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Classroom computer climate, teacher reflections and 're-envisioning' pedagogy in Australian schools

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Considerable resources have been committed to providing information and communication technology in Australian schools. However, little is known about their effects on professional practice and student learning. This paper reports two main aspects of the data emerging from a current, ongoing three-year study (2002-04) Years 3, 5 and 7 of Government and Catholic Education Schools in Tasmania, Australia. The aim is to develop a professional learning ICT pedagogy package for teachers. Relevant quantitative information and qualitative themes arising from survey questionnaire responses and preliminary findings from more in depth classroom case studies and the implications of these for pedagogy are discussed.

Introduction

There is an abundance of research and advice on the introduction of information and communications technologies (ICTs) in schools and classrooms (for reviews of this literature see Morrison and Lowther, 2002; Moseley and Higgens, 1999; Schrum, 1999). Emerging research supports the positive correlation of access to ICT with learning outcomes (Becta, 2001; Fluck and Robertson, 2002; Mann et al., 1999; Sinko and Lehtinen, 1999). For example, national testing results from 2110 schools in the UK demonstrated that schools with very good ICT resources had higher proportions of students performing at the higher levels of achievement in English, mathematics and science, independent of school socio-economic status and privilege (Becta, 2001). In fact, there is a growing body of literature questioning why ICT is still used only marginally in schools, given twenty years of computers in classrooms and the abundance of the research literature on how it can be successfully integrated (Conlon and Simpson, 2003; Mumtaz and Hammond, 2002; Reynolds, Treharne and Tripp, 2003).

One explanation for this situation is that there is a need for relevant responses in teacher training (Downes et al., 2002; DEST, 2000). In Australia, given that the government has invested $68 million over five years (2001-06) in its *Schools Online Curriculum Content Initiative* (The Learning Federation, 2003), the requirement for well-informed research that can guide the development of effective ICT pedagogy is urgent.

Our research position is that 'authentic pedagogy' (Biggs, 1999) is the key to informed decision making related to the use of and practices associated with ICTs in schools and classrooms. There is in this assumption the notion that meaning is created in context and the context varies with the personal aspirations of teachers and learners. Arguably, the take up of computers at home (79 percent of households based on 2002 ABS figures) heightens the need for teachers and learners to share their knowledge and personal views. How best to respond to this evolving context is part of the environment in which ICT based research must operate. In this regard an expanding literature now supports the view that developing 'authentic' responses that best reflect these situated meanings can evolve through the creation of communities of practice (Lave and Wenger, 2003) where personal aspirations are shared, or as Vygotsky (1994) has noted, are 'socially embedded'. For learners the pedagogy becomes 'authentic' or justly 'situated' when it take on personal meaning in their everyday lives or context (Van Oers, 1998). To achieve this level of understanding requires an analysis of the activities (Engeström, 2003) and tasks so that shared 'spaces' of understanding can be identified and used as a basis for constructing meanings for

lasting understanding. Taken from business models Engeström's Activity Theory is a way to accessing pedagogical understandings and moving towards genuine communities of practice and 'authentic pedagogies' (Ares and Peercy, 2003; Wenger, 1998). In brief, authentic pedagogy makes explicit the relationships between action, experience and existing knowledge and the possibilities for further inquiry.

Where such approaches to building understanding are taken in schools, research has indicated a marked improvement in the motivation and learning outcomes of students (Schliemann, 1998). Hence our search for authentic pedagogy has involved taking into account the specialist knowledge of teachers and learners in schools to 'discover' their conceptions of the curriculum and their personal perspectives on the transmission process in the learning context (Banks, Leach and Moon, 1999). Providing the learner with access to meaningful existing knowledge and support for inquiry promotes awareness of personal and shared experiences (Tenenbaum et al., 2001). Situating cognition or 'knowing' in real contexts that link personal and professional knowledge and skills of teachers is more likely to lead to practices that align with systems' targets.

We argue that teachers can best achieve the desired outcomes by adopting and adapting the action learning model similar to that proposed by Beaty and McGill (1995). This model links existing (programmed) knowledge, with the learner's actions and experiences. Through 'questioning insight' new knowledge is generated which helps to guide further action. Beaty and McGill (1995) noted that for effective learning to occur there is need for strong links between 'real' problems with 'real' people. In so doing, authentic pedagogy values the learner's own knowledge, experiences and products.

This paper describes early findings from an ongoing three-year study (2002-04) focussing on ICT usage and practices in Primary Years 3 and 5 and Secondary Year 7 within Tasmania government and catholic education systems. Our purpose has been to investigate the relationship between ICT integration into classrooms and student outcomes, and the factors affecting this relationship which contribute to an 'authentic pedagogy' for ICT. At the end of this three-year longitudinal (2002-04) project we seek to identify the relationships in the space that brings together a range of intersecting interests in teaching and learning (see Figure 1). Funded by the Australian Research Council Linkage Scheme (ARC, 2002) the study (2002-04) includes children and teachers in Years 3, 5 and 7 of Government and Catholic Education schools in Tasmania (in Tasmania Year 7 is the first year of secondary education, Years 3 and 5 are in the primary sector). Our project partners are the Department of Education the Catholic Education Office and Telstra. Inclusion of the Catholic Education Office is in recognition of the fact that a large proportion of students in Australia attend non-government schools (32%, of whom 63% attend Catholic schools; ABS, 2002). The dominant telecommunications company in Australia, Telstra, is our industry partner. The project is currently in its third year, although a pilot study (Fluck and Robertson, 2002) was completed before the commencement of the main study.

Figure 1 attempts to illustrate the scope of the project in terms of the various interests involved. Both education systems seek advice for guidelines to teachers on how to implement change processes aimed at flexible delivery of content in schools and classrooms that reflect the reality of student access to computers at home and other places as well as outside school. Telstra's interest lies in knowing more about the profile of the students and teachers and their access needs as potential clients. For the latter the degree of online access to digital learning environments is a particular interest. For us as the researchers we are primarily interested in understanding the nature of interactions within the learning spaces especially in schools and classrooms. However, our responsibility is to report findings consistent with the project aims to all major stakeholders. Regular meetings are part of the project arrangements and help the research team to respond to inevitable curriculum and staffing developments that take place in a project of this length. The level of cooperation achieved has facilitated this project implementation.

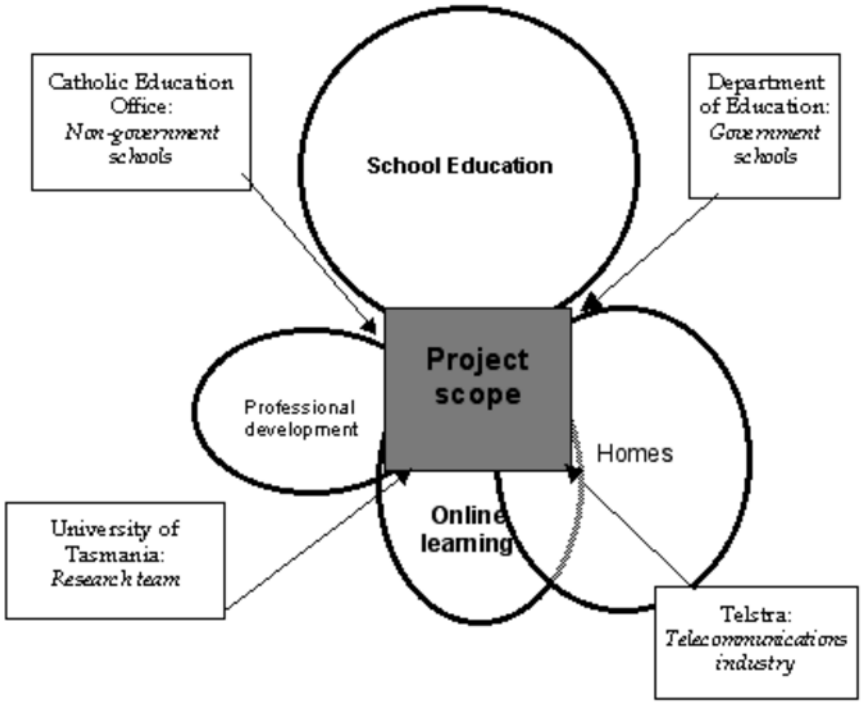


Figure 1: The project partners and research queries

To achieve this broad purpose we have three specific aims. They are first, to determine whether the link between an ICT rich environment and improved student learning outcomes (in terms of student national benchmark literacy and numeracy test scores) can be substantiated; second, to investigate the extent and nature of integration of ICT into classrooms, and the enhancers and barriers to this process; and third, to develop, trial and publish a professional development ICT related pedagogy package for teachers. Although the results from the pilot study are encouraging (Fluck and Robertson, 2002), the analysis of the link between ICT use in classrooms and student learning outcomes is not yet complete. Thus, this paper focuses on preliminary findings about ICT integration into schools and their implications for pedagogy.

The study design: Specific research instruments

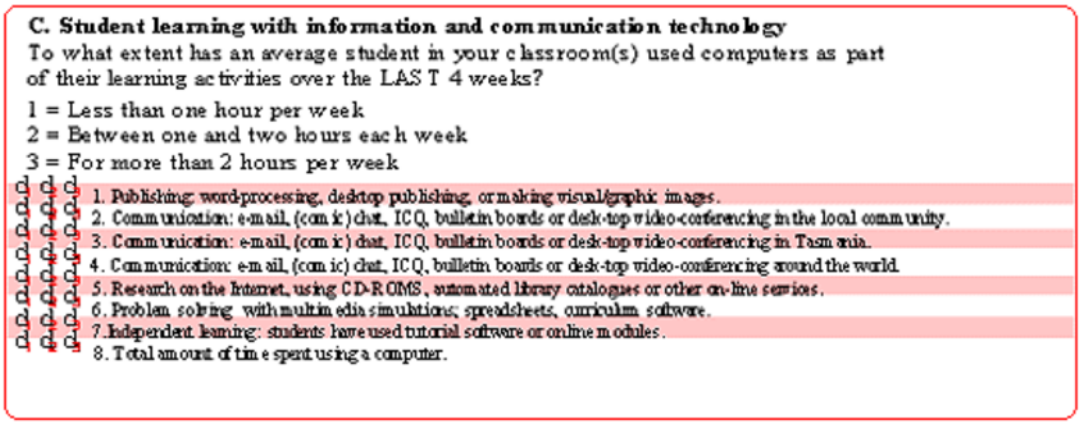
To achieve our stated aims we have developed two major data collection strategies. First, to find out the relationship at systems level of ICT contexts in schools and literacy and numeracy results of children a survey questionnaire, tested and piloted in 2001 has been distributed in each year of the study. Described below, the survey questionnaire is designed for all teachers of classes in the designated Years 3, 5 and 7. Results are linked with raw literacy and numeracy data for all children in these year groups. National tests of children in Years 3, Year 5 and year 7 will enable us to make longitudinal comparisons of student scores on these tests and their classroom computer 'climate'.

This blunt instrument approach was recognised as being limited for our research goal to discover the nature of the teaching and learning interactions associated with ICT usage in schools but was nevertheless considered to have merit as an indicator of statistical trends. To do justice to our aims we needed to 'drill down' inside classrooms and schools through observations and interviews with children, their teachers and school leaders. Hence to complement the survey questionnaire our second data collection strategy has been to make detailed observations in fifty classrooms representing the range of geographic and socio-economic variables in the state. Our third aim to produce a relevant professional package for teachers, while not reported in this paper is developing from these data rich observations.

These two main research instruments, teacher questionnaires and classroom observations, are described below.

The Classroom Computer Climate Survey (CCCS)

This system wide survey questionnaire is distributed once a year for three consecutive years (2002-04) to all teachers of predominantly Years 3, 5 and 7 classes in Tasmania. The response rate for the survey was difficult to calculate, given the large number of mixed year classes, especially in the numerous small schools of Tasmania. However, we estimate that fifty-nine percent of eligible classes responded to the survey, from forty-two percent of all Tasmanian schools. The survey items are of two main types. The majority are categorical 'fill in the bubble' type questions enabling rapid quantitative analysis of responses relating to three main areas relevant to an assessment of the classroom ICT environment - teacher, student and school characteristics. The categorical items investigate classroom teachers' assessment of, first, their own personal characteristics in relation to the use of ICT (for example, their estimate of their ICT skills, hours spent in formal professional development in ICT, personal and professional use of ICT); second, student use of ICT at school and access to ICT at home; and third, the school ICT resource environment (see Figure 2 for illustration).


C. Student learning with information and communication technology

To what extent has an average student in your classroom(s) used computers as part of their learning activities over the LAST 4 weeks?

1 = Less than one hour per week
2 = Between one and two hours each week
3 = For more than 2 hours per week

1. Publishing: word-processing, desktop publishing, or making visual/graphic images.
2. Communication: e-mail, (comic) chat, ICQ, bulletin boards or desk-top video-conferencing in the local community.
3. Communication: e-mail, (comic) chat, ICQ, bulletin boards or desk-top video-conferencing in Tasmania.
4. Communication: e-mail, (comic) chat, ICQ, bulletin boards or desk-top video-conferencing around the world.
5. Research on the Internet, using CD-ROMS, automated library catalogues or other on-line services.
6. Problem solving with multimedia simulations; spreadsheets, curriculum software.
7. Independent learning: students have used tutorial software or online modules.
8. Total amount of time spent using a computer.

Figure 2: Sample questions from the survey questionnaire

Items related to these variables have been validated through pilot testing and statistically demonstrate reliability as measurements of indicators listed above. The final two questions are open ended, giving teachers the opportunity of a written response to questions about, first, how ICT in the classroom assists student learning outcomes and, second, its likely effect on teaching practice in the future.

In this article we focus on the preliminary data that profile respondents and their perspectives on ICT. These data and respondents' comments highlight teacher professional development issues which complement those identified in the other project dimension of observation based classroom case studies.

Classroom case studies

Detailed classroom based case studies (N=50 over 2002-04 period) complement the system wide survey data gathered from the CCCS. These are providing the rich background information for testing emerging theories with teachers, students and school administrators. Data gathering instruments include individual teacher, student and principal interviews as well as observations of classroom and student ICT use, teacher-student and student-student interactions and information on ICT resources (equipment, facilities, and support). Interview transcripts and matching school and classroom data are still being processed. However, preliminary impressions and theory building are discussed below.

Now in the third year of the study, data gathered from the classroom observations form the basis of a working model for professional learning - trials of which commenced late 2003. Briefly outlined, our working theory is that online learning or e-learning works best when the learner is in control of the process of accessing relevant content where and when it is needed. This suggests that the teacher's style of agency is crucial in the delivery chain for improved learning. Cooperative approaches with peers helps create a community of practice from which to develop ICT competence and confidence to engage in new practices. This step in teachers' thinking requires acceptance of risk taking and the need to accept help and guidance from ICT 'experts' who can and often are the children in their classrooms. Coupled with this openness to sharing both within and between classrooms is the issue of school governance. Aligned

purposes and shared perceptions of tasks and goals are all part of the process that lead to the pedagogical outcomes that we believe best reflect communities of practice for authentic and sustainable ICT related learning outcomes. While the class and school based case studies include interviews with the Principal and ICT support person as well as the children in their classes, for the purposes of reporting in this paper we have focussed primarily on the teachers. We conclude with a working model for professional development.

Results

Selected survey findings

From the 474 surveys returned by teachers in 2002, sixty percent of respondents were older than forty years and seventy per cent were female (see Table 1). Results revealed that 58 percent reported less than 10 hours of ICT professional development training during 2002. ICT support staff/teachers comprised 12.5 percent of respondents. There were some age related differences. However, there were no statistically significant gender differences. Despite this low figure related to formal personal skill development, 88 percent reported having home computer access and seventy-two percent had home Internet access.

Teachers reported lower home access to ICT for students in their classrooms, with access to home computers at sixty-six percent and home linkage to the Internet fifty percent. These figures are the teachers' estimates of student access. While they agree with national estimates for 2002 for children under fifteen of home Internet access (59%), they appear to differ for access to home computers (79%, ABS, 2003). The survey results also indicated that teachers spend fifty percent more time than students during the working week using computers across a range of ICT tasks (total 6.6 versus 4.3 hours). The most likely computer usage in classrooms, by both teachers and students, was for 'publishing' and 'research'.

Table 1: Selected categorical data from survey questionnaire (N = 466)

	Category	%	n
Age of respondents	20-29 years	20	94
	30-39 years	20	90
	40-49 years	36	166
	50-59 years	22	102
	60+ years	2	10
Gender	Female	70	121#
	Male	30	52#
ICT teachers/support staff as a proportion of respondents		12.50	57
ICT professional development time (hours per year)	0-10 hrs	58	267
	10-20 hrs	25	116
	>20 hrs	17	65
Respondent estimate of their own ICT skill level	Below average	8	35
	Average	34	156
	Good	40	184
	Very good	19	88
Home access to ICT		Computers	Internet
	Teachers	88% (n=408)	72% (n=334)
	Students	66% (72%)*	50% (45%)*

Weekly use of ICT (proportion spending more than one hour per week on a task area)	Task area	Teachers (personal + professional)		Students (classroom only)	
		%	n	%	n
	Publishing	83	382	59	270
	Research	67	304	50	226
	Communication	46	211	9	39**
	Independent learning	46	209	18	81
	Problem solving	39	181	14	62

Only 173 respondents answered this question possibly due to a survey design fault;
* Figures in parentheses are ABS (2002) national estimates of computer and Internet availability in households with students under 18 for the year 2000;
** Figures averaged across three communication categories (local, Tasmania, world).

The survey questionnaire also included two open ended questions. These responses were read carefully and coded for meaning or presumed intention of the respondent. Codes were used to form categories of mentions. Numbers of mentions were counted to provide tables of frequency counts. Based on the technique of phenomenography used by Marton and colleagues (Marton, 1981), this analysis technique was a way of enabling us to quantify comments and produce summary tables for comparisons. This quantitative approach is important for comparing the direction of responses that will likely occur during the three year life of the project. Summary results of this coding process follow.

Open ended Question 1: How does the computer help students achieve their learning outcomes across the curriculum?

Table 2 shows the percentage of respondents who mentioned each of the main themes and the frequency of mentions of sub-themes for Question 1. The most common reported benefits of ICT related to the access and presentation of information as well as how ICT could be used as a tool in various ways to enhance learning. It was also often mentioned as a motivator and in terms of student communication and connectedness.

Table 2: Frequency data for Question G1
N = 346 respondents

	Theme	Respondents mentioning theme (%)	Frequency of mentions
1.	Use of information/ Research	75	490
	Access to information		178
	Presentation/ publishing		145
	Research		126
	Information management		41
2.	Enhances learning	71	408
	Skill development		134
	Expands range of teaching and learning tools		104
	Personalised/ individualised/ tailored learning		66
	Broadens and deepens knowledge and understanding		19
	General enhances learning		18
	Enriches learning experience		18

	Independent learning		15
	Integration of learning areas		12
	Efficiency/ increased work output		8
	Enables practical use of learning		5
	Other specific learning enhancement		9
3.	Motivation to learn	26	90
4.	Connectedness/ communication	25	104
	General connectedness/ communication		42
	Social skills		24
	To other students, classrooms, teachers, schools, nations		19
	Connects them to the wider world, other cultures, broadens their minds		10
	Collaborative learning		5
	To state, national and international education projects		4
5.	Constraints/ concerns	15	75
	Reliability problems		13
	Availability, access - too few computers		11
	Neglect of other valuable teaching and learning tools and skills		11
	Teacher time/ support		8
	Information overload - students waste time wading through, sorting out		7
	Other constraints		25

Open ended Question 2: How do you see computers affecting the future of classroom teaching?

The major and sub-theme data are provided in Table 3. It is worth noting that respondents tended to answer the question in terms of the future nature of *student learning* rather than of *teaching practice*. ICT was generally perceived as a growth area in schools with increased use and usefulness predicted as teacher familiarity and integration of ICT improved.

Table 3: Theme frequency data for Question G2
N = 336 respondents

Theme		Respondents mentioning theme (%)	Frequency of mentions
1.	ICT learning will be a much bigger focus in the classroom	66	287
	Increased use/ role/ reliance on in classroom teaching and learning		132
	Greater range of teaching and learning options		66
	An extra tool		37
	Better integrated into and across the curriculum		30
	Computer as teacher		11
	Better content, technologies, programs		5
	Other positive effect		6

2.	Constraints/ concerns	44	221
	Improvements required in ICT resourcing		114
	Keep ICT in perspective		82
	Other constraints		25
3.	Connectedness/ communication	25	113
	Students to other students, classrooms, teachers, schools, nations		45
	To immediate and up to date information, national programs etc		28
	Monitoring, tracking students progress and assessment improved		11
	General connectedness/ communication		11
	Home-school connections - more work done from home		10
	Teacher-teacher communication, support and idea networks		4
	Small and isolated schools have same opportunities, access		4
4.	Student centred learning	24	109
	Learning more tailored to individual needs/ student centred		32
	Students control of what they learn/ more independent learning		21
	Students will have a greater range and depth of knowledge (inc. ICT)		18
	Better learning outcomes in other areas		11
	Subject areas/ learning will be more integrated - more project based		6
	Students learn to be more critical/ discerning about information		5
	Equity		4
	Other learning implications		11
5.	Change to teaching practice	11	44
	Teachers required to manage, facilitate student use of ICT		24
	Less actual teaching		9
	Other change to teaching practice		11
6.	Break down of formal school structures	3	12
	Less one size fits all teaching, greater flexibility, personalised		4
	Other break down of formal school structures		8

Constraints and concerns were the second major theme, with the main issues being adequate resourcing (mainly number of computers, reliability of ICT equipment, ICT support, and teacher time for management of ICT in the classroom and for professional development) and the need to keep ICT in perspective and not neglect other valuable teaching and learning tools. The future value of ICT was linked to improving communication, connectedness and in student centred learning.

In summary, the open ended questions reveal the broad range of tasks that teachers are putting ICT to use. However, teachers were careful to note positive future outcomes are largely reliant on improved resourcing of ICT. The responses highlight the ICT awareness of teachers and their recognition of the need for more training to develop their own competence.

It is ironic, therefore, that the quantitative data report a minimal time commitment of teachers to related professional development. One dimension that needs to be considered in light of these observations is the impact of compulsory curriculum requirements in primary schools for literacy and numeracy testing. It is

likely that professional development priorities are more directly aligned with these current policy decisions. At the same time, our project initiative helps inform state and federal governments of the likely next priority phase for testing.

Classroom case studies

Case studies involve two days observations in each class and interviews with class teachers, a cross section of students, school ICT staff and the principal. As well an audit is taken of the computer equipment available in classrooms. This includes checking the software installed and the time speed for loading programs and accessing the Internet. All students in each class complete a simple questionnaire which requests details of their computer access outside school and the activities they engage in as well as their favourite web sites. Interviews are guided by separate schedules for each role and include questions related to the history of ICT in the school (Principal and ICT coordinator), classroom ICT strategies, difficulties and views on home use of computers (teachers) and students' views on computers and computer based learning (students).

At the time of writing, observations in classrooms are ongoing and have been completed in twenty-nine of the fifty classrooms targeted for this phase of the project. Needless to say the amount of information from these observations is likely to lead to ongoing analysis for some time. However, some findings are providing clear signals for classroom practice in relation to the use and provision of computing resources. As well, emerging themes shared below echo the issues raised by the teachers in the survey questionnaires. In particular, they indicate that in the early stages teachers experience considerable demands on their time and attention in order to be able to:

- Prepare for students to use ICT in the class programs, and to
- Manage the flow of classroom activity that includes the use of ICT.

The actual provision of ICT in the classroom (or nearby), for example, two networked linked PCs (which appears to be the benchmark for classrooms), is likely to lead to withdrawal of students in order to access the computers. By comparison access to six PCs allows group work using ICT to be organised in rotation with other class group tasks. Access to computer laboratories allows whole class activities and is particularly effective in the development of ICT related knowledge and skills across the entire class and school. Hence, where the provision is proportional to the need for ICT in the class activities it is possible for ICT to be well integrated into the learning process.

The incorporation of ICT into class programs may provide potentially powerful tools for both students and teachers but it also adds considerable complexity in terms of the necessary teaching and learning structures in the classroom in order to deal with:

- The management of the technology itself;
- Students undertaking a complex set of activities within complex tasks (operating the technology while undertaking the learning activities);
- Tasks happening within extended timeframes covering weeks rather than days (or even parts of days); and
- Curriculum terms of reference that are less certain - many teachers have reported being bewildered by the possibilities they are presented with through the availability of technology in their classrooms.

Perhaps not since the advent of the print media has there been such a challenge for teachers. The importance of professional development is crucial for the kinds of changes predicted for schools and how they may best match societal needs for educating future citizens. One teacher summed this challenge with the observation:

> I know that personally I find rate of progress and change in IT quite bewildering. It is simply hard to find the hours in the day to even keep up with your own skills.

Like print, the broad societal take up of ICT means that learning is no longer bounded or controlled by textbooks or related sources of delimited knowledge. Teachers are not, and can no longer be, the sole 'experts'. One ICT support person interviewed observed:

> I think we have got to think beyond just the notion of professional development for teachers but if we run a professional development for teachers in parallel with a professional development program for students, then we have a mutual support structure that supports the integration of ICT into teaching and learning program. So then it doesn't just become the responsibility of the teacher to think about how it might be integrated but the kids who are far savvier with all this than we are anyway...

His comments on teachers' learning styles provided more insight to the issues faced by schools.

> ...the thing is that what technology has done has turned the notion of how we learn on its head. First of all we are in a publishing revolution, which I think is as huge as the print revolution. Secondly, it is really interesting. We, as adults, were brought up on [sic] a process of linear learning in that we picked up a book and we started on page 1 at the top left hand corner and worked systematically through until we got to the end and gathered the information as we went. But with children, they don't learn in that linear fashion at all because what technology has done is that it means that you are learning from sound and pictures and words simultaneously.

One teacher appeared to sum the fears with the following comments.

> ... as a completely untrained IT person, how would I go about actually teaching skills like that and what do you do? Do you gather the children all around the computer; do you have three children at the computers who know what they are doing and have a group around? How do you do it? How would I go about teaching those specific IT skills if I actually had the time .. and where do I get some training to do it? At this other school they had a computer lab and it had a dozen computers at least - one for each child in the group but how do I do it?

Partnerships and linkages with non-traditional sources of knowledge are part of the new online ICT worlds. This suggests some clear challenges for teachers that make their role different from those posed by past changes. Scaffolding and mediating learning through collaboration with learners, ICT support staff and others is part of the re-learning about teaching. One of the most common observations about facilitating e-learning relates to the reliability of the technology itself. To avoid frustration and abandonment the technology must be available and 'reliable' within the window of opportunity for learning. Similarly the operational demands on the user of the technology must also be within their capability as the following interview extracts illustrate.

> I look back to when I grew up without them and think how plain and simple and easy it was and now people are simply assuming that you use all that time and you take all that time. They probably look at me and think - 'what are you on about' type of thing. So that is difficult and also the pure - the technical difficulties. Like when you were in there yesterday, and (student) had lost his file and you ask 'did you save that?', 'where did you save it?' and he doesn't know and he doesn't know whether he has or not or was it this computer or was it that computer. And then the printer won't work and then one of the kids has done something to something and mucked that up and then the power went off.

Teachers who demonstrate success and comfort in incorporating ICT into their class programs consistently report having a personal professional learning support network. Typically this network is made up of teaching colleagues and others. Membership of the network usually includes peers who are at a similar stage of development. One teacher commented:

> .. I have got a pretty good network of friends who we share sites and that is good [sic]...I suppose if I am surfing and I go into a site then I will jot that down and I will email it to a

> friend and he will do the same for me and my wife, in her role, does the same. She has a list of websites in her maths consultancy role and she was able to locate sites and get her own resources of those types of things.

The ad hoc nature of existing professional learning of teachers is well illustrated by one Principal's comments:

> I think it is more luck than good management. I think it has something to do with the people you are given...one or two or five who jump on the band wagon and run with it and they will pick up people by the coat tails and drag them with them because it is their mate and they will talk to them about it or show them whereas if the principal comes along and dictates that they need PD on this stuff or 'I have bought it and it is in your room and you will use it' then you will get people who will only pay lip service to it.

Many teachers report being discouraged when receiving assistance from 'technical experts' who do not explain the assistance they have provided. One teacher observed: 'Go back to basics'. Of the IT support team another teacher commented:

> I would like to have them sit in my classroom for a week and know what teaching is about and know what environment they are trying to help and then may be they would approach everything from a different way". "They [IT staff] are just from another culture in their heads and I just don't think they understand what they are supporting and I don't think they understand that they are actually supporting anything anyway. I think they think - this is us [teachers] and we can do this and you can't.

One teacher reflected on the need for 'a whole school approach to it but it is so difficult' including:

> I find unless I have an aide, then I don't get a lot done. And then the ICT support person comes along and has all these wonderful ideas and I think, 'I will try and do this, this, this and this', but....!

Discussion

So far the results reported in this paper have focussed primarily on the teachers' perceptions of ICT practices and policies. One of the many interesting dimensions to this study is the degree of match in the teachers' perceptions of their children's computer access and the actual access revealed in class case studies where information was collected directly from the children. To locate this information we have conducted a comparative analysis of the 2002/2003 survey data with the class based student results. Children in twenty-two classes surveyed (representing 513 children) have been matched with results reported by the same sample of children in the class based observations. What is fascinating is that although only a small sample of teachers (N=22) there is a statistically significant difference (Wilcoxon $Z=-4.363$; $p<.01$) in the teacher perceptions of home computer access and the actual access reported by the sample of 513 children. The figures represent an underestimation by teachers of student home computer access of around twenty percent.

Our research evidence suggests that when using ICTs teachers need to reconceptualise how they think about the teaching and learning needs of their students. Some clear challenges exist for teachers that make their role different from those posed by past changes. Now there is the need to consider external or 'outside school' experiences, including the transient nature of knowledge, and the interdependence we now all have with skilled others (such as IT experts) to make the systems operate efficiently. Scaffolding and mediating learning through the use of ICT requires greater collaboration at more levels than ever before. The technology must be available and 'reliable' within the window of opportunity for learning. Similarly the operational demands on the user of the technology must also be within their capability. Thus the provision, application and use of ICT require consideration at several levels: school system, school, class and individual activity levels.

Interview results confirm the view that at all stages in the process teachers need to be supported by their 'expert' colleagues. Teachers who demonstrate success and comfort in incorporating ICT into their class programs consistently report having a personal professional learning support network. Typically this network is made up of teaching colleagues and others. Membership of the network usually includes peers who are at a similar stage of development. Many teachers report being discouraged when receiving assistance from 'technical experts' who do not explain the assistance they have provided. Similarly teachers are often daunted, or 'made to feel guilty' by other teachers who are able to demonstrate the use of ICT well beyond the teacher's current level of practice. Out of hours access to an internet connected computer, frequent use of email and social contacts all enable this network to be effective beyond the immediate school in which the teacher is currently placed.

The implication from these findings is that the use of ICT is fostered by membership of one or more professional learning communities with some interest in ICT. The benefits of such membership include easier access to resources, more prompt support for problem solving and encouragement to be innovative in the introduction of new teaching practices. This aspect of teacher confidence and competence parallels the way in which many children learn about ICT from family and friends. Thus key professional development for many teachers is often social, informal and loosely organised by the participants in response to their own immediate and local needs and provided 'just in time'.

Conclusion

Arguably, schools and teachers making the 'best' use of ICT already model known best practice of good teaching and resource management. They know their purposes and subject matter well, are able to place the children learning activities within the child's zone of proximal development, scaffold children's learning activities and demonstrate excellent interpersonal skills especially in mediating the learning processes. However, we are not convinced from our research that these dimensions can be used in traditional ways to identify authentic pedagogies for e-learning. Learning can be located for learners in multiple spaces. This assumption applies equally well to teacher and student learners. Taken to its conclusion the flexibility of ICT and e-learning being possible in many places and times could see a future where teacher and learner need not be simultaneously located in the same physical space for the bulk of the teaching and learning activities. Nor does this signal a return to the ways of past distance learning.

We conclude from our research findings to date that there is need for new collaborative partnerships where both parties contribute to the design, management and monitoring of activities that result in learning. In these partnerships learners construct knowledge and teachers mediate for valid and reliable processes and outcomes that will best serve their mutual needs and those of future communities.

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