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

Submission to the Parliamentary inquiry into effective strategies for teacher professional learning, Education and Training Committee, Parliament of Victoria

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We are pleased to present this submission which draws on key findings from recent research and development that has been conducted by researchers in the Deakin Science, Technology, Environmental and Mathematics Education (STEME) group. This research has been funded variously by the Victorian Department of Education and Early Childhood Development, the Australian Research Council, the Australian Government Department of Education, Employment and Workplace Relations, the Association of Independent Schools of Victoria, and the national SiMERR (Science, ICT and Mathematics Education for Rural and Regional Australia) project.

Brief overview of the relevant research and development projects undertaken recently by the STEME group

A very brief comment about these projects will be provided here to give an indication of the breadth and depth of research and development which provides a framework for the issues raised and recommendations made in this submission. Some of the main foci and finding of these projects are included in these descriptions. References to the various publications arising from the projects are provided for those who wish to read further.

The School Innovation in Science project

The School Innovation in Science research project (SIS, formerly Science in Schools), which was run by Deakin for the then Department of Education and Training from 2000-2003 and involved more than 400 schools (Tytler, accepted for publication, 2007a, 2007b) adopted an approach to professional learning (PL) and school improvement built around science learning teams, with a strong focus on pedagogy. SIS was highly regarded and successful in changing teacher practice and also in changing the way science teams operated in schools. Prior to SIS, it was found that in secondary schools, teachers of science tended to operate independently in their classrooms and there was very little discussion of pedagogy. In SIS, professional learning was considered to occur through a range of mechanisms including team based development of practice, network projects, and individual workshop attendance. The success of the model led to its adoption in the Principles of Learning and Teaching, also developed by the Deakin team, and these are still in place in Victoria.

Middle Years Pedagogy Research and Development project

This project developed a pedagogical framework for describing effective teaching and learning in the middle years. A Deakin team worked with clusters of schools to develop an approach to PL through strategic planning within the newly formed Innovation and Excellence clusters. The project reflected a growing recognition that pedagogy is central to teacher PL and responded to a clear need for clusters to be given guidance in formulating improvement in teaching and learning.

Improving Middle Years Mathematics and Science research project

Research in the 'Improving Middle Years Mathematics and Science' project (Tytler, Groves et al. 2008) (IMYMS) has shown that there needs to be recognition, in PL provision, of the different cultures and needs of secondary and primary teachers. While the adage 'secondary teachers teach subjects, primary teachers teach children' has some cogency, as a plan for PL action through shared initiatives it has real limitations and was found to be inadequate as a basis for change in the IMYMS clusters. Secondary subject teachers have specific PL needs based on their closer attention to the disciplinary ideas that are the basis of their professional responsibility, and also the different school structures that arise from this. It was argued that generic formulations of pedagogy do not capture the real differences in subject cultures and practice and that teachers need PL support specific to their discipline areas.

An innovation framework for teacher professional learning and school development

In research involving the exploration of 16 'innovation exemplars' from the ASISTM project (Tytler, Symington et al. 2008) it was argued that innovation was a powerful framework through which to view teacher and school improvement. In these exemplar projects, partnerships with outside organizations (such as industry groups, community, government and independent organizations, and universities) and across schools led to the development of high quality learning experiences in science, technology and mathematics for students, but were also significant PL experiences for teachers in terms of content knowledge, knowledge about contemporary applications and human work in these areas, and also pedagogical knowledge since these projects were often exploratory and student focused.

Professional Learning Provision for Teachers of Mathematics and Science In Rural and Regional Schools in Victoria

In this SiMERR funded project extensive interviews were conducted with 50 Regional Project Officers, Principals and teachers from rural schools with a successful history of PL provision, to explore perceptions of issues and successful strategies for the PL of teachers of science and mathematics. The study has revealed some significant issues to be addressed in the provision of PL for teachers in rural and regional schools. The report of the project is in the final stages of preparation and should be released during the remainder of 2008.

Review of factors influencing students' engagement in STEM subjects and aspirations with regard to STEM careers.

A recent examination of the literature (see Tytler, Osborne, Williams et al, 2008) revealed that teachers are critically important in supporting student learning and engagement throughout schooling. Tytler et al found that pedagogy, rather than

curriculum content, was the key to engaging students in meaningful learning. Teacher learning must be a priority, particularly in the face of continuing change in the purposes and practices of schools, and calls for significant reform in subject provision.

Using ICT to Support Literacy and Numeracy in Rural Schools

In evaluative research of a 'train the trainer' model used by the Association for Independent Schools of Victoria (AISV) for ICT PL support (Campbell et al. 2007), it was found that an intensive workshop based program which prepared teachers both for development of their own practice and for supporting other teachers, was very successful in the first instance. It was partially successful in the second instance but the transfer of knowledge back in schools was critically dependent on the structures that were set up in the schools, in particular on school and teacher leadership.

Critical Thinking through Personal Learning Integrating Pedagogy and Web 2.0 Technologies

This project was an evaluation of the *Critical Thinking through Personal Learning Integrating Pedagogy and Web 2.0 Technologies* project (Chittleborough et al., 2008) devised and managed by the AISV. The evaluation aimed to provide an assessment of the effectiveness of the professional development intervention on the use of learning technologies in supporting teacher's development and students learning. Thinking skills thinking were investigated through five thinking characteristics: *Higher-order thinking, Metacognitive awareness, Team work/ collaboration, Affect towards school / learning and Ownership of learning*. The project findings emphasised the importance of teachers taking responsibility for their professional learning, being supported in this through individually tailored programs and collaborative planning, and recognition of teacher PD initiative.

Further background informing this paper

SiMERR National survey

The paper also draws upon some of the findings of a national survey conducted by the National SiMERR office (Lyons et al, 2006). The implications include:

1. More resources need to be provided for rural schools and teachers to avail themselves of PL offerings in metropolitan or regional centres, or indeed in relatively local settings, given the distance and cost constraints operating.
2. Ways need to be found to support both school based PL around shared themes, and the professional integrity of individual subject based teaching.
3. Ways should be found to encourage and support the use of local resources and expertise to support teacher learning and regeneration. Interactions between teachers and other professionals have the potential to foster enthusiasm and significant learning for teachers, and more relevant and challenging learning opportunities for students (Tytler, Symington et al. 2008).

SiMERR forum: Charting futures for Science, ICT, Mathematics Education in Rural and Regional Victoria (funded by SiMERR Australia and the Victorian DEECD)

A Forum organised by the Victorian Hub of SiMERR was held at Geelong on 17/18 March 2008. The participants were chosen to ensure that the Forum could draw on

expert knowledge relevant to the teaching and learning of science, mathematics and ICT in Victorian regional and rural areas. The ideas generated and discussed at, and following, the Forum have led to the formulation of the recommendations for action included as Attachment 1.

Issues which must be addressed in relation to enabling effective professional learning of teachers

Drawing upon the findings of these research projects, together with knowledge of the literature in the area, we would submit that the following issues are crucial for teacher PL and need to be addressed.

1. Professional learning for teachers must not be viewed simply in terms of delivery of new policy

In times of changing emphases in education, PL is an important aspect of policy delivery and quite properly much of the support for PL must focus on new government initiatives such as the implementation of the Victorian Essential Learning Standards (VELS) and the Principles of Learning and teaching (PoLT). However, teacher PL must also be seen in terms of individual growth and there needs to be support for individually generated and school generated PL initiatives that sit outside immediate government concerns.

2. Professional learning provision must acknowledge that teachers learn by participating in several discourse communities

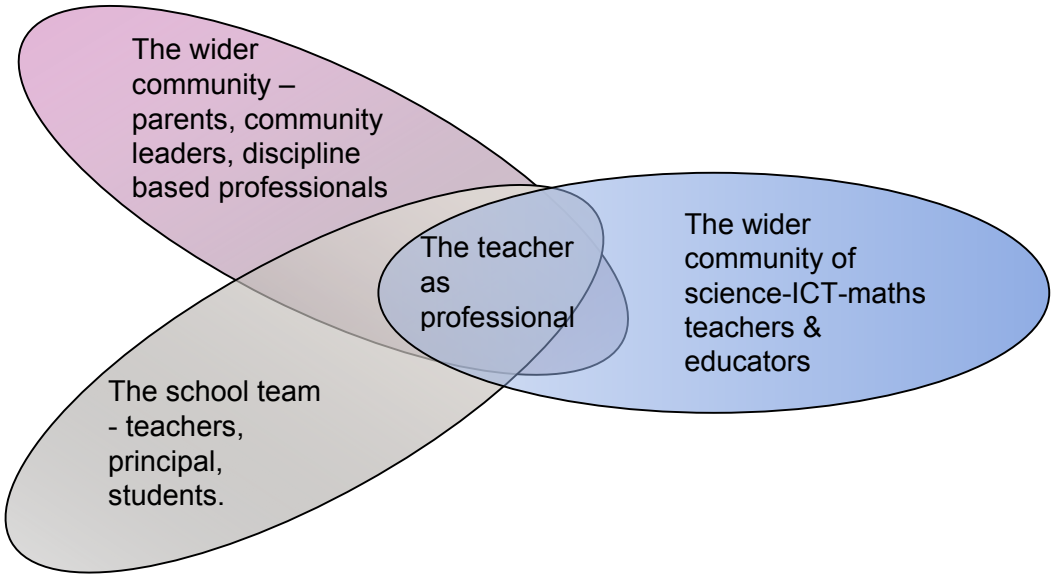

Figure 1: Teacher professional learning discourse communities

As Figure 1 indicates, our research shows that each of three discourse communities is important in the PL of teachers, in this case teachers of science, mathematics and ICT. Teachers' needs for PL change over the course of their career and each of the communities will play a different part at any particular time. The school community is central to the teacher's life. Early in their career it is important that the teacher 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.

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 on a less formal basis through the internet are important for professional growth.

Our research 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 practicing in the community, or from university colleagues, when jointly focussed on providing meaningful learning experiences for students.

3. Pedagogy needs to be a strong focus in PL provision

Our own and other research (see for example, Tytler, Osborne et al. 2008) has shown that teacher pedagogy is more critical to student engagement in learning than curriculum content, for instance, or teacher content knowledge. Support for pedagogical change must include an explicit focus on what constitutes good teaching and learning, and support at the classroom level for teachers to develop their practice.

4. Successful PL programs need to be multi faceted

There is a long history of understanding and advocacy of the deeply cultural nature of teacher professional learning and the need to situate professional learning initiatives within local settings. However, in trying to identify the characteristics of successful PL programs- it is evident that there is not a single formula- but rather PL events need to meet the needs of the individuals, provide networking opportunities among teachers, allow teachers time for practicing new skills, including follow-up or ongoing support, giving recognition to teachers for their efforts with allocation of time , support by school leaders, opportunities to use the new knowledge and skills , and support for experiences in the school setting. In particular, the experience of the Pedagogy and Web 2.0 project showed the need for teachers to take responsibility for framing their own professional learning needs and pathways, and the need for principals and government to recognise and support them in this.

5. Particular attention must be given to the needs of rural and regional schools and their teachers

Our research has identified that rural and regional schools have special problems to address in providing appropriate PL opportunities for their staff. There are multiple factors some of which are more easily solved than others. For instance additional funds would enable schools greater opportunity to allow their staff to participate in PL events such as subject association conferences which are mostly held in Melbourne. For schools in rural areas the costs become prohibitive when, in addition to conference fees and the cost of replacement teachers, the school needs to meet travel and accommodation costs. Similarly, if schools wish to employ city based consultants to assist with their PL program the costs normally are much greater than for metropolitan schools.

This problem is particularly an issue for subject based PL. Often in rural schools or clusters the focus of locally organised PL events centres round generic educational issues in order generate common ground, so that secondary subject specialists have limited opportunity to interact with colleagues from their discipline area. For rural secondary school teachers to have interaction with professional colleagues working in the same area they frequently have to travel some distance. Our research has shown that current levels of funding are not adequate to enable rural teachers to enjoy the same level of PL as their city colleagues.

It would be wrong to suggest that additional funds would address all of the problems experienced. For instance in some rural areas schools have no success in engaging replacement teachers to enable staff to participate in PL activities during class time, yet many of these activities are held during term school hours. Again in some remote schools the teachers have pointed to the problems not experienced by metropolitan based colleagues – "travelling late at night there's always the worry of hitting a kangaroo".

Much has been made of the potential of the internet to ameliorate some of the problems of providing PL opportunities for teachers in rural schools. However our research has highlighted the fact that frequently there is inadequate technical support to take advantage of such resources. We have found that the lack of technical support has a number of consequences for teacher PL. For some teachers it has meant that they have to spend a lot of time on the technical side to enable themselves and colleagues to access such resources. This diminishes the time available for their personal PL. Second, the absence of adequate technical support limits opportunities to try out in the classroom new approaches using the technology. There is a need to provide greater levels of ICT support for rural schools if they are to make use of the latest technologies and ideas.

6. There is a need for particular attention and further research regarding PL for teachers who are teaching outside their field of specialisation

Our research, and that of others, has drawn our attention to the extent of teachers being required to teach outside their field of expertise. This is particularly, but not exclusively, an issue for smaller secondary schools, particularly those in rural areas. For example, there are many teachers with a specialisation in physical education, mathematics or other areas who take classes in science. We have noted that while these teachers are in particularly need of PL in relation to teaching science they are less likely than their colleagues with science expertise to have such opportunities. When the staff of secondary schools breaks into groups around Key Learning Areas (KLAs) these teachers tend to meet with colleagues in their area of specialisation rather than science and so miss out on PL activities such as joint planning and evaluation of lessons. Again, when resources and time are limited, understandably these teachers tend to place their priority on taking up opportunities for PL activities in the field of their specialisation. It is our view in the light of our research, while there are shortages in some subject areas in the secondary schools system, that incentives need to put in place to ensure that teachers teaching outside their field of expertise take up PL activities in that field.

With regard to the nature of that support, our research (Darby, 2008; Tytler, Groves et al. 2008) has shown that effective teaching in a subject area requires much more than content knowledge. Teachers need to have an aesthetic understanding of a subject,

including a passion for the discipline, a sense of its coherence and meaning, and subject specific ways of making it relevant and engaging to students. This, even science teachers qualified to teach mathematics had difficulty translating their science pedagogical expertise across to mathematics. Particularly with the current and increasing shortfall of qualified science and mathematics teachers, there is a need for research and development that supports effective PL for teachers for whom these subjects are 'out of field'.

7. Teachers in primary and secondary schools have quite different needs with respect to provision of professional learning

There are a number of reasons, apart from the obvious ones such as the ages of the students, for suggesting that provision for the PL needs of primary teachers are quite different from those for their secondary colleagues. For example, almost all of the teachers within a primary school have responsibility for each of the KLAs. There is thus within most schools a body of people interested in sharing understandings, problems and successes in classroom practice in each of the KLAs. This is not so within a secondary school. In many schools the teacher of Physics, for instance, will need to look beyond their own school to find others with whom they can communicate about such matters.

Models of PL provision which involve clusters of schools can be quite powerful in supporting rich shared experiences and efficient planning, but where these clusters involve primary and secondary schools, the cultural differences and the differing needs of teachers need to be recognised. Our research has identified many examples of cases where secondary teachers did not participate in cluster focus activities, or resented wasted time, when these were focused on primary school concerns.

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Attachment 1: Recommendations from the Forum - *Charting futures for Science, ICT, Mathematics Education in Rural and Regional Victoria* (funded by SiMERR Australia and the Victorian DEECD)

Recommendations for action by Government

That Government develop a policy framework and funding base which will facilitate support for activity by schools systems, schools and universities to take appropriate action, including the actions proposed below, to ensure that schools are more effectively and appropriately able to develop the potential of students in rural and regional centres.

Recommendations for action by school systems

2. That school systems develop a strategic plan for the provision of professional development activity and increase the support for the provision of appropriate professional development for teachers in Victorian rural and regional schools.

3. That school systems put systems and people in place to ensure that worthwhile initiatives operating in Victorian rural and regional schools are communicated widely.

4. That school systems initiate a program to raise awareness in rural and regional communities of the value of education in science, mathematics and ICT both to the career prospects of the students and to the community.

Recommendation for action by schools

5. That rural and regional schools explore ways of collaborating with community members and organisations and using community resources, human and material, in programs in science, mathematics and ICT.

Recommendation for action by universities engaged in teacher education

6. That universities engage in partnership with schools systems to ensure that opportunities for students to engage in teaching experience in rural and regional schools are enhanced.

Recommendations for action by researchers

7. Researchers should undertake research into rural education which takes account of their wider setting and new ways of approaching opportunities.

8. Researchers should collaborate with schools and school systems to investigate effective ways of identifying and measuring the outcomes of innovative programs.