Supporting ICT based pedagogies in science in rural school settings

Peter Hubber

Gail Chittleborough

Coral Campbell

Wendy Jobling

Russell Tytler

Deakin University,
Victoria, Australia

peter.hubber@deakin.edu.au

ABSTRACT

Recent research has demonstrated a significant disadvantage for rural teachers in a variety of aspects of ICT use. This context provides a backdrop for two professional learning programs designed to support ICT-based pedagogies in teaching science in Victorian rural primary and secondary schools. In both programs the school-based workshops initiated a community of learners supported with online web-presence. One program used an intensive five-day workshop focused on developing teachers' knowledge, pedagogical expertise and leadership skills in embedding ICT into classroom practice. The second program provided a one-day workshop focused on integrating ICT skills in teaching science. Factors that affected the uptake of ICT included the considerable diversity in ICT availability and use, teacher competence, lack of support in schools, and online support. To redress rural disadvantage in ICT use, school commitment and focused leadership were identified as central to programs that supported and developed teacher skills and pedagogies over time.

INTRODUCTION

It is well recognised that many students are competent users of Information and Communication Technologies (ICT), such as computers, the internet and CD-ROMs, which they use in the classroom to assist with their school work (Levin & Arafeh, 2002). Whilst the literature recognises that ICT can have a positive effect on the teaching and learning of science (Becta, 2004), "research shows that even where technology is available, it is often underused and hindered by a set of practical constraints and teacher reservations" (Osborne & Hennessy, 2003, p. 3). Many schools and teachers are slow to respond to the benefits enabled by the use of ICT with a change in teaching practice (Levin & Arafeh, 2002). Many teachers have not recognised the potential or capabilities of the new technologies for their own teaching and students' learning (Levin & Arafeh, 2003); nor do all teachers have the necessary technological or pedagogical skills to teach using these type of technologies (Mishra & Koehler, 2006).

Osborne and Hennessy (2004, p. 5) argue that current research suggests that it is not appropriate to assume simply that the introduction of learning technologies in schools "necessarily transforms science education. Rather, we need to acknowledge the critical role played by the teacher, in creating conditions for ICT-supported learning". For schools to incorporate ICT into their curricula, and there are compelling arguments to do so (Harrison et al, 2003), a number of factors need to be in place (Ping, Swe, Hew, Wong & Shantri, 2003) with a principal factor being teacher competency with ICT. Annetta and Shymansky (2006), and Chalmers (2002), argue that effective professional development is critical to the integration of ICT in the curriculum.

A recent Australian national survey (Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006) has found that this situation is exacerbated in rural areas, with significant disadvantage for rural schools, teachers and students in availability and quality of on-line access, resource provision, professional development and access to technical assistance. Tytler et. al, (2009) identify particular impediments to professional learning through ICT, due to size and isolation of rural schools. Current thinking on teacher professional learning advocates school based communities of practice (Meiers, 2008). Leadership at the school level was seen as a key feature of the programs where "teacher learning proceeds most effectively when situated within school-based professional learning teams" (Tytler, 2009, p. 1805).

The concept of school and distributed online communities focussing on a particular aspect of professional development has the potential to benefit rural teachers, especially those suffering geographical isolation.

Professional Development Programs

Two professional development programs, referred to as Project One and Project Two, which occurred in rural Victoria highlight the key issue of teacher competencies in relation to supporting ICT based pedagogies and also provide insight into the role of school and online learning communities for ongoing professional learning.

Project One - was developed by the Association of Independent Schools of Victoria (AISV) to provide professional development and support for ICT based pedagogies. AISV collaborated with three separate hubs of rural schools involving 14 schools; 5 secondary, 4 P-12 colleges, and 5 primary schools. The school populations ranged from 50 to 600 students. The PD involved an intensive five-day training program, covering issues such as curriculum, inclusivity, pedagogy and ICT integration, and ICT skills. A blog was created for each hub. During the PD teachers identified areas of their own curricula where ICT could be embedded. There was an expectation following the PD, that the teachers would implement their ICT embedded unit of work, help train other teachers

back at their school, and continue communication through the blog (http://gippslandictpilot.blogspot.com/). There were also on-site visits by the workshop leaders, and a final hub meeting to discuss achievements.

Project Two - was a pilot study offering professional development in primary science education for teachers at 6 small (less than 50 students) rural schools in Victoria. The program included a single professional development day that focussed on science activities and an introduction to the project website (http://www.deakin.edu.au/alt/edsmf/simerr/). The project continued through online participation for both teachers and children over approximately 6 months. The objective was to build a community of learners. The project involved teachers and children working on common tasks called Science Challenges. These tasks targeting Grades 5 and 6 were on science topics that were relevant to the local area e.g. water, as well as traditional science topics e.g. electromagnetism. The Science Challenges were designed to extend children, encourage them to conduct a scientific investigation and share results online with other children. The website had provision for a webpage for each school as well as a forum where teachers could discuss the tasks with other teachers, and children could post images and files, and have discussions with other children.

Both projects were concerned with the setting up of communities of learners, utilising an introductory workshop and then ongoing online support. The research questions are:

> RQ1 What factors impact on the generation of school based communities of teachers extending their ICT skills?
>
> RQ2 What factors contribute to creating an online community of learners?

Research design and methods

An interpretive case study approach focussing on the teachers and their experiences was used with both projects. Researchers acted as participant observers attending the workshops at each project and followed the online discussions, making observations and building relationships with the teachers. Data sources included initial surveys of the teachers 'ICT skills and the schools' ICT resources, as well as field observations at the workshops and in schools, teacher interviews, online postings and student work samples. The analysis of data provided descriptive accounts of each case and looked for representative occurrences that were used to identify common characteristics. Themes were developed during the data analysis to address the research questions.

Results

Both studies are discussed in terms of the (i) circumstances and issues in the participating schools prior to the training program; (ii) the professional development program; and (iii) implementing change in schools following the training program.

Circumstances and Issues in the Participating Schools Prior to the Training Program

In Project One the initial baseline survey of the schools, teachers and students indicated significant variation across schools in terms of several key factors relevant to the way teachers responded to the project. For example, there was wide variation in the resources available to the schools. The following examples exemplify this variation:

> Garibaldi[1] College is an established large school (Prep - Year 12) (n= approx 900) with an advanced wireless and fibre optic backbone infrastructure connecting 80 staff laptops and 450-500 computers across three campuses via a common learning platform. Smart-boards are being introduced, data projectors are common, advanced software is readily available. The school employs an ICT manager to coordinate the resources and an ICT Teaching and Learning Coordinator. ICT is taught in an integrated manner.
>
> By comparison, Genoa College has two full time staff plus part time staff making up a total of 3.4 equivalent teachers. It has 60 students from prep to year 7. There are 12 computers in an activity/computer room - connected with wireless internet connection. Computers are serviced by a volunteer. There are other computers in classrooms – but they are old. ICT is taught as a separate subject.

Another key factor was the school culture of curriculum planning and integration of ICT. Researchers collected data about the school curriculum and the way ICT was taught and supported in the school. Some schools had a culture of curriculum planning that involved embedding ICT across the curriculum whilst most schools demonstrated a lack of coherent curriculum planning. In several schools ICT was taught separately from other curriculum areas. Commonly the ICT department and curriculum departments were run independently. There was also variation in the professional development opportunities available and the amount of professional development undertaken by teachers. Additionally, there was a lack of collaboration between teachers when planning curriculum and little evidence of networking across schools.

In Project Two, there was a disappointing response to invitations to be involved. The project focussed on small government primary schools with approximately 3-6 teachers. Participation in the PD proved difficult because of the lack of relief staff available in rural and remote locations. Once relief was organised, then travelling time reduced the length of the PD day to effectively 4 hours. However, the schools all had multiple computers in the classroom, reasonably good internet access and cameras available for students to use.

The Professional Development (PD) Program

The PD in Program One extended over five consecutive days allowing teachers time to be students. The quote below is representative of the insight teachers reported of the challenges of learning - through experiencing being a learner.

> *Day 1 blog –* ...a great day!! WOW! SO much exciting information. Can't wait to show the others at school... the children will delight that I have had to be a student again.
>
> *Day 2 blog –* feeling less nervous about the course today but totally embarrassed with what I don't know!! (morning)... really enthused and excited with this afternoon's session. Look forward to tomorrow.(afternoon).
>
> *Day 3 blog –* started out feeling confident...frustrations with my computer...my confidence and enthusiasm waned...what I had in my head when you first showed us, was not what I could remember an hour later...others

1. Pseudonyms have been used for each participating school and teacher in each of the projects.

were all excitedly showing their photo slides!!! I wanted to make a quick exit to the Ladies to have a cry and say I had reached my limit. told myself not to cry and worry others and do what I encourage my students to do – stop what you are doing, take a deep breath, remind myself that I haven't got it this time I can try again later and then get back onto the bike...I am still daunted and feel inadequate to meet the challenge.

Day 4 blog – I keep thinking how wonderful it would have been for our graduate teacher to be here who is technologically proficient and would have picked this up so quickly. I am so disappointed in my lack of ability to pick this up.

Day 5 blog – going through the pain barrier yesterday was hard but I'm glad I persevered. I really started to get into it last night and enjoyed it. (Blog comments)

Teachers working outside their comfort zones recognised the feelings their students sometimes have in learning difficult tasks. They relished the group work. This excerpt from the blog demonstrated the sharing and networking that seemed to be developing.

"What a great bunch of colleagues. I'm so glad to have had the opportunity to spend a week with such gifted and talented people, who have supported and encouraged along the journey. Coming together as a group – excellent – insights we can share. Everyone has skills that we can share. All have different areas of interest that complement each other".

The extended PD program provided an opportunity to develop teachers' skills in using ICT and increased their familiarity and confidence with various software programs.

By comparison, Project Two had more modest aims offering a single day PD program that demonstrated some hands-on science activities, and provided basic instruction on accessing the project's website, contributing to the forum and uploading data. All teachers were motivated to include more science in their teaching, and most teachers were able to navigate the website easily.

Implementing Change in Schools following the Professional Development Program

Despite the success of the intensive training in Project One, site visits and interviews revealed considerable variation of the implementation of ICT embedded curricula in the teachers schools (refer to Table 1).

One third of the teachers completed all stages of the project, which included the training of other staff in the school. However, whilst full implementation of units did not often occur there were changes in most teachers' practice. Almost all teachers could point to several instances where some of the ICT resources used in the PD were trialled in the classroom. Factors that impacted on the implementation of ICT into the curriculum (RQ1) included:

- The match or sometimes mismatch of the expectations of the project organisers and those of the school participants
- Resources and facilities to support change
- Commitment of school leaders to training and implementation
- Existence of a culture of joint curriculum planning
- Changes to the school, staff and/or coordinator's situation
- Time commitment required to complete the tasks
- Capacity of the teachers to take leadership roles

For some schools, the time for the PD of staff came under the school's formal PD structure, so that the project was not considered as adding to planned meeting and/or PD times. For 6 of the schools there was an explicit program of PD training, and for another 6 there was some training. For example,

> At Aragon College, a primary school, Yvette provided a one-hour PD weekly for all staff at the school with the aim of building ICT into all existing programs

For other teachers the school did not provide time within the normal school timetable structure for them to complete the training of other staff. This meant that whilst training was occurring it was on an ad hoc basis and was not able to be completed in the time set aside for the duration of the project. However, in spite of little formal time available, some teachers were able to train colleagues. For example,

Teacher planned ICT unit	Teacher implemented new ICT sequences	Teacher gave PD to other staff	New Trainee teachers implemented a new ICT sequence
7 - yes	8 – yes	6 – yes (training 12 teachers)	5 – yes
8 - no	2 – partial #	6 – partial	3 – partial
	4 – no	3 - no	7 - no
	1 - unclear		

Table 1: A Summary of the Results of Project One at Each Stage (n=15).

Note: # "partially" refers to the introduction of ICT to other staff, or their use by staff, on an informal or ad hoc or limited basis rather than in a more structured setting dealing with substantial innovation.

Sarah, a prep teacher at Garibaldi Primary School, held PD sessions at lunchtime and during the holidays.

Some teachers naturally assumed a leadership role and were willing to train staff in their schools while others reported when interviewed that they felt inadequate and underprepared for this role after the PD program.

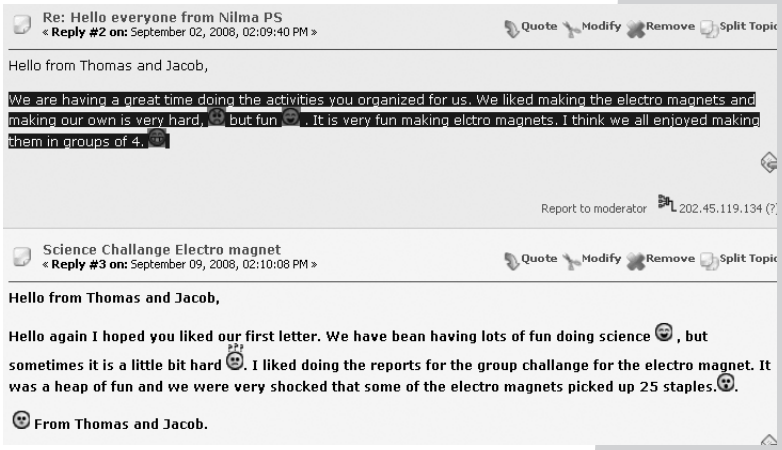
The Blogs that were set up for each Hub worked effectively during the PD, with each teacher reflecting on his/her experiences and supporting other teachers at the conclusion of each day. However, only one hub continued with the Blog after the PD program. This hub increased the Blog membership to include the teachers being trained. The number of posts on this Blog per month was 40 in July, 24 in August, 9 in September, 11 in each October and November and 10 in December; with three teachers maintaining the momentum.

In Project Two, there was minimal participation by the schools and a regular pattern of activity was not established, rather, several bursts of participation occurred as teachers found the time to participate. With individual teachers in rural schools, it proved difficult to establish a routine of communication for a sustained period of time. Sometimes the Science Challenges were out of sequence with planned curriculum. An important aspect of implementation was the embedding of ICT practices in an authentic curriculum context, which had been central to the rationale for Project One. Generally the teachers were constrained by time, technical issues and curriculum demands which limited the opportunities for teachers and students to fully implement the Science Challenge or if they did, to share their results with teachers and students from other schools.

However, students did post their results of undertaking the Science Challenge on the website. The formats included PowerPoint files (with movies and images embedded), movies, images text, and Word files. All students used visual records, taking photos or videos of their work. An example of a text message- posted by the students on their website:

> *"on Wednesday the 27th of August Ben and James made a device that would protect a egg from being damaged, we also put something under the device to protect the egg more. picture 11.jpg is the thing we put under the device. the person in the picture is James. Ben put heaps of paper in the parasute we used.*

Familiarity and confidence with using ICT varied. For example, embedding short video clips was problematic for some students and teachers but not for others who uploaded files without difficulty. Similarly, the discussion forum was either not used at all, or when it was, students posted messages within their own school rather than across schools (see Figure 1). One teacher commented on the need for a follow up professional learning day to be provided a month or two after the first. In Project One ongoing support on site visits was a positive feature.


Re: Hello everyone from Nilma PS
« Reply #2 on: September 02, 2008, 02:09:40 PM »
Quote Modify Remove Split Topic

Hello from Thomas and Jacob,

We are having a great time doing the activities you organized for us. We liked making the electro magnets and making our own is very hard, but fun. It is very fun making elctro magnets. I think we all enjoyed making them in groups of 4.

Report to moderator 202.45.119.134 (?)

Science Challange Electro magnet
« Reply #3 on: September 09, 2008, 02:10:08 PM »
Quote Modify Remove Split Topic

Hello from Thomas and Jacob,

Hello again I hoped you liked our first letter. We have bean having lots of fun doing science, but sometimes it is a little bit hard. I liked doing the reports for the group challange for the electro magnet. It was a heap of fun and we were very shocked that some of the electro magnets picked up 25 staples..

From Thomas and Jacob.

Figure 1 An example of a posting on the forum by grade 5/6 children

Conclusions and Implications

The results have shown a variation in the sustainability of online learning communities (RQ2). The aspects that can help to sustain an online learning community include: having a critical mass – with enough active people to maintain a blog; having a reason to blog - an incentive or task; recognising a value or benefit from blogging and teachers providing leadership to maintain the momentum of the discussion or activities. For teachers the sustainability was assisted by meeting face-to-face at the workshop; having common goals or aspirations, and having similar interests in teaching (common grades/subjects).

A professional learning model based on a flexible and sustained training program supported by school visits and ongoing communication through blogs has the potential to offer real change in the use of ICT in science in rural schools. However, based on the experience of schools and teachers in Project One, in order to duplicate the success of some teachers in implementing change in their classrooms and schools, more attention needs to be paid in the model to commitments and processes within schools, and support structures for ongoing change. The teachers' commitment in Project Two waned without any additional support or encouragement to participate, indicating the need for a follow-up visits or workshops. The structures that need to be acknowledged by any model, if it is to be effective, include policy frameworks and charters, organisational frameworks, the school and community culture within which teachers and students sit, and the cultures of subjects and other professional groupings within the school. Without attention to these multiple levels at which students, teachers and the school community interact, innovation and change runs the risk of being only surface deep.

REFERENCES

Annetta, L. A. & Shymansky, J. A. (2006). Investigating science learning for rural elementary school teachers in a professional development project through three distance-education strategies. *Journal of Research in Science Teaching, 43* (10), 1019-1039.

British Educational Communications and Technology Agency (Becta). (2004). What the research says about the use of ICT in science. Coventry: Becta ICT Research.

Chalmers, M. (2002) E-magine Online Campus: Tasmania's virtual school acting as a catalyst for the transformation of other schools. Paper given at the Australian Computers in Education Conference, Hobart, July 2002.

Harrison, C., Comber, C., Fisher, T., Haw, K., Lewin, C., Lunzer, E., McFarlane, A., Mavers, D., Scrimshaw, P., Somekh, B., & Watling, R. (2002) *The impact of information and communication technologies on pupil learning and attainment*. London: DfES Retrieved November 29, 2006 from http://www.becta.org.uk/research/impact2

Levin, D., & Arafeh, S. (2003) *The Digital Disconnect – the widening gap between internet-savvy students and their schools*. Pew Internet and American Life Project.

Lyons, T., Cooksey, R., Panizzon, D., Parnell, A., & Pegg, J. (2006) Science, ICT and Mathematics Education in Rural and Regional Australia – A research report prepared for the Department of Education, Science and Training. National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia, University of New England.

Meiers, M. (2008). Successful professional learning in schools through the Australian Government Quality Teacher Education Program (AGQTP): An investigation of factors contributing to successful implementation of professional learning in schools. Report for the Catholic Education Commission of Victoria Ltd. Hawthorn: ACER.

Mishra, P., & Koehler, M. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record 108*(6), 1017-1054.

Osborne, J., & Hennessy, S. (2003). *Literature review in science education and the role of ICT: promise, problems and future directions*. Bristol: NESTA Futurelab. http://www.nestafuturelab.org/research/reviews/se01.htm

Ping, L. C., Swe, K. M., Hew,T., Wong, P., & Shantri, D. (2003). *Exploring critical aspects of information technologies integration in Singapore schools*. Australian Journal of Educational Technology, 19(1), 1-24.

Tytler, R., Symington, D., Malcolm, C., & Kirkwood, V. (2009). Assuming responsibility: Teachers taking charge of their professional development. *Teaching Science, 55*(2), 9-15.

Tytler, R. (2009). School Innovation in Science: Improving science teaching and learning in Australian schools. *International Journal of Science Education*, 31(13), 1777-1809.

BIOGRAPHY

The authors are members of the STEME research group - re-imagining futures in Science, Technology, Environmental and Mathematics Education (STEME) at Deakin University. The STEME Research Group includes staff and associates of Deakin University, Victoria, Australia, who are interested in improving the teaching and learning of Science, Technology, Environmental and Mathematics Education through research into innovative educational practices.

Peter Hubber *is a Senior Lecturer, researcher and coordinator of pre-service secondary science teaching in science education at Deakin University. His main area of research is in the roles played by representations student learning of science.* **Gail Chittleborough** *is a Senior Lecturer at Deakin University. Her main area of research is the use of models, representations and ICT in learning science* **Dr. Coral Campbell** *has been involved in pre-school, primary, secondary science education, environmental education, technology education and mathematics education. She works closely with the local schools, promoting experiential learning for her education students. Coral's research interests are in the area of how children learn, particularly in science, environmental and technology education.* **Wendy Jobling** *is a Lecturer at Deakin University. Her research interests are in technology, science education and rural and regional education.* **Russell Tytler** *in Professor of Science Education at Deakin University. He has been involved in curriculum research and development over many years. His current research centres on socio cultural perspectives on science teaching and learning, teacher and school change, and rural and regional education*