professionalism of secondary teachers, is discussed as a critical framing of this issue for science and mathematics teaching in Victorian rural schools. Given the increasing incidence of teaching out-of-field associated with the difficulties in attracting teachers to rural and remote locations, further research is needed on the nature of professional development schemes that meet the subject-specific needs of such teachers in rural areas.

Where there have been instances of well regarded professional development in science and mathematics, these have been the results of special initiatives focused on these subjects as a matter of policy priority. Examples include the School Innovation in Science project and its offshoots, and the ASISTM initiative. There is a need to continue special PD initiatives like this if science and mathematics subject teachers are to access the particular knowledge and skills and orientations, based on research into best practice, that constitute the best elements of the subject cultures. In the absence of such policy support, schools and teachers are dependent on local initiatives, competing with a range of other priorities which tend to dominate PD planning.

Importantly the study has drawn attention to a set of schools which, while disadvantaged in some ways, as reported earlier, have leadership that is extremely professional in looking to meeting the learning needs of the staff, both individually and as a group. Further, within the schools there is a climate of support and a range of opportunities that allows individual teachers to grow professionally. This is a story which has importance for the recruitment of teachers to rural areas and should be widely shared.

Finally, the study has revealed that many teachers in these schools have a strong sense of professional identity with capability, giving appropriate support and resources, to plan and manage their own professional learning. It is in the interests of the system that they have every support to do that.

Implications

The study raises the following questions addressed to school systems and professional organisations: Are teachers of science and mathematics being given adequate opportunity to meet all of their needs for professional development? The findings suggest that amongst secondary teachers in particular there is an unmet demand for professional development in the area of subject-specific knowledge.

Do professional associations and other providers of professional development for science and mathematics teachers pay sufficient attention to the special needs of teachers in rural and regional schools? Our study has identified the significant barriers

to the teachers in these rural schools participating in science and mathematics professional development activities mounted by professional associations. This needs to be a policy priority for these organisations.

Do teachers in rural and regional areas have adequate technical support to enable them optimally to use technology to aid their professional development? Our study suggests that, while technology has great potential to reduce the isolation of rural teachers from their professional peers, this very isolation reduces the availability of appropriate technical support. ICT resource provision is especially important for rural schools, and its provision needs to be a priority for education systems.

Do funding models for professional development take sufficient account of the issues faced by rural and regional schools in adequately meeting the professional development needs of the teachers in these schools? Our study suggests that special funding regimes and initiatives are needed to address the particular issues faced by rural schools in relation to professional development.

Finally, the study found that for these teachers there is an imbalance between system wide, school and individual PD agendas and that this was particularly the case for secondary teachers. The broader implication of this is that education systems need to plan policy and funding targeted at increasing rural teachers' engagement in the different discourse communities of Figure 1. Teachers draw strength from these different discourse communities, and in rural areas particularly these need to be recognised and built upon in conceptualising professional learning provision. Attention needs to be paid to developing these communities within the school, across networks of schools, and within the local community. We argue, first, that priority needs to be accorded to the community of discipline based professionals, and second, the local community can be the site of powerful professional learning within subject-based, school-community partnerships.

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Attachments

Attachment 1

A conceptual framework for interpreting teacher professional development needs

Phase	Knowledge and attitudes	Perceived pd needs	Possible pd strategies
Inexperienced	Limited knowledge of discipline concepts. Inability to appreciate issues concerning student conceptions, content specific pedagogical strategies, or curriculum coherence . Lack of confidence, and perhaps interest.	Provision of productive classroom activities. Development of content knowledge at the level of essential facts and concepts. Support and confidence.	Strategic use of activities and resources to introduce questions of pedagogy and develop content knowledge. Ongoing support, and encouragement of shared narratives, related to trialling of activities, to reflect on learning and teaching issues.
Developing knowledge	Growing knowledge of discipline concepts, but unsure of the relative status of ideas, or of a range of contextual applications. Growing interest and confidence. Growing understanding of how children's understandings develop in the area.	Consolidation and extension of practice. Greater focus on connectedness of content knowledge. Better understanding of children's learning needs, and appropriate pedagogical strategies.	Increased focus on activities that challenge ideas about knowledge and learning. Encouragement of narratives that focus on broad pedagogical strategies, and structuring learning experiences. Support for development of productive teaching sequences.
Experienced	Aware of key concepts and links between these, and of contextual applications. Perspective on progression of conceptual understanding. Connectedness between conceptual and pedagogical knowledge, and children's learning. More student-centred focus.	Refinement of knowledge and linking with pedagogical strategies. Support in development and extension of existing practice. Concern with whole-school curriculum issues, including links with other subject areas.	Sharing of narratives to extend pedagogical insights and develop pd agenda. Use of research findings to illuminate practice. Focussing of discussion on issues of learning and teaching, and of curriculum coherence.

Attachment 2: Segment of interview with one of the RPO's

Interviewer: *Are there other schools or clusters and in particular places that would lend themselves well to being a particular case study for examples of the way professional learning is undertaken in school……..*

You mentioned (…) .

RPO: That's a secondary setting.

Interviewer: *A community relationship with industry. And (…) the contact. Are there other sorts of examples?*

RPO: In primary schools in terms of the way they organise the professional learning of their teachers. (…) Primary School is a small primary school with say 8 to 10 teachers. They've got an ongoing commitment to continual professional learning. Yeah, a classic primary school with great vision.

Another one, a large primary school, would be (…) Primary School in (…) which is a school you know of 40 or 50 teachers. But they're highly organised in the way they're attacking the professional learning of their teachers.

A tiny little school, (…) Primary School, is a 3 teacher school. Very isolated but doing exemplarily work. And they're 250km inland, so yeah doing some really interesting environmental work and yeah some science with their wine making.

Now I'll just go and grab my book because I was making some notes yesterday on schools I was contemplating. …….