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Effective Use of Information and Communication Technology (ICT) to Enhance Learning for Disadvantaged School Students

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Executive Summary and Introduction

1 Overview of project

1.1 Goals

As Information and Communication Technology (ICT) becomes more widely used in classrooms and schools, attention is being focused on how ICT can make teaching and learning more effective. This report responds to the questions: What are the effective practices using ICT that can enhance the learning of students who are disadvantaged? Who benefits when ICT is integrated into schools and classrooms? What are the barriers to more effective use of ICT in classrooms with disadvantaged students? What are the leading practices that are emerging around the integration and use of ICT and the strategies being developed to address these issues?

The project includes:

- A critical review of current Australian and international literature, together with an annotated bibliography.
- Description, discussion and evaluation of classroom practices and learning areas where the use of ICT has been shown to produce enhanced learning outcomes; small one-off style projects and larger systemic initiatives are discussed and evaluated.
- Examples of 'leading practice' models with an assessment of their transferability and sustainability, particularly in classrooms with differing socio-economic and geographical contexts within Australia.
- Description of the barriers to ICT and Internet use for disadvantaged groups and a discussion and evaluation of strategies suggested in the literature to address the barriers.
- Discussion of the barriers which inhibit teachers from using ICT in their classrooms.
- The professional development requirements of teachers who use ICT to enhance learning of disadvantaged students.

1.2 Project approach

The report was a joint investigation of the Deakin Centre for Education and Change, The Institute of Koorie Education and the Institute of Disability Studies at Deakin University. The search of published literature and web based documented practice was restricted to years Prep-12. We identified documented examples of school based practice by accessing system wide ICT personnel, teacher and school networks, websites and online conference proceedings, Australian and overseas researchers, the reference group and the research consultants. No research was undertaken in schools.

Despite a comprehensive literature search, there was a surprising lack of documentation (and lack of evaluations) of effective practice using ICT in schools because of the patchwork nature of ICT use across systems and in schools. What was

evident from talking to system and local personnel responsible for ICT policy and development and from our own research, was that many now see the issue of how ICT enhances learning as the key area of inquiry. All systems are moving to focus on this issue. Various projects are underway but without conclusive evidence that can be presented in this report (with the exception of Cuttance 2001).

The report was developed through a number of processes:

- Workshops with the Reference Group that developed the conceptual framework and identified key words.
- Focussed discussions between researchers in specific areas e.g. Indigenous education.
- Contact with teacher networks e.g. the Principals' Association, to access online conferences.
- Contact with ICT policy personnel in state education systems.
- A reference list of over 1000 items was collected that provided an overview from the late 1980s to the present. This list was distilled down to the items included in the bibliography through a process of discussion within the specific equity areas of gender, Indigenous and disabilities. A further distillation arose out of the writing of the final report. These references constitute the critical annotated bibliography.
- Over 200 websites have been identified, many of which are listed in leading practice or referred to in the text as sites that provide teachers with a range of ways of using ICT in schools. These and other resources are listed in Appendix 2.
- The project draft was circulated to the Reference Group and also the consultants for comprehensive feedback. Further research obtained in that period of review and feedback was included for the final report.
- The Internet sites mentioned throughout this document were available at the time of submission.

2 Conceptual framework

This report illustrates the complexity of the nexus between ICT, learning and disadvantage, and how gender, class, race, indigeneity, ethnicity, disability and location intersect when ICT is integrated into classrooms in unexpected ways. As with all learning, learning through ICT is mediated by school organization, culture, social mix and location; home environments; community expectations; and how and what curriculum is taught and received. Students are influenced by teacher and parental expectations, their attitudes to and relations with teachers, family and peers; and their cognitive, social and affective attributes.

While ICT offers considerable possibilities, the ways in which ICT improve learning outcomes has not yet been fully investigated, particularly in the case of students who are disadvantaged. Yet ICT literacy is perceived to be a central feature of work, leisure, community networks and global environments. ICT has significant potential to assist students who are currently disadvantaged by gender, disability, indigenous, ethnic and socio economic background. Teachers and schools are struggling with how that potential can be developed and used to benefit students currently seen to be excluded from, underachieving in, or disaffected by school.

As computer ownership becomes the norm in schools and in society, new forms of disadvantage can arise. ICT can compound disadvantage as many students in low-income families and communities do not have access to computers either in school or at home. When they do it is most likely ‘thin’ access with poor quality computers, minimal internet usage and out of date software rather than the thick access of a multimedia environment. This compounds existing disadvantages arising from isolation, indigeneity, race, socio economic and cultural background and gender.

The conceptual framework that informs the report is based on the Lankshear *et al.* (1997) depiction of the three dimensions of digital literacy—the operational (technical know how to use ICT, both basic and advanced); the cultural (use of appropriate ICT for specific needs and cultural contexts) and the critical (ICT as cultural production, reflection upon the role and value of ICT and its effects on society). All aspects were seen to be essential levels of practice in the use of ICT that teachers and students needed to develop in order to be able to participate fully in work and society.

3 Synopsis of findings in literature review

The research focus on ICT in general has only in recent years shifted away from access, infrastructure and technical issues to ask the question that is the focus of this report – how ICT can enhance learning. As yet, there has been less of a focus in research and documented practice on how technologies can inform learning outcomes. There are some rich case studies that illustrate how schools have integrated ICT into their practices, which have relevance to improving learning for such students in specific contexts (e.g. Cuttance 2001, Lankshear and Snyder 2000). Of the limited research that does consider classroom practice and disadvantaged students (e.g. Comber and Green 1999), there are few instances of rigorous evaluations of the effectiveness of the use of ICT in enhancing student outcomes, least of all the learning outcomes for students who are disadvantaged.

- Case studies and larger systemic reviews of the literature e.g. (Meredyth 1999, Wenglinsky 1999, Comber and Green 1999, Lankshear *et al.* 1997) suggest that teachers and parents agreed that ICT did the following when underpinned by innovative teaching:
  - motivated and stimulated learners;
  - solved some problems of students' 'motivation' for academic work and competence with literacy;
  - encouraged problem solving, analytical and creative thinking;
  - improved students' understandings, assimilation and creation of new knowledge;
  - provided new modes of communication to network locally and globally;
  - provided access to data bases, websites and discussions that were previously unavailable;
  - assisted in the development of independent learning and research skills; and
  - reduced failure for at risk students.

Wenglinsky (1999) also reported that ICT can assist in social development and can lead to the new skills necessary for a knowledge society such as digital or network literacy. ICT can also improve subject learning and vocational training.

Longitudinal studies indicate that the full integration of ICT into technology rich classrooms changes the nature of teaching and learning, creates more independent and self motivating learners, encourages the use of multiple teaching methods, and encourages team oriented inquiry. In general, the effects for students as perceived by teachers has been largely social and psychological in terms of changes in attitude and increased engagement and study habits. There is a weaker untested association between cognitive learning outcomes and ICT use.

3.1 Teachers, ICT and improving learning

In general, the integration of ICT into schools and classrooms is uneven both within and across classrooms, schools and systems. Downes (2001:6) usefully differentiates between levels of integration of ICT into the classroom:

- Level 1: ICT skills are added into school program through a separate ICT subject, while teacher practices in subjects remain unchanged;

- Level 2: ICT skills are integrated into daily work of teachers, with some teachers' pedagogical practices and classroom behaviours staying the same, while the practices of others change more radically;
- Level 3: ICT is transformative at the classroom level in that it changes content as well as pedagogy (what students learn as well as how they learn); and
- Level 4: ICT is transformative at the system level leading to changes in organisational and structural features of schooling.

Most schools are currently working at level one and two, particularly schools that have fewer resources as the trend to disperse computers into classrooms (e.g. pods, laptops that enable full integration into daily practice) is costly. Many schools assume that exposure to technology will lead to adequate learning about how to use it for improving learning (See also Cuttance 2001:16). There are few examples of systems, schools or classrooms working at levels three and four.

The greatest integration of ICT occurs when process and content are addressed simultaneously. Both teachers and students are more likely to enhance their learning if they learn about and learn to use ICT at the same time. This can happen when they undertake a specific pedagogical task that requires problem solving approaches with respect to both process (ICT) and content. Such approaches encourage cross curriculum inquiry based activities.

If there is simultaneously a strong focus across the curriculum on problem-based or project-based strategies utilising ICT, the issue of digital as well as print based literacy and numeracy can be addressed as a whole school issue. This is more likely to assist disadvantaged students whose needs can then be addressed in all classrooms by all teachers.

3.2 Traditional and transformational pedagogies

All research has pointed to the centrality of transforming teaching in order to integrate ICT effectively. ICT is seen as a catalyst of system, community, school or classroom reform because it provides opportunities to shift from teacher centred to student centred learning. In turn, ICT could also increase the pedagogical repertoire of teachers. This teacher effect is most likely to improve the outcomes of disadvantaged students because it attends to individual need and provides a variety of curriculum and assessment strategies to promote student capabilities across a range of learning outcomes. In that sense, good pedagogical practice in the use of ICT to enhance the learning of students who are disadvantaged is good pedagogical practice for all students.

Documented practices by teachers indicate that ICT can assist teachers to address learning difficulties and different learning styles because ICT:

- Has an edit effect in terms of quality of student work and practical examples through visualisation;
- Improves poor handwriting and English skills through word processing;
- Equalises individual differences and particularly has dramatic effects for students with special needs;
- Facilitates self pacing with increased capacities to deal with individual learning styles as students can work at the pace and intensity suitable to their needs;
- Enables collaborative learning with little indication of the isolated learner;
- Encourages use of peer coaching and peer reviews;

- Develops communication skills and awareness of different audiences;
- Impacts on resource–based learning and access to real world information through the Web;
- Increases reliability and currency of information adding to authenticity of learning tasks, with realistic and up-to-date information;
- Increases student motivation through hands on activity, visual representations and improved modes of presentation;
- Encourages independent learning and individual preferences for process, layout, style and format;
- Gives students more control;
- Allows to students to produce high quality multimedia products;
- Changes teacher practices, planning tools and assessment rubrics; and
- Increases opportunities for classes to evolve and for student experiences to shape outcomes.

Collectively, these lead to more individualised learning based on need and are more likely to tap into student's interests. Such effects align with effective teaching and learning theories that focus on literacy in early years, autonomous learning in the middle years and flexibility and self directed learning for post compulsory students.

3.3 Teacher attitudes

ICT also challenges teacher assumptions about ICT, disadvantage and learning. Teachers need to develop skills in their own disciplinary area and across the curriculum in utilising ICT in ways that are attendant to the operational, the cultural and the critical dimensions of digital literacy and do not just see ICT as another tool. Many teachers lack confidence in using ICT.

Other factors are the attitudes, expectations and approaches of teachers. Teachers vary in how they approach ICT as individuals, often resulting from their own experience of learning about and with computers. Much of the literature refers to how teacher attitudes to particular students become embedded in how they use ICT in classrooms, based on particular understandings about the nature of a particular student's difference and how they are 'disadvantaged'. Teachers who have low expectations and believe that students cannot learn unless they know the basics tend to use ICT as another way of developing basic skills in foundational literacy and numeracy. Teachers who perceive students have a literacy or numeracy difficulty tend to work on basic skill levels through drill and practice. This exacerbates difference in achievement amongst students because students already perceived to be 'good students' have their learning enhanced further with the greater use of advanced computer skills.

Teachers who believe that all students benefit from a challenge, that learning is not a linear process from basics to advanced, and that students can learn both basic and advanced skills simultaneously tend to use ICT more creatively for students who are perceived to be disadvantaged. Such teachers are more likely to see ICT as having positive benefits for these students, and schools as playing a critical role in providing the types of ICT experiences students do not receive at home.

More innovative teachers do not see ICT as a replacement for traditional teaching approaches, but as part of a repertoire of teaching strategies. ICT can improve learning when teachers are intensively trained to make professional judgements about the

appropriateness of particular ICT and the needs of their students. Therefore, there is a need for a significant shift in approaches to ICT professional development.

3.4 Gender

Girls, technology, maths and science

Despite girls' alleged 'anxiety', lack of interest in computer studies in secondary and further education, sense of exclusion from technology, science and maths due to the stereotypic representations of girls and technology in software and macho culture of many ICT classrooms, the gender gap in achievement appears to be closing rapidly. But the increased presence of computers in the classroom and their increased use by girls has not reduced girls' significant and increasing under representation in computer studies and post-compulsory courses on ICT that may lead to lucrative technology careers. This requires further research.

Competence and confidence: affective dimensions

In technology rich classrooms, female and male students are motivated, achieve equally, but use computers differently. Girls use email for communication and boys use computers for games. Girls' social interaction around the computer is more collaborative with a high level of linguistic interaction focusing on inquiry. Boys interact cooperatively but not reflectively, dividing up tasks between them. Gender differences emerge in the affective dimension, as boys and girls have different perceptions about competence and use value. Girls undertake sex stereotypic tasks and succeed, but also are less stereotypic in their attitudes about competence. Boys are more sex stereotypic, consider boys are better, and seek to control any interaction around the computer. Girls view computers instrumentally as tools, boys gain pleasure from computers as toys. The issue is therefore about how computers are more closely tied up with narrow notions of masculine identity and not seen to be central to feminine identity.

Boys and literacy

The notion of literacy needs to be expanded to include audio, visual and print. ICT will only enhance the learning of students who already have basic literacy habits although it can enhance the process skills of writing, revising and reflecting. ICT facilitates the view of pedagogy as play, performance and practice, possible strategies that can re-engage students at risk. The cultural apprenticeship model suggests that students can be engaged more in literacy learning when there is recognition of the family computer literacies, popular culture and ICT skills that the students bring to school.

In one case study, a cultural worker worked in partnership with four boys who were identified as being 'problems'. They were difficult to control in school, with poor literacy skills and aggressive 'macho' behaviour. They were seen to be practical and not intellectual. Although having a reputation for being disengaged and literacy 'failures', these four boys indicated a range of abilities outside school. They could easily strip down motorbikes and they had good relations with their parents in most instances. They appeared to have little trouble with literacy when reading and talking about motorbike magazines, manuals, and labels. This suggested that their school behaviours were performances of masculinity that they identified with at school but that

were not carried with them out of school. Yet there were few moments where their interests were used as the basis of their schoolwork. There was significant disjunction between the literacy practices in school and out of school.

Using the cultural apprenticeship model, the boys worked together with teachers on a real task to find out how to work with technologies more effectively. The students then became 'teachers' of other students. The boys indicated a high level of computer literacy, and they were able to gain new credibility in school where they mentored their peers. They could convert images into files and create hyperlinks through words or images. They also were able to talk about the cultural dimensions of technological literacy, such as the relationship between the motorbike enthusiasts and the Internet, how advertising works on the websites and the use of domain names to attract web users.

Language and computer mediated communication (CMC)

The 'cultures of computing', the network of social relationships that occur around computers, are gender, class and race inflected. While CMC facilitates capacity for anonymity and encourages risk taking, existing patterns of gender relations can be readily reproduced e.g. bullying.

3.5 Schools

Most effective use of ICT has occurred when there were whole school policies that were coherent, comprehensive and integrated with other policies, for example, the language policy and equity policies. These have provided a framework in which teacher initiative is encouraged; where there is a strong leadership culture that supports risk taken by teachers around ICT; where the focus is on improving learning of disadvantaged students; and where there are moves to maintain continuity of ICT learning for students across the curriculum and through the grade levels so that individual students are monitored.

ICT refocusses the use of the library to become central to technology planning. Librarians can

- locate, coordinate, cache and catalogue Internet sites, and CD Rom based material;
- train staff and students in accessing, verifying, evaluating and annotating online information, and developing online materials;
- identify inclusive subject matter, websites etc and train in gender-equitable and inclusive practices;
- extend computer access to students who do not have computers at home;
- provide one to one work with students to assist in upgrading skills and computer literacy in a problem solving capacity; and
- facilitate cross curriculum approaches.

Increases in pedagogical use of ICT in school classrooms occurs if computers are also available to teachers at home, if there is adequate technical support, *and* if teachers have access to ongoing professional development

3.6 Home-school

The literature suggests that home computer use significantly impacts on the capacity of ICT to improve the learning outcomes for all students. Home access is a key element as to whether and how students integrate ICT into their learning in school.

The socio-cultural contexts of children's domestic computing play an important part in shaping children's interactions with computers. In particular, the technology culture of home impacts on student dispositions. Students learn ICT at home and this makes students experts, changing their relations with teachers. Familiarity is a key aspect to developing 'habits of digital literacy'. Some students are able to develop a wide range of digital literacy skills while others with restricted availability and lower levels of familiarity, reach only basic skill levels.

Different use of computers between home and school results in schools controlling but not exploiting home based skills. The playability and exploratory possibilities that could act as a bridge between lower socio-economic students' home literacies and those valued at school. Awareness of these possibilities could inform a more relevant curriculum for those students.

3.7 Communities

ICT promises a capacity for schools to be linked to both local and virtual communities. At the same time, technology poor schools often have low socio economic and/or high cultural diversity student populations, and are often located in low income or isolated regions with poor telecommunications infrastructure. What schools can do with ICT to enhance student learning is therefore conditional on community resources, local community organisations' relationships with schools, and the distribution of ICT resources locally. There is enthusiastic support among communities for the uptake of new technologies at school and significant interest within such communities to make better use of a school's information technology resources.

Most individuals learnt ICT through social and community networks of friends and relations rather than formal educational institutions. Many students' computer use outside school related mainly to computing games and the quality of computer hardware and software was limited.

Structurally, schools are working more collaboratively through learning networks to meet the needs of students at risk, share limited resources, provide ICT infrastructure and professional development and gain support of local government services.

ICT can be a catalyst for community renewal that can address educational inequality. Governments are encouraging schools to establish learning networks in which students and teachers link more closely to their local neighbourhood communities, and also to virtual communities globally.

3.8 Indigenous students

ICT for Indigenous students needs to be located into a broader framework of influential factors that go beyond ICT more generally if ICT is to become an effective learning tool for Indigenous students. Factors influencing learning include school relations, cultural exclusion and the culture of schools. Indigenous students enjoy use of ICT. Successful programs for indigenous are community based, involving parents and elders. ICT provides opportunities for students to edit and review, self-correct and produce quality products. Students like to gain creative control over their work. Virtual communication

and presentation to different audiences means risks can be taken and mistakes made without any “shame” associated. Computers also offer quick feedback, colourful graphics and good visualisation, tapping into aural, oral and visual traditions. These all lead to engagement and improved learning. Successes for indigenous students occur when teachers have changed both the culture of their classroom teaching and their teaching styles to accommodate the needs of the students using ICT.

3.9 Students with disabilities

Studies looking at the factors that are essential in the use of ICT in inclusive schooling for these students confirm the importance of:

- collaborative learning;
- educational and technological support;
- parental involvement;
- support for development of social supports (e.g. friendships); and
- behavioural supports for students with disabilities with challenging behaviours (Soto *et al.* 2001).

Most positive outcomes are for students with disabilities when there is:

- technology use that is supported by the family;
- instruction that is scaffolded;
- periodic maintenance and follow-up activities to ensure skill application;
- strategy instruction to enable students to generalise problem-solving skills from simulations to new situations;
- use of homogeneous dyads to improve reading comprehension, (heterogeneous dyad groups being more effective in improving written expression); and
- instruction delivered to entire classes using networked, individual response systems with individualised feedback.

The design features of ICT that enhanced learning for students with disabilities were also identified and included the provision of:

- immediate feedback;
- learner options to use hypermedia enhancements and speech synthesisers to support understanding; and
- prior instruction in building declarative knowledge before students engage in fluency building practice.

Technology provides effective instruction when well designed and used under teacher control, and when teachers can effectively modify content in computerised study guides to enable students to learn content at appropriate levels.

Technologies with some empirical validation included:

- speech feedback in basic skill areas through speech synthesis;
- hypermedia textbook enhancements;
- multimedia composition (Fizgerald and Koury 1996);
- onscreen keyboard programs (Clicker 4 and Wordbar) (www.cricksoft.com) providing scope for both curriculum innovation and access technology;

- software programs with inbuilt switch access and automatic programming of adaptive devices (e.g. IntelliKeys) (www.intellitools.com); and
- software utility programs that include a combination of tools, including text-to-speech, voiced spell checkers, thesaurus, word find and word prediction features (e.g. WordSmith, TextHELP! Read & Write) [www.textHELP.com].

Technology is important for students with sensory and learning disabilities. Technology assists students with procedural tasks such as recording assignments and note taking and with cognitive tasks such as calculating, spell checking, and synthesising information.

The features regarded as important by teachers and parents of students with disabilities that are equally applicable to many learners from disadvantaged circumstances, are:

- allows students to proceed at their own pace;
- provides a format for individualised instruction;
- provides immediate feedback;
- increases enthusiasm for school in general;
- improves self-concept;
- increases engaged time, time on task;
- helps compensate for communication disorders;
- facilitates student learning about things they otherwise would not be exposed to;
- improves academic performance;
- fosters student participation in mainstream activities;
- provides socialisation opportunities;
- provides an increased range of leisure activities;
- enables better discipline.
- facilitates student interaction in creative activities;
- offers a format for playing of games to learn and develop cognitive skills such as cause and effect and remembering; and
- helps students learn life skills that support independent living.

3.10 Who benefits?

The literature review indicates that the use of ICT in classrooms does impact on student learning in general, but with qualifications. There is some evidence (large scale statistical studies, smaller experimental studies and case studies) that there is improvement in standardised tests in foundational literacy and numeracy for all groups with the use of ICT, but often only marginal and with no long term evaluation. There is little mention in most studies of the quality of the hardware and depth of integration of ICT into classroom practices.

Most teachers in most subjects have indicated an overall sense that students were more engaged with learning, but could not comment on why and what effect this had on the cognitive outcomes of learning.

Students who are not academically inclined can benefit from the development of ICT multiliteracies. Students engage with the more sophisticated multimodal uses of multimedia to acquire aesthetic literacies (design), aural literacies (music), visual

literacies, as well as digital literacies (technical expertise in computers and Internet). The broadening of outcomes to incorporate the full range of multiliteracies is an area that requires further exploration, particularly with regard to possible benefits for non-engaged students, particularly boys, and Indigenous students.

The use of computers changes patterns of learning (cognitive processes) and attitudes to the organisation of learning for both mainstream and students with disabilities. Students using ICT are more organised and began to understand metacognition (i.e. learning how to learn). Indeed, for all equity groups, the use of computers and the Internet increases motivation, particularly for students who do not like reading or students who have physical difficulties with books.

There are other psychological and social benefits that have been perceived by students, teachers and parents. Students have improved capacities to work collaboratively, to undertake longer term problem solving and tasks, to undertake independent learning, and to articulate their processes of problem solving. In most instances, working in groups around computers provokes discussion between students. CMC online also provokes interaction but at a more professional level among teachers, and at a more social level amongst students. Again, there is a need for studies of students working with computers that focus on these social and psychological outcomes.

There is quite consistent evidence that students with disabilities, Indigenous students, and students from low income homes all experience growth in their sense of self and agency and autonomy in their learning when given reasonable access to up-to-date computers at school. This is particularly evident when students otherwise marginalised are seen as experts in the use of ICT, as in the case of students with physical disabilities (Delzell and Hamill 1996). What is not known is whether this new sense of agency develops into longer term social, psychological and cognitive learning effects.

At the same time, this study emphasises that it is the quality of the social interaction and relationships, and in particular the student-teacher interaction that occurs once computers are fully integrated into classrooms that impacts most on student learning. All students, particularly students with learning difficulties, need prior and ongoing scaffolding, the metacognitive aspects of learning how to learn, that teachers provide in order to work effectively with computers. Computers are often a catalyst to radically change what is happening in classrooms as they facilitate moves towards student centred learning. However, such changes are less reliant on ICT and more reliant upon teachers' approaches to pedagogy and learning.

Most of the significant positive 'computer effects' are contingent upon students being in technology rich classrooms or come from action research based projects with researchers reflecting on practice. Students showing the greatest effects are immersed in classrooms over a period of time where teaching has been transformed along student centred lines with cross-disciplinary authentic curriculum and assessment tasks. Certainly, ICT can be a stimulus to reform classroom practices. But the most productive use of ICT is more likely to occur in transformed classrooms.

The primary impact of ICT is on the cognitive curriculum outcomes (e.g. literacy), metacognitive outcomes (e.g. organisation of work, making links), affective outcomes (e.g. confidence, competence, pleasure), and social competencies (e.g. social interaction, peer group, cooperative learning, communication skills) (See also Cuttance 2001:16).

4 Leading practices and strategies

This section presents exemplars of how schools, teachers and systems are utilising ICT in ways that positively enhance the learning of students who are disadvantaged. Vignettes illustrate ICT programs that operate in schools with disadvantaged students (in terms of high numbers of students of Indigenous, NESB and low socio economic background). Many of the vignettes were written by teachers. The vignettes indicate the capacity of schools, teachers, parents and communities to significantly improve the learning and school experience of students who are disengaged, underachieving and at risk when there are dedicated programs focusing on how ICT can transform classroom practices to benefit individual students.

These vignettes indicate the importance of context in shaping how new technologies are adopted and adapted in classrooms by teachers and students. Learning environments that facilitate the effective use of ICT tend to have the following characteristics

System level:

- university–school action research partnerships;
- targeted programs using ICT as a catalyst for school reform;
- additional funds from public and private sector; and
- a focus on whole school reform

School level:

- school based ICT policies;
- strong principal and teacher leadership teams focusing on integration of ICT for improving student learning as a means for changing teaching practice ;
- significant professional development support for teachers that focuses on how ICT can assist students at risk;
- full time technology coordinator on site to troubleshoot, plan, develop websites and online curriculum, improve communication channels;
- dispersed networks of computers equitably distributed across classrooms;
- student centred classrooms with a focus on independent and self paced learning , problem solving and inquiry based learning, authentic curriculum and assessment tasks;
- a focus on affective, social as well as academic outcomes;
- gender and culturally inclusive curriculum ;
- cross curriculum / cross classroom focus; and
- mix of virtual/real classroom interactions.

Home/school/community level:

- take home computer program;
- parent ICT literacy program; and
- community based networks.

Integration of ICT can promote significant changes in the practices of teaching and learning and can have benefits for students who are underachieving in school or are disaffected or excluded by school. The benefits from integrating ICT include:

- A shift from teacher centred to student centred learning that leads to a focus on individual difference and need;
- An enhanced, even new, capacity for authentic tasks and problem solving that has more relevance to a wider range of students;
- Changing what we understand as learning outcomes to be more broadly inclusive of cognitive, social and affective outcomes such as improved achievement, motivation, self concept and changed attitudes to school and school work;
- Making the processes of learning inextricable from the product, with multimodal processes and multiple products, that value a range of differences and learning styles and that are about improvement and reflection;
- Capacity for students through word-processing and processes underpinning web development to edit, revise and produce high quality work;
- Capacity of self paced computer based skills development in foundational literacy and numeracy to supplement other teaching strategies, imparting students with a sense of competency;
- Improved motivation and organisational skills for students who have difficulty with basic study practices;
- Development of metacognitive skills that provide learning scaffolds for learning as students make links e.g. invisible connections between text and images in web page development;
- Reduced anxiety and safer environment for students to take risks with learning through possible anonymity of learning communities;
- Authentic problem solving more likely to engage students with learning difficulties through multimedia dimensions with modelling, design features, data bases;
- Development of multiliteracies that incorporate a wider range of human skills and attributes—visual, aesthetic, oral and aural—through the multimedia capacities of ICT;
- Enhancement of student sense of self esteem and confidence resulting from the capacity of ICT to produce quality cultural products to a wide range of audiences; and
- Capacity to develop cultural inclusiveness through working with local and global communities both virtually and face to face.

These possibilities have significant implications for a more inclusive curriculum, a pedagogy that addresses individual need, and assessment that recognises a wider range of student interests and capacities.

The vignettes provide a range of strategies that teachers are employing in what are often technologically under resourced classrooms and schools. These are addressed below under 6.

5 Barriers

Barriers for students

As computer ownership becomes more universal, first order disadvantage comes from lack of access to rich technologies or thick access. Many working class students have 'thin access' to computers at home and schools, often hand me downs without the quality software, with minimal equipment and in many instances, a focus in teaching on the operational to the detriment of the cultural dimensions of ICT literacy. Most Indigenous students have no access at all. Most middle class families have thick access with high quality computers and Internet access. Students from these families attend technology rich schools that have technology rich environments with computers and the Internet and peripherals (i.e. multimedia workstations, peripherals, online courses, and the Internet on a needs basis).

Students learn digital literacies at home or from friends more than in school. Because of different ways of using computers and the Internet at home, students from low income families and black or Indigenous families tend to have less developed predispositions and habits of computer use due to less familiarity and less frequent use when compared to high income and urban students. This magnifies the existing 'home advantage' of middle class students.

Homeless students lack access due to limited hours and community providers such as libraries. Students with disabilities may not be able to access available technologies without the considerable expense of the adaptive/assistive software that has to be borne by families.

ICT is a new form of cultural capital that some students bring to school. Students from technology rich home environments tend to go to technology rich schools that are likely to have consistent policies and infrastructures for supporting teaching and learning using ICT, thus exacerbating existing advantages.

Barriers for teachers

ICT policies and teacher professional development have not made issues of individual difference and equity which is integral to successful use of ICT. The weakest area of teacher pedagogy is in the area of possessing a repertoire of skills that deal with individual difference and learning styles.

The focus of implementation of ICT policies and teacher professional development has been on the operational dimension (administration, access, resources, technical support), and not the cultural dimensions (gender dynamics in the classroom, control in the classroom, pedagogies), or the critical dimensions (values and attitudes). The cultural and critical dimensions of ICT are critical for teachers capacity to develop inclusive pedagogies, curriculum and assessment practices.

Teachers have not been encouraged to take risks or rewarded for innovation. Teacher professional development, both pre-service and in-service, has relied heavily on the care rather than courage approach, by adding ICT as another possible tool rather than integrating it into classroom practice in ways that transform the classroom (Downes 2001).

A major area for further development for teachers is how to make decisions about which technology to use for what students, how to do it, and how to judge the effectiveness of its use.

Teachers find that the demands of high stake testing and examinations work against cross-disciplinary problem solving, authentic curriculum and assessment.

Teachers have little time available for collaborative work or planning, or even professional development in ICT.

Teachers are anxious about using ICT because of its fragility—the unpredictability and insecurity arising from technical problems. As yet ICT is not part of the daily habits of most teachers.

Negative teacher approaches to students who are perceived to be at risk or as different can be transferred into a limited use ICT for those students i.e. focus only on operational ICT use for basic skills and not advanced ICT for problem solving.

Barriers for schools

Technology poor schools tend to be located in communities with inadequate communication infrastructure including small bandwidth, under resourced libraries, few Internet cafes, and even fewer ICT employment possibilities. The future digital divide, once access is universal, will be based on whether students have thick or thin access. No access means ICT has a multiplier effect in terms of disadvantage for NESB, Indigenous, low income and/or rural/ remote students. Thin access merely maintains relative position of students who are disadvantaged.

Systemically, there is a lack of coherent infrastructure policies or negotiations with telecommunication providers to supply access to low income families, low socio-economic and rural schools at lower costs resulting in narrow bandwidths and overall lack of regional infrastructure and employment in ICT.

Schools with greatest concentration of students with disadvantage tend also to lack community funds for ICT infrastructure, teacher professional development and rich technology classrooms. Cost escalates with isolation and for students who have disabilities.

Schools, particularly those that are disadvantaged, place greater demands on teachers, who find it difficult to sustain innovation due to the overload of responsibility and lack of long term funding. ICT has been the responsibility of individual school communities regardless of capacity to raise funds for equipment. Sustainability of any innovation or program addressing ICT and disadvantage is difficult because innovation is reliant upon a few innovative teachers who are more likely to be mobile. The danger is that the digital divide will increase as technology is further integrated into curriculum and assessment and becomes the norm of teaching and learning.

6 Strategies

ICT introduces another layer into the complexities of ways in which gender, socio-economic status, race, ethnicity, Indigeneity, and disability interact when ICT is integrated into teaching and learning. ICT has significant capacities to enhance curriculum, pedagogy and assessment in ways that are more inclusive of a wider range of learning outcomes and to address individual and group difference. ICT also has the potential to compound disadvantage for many students due to its costs and lack of availability of rich technology environments at home and at school.

This section includes both possible and ideal ways in which schools, teachers and systems can address issues of disadvantage. The strategies focus on changing student and teacher attitudes about ICT and also about understanding and valuing difference.

Transforming classrooms

ICT can be a catalyst for transforming schools, classrooms and the practices of teaching and learning. For ICT to transform classrooms, teachers need to change the focus from teacher centred to student centred classrooms. This requires significant re-organisation of social relationships and physical organisation of classrooms:-

- teachers adopting new roles as learners;
- disengaged students becoming tutors;
- parents of students with learning difficulties working in classrooms as both experts and learners in ICT;
- principals operating as managers of more equitable resource distribution;
- schools engaging ICT specialists with curriculum and pedagogical knowledge; and
- collaboration and mentoring arrangements between expert and non expert teachers in areas of both ICT and dealing with difference.

The pedagogical focus in such a classroom is on identifying and addressing individual difference and how this can be addressed through the capabilities of ICT. This approach focuses on:

- inquiry based problem solving;
- identifying individual and group learning needs (matching to appropriate ICT tasks);
- encouraging independent learning (self paced basic skills, extension, diagnostic);
- developing multiliteracies;
- monitoring and utilising a mix of group social interactions and teams to benefit all members of classroom (mixed sex/single sex, mixed/same age, mixed/similar ability);
- developing authentic, culturally and linguistically sensitive and gender inclusive curriculum and assessment tasks;
- encouraging students to move from 'learning to read' to 'reading to learn';
- developing *representational literacy,* ie. information, visual and media literacies, that focus on analysing and evaluating information in order to understand how meaning is created;
- developing *tool literacy*, i.e. images, graphs, audio and video with convergence of new software, hardware, Internet connections;

- using multiple modes of assessment that recognise multiple learning outcomes;
- utilising play, performance and practice to exploit student's prior learning from home and out of school e.g. popular culture;
- providing structured scaffolding of learning how to learn that can be made more explicit through ICT;
- mixing traditional and non traditional teaching methods—teacher talk, mini-lectures, student talk;
- maintaining a content focus;
- providing cross curriculum authentic tasks;
- developing programs that emphasise learning objectives in the context of individual curriculum plans, where the computer-based technology is integrated as a tool to assist in student achievement and not as an end in itself;
- utilising peer groups in ways that utilise the different gender dynamics of mixed and single sex peer groups by marching to appropriate tasks that address student need e.g. tasks that encourages girls to be risk takers and boys to be more verbally interactive; and
- increasing engagement using same-age and cross-age peer groups and mentoring that utilise mixed ability groups (subject and ICT) and same ability groups (ICT and subject).

6.1 Schools

Schools need to focus more on innovative methods that address real equity problems and develop coherent whole school policies that integrate equity principles. They need to encourage teacher leadership and innovation, and put pressure on systems to support greater risk taking for schools. System, school and classroom audits can be used to support pressure for equitable distribution of resources.

Central to successful use of ICT to engage with difference are consistent and convergent curriculum and assessment policies, school planning and teaching professional development that incorporate digital literacies and prioritise equity. These plans should be flexible given the way context shapes possibilities and the need for schools to work within constraints.

Support teachers and students need to develop collaborative learning across the curriculum that will extend student learning to include a wide range of multiliteracies and recognise a wide range of learning outcomes.

Schools need to require and support teachers to take responsibility for numeracy, literacy and computer literacy in all subjects through:

- School timetable reorganisation e.g. reduce number of periods to allow more indepth inquiry and cross disciplinary projects that also allow off block time for teacher planning to focus on individual needs;
- Hands on technical, curriculum and on-line development and support.
- Creation of programs that facilitate student peer groups and team work in the development of software and online activities;
- Encouraging a train-the-trainer model to both educating each other and gaining sense of competence;
- Identifying and sharing (through teacher networks and online data banks) a range of assessment tasks that address the full range of multiliteracies arising from

multimedia and computer based learning and that are inclusive of all groups. Consider assessment criteria of assessment for mixed mode multimedia; and

- Improving schools' access to support personnel in ICT and equity areas e.g. disability, either by the employment of staff on-site or increased access to metropolitan or regional support staff.

Schools also need to ensure that school leavers have a good understanding of ICT beyond operational competence by:

- Promoting curriculum development with different communities to raise students' and teachers' cultural awareness using computer technology as a means of ongoing communication and mentoring through cross cultural and cross community projects and curriculum;
- Initiating programs that focus on the integration of ICT into maths and science in ways that utilise the multimedia and multimodal possibilities created by ICT to make these subjects more attractive and inclusive for many equity groups;
- Rewarding innovative design that integrates ICT into pedagogy, curriculum and teacher professional development in ways that address difference and disadvantage;
- Developing a range of projects that consider various mixes of structured social interaction with other students and teachers, including peer support programs, same age and cross age mentoring, online tutoring and mentoring between schools and universities, and between teachers and trainee teachers, students and trainee teachers; and
- Exploring the different ways of assessing in multimedia environments in which students are both consumers and producers of curriculum.

These strategies mean reorganising school resources to allow for increased ongoing and dedicated time for teachers to reflect and engage in school, system and action research in partnership with universities. They also call for increased professional development, provision of teacher laptops for home and school use, rewards for teacher innovations, and creation of a public profile about ICT and its successful use by students who are disadvantaged.

School reform strategies

To achieve an inclusive ICT focus and cultural shift in schools and systems there is a need to develop teacher practitioner research and university school partnerships. Multidisciplinary collaborative projects must be developed that deal with the three dimensions of digital literacy—operational, cultural and critical. Team teaching and evaluation of innovations are other important aspects for development.

The primary objective of such approaches would be to use ICT to develop innovative pedagogies that address difference and redress disadvantage.

6.2 Systems

There is a need to institute technology plans and guidelines at State and school levels which specifically address the educational needs of students in all equity groups. There is a need to address the distribution of ICT resources across and between school sites in deprived geographical areas, the provision of computer hardware and software to equalise resources, and the establishment of school networks for teacher professional development and shared curriculum.

There needs to be development of a high profile focus on geographical areas that are seen as underprivileged (rural/isolated and outer suburban areas) through dedicated programs in which schools become the centres of community renewal through ICT. Particular attention needs to be given to remote Indigenous communities and disadvantaged young people in urban areas who have no access to computers in the home and have low use at school.

Programs that identify and develop networks for access to key databases (e.g. libraries, museums, local networks and community based organisations) need to be established and become resources for less well resourced schools.

Funding for on-site support is required by all schools in the form of a separate information technology appointment. This person should have curriculum, design graphics and technology expertise for online curriculum and pedagogical development to provide advice and training on software that is inclusive and designed for use with specific students. These staff could be locally based using online university courses to create jobs in rural and remote communities where unemployment is high and technical assistance low.

Teachers and schools need to be provided with criteria for the selection of appropriate assistive and adaptive technology to build confidence, support exploration and independence of students with disabilities.

Teacher professional networks (real and virtual) that bring teachers in technology rich and poor schools together need to be created and supported for teachers to share and learn from each other's experiences. These collaborations could include:

- allowing time for tryouts in the classroom between sessions;
- increasing the opportunity for teachers to increase their professional circle;
- giving opportunities for responsive adaptation of the face-to-face sessions by the theme group leaders;
- arranging visits or subsequent face-to-face meetings in the participants' various schools; and
- accessing online clearing houses of leading practice on inclusive technologies that focus on how to enhance the learning of students who are disadvantaged through the innovative use of ICT.

6.3 Home-school links

Strategies to address the home–school disadvantage of particular groups focus on the use of schools as centres of ICT learning in communities. This requires extended hours, (24 hour access to online resources), low cost or no cost leasing arrangements of computers for low income families, and low cost infrastructure agreements with providers. Parent involvement is encouraged through in-school training, participation in decision making about ICT resources, use of parental expertise, parents learning with students about ICT, parents as mentors and trainers, students as trainers of parents, and improved communication with parents about student progress and performance in communities. Home-school links are critical as most children learn ICT through familial and social networks. This early familiarity produces a home advantage that exacerbates the existing educational divide that arises largely from socio economic inequality. Home-school strategies include:

- Increasing familiarity with ICT in pre-schools with high proportion of students from low income, rural, NESB and Indigenous backgrounds by developing programs to encourage computer literacy of children by encouraging parents with preschool

aged children to become involved in schools or community based centres around learning about and with ICT;

- Encouraging students to develop with their teachers and parents individual plans that identify ICT needs e.g. home use; and that chart progress and the skills students acquire (similar to Pathways Planning for school work transition);
- Encouraging community, family and student use of local school technology resources by extending school hours and making ICT to be more 'family friendly';
- Enhancing relationships between home and community through parent and community ICT training programs;
- Providing online information and data bases, curriculum etc. to students and families; as well as guidelines for purchasing and borrowing software for home computers and information about protection of students online (e.g. NETALERT); and
- Developing programs that encourage and enhance Indigenous students and communities as cultural producers that can become integral to educational programs and inclusive curriculum.

Community based renewal

ICT has meant that the boundaries between home, school, work and leisure spaces are blurring. Schools cannot facilitate the integration of ICT into teaching and learning in ways that can benefit students who are disadvantaged on their own. In order to enhance the community/home/school links that are important to improving students' learning experiences, and also to use the school as the centre of community renewal in low tech and lower socio-economic localities with government and business support, schools can become centres of these learning networks, and also centres of community based renewal. Such an approach would bring together other networks and community organisations to provide access to the Internet and computers for out of school or homeless youth as well as to provide training that is focused on specific issues of interest to youth.

The models that can encourage partnerships with government, organisations, telecommunications and ICT organisations and unions to develop community based projects are designed to:

- Support students from low income families to gain access at home e.g. home computer schemes, sponsored laptop schemes, e-Learning foundations or low cost leasing schemes through schools;
- Establish mentor schemes for teenagers with ICT experts in workforce;
- Encourage ICT experts as volunteers to train students;
- Make strategic links with other educational and ICT providers to share infrastructure and expertise;
- Encourage commercial development of low cost multifunctional devices that are attractive to young people;
- Identify and mobilise low cost possibilities to purchase within a network (e.g. the ACTU scheme);
- Develop school partnerships with universities, TAFE, local government, libraries, community networks, education centres, welfare and health agencies, and develop local innovative projects using ICT to enable youth to become valued cultural producers in their communities;

- Employ local youth with ICT skills to be targeted for scholarships that would assist with online design development;
- Improve the lack of access to ICT by Indigenous by enabling increased home use of ICT for Indigenous families by developing community based programs that provide access to parents, teachers and students; and
- Extend and enhance successful models of ICT use by Indigenous people and students, e.g. Koorie Links, and other community based programs.

6.4 Teacher education

Teacher education is both a major barrier and a major strategy. Recent research reports agree to the importance of putting teachers first (Lankshear and Snyder 2000). ICT use and related pedagogy relies on teacher attitudes, teacher familiarity and access to ICT.

The report highlights that good pedagogy utilising a repertoire of teaching and learning approaches to address individual and group difference is a precondition to the effective use of ICT in classrooms. A major conclusion of this report is the need to prioritise teacher education, both pre-service and in-service, which addresses innovative pedagogies using learning technologies that address difference.

There is a need for systemic and systematic programs to up-skill many teachers that go beyond the capacity of individual schools to deliver. This is particularly the case for mid and late-career teachers. The basic principle of all teacher education, pre-service and in-service, is that it deals with all three dimensions of digital literacy—operational, cultural and critical—particularly if ICT is to address disadvantage.

Teacher education should provide a strong pedagogical and curriculum focus on problem solving together with identifying how to make professional judgements about the efficacy of using ICT, when to use it, and how to judge its effect. This means using more explicit teaching about the metacognitive strategies that can be used to assist students who are disadvantaged. These students require structured scaffolding with regard to how literacy and numeracy can be linked to digital literacies and need extended practice in application of skills that can integrate technology.

Good models of teacher education, both pre-service and in-service, are those that:

- make equity central to all programs;
- increase the awareness of all schools and teachers of the equity issues for Indigenous Australian students;
- address all three dimensions of digital literacy: operational, cultural and critical;
- develop teachers' repertoire of teaching approaches and ways of integrating ICT to focus on group as well as individual difference;
- are action research based, preferably in collaboration with university based researchers, provide time for reflection and planning, particularly around how to deal with individual difference;
- focus on product and process simultaneously by working through a pedagogical or curriculum problem';
- encourage teachers to undertake multimodal forms of curriculum and assessment development;
- provide curriculum and assessment frameworks in which ICT use is embedded that teachers can readily adapt to local circumstances and the needs of their students rather than prescriptive models;

- use online converging technologies to model how to learn about at the same time they learn to use ICT;
- assist teachers to develop a capacity to make professional judgements about appropriate use of ICT for specific groups and tasks;
- work with students on individualised learning programs including support and guidance about use of digital learning resources;
- assist teachers to identify and track students at risk earlier;
- develop teacher awareness of ICT issues for students out of school and ways of helping these students learn with and through ICT;
- use learning assistants and mentoring programs in classes;
- simultaneously focus on learning through and learning about ICT by focusing on problem solving tasks and dealing with both content and process; and
- identify ways that ICT can facilitate cross curriculum and inter school projects that require all teachers to assume responsibility for digital literacy.

6.5 Leadership

Principal and teacher leadership training is particularly important to innovate and support and sustain innovative pedagogies that will focus on students with learning difficulties. Strategies that can facilitate this approach include:

- Providing principals with professional development and peer group support (real and virtual networks) on how to manage ICT in ways that address disadvantage e.g. flexible timetabling / strategic planning to address specific needs of equity groups;
- Developing new approaches in which teacher pre-service and in-service education are interrelated and integrated in schools through a focus on student difference. For example, student teachers work with technology skills and then with teachers with pedagogical and curriculum experience to resolve learning difficulties in classrooms;
- Building principles of equity already in existing equity policies into existing professional development programs on ICT; and
- Developing specific programs dedicated to addressing ICT, learning and difference that address issues of gender and cultural identity and evaluating their influence on student options and classroom practices and behaviours.

6.6 On-line learning

The report highlights the need for culturally and gender inclusive software and online curriculum. One strategy is to encourage the development of design and graphics skills of online curriculum amongst students and teachers is to include disadvantaged students in the design stage of on line curriculum and pedagogy utilising ICT. In this way, online curriculum can incorporate relevant local knowledge available to students and teachers into curriculum. Such locally developed technology based curriculum material and software would seek to recognise learning differences and needs of specific groups to facilitate local adaptation. Computer mediated communication (email etc,) should also be based on protocols that are gender and culturally sensitive.

7 Further research

Issues raised in the report indicate the need for an integrated research program on a number of fronts. Research needs to focus to a greater extent on the complexities of how difference and disadvantage mediate the effects of ICT on learning rather than focus solely on single categories of disadvantage. Studies should be longitudinal where possible, consider a wide definition of learning outcomes, and be based on action research across a number of sites. The following areas require further research:

- Cultural attitudes and English language competencies and the ways they shape digital literacy learning;
- The use of vocational, recreational and community based ICT to encourage employment through online courses to increase access and post school options;
- The dynamics of computer mediated social relationships in classrooms and how they are inflected by gender, ethnicity, indigeneity, class and disability;
- The impact of popular culture, representations of difference; multiliteracies and multimodal assessment on learning;
- The impact on learning of pedagogies focused on play, performance and practice;
- Teachers' ways of learning about ICT and how this shapes their way of teaching with ICT;
- Virtual learning networks as a means of school and community reform;
- The long term effects of technology rich and poor schools and homes on learning and social outcomes;
- Professional development approaches, including train the trainer;
- Cross age and peer tutors telementoring;
- Identification and charting of how teachers make professional judgements with respect to effective use of ICT that address cultural, gender and individual difference;
- Development and assessment of 'train the trainer' and 'mentor' models, using students as teachers, teachers as learners based on the cultural apprenticeship model; and
- Development of understandings about the social, psychological and cognitive dynamics of learning through structured social arrangements, with particular regard to how teachers and students understand and work with social dynamics of the classroom with regard to difference (socio-economic, gender, race, NESB, disability).

The report concludes that in order to gain 'on the ground' research on ICT practice in schools in general, and ICT practices that focus on enhancing the learning of disadvantaged students in particular, more rigorous research projects across a range of systems, schools and classrooms are required.

Section A Introduction

1 Overview of project

Techno-cultural change has ‘profound implications for the way people work, interact, educate and entertain themselves in the future’ (NBEET 1995:4). Government, education systems, schools and families have invested considerably in the past decades in Information and Communication Technology (ICT).[1] Computer literacy is perceived to be a critical skill in individuals’ full participation in education, work, leisure and government in the knowledge-based economy.

Equity has become a major concern as information becomes a major commodity and key aspect of participation in society. The use of ICT is becoming widespread and taken for granted in schools.

On the one hand, Information and Communication Technology has the potential to provide a more inclusive and democratic education. Because of its 'virtual’ nature, ICT can be inclusive in terms of providing increased access to different cultures and perspectives, and forms of communication and interaction that are less informed by prejudices that are based on differences of gender, race, class, ethnicity and disability.

On the other hand, there are significant possibilities that ICT can produce new as well as reproduce old exclusions. Indeed, there is increased concern that ICT may, because of the cost of equipment and access, exacerbate social and economic divides to produce a new digital divide, thus increasing the polarisation between different educational communities, social groups and individuals.

While the most immediate equity issue has been that of access to computers, multimedia peripherals and the Internet; as access has become more widespread, attention has focused onto how ICT can be effective in student learning. This project focuses on how the new learning technologies in schools can enhance the learning outcomes of groups that have historically been disadvantaged in education.

[1] The encompassing term *information and communication technology* is now widely used in research to describe the multiple modes of communication and information gathering capabilities of computers. We will also use the notion of *learning technologies* as it captures the educational emphasis on pedagogy and includes the range of communication and information technologies that can be reasonably expected to be found in schools. ICT is used more because of the interactivity that is possible through new communications network. ICT includes hardware and software such as computer conferencing (using synchronous, that is, ‘real time’, and non-synchronous networks); Internet and intranet; databases; multimedia, including video conferencing, CD-ROM, online courses; as well as adaptive and assistive technologies that "increase ability and function" for computer users with disabilities (Sprigle & Abdelhamied 1998:229).

2 ICT, learning and disadvantage

This report seeks to consider some of the claims made about how ICT can enhance learning and in particular the evidence that suggests that ICT might enhance the learning of disadvantaged students.

The literature reveals much information on what constitutes effective teaching and learning when using ICT in primary and secondary schools. However, in looking at the use of ICT with disadvantaged groups, the questions became:

- What learning technologies can enhance the learning of which students, how and why?
- How can these processes be used with disadvantaged students to enrich and enhance their learning outcomes?
- What do we know about ICT integration into schools and classrooms and disadvantaged students that can inform how we address the ‘new disadvantage’ that ICT can itself produce?
- What strategies can be used to address disadvantage?

The integration of ICT into teaching and learning is now a key priority in most school systems and schools. Since the early 1980s, ICT has been introduced into schools and then into classrooms on the untested assumption that 'ICT is a good thing' with positive effects on teaching and learning. It was more a matter of faith than informed by research. In the past three years, teachers, researchers and governments have begun to focus on how ICT can enhance learning, in particular in regard to enhancing:

- higher order thinking e.g. problem solving;
- the complexity of tasks;
- student motivation due to use of multimedia;
- independent learning;
- simulation of real world environments; and
- self-paced learning.

At the same time, the move to self-managing networked environments has on the one hand provided individual schools with more flexibility to make decisions about how to organise teaching and learning. On the other hand, this increased capacity to make decisions about resources and staffing has seen government seek to maintain accountability through a stronger emphasis on learning outcomes, in particular the cognitive outcomes of literacy and numeracy, and more recently computer literacy.

ICT can change not only the nature of learning, but also the way we understand learning outcomes, as ICT develops a range of literacies - visual, aural, oral and aesthetic. Therefore the project not only considers performance indicators such as access, participation, retention and destinations but also emphasises the significance of cognitive, social and psychological learning outcomes (Willis and Kissane 1997). Cognitive outcomes include the more readily quantifiable outcomes such as levels of literacy and numeracy as measured by standardised assessment, or achievement in specific learning areas e.g. languages, studies of society and environment (SOSE) and the arts. Metacognitive outcomes include the ability to plan, organise and reflect upon learning, to understand the scaffolding that informs fields and the connections between different fields.

Social and psychological outcomes can include: improved self esteem and confidence; improved attitudes to learning and technology; increased motivation; greater

engagement with learning; cooperative and collaborative team work; a sense of design and aesthetics; full participation in curriculum offerings of a school and a classroom; good interpersonal relations; increased sense of competence; and increasing choices of further education and career. At the same time, these psychological and social outcomes are difficult to measure and are often seen in the research and anecdotal evidence in terms of teacher perceptions of improvement.

Outcomes-based education involves the premise that 'all students can achieve learning outcomes of significance only when the conditions necessary for their success is met' (Willis and Kissane 1997:2). The conditions of learning with respect to ICT means equity of access to computer hardware and software and other assistive technology that may be required for access; the quality of social interaction in teaching and learning that the technologies promote; and full and inclusive participation across the range of activities.

Finally, the project suggests that we also need to consider the types of outcomes most desirable for a knowledge-based society for all students. There is a growing body of documented practice arising out of school-based practitioner research as schools and teachers are asking the question: What types of knowledge and skills do students need for a knowledge-based society? An evaluation of the impact of the integration of ICT into a Navigator school in Bendigo Secondary College, Victoria (Toomey *et al.* 2000:13), reported how teacher perceptions, validated through survey, classroom observations and analysis of student work, identified a set of generic outcomes that included:

- investigating
- searching for information
- selecting relevant information
- researching
- organising information
- solving problems
- using information to support a point of view
- presenting information
- communicating in ways appropriate to an audience
- deciding
- being creative
- visualising ideas
- working cooperatively with others
- keyboarding
- learning autonomously
- learning independently
- sharing skills and ideas
- awareness of global issues
- making connections between school and the real world.

Increasingly, teachers and students need to develop more sophisticated capacities to frame their judgements about how to use ICT to enhance learning. Such generic outcomes are desirable for all students.

3 Digital or techno-literacy

ICT demands new forms of digital or techno-literacies. The New London Group (1996) suggests that knowledge based economies will require multiliteracies that include cultural, technical, text-based, graphic and visual, oral and aural literacies, emotional and physical literacies, as well as digital or techno-literacies**.** Digital literacy is more than the acquisition of skills in the use of particular technologies or software, e.g. email, spreadsheets. In *Uptime: students, learning and computers*, ICT access and literacy of tertiary students in Australia (DETYA 2000), Oliver and Towns define digital literacy as 'a set of skills and understandings required by people to enable meaningful use of ICT appropriate to their needs'. While expectations differ according to educational level, digital literacy is increasingly part of everyday for many younger students. There is a continual regeneration around what constitutes computer, digital or network literacy. Digital literacy is now comparable to the print literacies of reading and writing, and should be taught, many would argue, as part of core skills in schools.

The practices involved in new techno-literacies (or digital literacies) such as reading the Internet, designing a Webpage or publishing with Photo-shop are different from those related to print technologies. These are new modes of literacy that will be important modes of communication for all students in work and leisure as the Internet becomes as essential in communication as the telephone. These techno-literacies are particularly important for students as an avenue for experiencing success in schools where they have not previously in more traditional frames.

Tyner (1998) refers to three categories of literacy, two pertaining to technology:

1. *traditional text or alphabetic literacy*, i.e. narratives that move from 'learning to read' to 'reading to learn';
2. *representational literacy,* i.e. information, visual and media literacies, that focus on analysing and evaluating information in order to understand how meaning is created; and
3. *tool literacy*, i.e. images, graphs, audio and video with convergence of new software, hardware, Internet connections.

In *Education and Technology Convergence*, Tinkler *et al.* (1996) argue that it is necessary to go beyond digital literacy and consider ‘information literacy’ which takes into account the need for higher order thinking skills in processing information. The evaluation of the Information Super Highway report in the UK refers to the development of 'network literacy', i.e. the capacity to use electronic networks to access resources, to create resources and to communicate with others. These are extension of traditional literacy skills of reading, writing, speaking and listening (Lawson & Comber, 1998).

A most useful conceptualisation of digital literacy that informs this report arises out of the *Digital Rhetoric* (1998:5–6) report on literacy, technology and learning. The ‘3D’ model suggests there are three dimensions to literacy practices: operational, cultural and critical. These dimensions are equally applicable to digital literacy. They can be defined thus:

- The operational dimension involves competency with regard to the technical aspects of ICT.
- The cultural dimension refers to the meaning of ICT use within specific contexts and with regard to content. It is about understanding ICT in relation to the context of its use and the appropriateness of its use.

- The critical dimension addresses the socio-cultural context. The critical dimension is about understanding the ethical, cultural, environmental and societal implications of the use of ICT and the development of a sense of stewardship and responsibility regarding the use of ICT (Nixon 2001:192). The notion of critical digital literacy goes beyond the mere acquisition of operational skills, to including conceptual understandings of media as imparting messages and about validating the source in that they can learn to determine issues of reliability and relevance. Such a view of computer literacy aims to give it long-term validity in the face of the barriers described above, by distancing it from the operational specifics to a meta-cognition level.

It is something of a truism to observe that students' skills in the use of ICT outstrip those of their teachers. But this is largely at the operational level, most of which students have learnt at home. *Real Time: Computers, Change and Schooling* (Meredyth *et al.* 1999) found that almost all of the 6000 Australian students surveyed in 1997/8 were able to perform more than half of the information technology skills they specified as basic. Basic computer literacy was defined as 'the ability to use a mouse, turn on a computer, use a keyboard, shut down and turn off, exit/quit a program, save a document, print a document, start a program, open a saved document, delete files, get data from floppy disk or CD-ROM, create a new document and move files (Meredyth *et al.* 1999:27). Two thirds of them were able to perform them all.

More than half the students had 'advanced' skills, defined as including the ability to play computer games, draw using the mouse, use a computer for creative writing, letters etc., use spreadsheets or databases, use the World Wide Web, search the Web using key words, create music or sound using a computer, send an email message, copy games from a CD-ROM or the Web, create a program, use virus detection software, create a multimedia presentation and make a Web site/home page (Meredyth *et al.* 2000:27). This percentage reduced depending on the complexity of the skill, e.g. 48 per cent could do a multimedia presentation while 38 per cent could make a website. While there would be a filtering down effect with each successive age cohort as younger children have more access and use of computers. They are therefore more likely to have higher level of (skills) in successive groups. These figures indicate that the current generation of students are not as competent overall across a wide range of skills as is sometimes suggested.

Teachers by and large were found to be keeping up with the 'basic' level of skills, but were frequently less proficient when it came to knowledge of some of the 'advanced' technological capabilities such as multimedia creation, using video music and sound clips and creating Web sites or home pages (Comber & Green 1998).

Of specific interest to this report was the variance in digital literacies according to school types, size and sector, location and income area and according to students' socioeconomic status, cultural background and ethnicity' (*Real Time* 1999:xxvii). The *Real Time* report highlighted that:

> Indigenous students and those from small schools, especially in rural and isolated areas, were most likely to lack basic skills. In the advanced skills range, students from Independent schools and single sex boys' schools report familiarity with the most complex uses of informational technology. Students in small schools and schools in rural, isolated and low income areas are falling behind. Boys have a more advanced skill range than girls do, although their basic skills are on a par. They are also more confident about their ability, while students from language backgrounds other than English are markedly more confident (Meredyth 1999:xxviii).

The *Real Time* report reinforced the findings of other international studies concerning the disparity of students' skills and opportunities. Differential levels of digital literacy

outcomes for secondary school graduates can have a multiplier effect of disadvantage in terms of further education and employment outcomes, given the assumption in most jobs that employees have basic if not advanced computer skills. This long term awareness of the implications of students leaving school without the three dimensions of digital literacy is important in that ICT rich learning environments in the near future will include:

- increasing numbers of portable computers (laptops and wireless) deployed flexibly;
- broadband access to the Internet that will host a range of educational materials and information that can be accessed by teachers and students at home and school;
- personally owned ICT;
- effective access to a rich blend of educational content delivered through multimedia (Broadband to Internet, digital television, satellite and DVD) and facilitated by managed learning environments that lead to personalised curriculum and feedback;
- increased used of presentation technologies (digital processors and interactive whiteboards) that support whole class teaching and opportunities for students to express creativity through digital video technologies, publish and edit online
- opportunities for learners with special needs to participate fully e.g. voice activated software;
- transfer of media rich materials between home and school; and
- distributed learning such as master class across locations.

(NGfL *Transforming the way we learn,* Department of Education and Skills 2000:24)

These are all at the operational level. We suggest that all students in a rapidly changing technology environment will require all three dimensions of digital literacy—operational, cultural and critical—to be able to participate fully in society. This is because of the nature of disadvantage and how difference is socially constructed within and through schooling.

4 Difference and disadvantage

There is now significant research that identifies the factors that disadvantage students individually and collectively in and through education. The term ‘disadvantaged student’ does not imply some deficiency on the part of individual students or groups of students. Rather it understands disadvantage as a complex set of factors that prevent some students from equitable access to, and participation in, worthwhile educational experiences.

Access, retention, participation and attainment have been key foci in equity policy, and are important in assessing the effectiveness of schooling for any group. These measures may demonstrate the existence of disadvantage, but do not provide much insight into how disadvantage actually operates. Indeed, the categorisation into discrete ‘equity groups’ so evident in the research, based on gender, race, Indigeneity, socio-economic and NESB background, or disability, can disguise the complexity of intragroup and individual experience by focusing on potentially stereotyped group characteristics. School failure can be too readily attributed to a kind of group pathology rather than on a range of social and economic conditions and relationships. Such categorisations provide explanatory models that fail to deal directly with practice; and ignore subject concomitants of disadvantage. For example, how Indigenous students make sense of and respond to the exclusion, domination and constraints that constitute disadvantage (Gilbert & Gilbert 1994:1–2).

‘Disadvantage’ is better understood as the cumulative effect of a complex conjuncture of factors. Groups traditionally understood to be disadvantaged in Australia are rural and isolated students, Indigenous students, students with disability, children of non-English speaking background and girls. But it is not a disadvantage *per se* to be male or to be female, to be an Aboriginal, or to have physical or intellectual disabilities. Yet these groups may suffer disadvantage through a range of socio-political factors, through living in isolated communities or through physical barriers to participation. The question therefore is “disadvantaged by what?” Dunn (2001) concludes, ‘disadvantage is the inadequate response of educational institutions to such conditions that cause disadvantage’.

The introduction of ICT into schooling can create a new dimension of disadvantage. Technology can promote inclusion or mediate exclusion, depending upon a number of factors: the currency of hardware and software; the conditions of use; the context of the field of knowledge or disciplinary area; the pedagogy associated with the use of ICT, including the level of accommodation of different learning styles; and the purposes for the use of the technology, whether for enhancement, consolidation or remediation.

ICT can promote inclusion in terms of its possibilities of reducing isolation, providing new modes of communication across cultural groups, providing new forms of access to students with disability.

These are the multiple factors that need to be taken into account as we consider how teachers grapple with the complexity of disadvantage in classrooms and how ICT can assist students who are underachieving.

4.1 The complexity of disadvantage

While recognising that disadvantage is the cumulative effect of a range of interacting factors, the project found that much of the research and indeed policy has focused on particular equity groups with little disaggregation within e.g. gender with no mention of ethnicity, race or socio-economic status. Furthermore, the equity areas named in policy (gender, socioeconomic, NESB, Indigenous background, and disability) have different histories that have produced particular understandings about what it means to be 'disadvantaged', as outlined below.

Socio economic issues

There is now considerable literature on how socio-economic factors impact on student learning. Poverty increasingly coincides with single parent (mostly female headed) families, school-aged individuals with disabilities who are homeless (Anderson-Inman 1999); those who have little parental support (Anderson-Inman 1999, Meredyth *et al.* 1999); those with different racial/ethnic backgrounds (Kaye 2000); and those from rural environments (Meredyth *et al.* 1999). The convergence between school learning and home are increasingly recognised as being central to student achievement. Yet many families in poverty experience a dissonance and disaffection with schools arising from the discontinuity between school and community/home language, learning and literate practices (Comber & Green 1999:64). School cultures (disciplinary policies, emphasis on competitive academic curriculum, inflexibility about uniform, poor student teacher interaction) tend to lead to formal and informal exclusion of ‘at risk’ students who do not ‘fit’. Despite their high expectations and commitment to their children’s education, many parents are unable to provide costly ICT home resources, high quality computers and access to the Internet for their children even though they see digital literacy as important to their children's education. Yet the widespread integration of ICT into schools has the capacity to magnify the gap between low and high income families. The difference is further compounded by the fact that many such families live in poorer or more isolated communities that are unable to maintain ICT infrastructure. This has significant implications with regard to exacerbating differences between schools as ICT becomes a key indicator of a good school and attracts students. Socio economic issues therefore permeate through how ICT mediates the important links between home, school and community that underpin school achievement.

Cultural and linguistic diversity

In all schools there are students with a range of literacy repertoires and capacities as well as children with diverse linguistic and cultural heritages. Students bring different literacy practices to school as they possess different linguistic, cultural capital and literate resources. Some have resources that match those valued by the school more than others. Others may have resources (cultural knowledge, language skills) that they are unable to use at school because these resources are deemed irrelevant or inappropriate (e.g. bilingualism). Many children, because they are not fluently bilingual, have difficulty in fully engaging with the curriculum either because they have not yet grasped the English language, or because they have not previously engaged with the cultural experiences assumed in the curriculum (Nixon, forthcoming: 4–6). Many students can be progressing in English skills but miss the key points in their reading and in teacher presentations (i.e.metacognitive links). ICT provides opportunities for the development of basic English skills, non verbal visual and arts based activities and computer assisted instruction (CAI) in language that can be inclusive of cultural

difference. ICT can also, because of the strong assumption about the English skills base, exclude students from more complex textual presentations and expectations.

Gender

There is now significant research and policy that informs gender equity practices in teaching and learning. Since the early view of gender difference as being a product of sex role stereotyping and socialisation in the 1970s, we now understand gender as being a socio-cultural construction that is an expression of identity embedded in the structures and cultures of organisations, society, home, school, work and society. This socio-cultural perspective considers that the social relations of gender construct femininity and masculinity in relation to each other. Different cultures and contexts produce different masculinities and femininities and therefore different relations of gender, to which any individual may conform or dissent (Kenway *et al.* 1997). Such a perspective sees disadvantage arising out of a set of historically embedded social, political and economic structures, cultures and practices in which particular masculinities and femininities are privileged over others in specific contexts. Gender is seen to be relational; the interactions between boys and girls involve institutions and cultures that shape their gendered identities. Schools therefore have aspects that are culturally masculinised and other aspects that are culturally feminised e.g. dominant male leadership, feminised early childhood, competitive or caring ethos.

The disadvantage experienced by girls is now understood to be less about their socialisation into gender stereotypical roles, their lack of skills, sense of competence and self confidence, and more to do with their under-representation in particular fields of study such as science, engineering and most recently computer science and related careers, despite their apparent educational achievement. This under-representation is explained by their own sense of identity and a range of factors related to how they make choices about their futures and careers within different cultural, economic, social and familial contexts. It also points to the importance of the ways in which institutional cultures in school and work inform girls' decisions (Kenway *et al.* 1997).

The recent focus on boys has been on their perceived academic underachievement, as well as therapeutic issues such as their inability to manage their emotions, their lack of interpersonal and communication skills, and associations between masculinity, violence and suicide. Increasingly there is recognition that differences between boys and girls in terms of how low income, ethnicity and race impact on educational achievement and who is at risk are greater than differences between boys and girls (Gilbert and Gilbert 1998).

The gender issue therefore is more about 'which boys' and 'which girls' are disadvantaged and how ICT can enhance the learning of particular groups of boys and girls (Collins *et al.* 2000). In terms of gender, technology is a new variable that shifts what constitutes disadvantage, as there are strong associations between masculinity, science and technology; and negative associations between femininity and technology. Technology may therefore introduce new forms of advantage for some high income boys and a new element of disadvantage for most girls.

Indigenous students

Numerous historical factors have contributed to the disadvantage of Indigenous students within the schooling sector, although Indigenous people do not use the term 'disadvantage' to describe themselves. Indigenous students are not disadvantaged

because they are culturally different from the mainstream students. They are disadvantaged because of the way in which the mainstream culturally excludes them. Racism and the impact of previous political and social policies on families and communities, together with different forms of exclusion through education are the factors that disadvantage Indigenous students. Stereotyping leads to further disadvantage, and has a negative affect on how Indigenous students understand their life opportunities. Historically, Indigenous people have had limited access to the education system, and when they were able to access education, its effect was diminished by its lack of resources and restricted curriculum delivered by largely unqualified or under qualified people. Contemporaneously, the exclusionary practices of schooling are a more subtle form of cultural exclusion with the unproblematic acceptance of the schools' institutional culture that has particularly narrow models of success that means mainstream schools are still not catering for the needs of Indigenous students. For Indigenous students, their disadvantage in education is exacerbated because the majority of Indigenous families are located in the lower socio-economic group.

Cultural barriers remain as an integral part of the system and result in the tendency to exclude Indigenous knowledge, thereby presenting a barrier for the full participation of Indigenous students. This is evident in their lower retention rates, lower literacy and numeracy levels and lower employment levels (Collins *et al.* 2000). The relatively poor learning outcomes of Indigenous students are identified in the findings of the Inquiry into Indigenous Funding Report:

> Participation rates by Indigenous students are lower than those of non-Indigenous students at the primary level. Indigenous retention rates to year 12 are less than half those of non-Indigenous students. The limited Indigenous Education Strategic Initiatives Programme (IESIP) performance monitoring data indicates that Indigenous grade progression rates are much lower than those of non-Indigenous students. Reading standards achieved by Indigenous Year 3 students are much lower than those of non-Indigenous students. All of these indicators are the indicators of success for students in the schooling system *(Commonwealth Grants Commission draft report 2001:8)*.

The National Strategy for the Education of Aboriginal and Torres Strait Islander Peoples (2002) recognises that the enhancement of learning outcomes for Indigenous students is dependent on a community based approach with a focus on equity of outcomes, where community is understood not just to be the Indigenous students and their community.

Whether ICT has the capacity to enhance learning outcomes for Indigenous Australians depends on correctly identifying the problem. To focus only on basic skills in Aboriginal literacy programs is not likely to improve literacy levels or participation levels in schools because it does not address cultural exclusions. Exclusion for Indigenous students is based on the same patterns that have worked against them in the past. By exclusionary patterns we do not mean physical exclusion but the socio-cultural climate and practices of 'normal' schooling. To address cultural exclusion means schools and teachers need to contribute significantly to social reorganisation of schooling and its relationship to community (Dunn 2001).

While we document studies that have indicated that ICT can enhance the learning of Indigenous students in particular ways, there is a need to recognise that there is no one strategy that will overcome the high level of disadvantage of Indigenous students. There is a danger of transferring the deficit models that have been developed in literacy programs across into the instruction, software and methodology of the ICT area. The same principles that underpin the learning of literacy, underpin the learning of ICT as a

new form of literacy. Furthermore, it can be predicted that Aboriginal students will experience further discontinuity between home, school and community because of lack of access to ICT outside the school environment. To address this situation, there is a need to focus on strategies for overcoming the discontinuity between home/school for Indigenous students.

Students with disability

Disability constructs particular forms of disadvantage that focus on access to, and participation in, the full range of experiences and opportunities open to most students. There is a range of responsibilities embedded in Commonwealth and state legislation to ensure that all students and young people, including those with disabilities, receive an adequate education[2]. Funds are targeted at those students in greatest need, focusing on schools with a high concentration of students with disabilities. Disability standards for education are currently being developed under the auspices of a national taskforce established by MCEETYA in 1995 to cover areas such as enrolment, participation, curriculum development, accreditation and delivery, student services and the elimination of harassment and victimisation.

Students with disabilities have been categorised by educational policy as a 'disadvantaged' group deserving of resources allocated to 'special needs'. Because of the nature of physical and intellectual disability, compliance to standards of provision for educational and training institutions require adjustments to the curriculum, institutional organisation, and learning and physical environments. Policies have already led to the introduction of integration and inclusive schooling policies with a range of supports from building ramps and special amenities to provision of assistant teachers, teacher aides and personal carers.

Technology can reduce the effects of impairment by improved activity and greater participation, to promote inclusion of students with disabilities.[3] Access to ICT for students with disabilities may require more (and more costly) resources than are provided for other students. Different technologies are adopted or adapted for use for students with hearing, vision, communication, physical and intellectual disabilities.

Technology issues arise in two ways for students with disability. First, the emphasis has been on the costs of providing services to people with disability in the form of assistive technologies, rather than the costs to society of not providing services resulting from dependence on welfare and the loss of productivity, apart from wider social costs. Technologies which provide universal access should contribute to future reductions in the costs of specialist technologies. The trend towards inclusive schooling, exemplified in the moves to integrate students with disabilities into mainstream schools, has been supported by the development of assistive and adaptive technologies (AT), which aim to compensate for physical, sensory impairments and communication impairments. Technology can increasingly be regarded as a

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[2] Under the Strategic Assistance for Improving Student Outcomes (SAISO) program, the Commonwealth is providing almost $1.4 billion over the 2001-04 quadrennium to support the work of schools and teachers in assisting educationally disadvantaged young Australians, including students with disabilities.

[3] The *Real Time* study (Blackwood, 1999) cited 4 per cent of Australian students had a disability and 6 per cent had learning difficulties. Students in special schools were not represented and the current policies and practices for these students were not comprehensively covered in the Blackwood study.

participatory tool in *general* classrooms due to hardware and software upgrades and the availability of AT.

Second, with the introduction of ICT as a new mode of pedagogy, access to computers enables students with disabilities to participate more fully in learning activities. In turn, such participation will prepare them 'to participate in the knowledge based economy of tomorrow' (Fichten, Barile & Asuncion, 1999:6). The employment demands of technological competence, and the ability to engage in teleworking, internationalism and outsourcing, mean that older students with disabilities who have ICT skills can aim for employment using synchronous or asynchronous communications (Greenhill, Fletcher & von Hellens 1999, Coutts 2000). The Internet in particular can **en**able students with disabilities as it puts them in touch with people and knowledge they would normally have no contact with (Anderson-Inman 1999, Delzell & Hamill 1996). Fine (2001) points out that the Internet can equalise, **en**able, and "level the playing field".

The corollary is that students with disabilities are doubly **dis**abled when they have access to neither assistive technologies or use of ICT pedagogically. Thus there is the potential for technology to further marginalise students with disability.

There is another possible dimension of exclusion. Often hardware and software are not accessible in the school environment to students with disabilities because of the lack of enhancements in visual, sound or tactile features, but also because the availability of these features elsewhere (e.g. at home) encourages students to work in isolation from peers (Barlow *et al.* 1998). In school environments, downloading and using software available over the Internet is also restricted by ICT administrative functions (e.g. firewalls) which prevent full access. Access to internet-based programs, including government funded software specifically for people with disabilities, is impeded (Owens and Keller 2000).

Finally, the increased sophistication of computers, technology, tool programs, and hypermedia-based instructional materials means people with disabilities are likely to become the 'information poor' class in society (Edybum 1991). As the nature of teaching and learning changes in the technological classroom, the real challenge for teachers of students with disabilities goes beyond technology and instruction. Indeed, the ultimate challenge is to provide students with technology survival skills for a changing future.

Issues arising

What is common across these 'categories' is, first, the dilemma of categories themselves. To categorise a group in order to address a specific set of needs is to immediately name them as different with a tendency to compensate or highlight differences that can promote prejudice and stereotypes and to deny difference within categories. To promote inclusiveness into the mainstream is to deny recognition of difference through policy interventions and thus maintain the disadvantage. This is the dilemma that permeates this report. Equal treatment does not necessarily produce equal outcomes.

Second, both addressing disadvantage as well as integrating ICT fully into classrooms, requires whole scale school and systemic reform that recognises difference and prioritises equity. The capacity for ICT as a tool, albeit a sophisticated one, to enhance the learning outcomes is contingent on a shift in values, institutional relationships, school and classroom organisation, as well as teaching practices.

5 The ‘New Disadvantage’

This report signals that ICT has significant potential to advantage students previously excluded from the benefits of schooling, such as collapsing distance for isolated students and enhancing physical capabilities to allow for greater participation for students with disability. The Leading Practices outlined in this report indicate how teachers adopted and adapted technologies in ways that addressed the complexity of difference by addressing the multiplicity of factors that lead to students not achieving in school through a focus on specific student learning needs. At the same time, this approach was more successful when there was a wider understanding by teachers and within schools of what disadvantage meant for different students, and how there was a need to cater for difference collectively as well as individually.

At the same time, ICT also has the dangerous possibility of becoming another 'factor of disadvantage' that exacerbates educational inequality—in terms of differential access, participation, and success. Disadvantage is compounded for many students because of the coincidence of poverty, race, and isolation, for example. To distil some of these complexities through particular cases:

- Gender differences for boys’ and girls’ levels of literacy achievement are greater among students from low socio economic backgrounds than among students from other socio economic groups (Masters and Morrison 1995). Female lower income students are less likely to have access to computers and the Internet. Yet these girls are most likely to be high users in work on particular types of low skilled clerical work.
- Low income/poor and Aboriginal boys do most poorly on current literacy tests and over-represented in remedial and behaviour management program, truanting, suspension and school exclusion lists. They leave school early and have least chance of long term or decently paid employment, are over represented in the youth justice system and feature in suicide and death from substance abuse statistics. Their access to ICT is limited in school, and less likely out of school. Yet ICT is most likely to engage them and therefore keep them in school (Gilbert and Gilbert 1994).
- Indigenous girls, on the other hand frequently suffer from low self-esteem as a result of the racist and sexist attitudes to which they are exposed in the school environment e.g. name-calling. They are more likely to live in poor communities, which frequently are coping with the destruction of traditional roles for men and women and the struggle to create new, viable, contemporary options. These same isolated and poor communities lack the telecommunication infrastructure that makes these girls’ access to ICT training and work less likely once they leave school. At the same time, these girls are more likely to return to education and gain basic computer literacy through community based networks.

Disadvantage can therefore be exacerbated by ICT in a number of ways. The most significant factor disadvantaging students with regard to computers is lack of computer access (Bimber 2000, Meredyth *et al.* 1999, Lawson & Comber 2000, Hoffman and Novak 1998). Burbules and Callister (2000) suggest the following levels of access:

1. technical access (computer and Internet connection);
2. development of skills, attitudes and dispositions that are necessary to effectively use the computer, i.e. the 'habits' associated with digital literacy;
3. practical access, the conditions and criteria or circumstances that differentiate who can and who cannot use the Internet, time spent and quality of use i.e. patterns of exclusion and inclusion; and

4. form and content of online environment, i.e. modes of thinking, ways of learning and doing, openness that leads to harassment etc. (Burbules and Callister 2000:20–32).

The first two levels are the critical ones because they can, unless there is universal access, create a new digital divide both in and out of school.

This report focuses on the quality of access and what teachers can do when they and students have access. This produces another dimension. Burbules and Callister (2000) usefully distinguish between thick and thin access:

Thin access is based on the assumption that access is a gateway that everyone just has to enter and everything will be equal.

Thick access is about both access and credibility.

> Issues of access to the Internet, or who can use the Internet (who can afford, a computer, who can get an online connection, who knows how or use the software etc…) and issues of credibility (who can make sense of what they find on the Internet, who can judge what is and what is not worthwhile and who can gain credibility and visibility as an information provider) (Burbules & Callister 2000:19).

Thick access occurs when students understand and are heard. They access multiple levels of ICT. It means ready access in the classroom, home, or out of class for a significant time, and the quality of access in terms of up to date equipment, assistive technologies for students with disabilities and technical support and multimedia and online learning.

Disadvantage can be exacerbated through ICT if there is only thin access, usually the conjuncture of low socio-economic homes and schools, poor quality computers, high student to computer ratio, and teachers without computers in school or at home. Thin access is also when there is an over emphasis pedagogically on basic skill development and dispositions, or in schools without a strong desire for innovation using ICT.

Much of the literature focuses on thin access to the telephone, Internet, computers and online courses. Most studies equate quality to the numbers of students per computer. There is little information in most studies about thick access and the quality of either the software or hardware, or of content and pedagogy.

While thin access will reduce the possibility of a growing digital divide in schooling and in later life as technical access increases, thin access also will maintain existing conditions. Many of the Leading Practices indicate how the more innovative teachers can use ICT successfully in their classrooms to assist students with learning difficulties despite thin access. Indeed, the emphasis is more on the cultural and critical dimensions because of the lower level of technical infrastructure. But thick access makes the difference in terms of more equitable educational outcomes and occupational futures in the long term. Thick access at home and at school, which means thick pedagogies in terms of dealing with the operational, cultural and critical dimensions, prepares for working in the new knowledge economy and online environment, and is more likely to produce attitudes and way of seeing more creative use of new technologies.

Section B Research on Difference, ICT and Learning

Background

In 2001, Professor David Reynolds, in the UK report *Primary Schools of the Future: Achieving Today* (DfEE, 2001:3), stated:

> Thus far, the research into whether ICT has effects, the appropriate utilisation of it, and 'what works' in terms of the balance between hardware, software and teacher input is an area of assertion more than evidence.
>
> Such research that has been done internationally is of dubious validity, sometimes relying on studies of innovative persons and schools using ICT in which it is unsure of the extent to which any effects are because of the technology or the persons using it. The historic research is often on small samples, rarely controls out effects of things other than ICT. It is rarely rigorous enough in its methodology, or its search for explanations of findings to support the weight that has been put upon it.

The Reynolds Report sought to identify instances of fundamental change that focussed on teaching and learning with particular regard to equity. It found that the research tended to reduce issues of equity to matters of access, listing the barriers to implementation. This is typical of much of the published research.

As we found in this literature review, there is not as yet a substantive body of research illustrating fundamental changes in practice arising from the introduction of new learning technologies into the classroom, with some recent exceptions (Cuttance 2001). How ICT enhances learning is now a key focus of both university researchers and education systems, often working in collaborative partnerships[4].

Furthermore, there is even less research on how learning technologies can address issues of disadvantage and difference. The reality is that many teachers and schools are still struggling to confront the immediate practicalities of integrating computers into schools and classrooms, focusing more on 'learning about technologies' than 'learning to use the technologies' in their teaching. Much of the research has focused on using computers in programmed instruction contexts, and therefore maps certain effects (e.g. benefits for students with special physical needs in terms of access) and not others (social and pedagogical effects). There is less attention paid to how different information and communication technologies can be used for different purposes (e.g. teacher and student administration, curriculum development, pedagogy) or to benefit particular social groups. The research that is available is uneven and located in individual schools.

Research on ICT has adopted different approaches over time. The use of experimental design in the 1970s has been largely supplanted by qualitative studies focusing on ICT

[4] A Linkage grant between University of Technology of Sydney, Deb. Hayes and Lyn Yates 2002-4 in partnership with the NSW DET is focusing on How Technology Can Enhance Learning. This is an example of collaboration between researchers and practitioners and government to undertake inquiry into practice.

as socially constructed practice in the 1980s. The past decade has seen more use of multiple research methods in the 1990s that include key macro surveys providing statistical snapshots of computer access and use across large populations, experimentally designed studies contrasting small cohorts of students, case studies, and some longitudinal ethnographic studies of classrooms and students. This has created difficulties in interpreting studies that reflect contrasting conceptual frameworks (Snyder 2000:101).

To some extent in Australia, the foci of research on ICT followed on from policy initiatives. For example, the *National Policy for Girls in Australian Schools* in 1987 led to an increase in research and affiliated activities on girls' education, including studies of gender differences and ICT. Similarly, policy developments in Indigenous and integration education more recently have prompted new research into its efficacy for these groups. Technological innovation is especially strong in prompting research in the area of disabilities.

The Australian literature falls into the following broad areas:

- Access
- ICT literacy and skills development
- School management issues: school policies, resources, infrastructure
- Evaluations of implementation strategies e.g. state wide policies such as laptop programs and professional development
- Attitudes to ICT of teachers, students and parents
- Perceptions by teachers as to impact on learning
- Barriers to the use of ICT
- Teacher professional development

Disadvantage is a focus of some research and reports, but has been generally addressed under access and type of use issues.

There have been similar shifts with respect to ICT and disadvantage reflecting policy shifts, with an early focus internationally on race, and in Australia on gender as the key ICT and equity issues. Only recently has there been attention to ICT, indigeneity and ethnicity in Australia and internationally. There is a dearth of research on the types of pedagogical strategies teachers can use with students with disabilities, given that the issue for students with disabilities has largely been defined as one about access and communication.

Classroom practices are the focus of this section. In order to consider the use of computers by school students for learning across the curriculum, one has to look at a broader range of environmental variables as what teachers can do in classrooms is highly dependent on a range of contextual factors.

How ICT impacts on learning is mediated by experiential aspects of digital literacy, familial use of computers, personal attitudes, peer and teacher social relations as well as contextual factors such as school, classroom and peer 'techno–cultures'. In turn these are inflected by the dynamics of race, gender, class, location and physical attributes that can produce new forms, or remediate old forms, of disadvantage.

This chapter first considers research on how ICT can be linked to learning, then focuses on what this means for particular groups. The chapter concludes by raising the issue of who benefits and how from ICT, and points to significant gaps in the research.

1 Links between ICT and learning

There is significant evidence that the integration of ICT into classrooms and schools changes the processes and nature of learning. There is less comprehensive and rigorous evidence of the effectiveness of ICT directly linked to improving learning outcomes. Views of teachers involved in the use of ICT are generally positive. The Information Technology Learning Environments and Disadvantage project (ITLED) in South Australia that worked in disadvantaged schools commented: 'the teachers' optimism and enthusiasm for IT as essential to teaching English in a disadvantaged school is palpable' (Comber & Green 1998:98).

At the same time this project, as did others, felt that much of this was based on an untested faith on technology being able to motivate, maintain enthusiasm and provide new pedagogical possibilities. Wenglinsky (1999) in a two year English project on computer use with fourth and eighth graders (*Does it Compute?)* argues that there has been little data, research or programs that have explored whether computer delivered instruction actually improved performance for any students. When ICT is fully integrated into classrooms it can become a catalyst that changes the pedagogical relations and nature of learning. This makes it difficult to disaggregate the impact of ICT from other factors when evaluating learning outcomes.

Large scale quantitative studies indicate that ICT produces a statistically significant difference in learning outcomes on standardised tests of literacy, numeracy and science (e.g. Wenglinsky 1999; Reynolds 2001; Weaver 2000). The improvements are similar across all ability levels. These same studies also indicate a close connection between schools with better ICT resources and better grades. That is, computer use is significantly correlated with gender, socio-economic status, parents' level of education in maths, all interdependent variables that are possibly more important contributors to student achievement than computers. The outcome measures used for quantitative studies also tend to be on limited outcome measures in maths, literacy and science. For example, Yelland (2001) concludes that computers can increase the mathematical achievement of students in preschool and primary, the largest gains being made when they are used for mathematical drill and software programs. But most often technology implementation is limited in maths to utilising graphical calculators and ICT for visualisation without any fundamental changes in traditional curriculum or pedagogy. Yelland (2001) suggests there are possibilities to expand conceptual frameworks using software. For example, SimCal and ThinkerTools use probeware in which students can explore the concepts of decimals and graphs, and Middle School students can use Model-IT and Stella that include spreadsheets, Logo, data packages and Computer Assisted Drawing Tools to create dynamic models in geometry. American research (e.g. Burton & Jaworski, 1995) on particular mathematics software applications such as Cabri Geometry; Geometer's Sketchpad and Micro-Worlds appears to focus on cognitive outcomes. But this has not yet been developed. Indeed, there is little systematic collation of data on the range of computer applications being used in Australian mathematics classrooms (Forgasz 2001).

These results should also be treated with caution. The test scores tend to be based on computer self-paced exercises for development of basic skills in literacy and numeracy utilising basic ICT skills, with very narrow understandings of both digital literacy and of learning outcomes (Yelland 2001). Furthermore, while students can do more earlier and faster, with Year 3 students engaging with notions of variables, quadrants and negative numbers, their conceptual understandings may be limited. Certainly, their learning experiences in an interactive environment could be expected to have some

impact on later achievement (Yelland 2001). However, Yelland concluded that the effective use of ICT in schools not only influences learning outcomes in terms of the quality of work produced by students but also predisposes them to engagement with mathematical ideas and affords them the opportunity to learn in new and dynamic ways that were not possible without the technologies (Yelland 2001:1)

Some schools and systems have moved towards laptops—either for individual students, as class sets, dispersed through schools and/or for teachers. The results indicate a more positive relationship between laptops and attitudes to schooling rather than achievement (Belanger 2000, McDougall *et al* 2001). Abrams' (1999) evaluation of a laptop program in a selective private girls' school indicated that girls saw computers as improving what they valued in terms of presentation, taking notes, efficiency, access to data bases (e.g. Encarta) and the capacity to include pictures and graphs in projects, particularly in academic subjects of English, history and science. Achievement improved when laptops were part of wider curriculum and pedagogy based on inquiry such as in middle school science. As yet there are few longitudinal studies as to their effect, with the exception of McDougall *et al* (2001).

Laptops have potential in terms of equity, since they are mobile between school and home, can be leased, refurbished, and acquired more readily through sponsorship and grants. They are also more prone to theft, damage and high maintenance costs.

The Australian research strength lies in qualitative studies about ICT and broader understandings of what constitutes successful learning, based on case studies of individual classrooms and schools that will be referred to throughout this report (e.g. Downes 1996, Comber & Green 1998, Lankshear *et al.* 1997). There are smaller case studies such as that by Honan (1998), who undertook a teacher-as-action-researcher project investigating the impact of computer-mediated instruction for health education and physical education on cognitive, affective and physical development in a Year 2 class. He concluded that:

- teaching methods were crucial to success;
- gender, behaviour, and access to home computer also affected student performance; and
- using computer-mediated learning required a change in pedagogy.

These themes are common to other studies.

These case studies and larger systemic reviews of the literature e.g. (Meredyth 1999, Green 1999, Wenglinsky 1999) suggest that teachers and parents agreed that ICT:

- motivated and stimulated learners;
- solved some problems of students' 'motivation' for academic work and competence with literacy;
- encouraged problem solving, and analytical and creative thinking;
- improved students' understandings, assimilation and creation of new knowledge;
- provided new modes of communication to network locally and globally;
- provided access to data bases, websites and discussions that were previously unavailable;
- assisted in the development of independent learning and research skills; and
- reduced failure for at risk students.

Wenglinsky (1999) also reported that ICT assists in social development, leads to the new skills necessary for a knowledge society such as digital or network literacy, as well as improved subject learning and vocational training.

1.1 Technology rich classrooms

Bede (2000) argues that ICT impacts on the complex relationships of the classroom and school—between curriculum, assessment, pedagogy, professional development, administration and organisational structures. One of the earliest longitudinal and qualitative studies to investigate what happens when ICT is fully integrated into classrooms was *Apple Computers of Tomorrow*. ACOT was a research based partnership between schools, university researchers and the Apple Company commencing in 1980, which provided each of the 216 students in 7 schools (four primary and three secondary) and their teachers with a computer at school and at home. These classrooms were seen to mirror the student population characteristics (race, gender and class).

The limited software available at the time meant teachers developed imaginative integration of technology across the curriculum (e.g. word processors, graphics programs, databases, spreadsheets, and Hypercard for educational uses). After two years, drill practice decreased and more interactivity increased. There was a transition phase in which teachers transposed traditional pedagogies and materials, such as whole group instruction using computers, to group work and student centred activities. Student deportment and attendance improved, as well as students' attitudes. Test scores indicated that at the very least, students were doing as well as they had without the technology, and some were performing better. In some sites where test scores were a focus, there was a significant improvement. Qualitatively, ACOT students did write more, and with greater fluency, completing year levels more quickly.

Teachers worked more in teams, including cross-disciplinary teams. They changed school schedules and classroom organisation, and increased focus on projects and tasks with different mixes of learning and communication tools. Teachers' lessons and students' projects indicated mastery of multimedia presentations. The project found:

- students did not become social isolates but rather computers fostered cooperative learning and task related activities;
- students' interest in and engagement did not decline with use but they demonstrated an ongoing fascination and used it more frequently and imaginatively as their technology skills increased; and
- training for students and teachers was most effective when they did technical and subject concerns together.

Dwyer (2001) listed the benefits after five years in these technology rich classrooms. There were significant differences between the 216 ACOT students and their student cohort in the same schools with reductions of average absenteeism by half, 90 per cent of ACOT students graduating on to college compared to 50 per cent of their cohorts, and 21 ACOT graduates receiving academic awards. Importantly, there were long term benefits in terms of attitudes to learning and study habits. Students later indicated that they had learned to organise and undertake schoolwork differently. That is, these technology–rich classes developed inquiry, collaborative, technological and problem solving skills uncommon to traditional high school graduates. Many ACOT students were hired by local businesses.

Other longitudinal qualitative studies of technology rich classrooms indicate there are clear benefits in terms of a wide range of outcomes. For example, Mayer-Smith *et al.* (2000) found that technology-rich science classrooms attracted both female and male students who then achieved similar success, promoted greater social interaction, produced greater student satisfaction, and improved learning outcomes in general.

Mayer-Smith *et al.* (2000) undertook a seven-year longitudinal study, Technology Enhanced Secondary School Instruction (TESSI), of two Canadian science classrooms, Years 9 through to 12, one being a lower socio-economic culturally mixed school and the other a middle/upper class Anglo school. These classrooms were technologically rich with multimedia computers, printers, laser disc players, data acquisition that allowed for computer simulation, multimedia presentations, digitised images and video as well as the Internet. These non-traditional sources were supplemented with textbooks, laboratories, demonstrations, problem sets and fieldwork.

The combination of technologies, resources and new instructional strategies led to a 'classroom-in-action'. Students entered the classroom with a clear sense of purpose and set to work without teacher direction. Typically, different science activities were occurring simultaneously. Students could elect to work in pairs, individually, or in small groups and determine their own path of learning within limits. Students positively believed that these classrooms were different and special.

Yet the technologies were not the focus of the discussion—the emphasis was on the different modes of teaching and learning that occurred. Both males and females had similar experiences in these technology-enriched settings. Students identified a number of features they found to be valuable for their learning. These were student centred and included self-pacing, flexibility, choice and activity oriented, self monitoring and working with peers. They said that the project focused them on learning how to learn. Those students who did not enjoy the unit pointed to the lack of teacher direction, having the expectation that teachers as experts should tell them what to do.

Barnes (2001:7-8,15) reports that in the Discovery Schools in South Australia, learning outcomes could be attributed directly to the use of technology in terms of the extension of ways of learning, the amplification of exploration and discovery, and the transformation of learning. Students were freer to focus on the bigger picture while technology performed processing, sorting and display tasks. For example work was more structured, could be edited for quality, and took account of different audiences. Students could extend their thinking through computer assisted planning, sorting, graphing, visuals, presentation or communication. Students were more willing to be creative and fearless and work through trial and error because of quick feedback. Students were able to access information previously inaccessible. They could communicate their learning in new ways, ones that they were more comfortable with, such as through visual representation, through animation and by digitised voice and email. Teachers' comments were about students with motor skill difficulties who were able to type more easily than write, and for the ability to provide instant feedback. They commented on the capacity of students to focus more on learning than writing, using various programs as tools. Teachers had the flexibility to manipulate variables and situations, to use visual forms such as concept maps, and to use the Intranet within the school to access sources of up to date information. The report indicated that some forms of learning were done better on computers, in particular editing and production of high quality texts, charting options, and discovery learning. The learning technologies tended to equalise individual differences particularly for students with special needs, those with poor handwriting and poor communication skills. The technologies also promoted authentic learning through access to resources. Students were generally, but not always, highly motivated when using technologies, although this depended on length of project and decrease of the novelty impact, especially in Middle Schooling. There was an increase in student control and independence allowing individual preferences in style, layout and tasks.

There were no comparative analyses or evaluations made between the schools on the basis of differences in attitudes, performance, of gender, race, ethnicity or class. The evidence for success was largely based on perceptions of teachers and students.

Summary

These longitudinal studies indicate that the full integration of ICT into technology rich classrooms changed the nature of teaching and learning, created more independent and self motivating learners, encouraged the use of multiple teaching methods, and encouraged team oriented inquiry. In general, the effects for students as perceived by teachers were largely social and psychological in terms of changes in attitude and increased engagement and study habits. There was a weaker untested association between cognitive learning outcomes and ICT use. The key features of these projects, which appear to contribute to the effective use of ICT and its contribution to the positive changes observed are:

- the integration of ICT facilitated a move to student-centred rather than teacher-centred learning;
- curriculum became more integrated and based on problem solving;
- students were given increased autonomy and flexibility;
- teachers worked in a more collaborative teamwork based environment and were given the opportunity for professional development; and
- the innovation was highly resourced.

Some questions that arise are:

- whether there is a placebo effect of the introduction of innovation itself that made the students feel special and therefore perform better;
- whether the key features of the integration such as the student centred approach, curriculum and pedagogical changes, etc could be achieved without the use of ICT and whether less resources could produce similar results; and
- whether it was the integration of ICT which facilitated a move to student-centred rather than teacher-centred learning.

1.2 Teachers, ICT and improving learning

Integrating ICT into classroom practice

Wenglinsky (1999) in the UK concluded that ICT can alter traditional relations between teachers and students who have to ‘find new ways of working together’. The integration of ICT into most Australia schools is still uneven, differentiated according to location, type of school and level of ICT integration (Meredyth 1999). Schools may have computers, but most do not have the capability to run the large variety of multimedia software that full use of graphics of the Internet requires with particular geographical and social disparity (Anderson and Ronnvikst 1999). Other inequalities are founded in this differentiation.

Downes (2001:6) usefully differentiates between levels of integration:

- Level 1: adding ICT skills into school program through a separate ICT subject, while teacher practices in subjects remain unchanged;
- Level 2: focuses on integrating ICT into daily work of teachers, with some teachers' pedagogical practices and classroom behaviours staying the same, while the practices of others change more radically;
- Level 3: transformative at classroom level in that it changes content as well as pedagogy (what students learn as well as how they learn); and
- Level 4: transformative at the system level leading to changes in organisational and structural features of schooling.

As yet there is little indication that many schools have radically altered their practices with ICT. Changes are superficial and at the first and second levels with little indication of transformative practices at classroom or school level.

Comber & Green (1999) and Lankshear *et al.* (2000) suggest that for teachers new to using ICTs in the literacy curriculum, new issues arise from changes in classroom organisation, unreliable hardware and networks, and unpredictable changes in teachers' and students' work.

These changes were evident in the case studies of the Discovery Schools in South Australia, whose aim are to:

- Discover how to transform learning;
- Develop and showcase best practice models with respect to pedagogy, teacher methods and school change;
- Develop principals' expertise as users, curriculum leaders and managers of technologies; and
- Ensure departmental enabling policies and practices are in place. (Barnes *et al.* 2001).

Four primary and two secondary Discovery Schools were selected on the basis that they were already engaged in curriculum-driven practices with learning technologies. Once ICT threshold skills were developed, learning benefits occurred and teachers saw the technologies as more conducive to discovery learning. The report indicated the following:

- Some learning is done better with ICT, e.g. edit effect in terms of quality of student work and practical examples through visualisation.
- ICT equalises individual differences and particularly has dramatic effects for students with special needs. Teachers have increased capacities to deal with individual learning styles as students can work at the pace and intensity suitable to their needs. In particular, it improves poor handwriting and English skills through word processing.
- Collaborative learning is enabled and there is little indication of the isolated learner. Peer coaching and peer reviews are used more often and there is a development of communication skills and awareness of different audiences. Improved modes of presentation improve student motivation.
- The Web impacts on resource–based learning and access to real world information. The level of reliability and currency of information adds to authenticity of learning tasks, with realistic and up-to-date information.
- There is increased student motivation associated with ICT. The novelty effect can decrease at middle school level and sometimes there is excessive and inefficient use of the Web.

- ICT encourages independent learning and individual preferences for process, layout, style and format. It gives students more control.
- Learning technologies change teacher practices, planning tools and assessment rubrics. Teachers also plan less, let classes evolve and allow student experiences as process of learning to shape outcomes.

The report and examples of teaching practices are available on [http://www.tsof.edu.au/LT.SA/research/].

Such findings have obvious implications for more individualised learning and addressing of difference that is central to improving the learning outcomes of students who are disadvantaged. Bede (2000) argues that to achieve level 4 integration of ICT requires a paradigm shift towards 'knowledge networking' and virtual communities that have communal memories. Lawson & Comber in the UK in evaluating the *Information Superhighway Initiative (2000)* and Smerdon *et al.* (2000) in the USA found that teachers' use of ICT for pedagogical purposes is more likely with increased availability, especially if an adequate number of computers were also located in classrooms and not in computer labs.

Providing teachers with computers does not necessarily mean that ICT was integrated into classroom practice or that the full range of technologies and multimedia available were fully utilised. The Australian examples of leasing personal laptop computers to teachers (McDougall *et al.* 2001) did not necessarily mean that ICT was integrated into classroom practice or that the full range of technologies and multimedia available were fully utilised (Marshall *et al.* 2001). The teachers tended to use them for classroom and curriculum organisation and assessment. Downes (1996) concluded that, in part, teacher discourses about technology and uses in the classroom were informed by teachers' personal experience and that they accrued computer knowledge through hit and miss approaches.

1.3 Traditional and transformational pedagogies

The challenge for education is whether ICT will merely become another mode of transmission of traditional curriculum that may be faster and more comprehensive, or whether ICT will transform the content and process of curriculum, pedagogy and assessment (Lawn and Comber 2000:42). Much of the literature perceives current changes as being part of a transition in teaching practice from 'traditional' to 'transformative' pedagogies. The initial use of new technology tends to be a 'grafting on process' that uses ICT within traditional ways of working and differentiated curriculum as the norm (Yelland 2001). This can reinforce current practices and not address issues of disadvantage as the focus is not on learning but still on teaching.

Both teachers and parents are ambivalent about the 'easiness' of computers and lack of challenge to students. Students are perceived to be vulnerable as learners and not encouraged to take risks, as getting it 'too easy' and missing out on the traditional skills. Teacher emphasis can be more on 'the look' made possible by computers, on product not process. Schools were for learning about computers and not for working with computers (Downes 1996).

Certainly, the longitudinal studies of technology rich classrooms indicated that teachers moved over time from first level change in which they merely adapted traditional pedagogies to incorporate the use of computers, to second level change in which they fully integrated computers into their daily practice in ways that substantively changed their teaching practice and assumptions about learning. Dwyer (2000) and Mayer-Smith *et al.* (2001) both reported that as teachers became more familiar with ICT they

worked more in teams and across the curriculum, thereby changing school schedules and classroom organisation. This was the result of an increased focus on projects and tasks with different mixes of learning and communication tools that are prerequisites in dealing with students who have different needs. Teachers' lessons and students' projects indicated a mastery of multimedia presentations, providing both teachers and students with greater choice. Traditional paradigms were not fully replaced by emerging or transformative pedagogical paradigms. Instead, teachers expanded their repertoire, utilising a range of pedagogies from the traditional format of teacher centred lectures to inquiry, problem solving and team-based pedagogies. In so doing, ICT addressed a wider range of individual and group student needs, an important focus when seeking to improve the learning of students who are disadvantaged.

Barnes *et al.* (2001) report on the case studies of the Discovery Schools in South Australia noted that the new technologies changed teacher methodologies as they were introducing new planning tools and assessment approaches. Sometimes teachers planned less and allowed a freer flow of activities in the classroom. The technologies supported collaborative working models such as peer coaching. There was amongst students an improvement in communication skills and greater awareness of different audiences. The email was valued for asynchronous communication. Teachers began with identifying weaknesses, promoting fluency, making learning more efficient, optimising use of personnel and removing logistical hurdles. Then they moved into more constructivist approaches to learning that was about creativity, metacognition, problem solving, group work, and new forms of visual literacy. In other words they moved from instruction to construction, from drill and practice to discovery. This was most often in primary schools.

Differences emerge in teacher practice when computers are introduced into classrooms, both between primary and secondary schools, and between disciplines.

Primary school teachers were more likely than secondary school teachers to use the computer or Internet to communicate with parents at home, to use computers in the classroom, and to assign projects or to assign students to practice drills in the classroom (Smerdon *et al.* 2000:9). Secondary teachers were more likely to use computers for administrative record keeping at home and school, to communicate with students, to assign computer-based projects out of class and to assign students to conduct research. Primary school pedagogical practices were more receptive to the use of computers for problem solving, self-paced learning, and enhancement (Nixon 2001:12), and therefore more individualised work. Secondary schools relied heavily on home work and as is argued later this has significant inequitable impact on those students without home computers.

In secondary schools, where teaching is more content driven, discipline focused, and examination and assessment driven, computers were used more for word processing and information gathering than for problem solving. The content focus in particular subject areas meant teachers were more dependent on available software in the field. Traditional curriculum therefore worked against the integration of ICT with a clear focus on academic outcomes.

ICT did not break down subject and department boundaries. This maintenance of the disciplinary boundaries and traditional valuing has significant implications, in particular for students at risk of leaving school as the more academic subjects (other than English) have not integrated ICT rapidly whereas arts education has been particularly receptive to the use of ICT and multimedia. Arts education not only utilises depth and breadth of online access to museums and art gallery collections, but also allows and legitimates student production of a range of multimedia outcomes and modes of assessment e.g. portfolios (Sefton-Green 2000). The ITLED project found that those areas of the curriculum where computers were most highly integrated included Studies

of Society and Environment (SOSE), English, Technology and Enterprise. Nixon (2001) argues that cross-curriculum computer literacy strategies have led English specialists to understand better computer-mediated learning, and subject area specialists to understand better literacy issues. By contrast, maths and science had lower levels of computer use.

This cross-curriculum push encouraged by ICT has considerable potential in terms of moving literacy learning across the secondary curriculum and making it a responsibility of all teachers, and possibly improving the literacy of at-risk students.

ICT is also integrated into teaching practice when teachers come to use ICT more 'generically' over time as they utilise the full range of available technologies (word processing, multimedia, digital cameras, Internet, email and Web page publishing) across the curriculum. This in turn has wider school ramifications. Sefton-Green (1999) indicates that the ways in which school days are structured and subject disciplines are bounded, and the nature of top down assessment, are in opposition to the principles of project based interdisciplinary activities that are becoming the leading practice in the use of computers.

Summary

An expansion of the repertoire of teaching methods and tools used by teachers produced beneficial outcomes for all students. The increase in teaching repertoire is most likely to improve the outcomes of disadvantaged students because it attends to individual need and provides a variety of curriculum and assessment strategies to promote student capabilities across a range of learning outcomes. In that sense, good pedagogical practice in the use of ICT to enhance the learning of students who are disadvantaged is just good pedagogical practice.

The greatest integration of ICT across the curriculum occurs when process and content are addressed simultaneously. Both teachers and students are more likely to enhance their learning if they learn about and learn to use ICT at the same time. This can happen when they undertake a specific pedagogical task that requires problem solving with respect to both process (ICT) and content.

If there is simultaneously a strong focus across the curriculum on problem-based or project-based strategies utilising ICT, the issue of digital as well as print based literacy and numeracy can be addressed as a whole school issue. This is more likely to assist disadvantaged students whose needs can then be addressed in all classrooms by all teachers.

1.4 Teacher expectations and attitudes

Teacher expectations influence student learning. Low teacher expectations can create a self-fulfilling prophecy of low performance in students. Stereotypical responses by teachers influence how particular groups of students see themselves. Similar perceptions and expectations are also linked to technology in its pedagogical context including what type of ICT activity is undertaken, and how students are assigned to use computers in the classroom. The choices teachers can make that impact on student learning include: the mix of software programs for self-paced learning, practice drills, problem-solving, information and data gathering and data analysis, use of the Internet, projects, music, multimedia programs, word processing and spreadsheets, and communicating via chat rooms and email.

Computer-literate teachers still tend to have lower expectations of students in schools with high poverty and cultural mix and tend to use multimedia less, due in part to lack of computers. In US schools serving at-risk students when computers are present, they are most likely to be used for drill-and-practice basic skills programs rather than as tools to support students working on their own projects as is more the case in high income schools (DeVillar & Faltis:1999). This pattern continues, despite any evident improvement in computer literacy or student achievement overall, that is, once a problem always a problem.

The problem also derives from particular theories of learning teachers hold in particular studies. Teachers have a widespread belief that students must understand the basics before moving into advanced cognitive thinking or computer literacies.

Teachers' understandings about how children learn mathematics and indeed any subject effectively, and the pedagogical approaches they adopt, appear to be related to their own beliefs about the effectiveness of computers, how they learn with computers and their own understandings of how students learn their subject. The confidence and skill levels of teachers in using ICT are also implicated. Norton's (1999) study of teachers' responses to and beliefs about using computers for mathematics learning was conducted in seven technologically-rich Brisbane schools. It was found that:

(i) few secondary mathematics teachers used computers at least weekly;

(ii) computers were considered equal to, or more effective than, traditional instruction for doing calculations or providing basic skills practice;

(iii) few teachers considered computers useful in developing conceptual understandings; and

(iv) no teachers used computers with less able senior mathematics students.

There was a clear association between teachers' perceptions of students' abilities and whether they use ICT as well as the ways they use ICT. Baturo *et al.* (1999) in a study in Queensland found that those teachers who endorsed Integrated Learning Systems (ILS) in Grades 4 to 7 had more limited knowledge about computers and held more traditional pedagogical beliefs about effective mathematics teaching than teachers who disapproved of the passive learning of ILS because it encouraged student passivity.

Motley (1999:65–7) reported that as with other studies, teachers tend to assume socio-economically disadvantaged students lack access to ICT at home, yet most families had access to a range of multimedia equipment, although it is not as up to date or computer based e.g. video recorders, video cameras. In the South Australian ITLED project (Comber & Green 1998:99) many teachers reported that they had positively re-evaluated their assumptions about the capacities of young people in their classrooms after the introduction of ICT into the classrooms. However, other studies indicate that teachers often over-estimated students' competence and/or over-generalised that 'all' young people would be attracted to new technologies (Motley 1999). Teachers believed that new technologies solved some problems of students' 'motivation' for academic work and competence with literacy. [The ITLED project can be found at: http://oac.schools.sa.edu.au/itled and http://www.literacy.unisa.edu.au/ITLED]

Incorporating new technologies into the curriculum changes the nature of teachers' and students' work practices in ways that challenge teacher professionalism. A key issue for teachers is that they do not know what criteria to use in making judgements about the specific needs of their individual students or how they can be best met by ICT (Blackmore & Johnson: 2000). This point is confirmed by the Queensland New Basics Report (2001) that identified the major weakness of teachers as being the way they dealt with individual difference. Likewise, Comber and Green (1998) commented that

teachers found it difficult to name, identify and specify students' new learning when they did use learning technologies. That is, there are new professional judgements that need to be made at all stages when integrating ICT for which there is as yet little guidance. This level of professional judgement requires not just operational digital literacy, but comprehensive knowledge and understanding about the cultural and critical dimensions of digital literacy, that is, appropriateness, ethics and selection.

Summary

Teachers need to develop skills in their disciplinary area and across the curriculum in utilising ICT in ways that are attendant to both the operational and the cultural dimensions of digital literacy. Teachers need to learn about technology at the same time as they learn with and how to use technology in order to challenge their own assumptions about both ICT and learning. Teacher professional development should be informed by a strong pedagogical and curriculum focus on problem solving together with action research projects that explore how to make judgements about the efficacy of using ICT.

The Milken Foundation (1999) study of wide-scale integration of ICT into US schools indicated that when software development is combined with the key elements of a good implementation plan (teacher education, adequate ICT resources in schools, and supportive educational leadership) there are clear gains in literacy and numeracy.

2 ICT, learning and disadvantage

The following sections focus on reviewing recent research on ICT and learning for particular equity groups. This section works through key policy debates: (1) gender issues in the three areas of science, maths and technology; (2) literacy; (3) computer games; and (4) language and communication. Later sections focus on schools, communities, Indigeneity and ICT, and students with disability and assistive technologies. There is a paucity of research on ICT use and students from non-English speaking backgrounds, and low socio-economic status is equated simplistically to access issues.

Studies investigating differences in educational achievement find that gender interacts with race, class and indigeneity in specific ways. Here, we present the findings related to these categories, remembering that in practice, these groups cannot be so simply disaggregated when considering participation, retention and success.

2.1 Gender, learning and ICT

For girls, there is an ongoing low participation in the maths, science and technology subjects that provide access to higher paid, high technology jobs (Staberg 1994). There is even lower, but less publicised, performance of low socio-economic status/NESB girls in these areas (Collins *et al.* 2000). Girls experience a growing loss of self-esteem with respect to technology and schooling at Years 9–10 at a time when boys' self-esteem increases (DETE 2001 b). Participation rates in ICT courses in general have decreased for girls and women (Cameron *et al.* 1999). The Cameron Report, *Participation in IT and telecommunications in education and training* is available at http://www.detya.gov.au/iae/analysis/it_participation.htm (accessed 8/4/2002).

Even when girls achieve well and undertake ICT to Year 12, they do not choose ICT for a career or in higher education. Women, in Australia as in Britain, USA and Germany, are now under represented in particular specialist areas of ICT with only 20 per cent of ICT professionals being females (Cameron *et al.* 2001). There is a clear gender division of labour that connects computer courses in school, to post-school and occupational destinations (Weinman & Haag 1999, Collins *et al.* 2000). Boys design and manage the hardware and software, females put them together and use them. This signals possible new disadvantages arising for girls.

For boys, there is a relatively small, but systematic disadvantage on some tests in early schooling. Gender differences in literacy achievement are greater for writing and speaking (the expressive modes for literacy) than for the receptive modes of reading and listening (Master & Forster 1997). Many boys are failing at and/or disenchanted by print based school literacies and literacy at middle school level, in particular Indigenous and working class boys (Comber & Green 1998). In Years 11 to 12, boys over-concentrate on the narrow range of traditionally male subjects of maths, science and technology. This results in more boys underachieving as their abilities or interests may lie elsewhere (Collins *et al.* 2000). The issue is whether ICT has potential to address boys' disengagement with literacy.

Gender, technology, maths and science

Early research on ICT and gender focused on women's exclusion from technology, the anxiety felt by girls and women about ICT, stereotypic representations of girls and technology, and how girls were unchallenged by unstimulating assignments and discouraged from pursuing careers in technology. Girls' learning outcomes and their decisions to persist with studies in mathematics once it becomes optional are influenced by psychosocial factors (self-confidence), socio-economic and socio-cultural factors, race/ethnicity variables, pedagogical approaches, curriculum, and learning environments (Leder 1992, Leder *et al.* 1996). Paradoxically, despite the girls' alleged 'anxiety' and lack of interest the gender gap in achievement in maths and science appears to be closing rapidly although girl's representation in computer studies and careers is decreasing (Collins & Forgasz, forthcoming). Research on computers in mathematics classrooms has paid less attention to socio-cultural factors than to cognitive factors. Most of the research has treated gender as a variable only in terms of student behaviours i.e. gender differences. There has been little to no research on other cultural factors, or intersections of gender, ethnicity, race and socio economic factors. This requires further research.

Computer use at school and at home

There is a now clear pattern evident in Australia and internationally that boys tend to make greater use of home computers than girls, and tend to access computers more at school when there is an open door policy on use. *Real Time* (Meredyth 1999) indicated that while both boys and girls are most likely to gain their basic computer skills from home, boys are more likely to gain advanced skills from home. Girls gain any advanced skills from school, although there was no breakdown according to cultural background, NESB or level of income. The differences between use by boys and girls in general decreased with increased computer access for girls at home. Jones (1998) reported a positive link between IMS (International Maths Survey) maths achievement levels and the frequency of computer use at school and at home. Gender differences emerge around where, when and how often computers are used, how they are used and for what purposes, yet SES status was the best predictor of future participation, retention and achievement in school.

Studies in the 1990s indicated that boys tended to use computers more often in school, to make use of computer labs, and to dominate computers when available in co-ed classrooms (Durndell *et al.* 1995). Despite gender differences in behaviour patterns in use of computers most clearly at Year 10 in maths, both girls and boys meet the task requirements, are committed and enthusiastic, and applied mathematical concepts and skills (Vale 1998).

Attitudes: personal interest and pleasure

Boys, in general, show at all age levels more positive attitudes to computers, even if only slightly more, than girls (Liao 1999, Fitzpatrick & Hardman 2000). The most recent studies indicate few differences between boys and girls with respect to skills once they have the same level of usage.

Explanations regarding this vary. Most studies conclude that girls tend to use computers more on a 'need to know', instrumental, pragmatic basis, for word processing and graphics whereas boys use ICT for pleasure (Schott & Selwyn 2000, Shashaani 1993). Girls at secondary level are less likely than boys to voluntarily use

ICT e.g. action research project, lunchtime or free choice activities (Comber & Green 1998, Henney 1986, Edmonds 1989).

Other explanations about differential use suggest that computers are part of the trilogy of science, maths and technology that girls consistently rate as being of less interest to them than, for example, language (Makrakis & Sawada 1993). When computers were used for learning mathematics, Vale (1998) identified four main themes that appeared to explain the positive attitudes of Grade 8 and 9 students towards the technology: pleasure, success, relevance, and power of the technology. Pleasure and relevance, in terms of the enhancement of computer skills, were key factors for boys. Girls were more concerned with issues of success, and thought that computers would enhance their mathematical learning or make the mathematics easier.

Familiarity is a major factor when it comes to computer related attainment. Brosnan (1998) in a study of 48 primary schools children indicated that boys not only had more positive attitudes but also higher levels of computer related attainment than girls. Studies also indicate gender differences in computer related skills, particularly in areas of visual control and self-control as opposed to system controlled (Chan Lin 1999). This research is still contested. However for girls, there is little relationship between computer use, success and the perception they have of their maths achievement - they still lack confidence in their ability.

Shashaani (1993) argues that attitudes to computers are shaped early in primary school, and are influenced by peer, teacher and parental attitudes. There is a strong positive correlation between a student's interest in computers and the amount of encouragement they receive from parents, teachers, school career counsellors and peers. For some girls, there is an association between fathers' attitudes about appropriateness of computers for girls as a career. This may be an issue when it comes to cultural differences although any generalisations about any particular ethnic group must be treated with caution.

Competence and confidence: affective dimensions

Associated with attitudes to computers are the affective dimensions of self-confidence. Girls may lack interest in computers because they are anxious about using them, but this anxiety decreases with increased access and use in a supportive environment. Girls may express their anxiety more overtly and are less confident in terms of their abilities than boys. Although they may lack confidence as individuals, girls ascribe to other girls the capacity to undertake computing (Durndell *et al.* 1995). Mayer-Smith *et al.* (2000) considered technology-related differences in attitudes, participation and achievements in technology-rich innovative classrooms where students had ready and constant use. They concluded that girls and boys appeared to be participating and achieving equally. Despite disabling discourses about girls and computers, anxiety about computers is not limited to girls. Boys just 'cover up' to keep face.

Despite few differences in competence, 'boys and men demonstrate greater sex-role stereotyping of computers, viewing it to be a male domain (Leder *et al.*, 1996, Durndell *et al.*, 1995; Makrakis & Sawada, 1996). Fitzpatrick and Hardman (2000) found that in a study of British primary school children aged 7 and 9 that 'there is little difference between girls and boys in their appreciation of the importance of computers and in their individual performance on specific computer tasks' (p.431). Yet gender stereotypes are perpetuated regardless of ability. On the one hand, boys and many male teachers do not see girls in general to be as competent as boys, thus reinforcing girls' self-perceptions. This is particularly the case for gifted boys, although gifted girls are more self assured and confident (Bailey 1995). On the other hand, boys and men generally

have more confidence in their computing abilities, a confidence that does not reflect actual skills. This male ‘overconfidence’ is because computing skills are seen to be socially desirable and required to be accepted as a male (Durndell *et al.* 1995:223).

Attempts to change such attitudes by pointing to girls’ achievement using ICT produced more positive attitudes to science and technology for both girls and boys, but the boys did not alter their gender bias (Bailey 1995).

This suggests on the one hand, a need to make science and technology classrooms more girl friendly, and on the other, a need to broaden boys’ attitudes about masculinity and femininity in ways that provide less stereotypic options for boys and for girls.

These studies indicate the importance of addressing the social relations of gender, and changing notions of masculinity and femininity with ICT use in classrooms.

Shashaani (1993) concluded that gender differences were influenced by socialisation and achievement and closely associated to teacher and parental expectations about the capacities and competencies of girls and boys. Bramald and Higgins (1999) reported that British teachers’ competence in ICT use in primary mathematics classrooms was strongly related to student achievement outcomes. Effective teachers who used ICT were found to be confident and comfortable with ICT ‘as an enabling addition to their pedagogical armoury’ (p.97).

Wenglinsky (1999) focused on whether computer use with 6,227 fourth-graders and 7,146 eighth-graders is making a difference in mathematics. Wenglinsky reported improvements in learning outcomes, but the computer effects were much smaller in the fourth than the eighth grade. He concluded that the primary focus of all technology initiatives should be on middle schools rather than elementary schools. He also suggested teachers should focus on using computers to apply higher-order skills learned elsewhere in class. Computers should be a component of a seamless web of instruction that includes non-technological components.

But again such large-scale studies premised upon standardised tests need to be queried. Yelland (2001:393) points out that the ‘benchmarks of performance used in such reports are characterised by ‘male performance’, that gender differences can often be attributed the tests and format, content and type of questions themselves. Indeed, higher maths test scores for males was in one aspect of spatial knowledge—spatial visualisation—with no differences apparent until adolescence.

This suggests that girls are not necessarily underachieving in maths as a group; just that they are achieving in different ways. Similarly, girls’ and boys’ use and attitudes to ICT may be different, and that needs to be recognised.

Summary

While there are no differences in achievement once there is equivalent experience, there are a range of other factors that impact on attitudes and perceptions which in turn influence subject and career decisions but not necessarily use patterns of competence. Both females and male students are motivated, achieve equally, although they have different perceptions about competence and use value (Dix 1999).

Mayer-Smith *et al.* (2000) suggests that technology rich classrooms can attract more girls and boys, and that males and females interacted equally well and with equal outcomes. This occurs when there is the use of multiple technologies and provision of choices, a balance between interdependence and independent learning, time made for student talk and interaction, encouragement of self pacing and negotiation of well established rules of operating in communities of practice.

Girls will undertake sex stereotypic tasks and succeed, and also are less stereotypic in their attitudes about competence. Girls see girls and boys as equally capable. Boys are more sex stereotypic in that they consider boys are better, and see particular tasks as significant, such as control of mouse. Computers in that sense are more closely tied up with masculine identity than feminine identity. This confirms other gender equity research that suggests boys in general tend to have more stereotypic views of appropriate behaviours, skills and interests and a narrow understanding of girls' and their own gender identities.

Age and gender

Gender differentials in computer use begin early and vary over time. In early childhood studies, Bhargava *et al.* (1999) and Kirova-Petrova *et al.* (1999) found gender discrepancies in classroom computer access and use, and attributed this to gender biases in classroom practices, lack of female role models, home computer gender gaps and the scarcity of bias free software.

Middle and upper secondary levels are seen to be a time when girls become less interested in computers. There are fewer gender differences in primary years (e.g. Hattie and Fitzgerald 1987; Nelson 1988). Girls are least interested at the time when they are making decisions about their future careers. This turning away from computers is explained more by socio-cultural factors than by lack of competence. Mayer-Smith *et al.* (2000) and Clarke (1990) refer to the 'Snark' effect where discourses about gender and technology generalise that 'girls can't do science', girls dislike technology', or 'girls lack spatial ability'. These discourses have powerful effects on girls' attitudes and perceptions and can become self-fulfilling prophecies. Girls often take up and internalise such discourses in the middle school years.

There is need for more research to identify how attitudes to girls appear to be inflected by socio-cultural factors such as socio-economic status, race and ethnicity.

Engagement

Computers are often seen to be more relevant because of their capacity to model 'real life'. Yet, it is the very abstraction from the real that is the nature of the virtual that can lead girls to disengage. And it is the hands on nature of computers that make them so appealing to younger students, particularly lower income and Indigenous boys. The ITLED (Comber & Green 1999) project reported that high levels of engagement appeared to be the norm for most students when using computers for school activities, and this is widely confirmed, although there is no link to whether this improves cognitive outcomes.

Social interaction: culture of the classroom

What computers <u>do</u> as a learning technology is less important to improving learning outcomes than changes to the social dynamics of classrooms that result. Social interaction is promoted by students working on computers. This is a significant shift from the earlier view that computers led to isolationist and anti-social behaviour. The stereotype of computer 'nerd '(male) who is socially alienated and isolated is disappearing as computer use becomes more the norm and as girls use computers as often and as competently as boys. Boys socialise around computers and not in isolation. Computers can serve as catalysts for social interaction, with young children spending nine times as much time talking with peers while working at computers as

doing puzzles, although this is dependent on the type of software used and the physical environment. Further studies are required around the social interactivity promoted by ICT in terms of content, learning and outcomes.

Group work

There are a number of issues around gender, group work and computers arising from both experimental and classroom observation studies. Much of the research has been in science education because the trends in science education have been towards practical work, project and problem solving through group work based around experiments, and data handling, modelling and simulations of laboratory experiments (Scanlon 2000).

There is agreement that computer use changes the nature of interaction and gender dynamics, and that this happens in a range of ways: how the computer is used, the type of social interaction, the use of space and positioning, and the type of language exchange. Oberman (2000) indicates that in a comparison of computer and non computer based activities there was more conjectural interaction with eye to eye contact in mixed and single sex computer groups, and more descriptive, explanatory and declarative language in non-computer groups. In mixed sex computer groups, boys are more likely to dominate the use of the mouse. Computers therefore change the mode of communication but not necessarily gendered patterns of behaviour.

Gender and computers alter the group experience in particular ways. Group work (and in pairs) that is computer mediated can have positive or negative effects for girls depending on the context and the task. Scanlon (2000) concluded that the ways boys and girls work together depends upon the composition of the group and the task. A number of studies on gender, mathematics and science have found that:

- In science it is better to pair on the basis of conceptual differences. Conflict arising from different ways of viewing an issue can promote learning. If the difference is based on social conflict, it tends to be counterproductive for learning.
- Boys can find it difficult to distinguish between debating different ideas and quarrelling (Scanlon 2000; Yelland 2001a).
- Boys and girls react differently when they do not agree. Girls continue to persist until agreement is reached as collaborative work requires. Boys tend to split up and use different computers in the cooperative sense (Scanlon 1998).
- Girls and boys find different factors salient to cooperative interaction, with girls rating getting along with each other more important than other factors.
- Boy-girl pairs perform significantly worse in computer based language tasks than same sex pairs (Underwood *et al.* 2000).
- In gender neutral tasks less variability in behaviour by gender exists. Tasks such as treasure hunts can lead to certain dominant behaviours by boys.
- There are more fragmented styles of working and cross gender antagonism, leading to one individual becoming more dominant, most often the boy.
- Same sex pairs perform better than mixed in maths, although Yelland (2001 a) disagrees, suggesting that boy/girl and girl only pairs work more collaboratively in open-ended tasks compared to all boy pairs.
- There were no significant differences in the ways in which all girl and all boy pairs collaborated (Scanlon 2000:441).

- In computer-mediated problem solving maths tasks, nine year old girls' behaviour is based more on reflection, taking turns with mouse, discussion and consensus. Boys' behaviour is based more on acting without planning (Yelland 2001 a).
- In science, significant research on group work and gender has indicated that in non-computer tasks and social interaction girls lack confidence and are more likely to defer in classrooms and groups generally. They are less active verbally and less influential and more likely to agree and praise others (Scanlon 2000:465; Light 2000).
- In technology-rich secondary science classes that use a range of computer-based projects, texts, video and lectures, there was significant engagement and improvement in learning by both girls and boys but with little differential in outcomes (Mayer-Smith *et al.* 2000).

There have been no studies of mixed groups with NESB/non NESB students, students with disability and those without, or Indigenous and white students and how gender interpolates the social relations of computer mediated learning in these groups.

In mathematics, with more open-ended Logo tasks in which young children worked in pairs, Yelland (2001a) reported that girl pairs collaborated differently from boy pairs with respect to planning and task completion requirements. Girls made more moves and took more time to complete a maze task than boys, but they performed better than boy pairs. As in science, performance was moderated by task structure, style of interaction of the pairs and personality characteristics. Performance was also moderated by differences in terms of comprehension of the task requirements, selection of appropriate strategies for solution and application of executive processes. Girl pairs more often sought information from each other than boys and used verbal strategies for problem solving.

In contrast, boy and boy/girl pairs tend to make independent moves without consulting and when they do converse it is based on disagreement rather than clarification of ideas or process (Yelland 2001a:396). When there is disagreement, boys tend to resolve it by physically controlling the mouse. The girls do not work as fast, and while also listening to their partners, take more time to evaluate the success of each move in terms of reaching the goal. They are prepared to make changes to moves. Boys make more moves, do not reflect, and run out of energy to resolve problems, becoming more frustrated with each other, verbally and physically. This was evident in the high level of verbal insults between boys, whereas girl pairs traded praise as in boy/girl pairs. Yelland (2001 a) concludes that when girls work together at a young age they do not seek boys' help to complete tasks. She emphasises that girls work differently in a way that leads more often to successful completion of tasks. The problem solving approaches girls indicated were characterised by:

- planning prior to starting the tasks;
- reflecting on the effectiveness of their strategies;
- predicting the effectiveness of moves;
- monitoring their progress after each move;
- engaging in dialogue about the tasks;
- working cooperatively in problem solving; and
- interpreting and understanding the task requirements.

Motley (1999) concluded that girls saw advantages and disadvantages of working together and that often they liked to work independently. Boys preferred to work alone

except in ‘big projects’ as it cut down the work. Girls saw working together as more conducive to learning, while boys saw it as a hindrance and restricting computer use.

This research on groups in science and maths is important. First, it raises questions about what boys can learn from girls in terms of problem solving approaches and vice versa. Perhaps boys are not gaining the full advantage of ICT use because of their social behaviours around the computer. Perhaps girls should be encouraged to be more risk taking.

Second, it points to how computer-mediated learning is context specific. Using one strategy such as group work in science may not work in another subject that has different tasks and content. There is need for research on how cross-disciplinary projects can also lead to transferability of digital literacy in ways that also enhance learning in general. Such cross-disciplinary projects would need to take into account both the content and tasks undertaken.

Third, it further highlights the social relations around the use of ICT and improved understandings about grouping. Teachers should consider balancing the use of mixed pairs and single sex pairs rather than assuming gender equality is about equal representations of boys and girls in all groups.

Students as tutors, teachers as learners

Much of the learning about ICT is from peers, both for teachers and students. Many of the more successful interventions in classrooms with ICT are also peer based—both cross age and same age. Students in the ITLED project showed great willingness and capacity in learning to act as tutors for their peers and teachers. In contrast to teachers, students were willing to tolerate high levels of uncertainty in learning to use new software and applications, and to take risks. This mentoring can be focused on learning about ICT but also in online discussions.

Motley (1999) indicates that multimedia work positions both teachers and students as learners. It also leads to a greater emphasis on the body, because of the physical and visual aspects of ICT. Motley (1999:107) also noted how teachers actively used student expertise as a means of distributing learning by sending children in need of specific skills to students who were experts in that skill. Teachers trained students in particular aspects of the hardware and this ‘changed the hierarchy of student computer expertise’ in the classroom, important with regard to gender and race. In her study many of the new experts were girls, who in turn expressed a sense of agency and achievement. The problem was that these girl experts were called upon for support by both boys and other girls more than boy experts because of their greater willingness to collaborate. Boys continued to be reluctant to admit they needed help or to work collaboratively. They were happy to be experts but not novices. Students were given specific instructions about behaviours, roles and skills that were to be valued and assessed e.g. group work.

Participation in Computer Studies and career choices

Despite the growing shortage of skilled people in the ICT industry, and the assumption in post-school education, training and work of high levels of digital literacy and competence, there is a shortage of ICT trained personnel and low representation of women (Meredyth 1999: xxiv). There are a range of explanations:

- dominant pictorial messages in computing environments;
- absence of female role models and mentors in computing and computer environments;

- competitive work relations around scarce resources of computers;
- focus on activities based on masculine interests;
- psychological and cultural perceptions of computing as a male field;
- level of abstractness and lack of relevance to girls' relational needs;
- attitudes and expectations of teachers; and
- girls' inaccurate perceptions of computing as a career.

(Clarke 1991, 1994; Lang 1998; Durndell *et al.* 1995; Leathwood 1999; Vale 1998).

Even the most competent girls' disinclination to move into computing is part of an overall trend. As both boys and girls get older, they become less interested in computing as a field of study or occupation. Girls are least interested at a time when career decisions are made; they do not see computing as a desirable career for themselves (Durndell *et al.* 1995). Wilson (1998) suggests that the technical necessity that drives the design of computer literacy courses produces training that is depersonalised.

Summary

Computer mediated learning can benefit students in ways that address gender. Girls and boys use and interact around computers differently. Girls are as competent as boys and are prepared to use computers when they see it as relevant to their success in school. Their social interaction around the computer is more collaborative with a high level of linguistic interaction that focuses on inquiry. Boys are happier to use the computer, are more attached to computers in terms of pleasure, interact cooperatively but not reflectively in dividing up tasks between them. This has implications for how teachers might tap into boys' and girls' predispositions in classrooms.

Peer groups are important in engaging with computers but teachers should work to balance the gender dynamics of mixed and single sex peer groups. There is a need for careful consideration about the composition of groups, content and the tasks. While a key benefit for improving learning is mixed groups sharing a computer, teachers should not allow casually formed groupings around the computer. Girls are more likely to become discouraged if the learning atmosphere becomes competitive. Gender dynamics in groups may differ in different subjects.

The development of same-age and cross-age peer groups is an important classroom strategy. Tutors benefit as much as students in mentoring arrangements, which raises possibilities about mixing students by ability as a strategy to assist students in specific subject areas.

The socio-cultural perspective focuses less on the mapping of gender differences and dominance (based on time spent on computers), assertiveness in classroom, attitudes to computers and the social and gender dynamics around computing. The focus is more on which girls and which boys benefit most, why and in what circumstances (Collins *et al.* 2000).

Exploring how gender identity is understood and acted upon, the discursive representations of femininity, together with the social organisation of computing both in school and at work are important areas to be investigated. In terms of educational outcomes for girls, a better understanding of gender and technology is important for expanding post school occupational choices. At the same time, more attention should

be paid to men's and boys' attitudes, and to establishing programs to attract, and more importantly retain, girls in computer science.

Harrell (2001:48) argues that: 'there are usually no significant differences in competence and interest in computer-based work for young children. It is not the nature of the work that usually causes problems for girls, so much as the social organisation of that work'.

2.2 Literacy

Schools are expected to develop curriculum and literacy to enable students to be capable and critical users and producers of the texts and information. Research studies and Government policy alike stress the intimate relationships between literacy, technology and schooling, and young people's present and future needs. The Australian National Literacy Policy, *Literacy for All: The Challenge for Australian Schools (1998)* pointed to 'profound changes in the range and nature of texts, and to ways of accessing new information' brought about by new information technologies (DEETYA, 1998:41). The need for further research into the area of literacy and technology to enhance literacy skills for all Australian children is reinforced in *Learning for the Knowledge Society* (DETYA, 2000).

Literacy has been closely associated with disadvantage, with studies indicating that poor literacy is readily associated with early school leavers. There is also a danger that the notion of disadvantage is reduced in policy to being a matter only of print-based literacy, that is both the problem of, and the solution to, disadvantage (Comber & Hill 2000).

In Australia, two key reports have focused on literacy and disadvantage. These are *Digital Rhetorics* (Lankshear & Bigum 1998) and the *Information Technologies, Literacy and Educational Disadvantage* (ITLED) study in South Australia that considered how new technologies were being taken up in disadvantaged schools (Comber & Green 1998). Since these reports, there has been considerable advancement both in the spread of use of ICT, but also the technological and pedagogical capacity of ICT. Studies into the use of ICT and the implications for literacy in Australian schools stress the unevenness with which the use of digital literacies are taken up and supported within schools, and the apparent exacerbation of existing inequalities and disadvantages.

Technology is changing the nature of literacy. Debate surrounds the degree to which schools should/do attend to this and the degree to which proficiency in print literacy as the medium of power is what 'really' matters. Should schools be anticipating a possible future of multi-literacies, or concentrate on preparing students for a twentieth century print world' or both? Our report confirms that when focusing on disadvantages that shape the learning of students, there is a need for a broader understanding of what constitutes literacy.

Snyder (2000) reviews the changes in the paradigms in which literacy and computers have been framed, from the social psychological through to a critical pedagogy. Studies in the 1970s in cognitive psychology indicated that computers were better at producing texts (revising and editing texts). ICT also appeared to have marginal motivational effect in some instances in that it is easier to correct drafts and publish at a high level (free of spelling and handwriting errors). The 1980s sociocultural approach focused on language and the writing process, revision of text and attitudes. The research was equivocal as to effect of computers on reading and writing. Volland and Toppings (1999) in a comparative experimental study found that students undertaking

the computer based program scored better on tests than did those in the ‘alternate’ (teacher-centred) class. Snyder (2000) suggests that this however, merely shows that students got better at taking these tests. It offered a reductive and mechanistic, test-score centred view of reading and utilised highly limited conceptions of ‘reading’, ones most likely to be harmful rather than productive for students with reading difficulties. Such approaches are at odds with constructions of literacy taught and valued in Australian schools.

Most studies on ICT and writing conclude that it all depends on the writer’s preferred writing and revising strategies, keyboard skills, prior computer experience, supplementary teaching interventions, the teachers’ goals and strategies, the social organisation of the learning context and the school culture’ (Snyder 2000:100). Students needed a range of skills prior to being able to fully utilise and develop digital literacies. Hawisher and Selfe (1997) concluded that even with word processing, the writing technology of choice, the writers’ or students’ habits and strategies for composing take precedence over the influence of the computers. Writers bring their routines and patterns of writing with them. If they are not extensive revisers before word processing, they probably will not become so with computers, even when revision strategies are part of the instruction.

Word processing was linked to an improvement in revision strategies. When combined with effective writing pedagogy, computers also assisted in teaching students strategies about how to write but only when in a dynamic integrated classroom environment. Improvement was in the form of improved quality of writing, greater collaboration and more writing-focused talk, with a move to student-centredness and the transformation of writing to a more public activity. Snyder (2000:100-1) and Bourke *et al.* (2000) noted that the use of computers allows students to feel in control of their learning situation by working at their own pace and level. Logan and Sachs (1992:356) found that ‘the use of IT allows for the provision of types of learning opportunities that promote cultural reflexivity through students influencing control over access, sequencing and pacing of their learning, the attention given to the cultural relevance of the content, materials and learning tasks, and their own individual or group learning tasks’.

The studies show that for disadvantaged students improvement is more likely if students are experienced users, but that differential writing abilities did not dissipate. That is, there was no improvement of students relative to each other. Computers did not significantly improve writing skills of similarly matched groups. Word processing and all its functionalities that could possibly assist students who are poor readers or writers still relies more on teacher practices (Johnson 2000). Students are not learning the critical higher order thinking skills required for good readers (Wenglinsky 1997). Social context is critical in terms of how computers can impact on literacy practices. Ethnographic studies of writing and computers add another dimension, suggesting that as students talk, computers take writing into a more public activity. This intensifies the difficulty of extracting the ‘computer effect’, an ongoing issue in all studies of how computers affect learning.

Whether technology improves society cannot be understood without considering the social and material contexts and relationships in which the technology is embedded. Computers are now seen as sites of knowledge production. The focus of research is now on what students do with computers and what technology is doing to them as gendered beings (Snyder 2000). Critical digital literacy approaches emphasise the need for teachers and students to move beyond operational digital literacy, to a critical dimension that teaches students how to assess reliability and value of information on the Web by considering not only its textual but also its non-textual features, such as images, links and interactivity. Being literate is about being able to make meaning, to

create and shape social practices through operational, cultural and critical dimensions. It is about knowing when and how to use resources from different settings (Freebody *et al.* 1995). It is at the level of the dynamic and micro accounts ('ways with words') in which children engage that can explain the link between social factors and school success' (Angus *et al.* 2001:2).

The importance of the socio-cultural approach to literacy and to digital literacies in particular is that it establishes all students as gendered, classed and raced beings who have different cultural experiences that can be brought to bear upon their learning. The most recent Australian research on disadvantage, ICT and literacy has been based on the socio-cultural perspective. Nixon (2001) points out, for example, that children appropriate popular media in terms of content, forms of communication, graphics conventions, voice utterances and ideologies. Teachers can utilise this to make schoolwork more authentic and to tap into student interest. Teachers seeking to engage students whose family literacies are based in popular culture, as distinct from school literacies based on the printed text, need to take advantage of children's appropriations. Such activities may include acting out and performing before writing; drawing before writing; playing with voices; using video; presenting media presentations. Millard and Marsh (2001) argue that the introduction of popular culture into the curriculum has positive benefits on the literacy development of young children. The use of comics in Years 1 to 3 provided quiet and shy children an opportunity to be involved in a different way. Many were girls. The interactive nature of the comics (puzzles etc.) was a most popular feature. Marsh (2000 122) found that the introduction of the TV program Teletubbies and cultural texts associated with these shows provided motivation for children who rarely spoke or were not involved in writing activities. This was achieved through writing Teletubby recipes, reading Teletubby comics, writing letters to the Teletubbies.

The use of popular culture as a focus is critical at middle years when there is increased expectation for reading and writing for academic work. 'Popular culture provides them with material against which they can test their identities and with which to connect socially with like minded peers' (Nixon 2001:5). Young people's Internet use is closely associated with the other popular cultures of music, film, television and computer games. These are the communicational webs that provide possibilities for teachers to develop connectedness at critical transition points and with particular groups of students often who become disengaged with academic schooling.

This is not necessarily an uncritical treatment of popular culture. Rather it is necessary to provide all students with a capacity to adopt a critical position to different modes of communication and a capacity to develop a critical dimension of literacy practices—print, digital and visual—that provides an understanding of cultural context.

Gender, literacy and learning technologies

Whereas science and technology and maths are seen to be problematic for girls, literacy has been constructed as a problem for boys. A number of contradictory hypotheses circulate regarding boys and literacy which attribute their underperformance to a number of factors: social development, materials in schools that do not attend to boys' interests, boys' preferences for visual and physical activities, classroom literacy strategies that may systematically disadvantage boys, particularly Indigenous boys, and the feminisation of literacy practices themselves (Connor 2001). Hamston (2001) points out that boys with linguistic and cultural capital choose not to read, despite home environments conducive to such literacy disposition towards reading. This issue builds on considerable research conducted into family literacy

practices (Cairney & Ruge 1998) and into how parents support children as cultural members (Heath 1989).

Communicational webs

There is significant support within the literature (Kress 2000) for the view that boys (or some boys) 'inhabit different communicational webs', preferring the digital and multimedia texts and experiences. Boys may be living in a web structured around visual media in which the screen TV or PC is dominant. The visual mode takes priority over the written, which leads to language as speech having new functions in relation to this. Modes of communication are image, writing, and then talk. In contrast, the 10 year old sister will have a differently structured communicational web based on books (fiction), with more conventional narratives. Talk will be more prominent as will self-initiated play. This has implications for pedagogical approaches that may begin with visual and image based cues, and then move to oral and written texts. Again, this is conjectural at this point.

Alloway & Gilbert (1998:256) suggest 'that there is a potentially abrasive interaction between the social and pedagogical production of students as literate subjects; institutional attempts at regulating students at school; and the ways that boys take themselves up as masculine subjects'. Gender construction may be the key to the seeming reluctance of many boys to engage with school literacy tasks, including reading fiction and writing narrative, despite teachers' best attempts to make these relevant in terms of content.

Gender identity and ICT

'Peer rejection' may also be the reason many boys are reluctant to be seen enjoying literature, as masculinity is learned as stereotypes from the media, of boys learning 'acting male' from peers, of building identity based on opposing 'female behaviours'. If reading is a learned behaviour, boys do not learn it from men (Alloway & Gilbert 1998). Family literacy studies similarly indicate that there is a clear gender division of labour in the family, with mothers largely doing the literacy work. Interestingly, when computers become the medium, fathers are more of a presence in homework and play (Blackmore & Hutchison 2001). Many boys generally display different communicational competencies to girls, using a range of performances such as multimedia. Teachers should value what boys know and can do by not privileging the printed text and literature and by utilising boys' preferred reading texts.

Teachers can exploit the motivational aspects associated with boys' interest. ICT can provide a range of textual orientations and interests (games, multimedia, visual and textual). Boys can move towards a slow absorption into printed fictional narrative (Kress 2000). Nixon (2001) in the Westview project illustrates the paradoxes of gender in the take up of ICT and its implications for students' learning. The project was based on the understanding that digital literacy (as one of the multiliteracies) was as critical as print based literacy and numeracy. The focus was on multimodal presentations to make the year 7 students cultural producers constructing an interactive multimodal text that rewrote the existing print history of the schools. They focused on a range of topics, and interviewed long serving members of the community and parents.

In this project, Nixon mapped how the two 'at risk' boys were motivated by this task, asking questions of others and the teachers and working with each other. In computer mediated lessons a feature of their engagement was their constant talk. When the teacher made reference to how a particular moving symbol on the screen was like marching ants the two boys developed an interaction that was about acting, moving,

word associations, puns and references, songs, jokes and narratives. In this way it became a type of popular media presentation. Nixon observed that these were similar to the type of out of school behaviours that boys learn from frequent use and games to move into performance and play.

At the same time, the use of computers provided new opportunities for exacerbating the well-documented gender inequalities based on boys' disruptive, demanding and dominating behaviours in classrooms. There was no opportunity for teacher overview in this dispersed computer-mediated classroom. Many behaviours went unnoticed because of the distribution of bodies, machines and desks. One girl was significantly harassed by boys near her, and by their refusal to reduce noise and comments that acted upon her work. She at the same time provided considerable technical assistance to these same boys. She was denied airspace because of her ability to use the voice recording technology in a situation where the boys could not and in that sense her technical abilities were not recognised.

In another Australian case study exploring masculinity, literacy and learning technologies (Rowan 2000; Rowan *et al.* 2001), a cultural worker worked in partnership with four boys. These boys were identified as being 'problems', that is, difficult to control in school, with poor literacy skills and aggressive 'macho' behaviour. They were seen to be practical and not intellectual. Although having a reputation for being disengaged and literacy 'failures', these four boys indicated a range of abilities outside school. They could easily strip down motorbikes and they had good relations with their parents in most instances. They appeared to have little trouble with literacy when reading and talking about motorbike magazines, manuals, and labels. This suggested that their school behaviours were performances of masculinity that they identified with at school but that were not carried with them out of school. Yet there were few moments where their interests were used as the basis of their schoolwork. There was significant disjunction between the literacy practices in school and out of school.

The researchers and teachers worked with students using the '*cultural apprenticeship model', that is,* learners together with teachers and researchers working on a real task to find out how to work with technologies more effectively (Rogoff 1996). The students then were to become 'teachers' of other students. When talking about reading, writing, speaking and listening in class, these students characterised 'being a good student' as doing what the teacher said, being quiet, looking as if they were working. It was the teacher dictating what they read, wrote, and spoke about. When they did not comply they were seen as troublemakers.

There were significant 'good outcomes' for this project. The boys indicated a high level of <u>operational</u> computer literacy (creating and imaging HTML files), and they were able to gain new credibility in school for themselves as assistants in the Tools and Technology classes where they mentored their peers. They could convert images into files and create hyperlinks through words or images. They also were able to talk about the <u>cultural</u> dimensions of technological literacies, such as the relationship between the motorbike enthusiasts and the Internet, how advertising works on the websites and the use of domain names to attract web users. They were displaying publicly wider modes of masculinity that were not macho and they expressed interest in a range of other areas such as poetry.

When these four boys were back in the classroom there were different masculinity dynamics. Another boy, Jarrod, the archetype computer 'nerd', was treated by the teacher and his fellow students as a computer whiz or expert, a label that exaggerated his expertise. This reinforced particular associations between masculinity and technology. Despite their new expertise, the four boys refused to take on the name, seeing it as boring and unattractive. Yet they were happy to be called experts, again

reasserting the masculinity and expertise connection. Paradoxically, this use of boys as cultural apprentices tended to reinforce labelling about expert and novice, and associations linking masculinity to computer expertise (Rowan *et al.* forthcoming).

Summary

These studies on ICT and literacy, including disadvantage, suggest that the use of ICT will only enhance the learning of the students if students already have the literacy habits of writing, revising and reflecting. Teacher preparation of students in the basic literacy skills is the key factor in the successful use of ICT to improve literacy. ICT in itself does not improve literacy and numeracy for those with difficulties in literacy.

There are various innovative approaches that seek to address boys' literacy. The cultural apprenticeship model suggests that students can be engaged more in literacy learning when there is recognition of the family computer literacies that the students bring to school. Popular culture using ICT can then lead students into school literacies. It is particularly important for students who become disengaged from schooling in adolescence. ICT can be both the source of popular culture and the means of accessing and developing a range of literacies that exploit the different communicational webs of students. What is also evident is that all pedagogical innovations are open-ended, and can have unexpected consequences, as in the case of the cultural apprenticeship model, if gender dynamics and relations are not also addressed simultaneously.

2.3 Playing games, literacy and learning

Another possibility for improved educational outcomes offered by ICT is to tap into areas that boys already indicate significant interest in, such as computer games. Games are also part of an online popular culture that students access through the Internet. Boys appear to be more engaged by the new technologies than are girls, both in and out of school contexts. Computers and computer games are designed for boys rather than girls with an in-built slant on learning styles associated with ICT learning and teaching practices. Yet test scores show boys performing less well than girls in print literacies (Comber & Green 1998). Boys' use of computers for games has implications for the literacy learning of boys and girls 'because computer game playing might be a precursor to computer literacy, and the belief that computer literacy will be increasingly important for success in society' (Roberts *et al.* 1999:12).

Computer applications, and games, shift the balance of information processing from verbal to visual, that is, to the spatial, iconic and dynamic. The structural features of games, their spatial and dynamic imagery, iconic representation and the need for dividing attention across different locations on screen are relevant here. Schott and Selwyn (2000) see the types of spatial representation in computer games as being important in being able to 'read' and utilise information on computer screens. The iconic skills of being able to read certain types of images such as pictures and diagrams are also crucial to scientific and technical thinking. There is little research to back this hypothesis.

The utilisation of computer applications requires a visual attention that can keep track of a lot of different things at the same time (Schott & Selwyn 2000). Apart from this study, there is no research that documents a link between video game playing, attention skills and success in academic performance.

Electronic communication may enhance the communication of under achieving secondary school boys. McGuinn (2000) argues that the frame of the computer screen has the potential either to offer a supportive structure upon which boys can build or another means to measure their academic failure.

Instead of tapping into educational use of boys' familiarity with games many schools do not allow games to be included in modes of learning. Nixon (2001), Beavis (1997) and Vered (1998) conclude that educators can no longer ignore games, or the new forms of literacy that students bring to school, or the gendered sociality around computers. Lemke (1997) suggests there are four new digital literacies—multimedia authoring skills, multimedia critical analysis, cyberspace exploration strategies and cyberspace navigation skills.

At the same time, games are themselves cultural and commercial products that reinforce stereotypes about what boys and girls are interested in and can do (Beavis 1999)[5]. Roberts *et al.* (1999) argue that male dominance of games is because games are designed for boys, and there have not been significant inroads into having a critical view of gender in terms of instructional design and content.

Nixon (2001) points to the dilemmas for teachers as computers attract the types of boys that are often disengaged, but at a cost to girls because of the demands made by the boys. Rowan *et al.* (forthcoming) question the notion that computers (in particular games) are solutions for boys and the literacy crisis. There is a simplistic equation of boys + computers + literacy = literacy learning. Their study indicates how women and their representations in computer games are negotiated among software production teams. They are depicted in highly sexual ways but also as having brains and brawn. But the thrash and kill games still appeal to boys and the creative problem solving to girls. Girls look for high skill and not high kill. One producer of girls' games found that girls looked for social interactivity, but that traditionally the games for boys were too juvenile. Girls' playing preferences came down to everyday characteristics, relational, complex solutions, multi-sensory and real life simulations. On the other hand, boys' play was fantasy based, action packed, surrealistic, had winners and losers, with success equated to elimination.

Games are the exemplar of masculine aspects of computing, linear abstract programming and 'nerdy' ICT image of the programmer. Vered (1998) argues that it is not the computer text itself that girls find off-putting, but rather the social text around the computers and group play. Girls become uncomfortable with the expanded interactivity and focus on performance displayed by the boys in classrooms.

In a small case-study that investigated the effect of introducing computer games into the curriculum, Beavis (1998) concluded that the units were seen as fitting readily into existing English curriculum and priorities, providing opportunities to integrate print and electronic literacies and texts, or to study electronic texts in their own right. The units provided opportunities to be both critical and creative, and to utilise both literacy forms. The teachers in the study were very positive about expanding definitions of text and literacy to incorporate electronic forms.

For most classes, teachers commented on the higher levels of interest, involvement and collaboration from less strong, less attentive or less school-oriented boys. Students

[5] There is the case of the Mattel Barbie PC, a Barbie computer for girls, that came loaded with half the educational software that was loaded on to the boys' Mattel Counterpart, that is, without the body Works program that teaches human anatomy, and three-dimensional visualisation and thinking games. In this case the Barbie fashion designer software was seen by the manufacturers to take more memory and therefore could not be included.

in the non laptop school had less access and tended to be less involved. Conversely, some of those who were usually participated more actively had less to say. In one class at the laptop school, girls were as involved and interested as the boys were, but in the other classes girls were not so interested. The teacher in the non laptop school commented that students usually uninvolved in English work became more involved.

Some girls responded enthusiastically but others continued to make it plain that computer games were not for them (Beavis 1998). Girls tend to show a lack of interest in electronic game culture; and 'girls' views of electronic game culture are in keeping with widely held social views about computer violence and the banality of many computer games' (Gilbert 2001:4). Harrell (1998) notes that girls' interest increases when computer based activity is less concerned with computer games and more co-operatively based. Cole (1996) in a program set in an after school setting, argues that 'well designed games and Internet activities for home use can have lasting impact on a child's academic performance'. Again there is little research to support this contention.

Recent Australian research by Downes (1996) pointed to a way in which games can become part of classroom practices. Children bring a range of attitudes and behaviours from home that impact on successful use of computers for instructional purposes. She suggests that the co-agency between the child and the computer at home leads children to learn through a blending of play, performance and practice. This is in contrast to the approaches imposed within schools when children are engaged in learning, either with or without the use of computer-related technology. Her study of home-school links suggests that playing games assists in learning to solve problems, developing thinking skills, having patience and developing perseverance, memory and imagination. Children learned more about the computer through game playing (using mouse, installing software and switching between operating systems). Playing games involves constant visual, aural and concentration. Learning by doing and trial and error approaches alter children's predisposition to learning.

Other studies by Somekh (2001) and Furlong *et al.* (2001) come to similar conclusions. The significance of these findings challenges both the way we integrate computers into schooling, but also the assumptions that underpin current teaching and learning practices in schools about what constitutes play and learning.

Summary

This review of research on games and the ways in which computer literacies are transferred into school indicates that the notion of literacy needs to be expanded to include audio, visual and print. It suggests that schools need to take up more what is learnt at home and the way it is learnt to engage students with learning at school. Downes (2001) identifies the key themes that emerge about pedagogy as play, performance and practice, and argues that teachers should develop these in their pedagogical approaches:

- The discussion on games raises the question as to whether the types of spatial representation and iconic skills (the ability to read images such as pictures and diagrams) are crucial to scientific and technical thinking. If they are learnt through playing games are they 'transferable' to other contexts and content?

There is also clear evidence that games and software should be developed that tap into girls' interests in problem solving and relational matters.

Of course not all boys like computer games not all boys are the same. Many boys identify with computers because their peers require this as male behaviour rather than because of any particular preference. It is dangerous to portray boys as 'lovers of

violence, speed and action, only interested in linear stories; if interested at all; attracted by seemingly stereotyped solitary lifestyle of computer programmers, in no way a social being interested in social interaction and so on' (Rowan *et al.* forthcoming:17). Many boys, adept and interested in computers, also play sport, and interact in a range of ways in other social and sporting groups.

2.4 Language and computer mediated communication (CMC)

Increasingly there is a focus on online learning to enhance learning for all students. The Internet provides:

- communication with others globally and locally;
- ready access to databases such as government reports, statistics;
- websites for information for local and global government and non government organisations; and
- one-on-one and group exchange and discussion.

Computer mediated communication (CMC) can challenge the ethnocentrism of students, while allowing students to become connected to local sources. For example, the *English Superhighway Initiative* project in the UK provides case studies of use of the Internet for cross-cultural communication. Students were allowed to communicate cross culturally, exchange ideas and data, and therefore produce a comparative analysis, e.g. of British and Tamil students' women's magazines by accessing Tamil language publications in Sri Lanka. Video conferencing between English and French students allowed them to develop their own etiquette—direct access to other language speakers and additional resources from that country (Lawson & Comber, 2000:428).

In each of the above cases, students showed a significant capacity to take up and use appropriately the language associated with new technologies, while carrying similar patterns of language evident in face-to-face communication (Comber & Green 1998). CMC is somewhere between spoken and written language. However, Hawisher and Selfe (2000) suggest that it allows the writer to forget who the audience is, leading to a readiness for 'flaming' or hurtful language inappropriate for classroom settings.

Other debates in research around CMC focus on whether CMC can provide gender and race blind modes of communication. On the one hand, computer mediated learning is seen to possibly provide a 'risk free' approach to learning that is likely to encourage students who lack self confidence. For example, computer mediated learning provides a means of interacting which does not highlight student difference. CMC, Harrell (1998) suggests, will lead to more equitable learning outcomes because social and gender differences are obscured, and thus a more diverse range of students will feel enabled to participate, and social stereotypes are less likely to prevail.

Singh (1993) commented that 'For Indigenous students undertaking an on-line unit, this usually means a shift away from the deficit models of learning, which casts students as lacking in essential academic skills, stranded outside the mainstream academic culture. This deficit view assumes that once Indigenous people are shown the superiority of the European way they will reject their own culture and become westernised in outlook, lifestyle and community organisation (Singh, 1993). CMC therefore provides ways in which Indigenous students can communicate without stereotypes coming into play.

Some suggest that CMC facilitates active and cooperative learning, enhances teacher-student feedback, and provides an effective way of 'reaching and educating culturally and linguistically diverse students and other than non-traditional learners' (Harrell

1998:50). Moreover, the anonymity can help reserved students who can respond when they are ready.

On the other hand, Yates (1998) suggests that CMC is not necessarily empowering and democratic for everyone. She refers to the how electronic discourse communities produce patterns that can exclude or privilege individual females through negative interactions through the use of sarcasm, insults and the 'one-upmanship behaviour' of males in the group (Lemon 1999). There are gender differences in language and response style among participants on electronic list servers that make their gender identifiable. Male-authored texts received more responses than those authored by females and males write longer contributions. Conversational patterns emerged in e-lists that were similar to face-face interactions. 'It suffers, like all communication media, from the intrusion of existing social relations, including those that are based upon inequalities of access and power' (Yates 1998:24–33). Overall Yates found that the emancipatory possibilities of CMCs were not borne out by close analysis of gender differences in language and net style. 'While CMC may provide opportunities to encourage the participation of all students regardless of class, race or gender, 'social science research should be scrutinised carefully before being applied to literacy classes' (Eldred & Hawisher 1997:9).

Summary

The 'cultures of computing', the network of social relationships that occur around computers, are gender, class and race inflected. The language use in CMC, discourses about competence, distribution of resources at home and in the classroom, school and teacher cultures, and working in pairs and groups indicate how gender and race come into play. Gender is part of a complex set of relations between socio-economic status, location, culture and language background (DETYA 2000:79).

The studies present new dilemmas to parents and teachers:

- While there is more action oriented software, boys are mainly interested in games and not educational software.
- While there is increased social interaction of boys around computers, this is also manifest in ways that can exclude girls.
- The improved communication skills in terms of intertextuality are often to the detriment of girls.
- Computers and the Internet provide an endless array of information and programs that will interest boys, but also access to high levels of violence and pornographic material.

3 Schools

Schools as definers and legitimators of knowledge are under challenge. Curriculum is more provisional since students are now not only consumers but also producers of knowledge. Schools have the potential to become nodes in local and global social and communication networks. ICT blurs the boundaries between school, home, work and community.

Are schools as institutions under threat with online learning, or just requiring re-organisation so that they can utilise ICT more effectively? Can and should students work from home? If so which students?

ICT provides new opportunities for students who may be most at risk. It promises improved school-home communication that assists students with severe physical disability, workplace learning for disengaged students, online courses for rural and isolated students, community based learning in Indigenous communities, links between schools and workplaces for vocational education courses, work experience and community based projects.

3.1 School organisation

During the 1990s, schools were not organised to deal with converging technologies. The architecture of a school shapes the pedagogy and how ICT is used (Motley1999). The size of classrooms and lack of space can discourage student movement across a range of multimedia to provide the seamlessness now assumed in hi tech environments. The ‘across the curriculum imperative of ICT’ (as with language and literacy) has material effects on the ways rooms are booked and how computers are placed; ‘the how, when, where and by whom the computers are used’ (Nixon 2001:203).

Schools first put computers into laboratories or dedicated classrooms under a specialist teacher and the Internet available in the library in what is called **vertical integration**. This was due to cost, easy monitoring and maintenance and because the teaching focus was initially on upgrading technical skills. This created timetabling dilemmas, particularly in high schools due to the intense demands of senior computing classes. By the late 1990s, the trend had moved towards computers being dispersed across classrooms into pods with Internet access in all rooms to facilitate full integration into classroom practice, a strategy called **horizontal integration**. Other strategies in wealthier largely private schools have included students owning or leasing laptops, which has led to a seamlessness between school and home. Many disadvantaged schools with limited numbers of computers still have computer labs and limited Internet access, which is a major impediment to integration.

3.2 ICT, leadership and whole school policies

Principal and teacher leadership and whole school policies are linked closely to the successful integration of ICT (Lankshear and Snyder 2000, Means *et al.* 1995, Wenglinsky 1999, Comber and Green 1997). Yet surveys of ICT use by principals have found that many principals do not often model computer use as part of their everyday practice. Many remain reliant upon administrative staff (Kenway *et al.* 1999). In some schools, the support of the head teacher or the approach to collaborative work in the

school enhanced development work more than expected (Mosley and Higgins 1999). Distributed leadership also facilitates and encourages bottom up innovation and creativity. At the same time, planned direction and an explicit statement of principles, of which equity is one, for the school are prerequisites. When it comes to policy, it is easy for disadvantage to be subsumed under technology rather than vice versa (Nixon 2001:12).

The *Real Time* (1999:xxxii) survey indicated that in schools there was a positive link between policy prioritising ICT, the level of resourcing, networking, technical support, professional development and the integration of ICT across the curriculum. *Digital Rhetorics* cited four elements of a whole school policy that led to effective integration of IT across the curriculum:

- teachers first: teacher professional development before integration of ICT into programs;
- complementarity: skills taught at the same time as technology introduced;
- workability: assessing whether it improves teaching and learning and what will work for teachers and students; and
- equity: ICT leads to re-allocation of resources, and equity should be in the foreground.

Digital Rhetorics argued that schools need to constantly monitor how their ICT policies redistribute resources and to what effect. Take up of new technologies was most effective when there were whole school policies that were coherent, comprehensive and integrated with other policies, for example, the language policy. These provided a framework in which teacher initiative was encouraged; where there was a strong leadership culture that supported risk taking by teachers around ICT; and where there were moves to maintain continuity of ICT learning for students across the curriculum and through the grade levels (Lankshear & Bigum 1998:68–71).

3.3 Teachers and technocultures

Teachers and familiarity

Lawson and Comber (2000:429) argue in the English Department's *Superhighway Initiative* project in the UK that the stereotypes of 'technophobes' and 'technophreaks' amongst teachers collapsed with familiarity. The enthusiasts and resisters were particularly attracted to the relevance of the Internet:

> It was the sheer salience of the Internet to their pedagogical concerns that acted as a transformative catalyst in many cases. There were numerous examples of teachers who began the project with some degree of reluctance, but ended up as enthusiastic advocates of the Internet … and who were also beginning to explore the other potential uses of electronic communications in the classroom.

Smerdon *et al.* (2000:9) found that one third of US teachers surveyed felt comfortable and well prepared to use ICT in the classroom, but that there were clear patterns in computer use. There were increases in pedagogical use in classrooms if computers were also available to teachers at home, if there is adequate technical support, *and* teachers have access to ongoing professional development (Lawson & Comber 2000). Among teachers with home computers, those with fewer years of experience were

more likely to use computers or Internet at home to gather information for planning and preparation for curriculum materials (91 per cent compared to 82 per cent), and were more likely than more experienced teachers to use technologies to access model lessons (Smerdon *et al.* 2000:ii). This suggests that the next generation of teachers will treat computers as another pedagogical tool rather than just a bonus to assist in classroom administration.

Teaching in a technology rich or poor culture can also impact on how teachers perceive computers and their sense of efficacy and a reason for not integrating ICT (Blackmore & Johnson 2000). School cultures contribute to different ways of working with ICT. When teachers work in a technology rich school culture, teachers are more likely to make good educational use of already available information, communication and learning technologies, such as cameras, video recorders, audio recorders, fax machines and photocopiers (Mayer-Smith *et al.* Smith 2000). Hickling-Hudson's (1992) review of research on computer use in Australian schools found that wealthy schools could utilise their greater material and human resources to create sophisticated computer education cultures compared to poorer schools.

At the same time, in education where school identities are so important, hi tech is still too easily equated to the presence of computers in schools, and of the school having a website. Schools develop different responses and predilections towards Internet access, (e.g. the *Information Superhighway* and the *National Grid* in the UK), that often can have little or no educational or economic value. How they use the Internet is dependent upon the different educational, social and economic resources available to them, a finding that is 'at odds with the popular discourse that application of the information superhighway will alleviate inequalities between schools' (Hesketh & Selwyn 1999:517). They conclude that the 'massification' of the information highway will most likely exacerbate existing inequalities.

Summary

Hi tech is closely tied to school identity in more market based systems of education. While the presence of hi tech in itself does not necessarily produce improved learning outcomes, rich technology cultures are more likely to encourage teachers to adopt and adapt ICT, to create favourable dispositions of students and teachers towards the use of ICT. Conversely, technology poor cultures can inhibit and discourage students and teachers and do not lead to the habits of use that will soon be considered the norm.

4 Home–school links

Home–school links are increasingly seen to be critical to how students learn and succeed in school. Hoffman and Novak (1999) suggest that while inequalities in Internet access at school persists, the inequalities in Internet access at home may be more problematic. Access tends to translate into usage. Home computer use is seen in the literature to have significant impact on the capacity of ICT to improve the learning outcomes for all students[6]. Parents now see computer literacy as essential. In the WA Warriparri cluster of preschool institutions, three year old computer literate children now enter pre school. (Sixty-eight per cent of 3–31/2 year olds and over 85% of 4–5 year olds have computer access at home, 50% are able to recognise components, can turn computers on and use the mouse (DETE 2001).

Home computers' impact on learning has become a major focus of research for several reasons. First, home access is a key element as to whether and how students integrate ICT into their learning in school and at home (e.g. Wenglinsky 1999; *Use of Technology to Strengthen K-12 Education Report, USA, 1997*).

Second, whereas schools and teachers had been the primary sites of learning and source of information through print based texts, now many students have home access to a multiplicity of databases, references, discussion sites, bibliographic and visual as well as aural resources. This changes the relations between teachers and students in schools. Teachers no longer define valued knowledge.

Third, we know very little about how young people actually learn to use such technologies and how they engage with them as 'cognitive tools' outside school (Furlong 2001:1). Yet most children learn most of what they know about computers out of school. Teachers in the ITLED project in SA were surprised at the extent of access to information technologies, given the low socio-economic circumstances of the students' immediate communities. Students were accessing computers through extended family, friendship networks and workplaces, although for many students computer use outside school related mainly to computing games and the quality of computer hardware and software was basic. There was enthusiastic support amongst communities for the uptake of new technologies at school and significant interest within such communities to make better use of a school's information technology resources.

ICT has the potential to change the relationships between schools and home. Access to home computers tends to increase the use of computers and Internet in schools. A small number of students have access to and expertise in far more sophisticated information technologies than those available at school (e.g. Comber & Green 1998). Technology can therefore be a compounder of educational advantage.

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[6] The ABS expected that by the end of 2001 every second household in Australia would have Internet access. Slightly over half of all households (56%) had a computer in November 2000. As might be expected, higher levels of both computer and Internet access occur in households with higher incomes. In November 2000, 77% of households with incomes above $50,000 had access to a computer at home and 57% to the Internet compared with 37% and 21% respectively for households with incomes below $50,000. Computer and Internet access was also higher in households with children under eighteen years, and in metropolitan areas. In terms of income, it was clear that, as an adult's income increased, they were more likely to be a computer user both at work and at home. In terms of gender, there were very small differences between adult male and female computer and Internet usage (67% and 53% for males and 65% and 47% for females) (ABS 2001).

Television is still dominant in terms of time in most children's and adolescents' use of leisure time, although there has been a small shift to video games, chat rooms and the Internet (ABS 2001). But computer use for leisure and education is growing in significance. Students' use was:

- email chatrooms (51.5 %);
- playing games (39 %);
- using web for school or educational purposes (82 %);
- browsing Internet for pleasure (49 %); and
- using Internet for other purposes (6.3 %).

Familiarity

The capacity to develop higher order skills of digital literacy is increasingly dependent on access to technology rich home and school environments. Familiarity refers to the extent and nature of computer use. Evidence indicates that familiarity with technology in the home and in the classroom increases use in classroom and out of classroom. There would appear to be a high level of transferral between home and school use once students feel computer competent. This sense of competence increases with use, and students are more likely to use computers in a range of activities in and out of school (Meredyth *et al.* 1999; Lawson & Comber 1999).

In *Real Time, Computers, Change and Schooling*, Meredyth *et al.* (1999) found that:

- The majority of students acquired basic and advanced skills at home (85% students in sample using computers outside school).
- The earlier students begin using computers the more frequently they use them at a later age.
- The earlier the student started using computers and the Internet at school, the more likely they were to use them at home.
- Students gain familiarity through games, educational programs, with the latter more important in later years.

Familiarity with computers produces a sense of competence for most social groups, but does not necessarily change attitudes with respect to their perceived use value or pleasure value. Girls are equally competent in computer use as boys with experience, but still indicate lack of interest in computers in terms of careers or leisure.

Beamish (1998) found (in 25 classrooms in 12 schools in NSW with 541 students) that students' previous computer experiences influenced their approaches to learning information, processing ability and attitudes to computers. He also reported more positive attitudes to computers and these directly influenced student cognitive and attitudinal outcomes.

Familiarity is a key aspect to developing 'habits of digital literacy'. Some students are able to develop a wide range of digital literacy skills while others with restricted availability and lower levels of familiarity, reach only basic skill levels.

Familiarity changes attitudes, increases skill levels and self-confidence. Large scale studies of student populations in the UK, USA and Australia identify the 'computer poor' to be those students living in poverty or in low income families that tend to be single parent, female headed, black, and most often in inner urban or rural locations (Hoffman & Novak 1998; Meredyth 1998; Funston & Morrison 2000). Students from these families are less likely to be as familiar with computers as other students, and therefore

less likely to develop the kinds of dispositions that lead to transferability of skills between home and school.

Home advantage

Meredyth *et al.* (1999) concluded that there are significant links between students' IT skills, confidence and enjoyment, their use of computers outside schools, the level of access in their homes, and their personal ownership of resources. This produces a 'home advantage' for students from higher income families where there is likely to be greater home usage.

There is strong evidence from both quantitative and qualitative studies that link home and school computer use to improving learning outcomes for particular groups (Mumtaz 2001). Downes (1996:281) found that 'the socio-cultural contexts of children's domestic computing played an important part in shaping children's interactions with computers'. Students' use of computers in school is greatly influenced by their out of school use of computers. Students have access to more technology in their homes than most teachers expect, and much more than schools make available. Most families have computers that are used as tools (for work and school) and toys (leisure and pleasure), but in less affluent communities, older machines and lack of peripherals diminished the variety of tool use.

The literature indicates home computers benefit some groups more than others, with an emphasis on gender differences. For example:

- Computer use at home varies considerably between social groups in ways that can create new forms of disadvantage. In the USA, whites were more likely than blacks to use a computer at home and at school (Hoffman and Novak 1999).
- The proportions of students in grades 7–12 who used a computer at home or at school in the UK increased at similar levels across family income. Large USA and UK studies indicate that having a home computer was associated with higher test scores in mathematics and reading, even after controlling for family income and for cultural and social capital (Reynolds 2001).
- Social inequality impacts on the frequency of home computer use, and the way computers are used, and hence affects the educational benefits derived from home computing (Mumtaz 2001:348-9). Children from higher socio economic homes received higher benefits from home computers than those from lower socio economic homes (Attewell & Battle 1999).
- Boys' performance advantage in standardised tests was larger than that of girls, the likely cause being more time spent on computers. There is a gender gap in educational benefits in reading and maths, with girls missing out on 43 per cent of the computer benefit boys enjoy (Attewell & Battle 1999).
- Home computer use was primarily for games, and more so for boys. Boys are more likely to use computers out of school hours than girls (Russell 1993). Nine to 14 year old males spent more time on home computers, but not online, than their female peers (Land 1999). Boys use the Internet for leisure and entertainment (games and sport). They are more likely to play games that involve changing and reconfiguring the computer's operating system, thus gaining a better understanding of its operating systems.
- Girls use computers more for interpersonal communication (email) and educational purposes (Downes 1996; Weiser 2000; Bimber 2000; *Digital Divide* 2000; Subrahmanyam *et al.* 2001). Girls' use coincides more with parental use and family rules tend to influence use of games (Downes 1996:285). Girls will also play

computer games at home or in primary school, but that decreases with age (Downes 1996). There is a slight trend for older girls to use computers 'a bit more' for schoolwork than boys as they get older (Roberts *et al.* 1999). Girls' expertise lies in word processing and desktop publishing (Durndell *et al.* 1995; Downes 1996).

- Home access and use relates to levels of parental involvement with computers. Computer use requires a high level of infrastructure and interpersonal support to create a 'learning environment' in the home. Educational use of technology was highly dependent on parental support, including choosing software and hardware, working with and praising students (Angus *et al.* 2001, Downes 1996). There was parental ambivalence about computers evident in the expectation of children to be literate in both the new technologies (ICT) and traditional technologies (print).

Some students therefore come to school with a significant 'home advantage' that is magnified by ICT. Mumtaz (2001) concluded that 'the observed findings are discouraging for those who hope that home computing might ameliorate socio-economic disadvantages. … Home computing … may well widen educational inequality rather than narrow it' (Mumtaz 2001:5).

When those students without home access come to school, school practices further exacerbate educational inequalities as they do not have the habits towards acquisition of digital literacies of other students.

> These students are not compensated by access elsewhere. Schools were themselves key sites of reproduction of out-of-school inequalities in relation to the computer use and access. Because of the lack of computer skills and confidence these children were less likely to access computer clubs or 'open access' facilities in school libraries. These were the domain of the skilled or highly motivated users. Furthermore, they frequently felt that teachers, lacking ICT skills or resources themselves, compounded their exclusion by giving access in the classroom to more experienced computer users whose teaching demands were low (Furlong 2001:6).

Home computers as the new form of cultural capital

Furthermore, acquiring home access does not necessarily equalise opportunities. Quite often the home environment is not a computer rich learning environment. Various parental discourses circulate in families about computers as the future, computers for education, computers as a form of personal productivity tool and computers as entertainment (Downes 1996). Most parents saw computers as educationally beneficial, leading to careers and necessary for further education, and a source of increased productivity. The cultural practices of the home are gendered and related to affluence, with fathers from more affluent households most likely to have the expertise and use computers with a range of peripherals although this did not directly relate to student computer use. The dispersion of expertise in families varied, often individuals in computer rich homes had no disposition towards using the computer (Downes & Reddacliff 1996).

There are a number of convergences between family and school discourses about computers, most particularly, where the benefits are treated as highly utilitarian in terms of future study and employment. Both schools and families agree that computers were motivating students to do more homework, and made schoolwork easier (particularly editing) and in particular made work 'look better' (Downes 1996:283). While there was recognition that word processing facilitated editing, the emphasis on

‘the look’ of the texts and ‘getting information’ dominated rather than more complex understandings of transforming information into knowledge.

Birenbaum *et al.* (1994), in a study that compared students given home computers to a control group who were without computers, confirmed that the most educationally disadvantaged children gained less from home computers compared to slightly more educationally skilled disadvantaged children. That is, students with severe reading and writing difficulties were not able to benefit from computers without initial skill development and intensive teaching.

An Israeli study where computers were placed in homes of low and high income students found that any equalising impact of computer integration is mediated by familial cultural capital (Levy & Danon 1991). Middle class students quickly acquired the ‘habits of digital literacy’ in home environments where computers were integral to the daily life of their parents in their professional occupations. As with academic learning, the ‘cultural capital from the home impacts on cultural capital of the school’, thus enhancing existing advantages (Levy & Danon 1999:7).

ICT also changes relations between parents and teachers. Middle class parents’ knowledge about the capacity of computers and purpose and genre of computer based reports means such parents pressure schools to be innovative and develop higher order thinking skills rather than use the drill and practice exercises typical of lower income schools (Levy & Danon 1991). Students in lower income families tended to use computers in a more technical fashion, as did their families. Consequently, teachers tended not to include innovative approaches in their classes. Computer effects therefore cannot be simply reduced to either achievement level or distribution of computers but are also about cultural power. Computers are a new form of cultural capital.

One strategy is to provide home computers. Angus *et al.* (2002:1) undertook an Australian investigation to research ‘home and school computer-mediated communication practices (CMP) in low socio-economic communities’ through an alliance between the Australian Council of Trade Unions (ACTU), a computer and software distributor and training company (Virtual Communities), and an Internet provider (Primus). Despite the optimistic view that ICT would offer a new range of information bases and identity formation, Angus *et al.* concluded that the four low income families in the study ‘learnt many complex lessons about identity and representation, and also literacy, judgements based on reading of signs, poly-discourse, imagery, language and dialects, creativity, decision-making, visualisation, manipulation, interpretation, interactivity, and new forms of composition. Yet such families remain in a vulnerable position with limited cultural resources.

Another approach has been to provide laptops to families of children in school as in the *New York Community School District Six Laptop Project* (Metis 2000). Two pilots were undertaken in high minority group schools with mix of Hispanic, black and low income families. In the higher performing academically selective school, laptop schools increased their standardised test scores, students indicated they worked more on their schoolwork, teachers indicated students were more organised and willing to do more home work, and their work was neater and more organised. Teachers considered that they had moved to become facilitators of learning rather than knowledge providers. The use of laptops encouraged multidisciplinary innovative projects and enhanced moves towards inquiry based activities. In the non-selective lower socio economic school, laptops meant students maintained but did not enhance their performance, while comparable schools without laptops went into decline in achievement scores. In the third program, students were taught to be experts to teach other students through a summer school.

In all three programs, students expressed a growth in confidence, improved classroom behaviour and a greater sense of achievement with a generally improved attitude to school. Student gains were in organisational and writing skills, and many took time to teach parents and siblings the new technologies. Again, these results are equivocal in terms of learning outcomes as all participants were self-selecting students who were above average achievers in their cohort.

Students learn ICT and use ICT as part of the overall socialisation process arising from their lived realities. The home advantage, so clearly differentiated along the lines of income (and therefore often race and ethnicity), impacts disproportionately on how students can capitalise on new technologies in school (Furlong 2000).

Most studies confirm that while some students who have been given home computers have shown a marked improvement in school performance, home-computer users as a whole have not out-performed matched control groups. There is no improvement in relative advantage. Home computers do stop some students falling behind further. Meredyth *et al.* (2000) in *Real Time* found that inequalities in home computer access seem to have grown, not shrunk, in recent years, and racial differences remain large.

Home school differences

There is a distinct difference in use of computers between home and school—with schools seeking to control the playability and exploratory possibilities of computers, in part due to issues of classroom management but also efficiency in time use (Downes 1996). Yet schools expected students to pick up computer use with minimal instruction and have little sense of what computer use students have at home. Schools encourage passive relationships to computers. The dominant use of the computer in homes is the playable computer, where children learn through exploration and the visual and auditory interactivity.

Sutherland *et al.* (2000:210) in the English project *Screen Play* suggests we need to think of the computer as a cognitive tool in which the culture and context of use shapes its potentials and possibilities. ‘It is therefore appropriate to consider the home computer as qualitatively different from or having similarities with the school computer’.

Computer use is constructed differently in different families. A student’s view of computers arises out of a variety of structuring discourses—discourses of production, family, popular socialising and of the child/youth culture—that may shape the way computers are perceived. Young people are also agential in constructing their own definitions of computer technology. The issue therefore is how to capture that agency.

Motley (1999) argues that the differing values schools may put on the ICTs used at home and those incorporated into the curriculum need to be examined. For students without up-to-date ICT in the home, Motley (1999:67) suggests that:

> Including ICTs (and the popular texts represented through ICTs) that make up part of the student’s home literacy even in the school curriculum, could provide the bridge between lower socio-economic students’ home literacies and those valued at school, constructing a more relevant curriculum for those students. It may be appropriate for teachers to re-look at the way they employ older ICTs (television, audio cassette players and popular texts) in the curriculum they offer students. Using the new ICTs to construct mixed mode multimedia texts at school is a logical extension for this.

The visual emphasis meant that the dominant use of computers for text production was to make it ‘look good’. Downes (1996) and Sefton Green and Buckingham (1996) comment on the limited use of multimedia texts, how children use ICT to create paper based written texts with decorative borders, and some manipulation of images, but with little sense of purpose and audience.

At the same time, there are on the whole more positive outcomes for inclusive education for the students with disabilities, their families, the teachers and the schools when ICT is a feature of home life. Students can have access when ill to a range of resources and teachers through CMC and the Internet. As with the other groups of students affected by disadvantage, the involvement of the family in technology use supported its successful use in the school (Erickson & Koppenhaver 1998; Sturm 1998).

5 Communities

ICT promises a capacity for schools to be linked to both local and virtual communities. At the same time, technology poor schools often have low socio economic and/or high cultural diversity student populations, and are often located in low income or isolated regions with poor telecommunications infrastructure. What schools can do with ICT to enhance student learning is therefore conditional on community resources, local community organisations' relationships with schools, and the distribution of ICT resources locally.

The Information Technologies, Literacy Education and Disadvantage (ITLED) Project in South Australia (Comber and Green 1998), and overseas studies such as Goslee and Conte (1999), reported that individuals learnt through social and community networks of friends and relations rather than formal educational institutions. In the ITLED project teachers were surprised at the extent of access to information technologies, given the low socio-economic circumstances of the students' immediate communities. Many students' computer use outside school related mainly to computing games and the quality of computer hardware and software was limited. There was enthusiastic support among communities for the uptake of new technologies at school and significant interest within such communities to make better use of a school's information technology resources.

Structurally, governments are encouraging schools to establish learning networks in which students and teachers link more closely to their local neighbourhood communities, and also to virtual communities globally. Schools are no longer seen to be able to assist students all alone, particularly students who are disadvantaged. Learning networks are therefore becoming the basis of school and community renewal (Victoria Learning Networks Discussion Paper Sept. 2001; multi campus models in NSW; district provision in WA). Virtual or real learning networks or communities are also the basis for teacher professional development (Kenway, Blackmore *et al.* 1999). ICT is therefore seen as providing an opportunity to expand the scope of students' and teachers' learning through new 'virtual' experiences and interactions, multiple knowledge sources and real and virtual learning networks.

The CIRCLE project funded by the US Department of Education explored collaborative technologies as a catalyst for changing teacher practices and developing knowledge building communities. The project involved linking low-income inner city schools to high-income suburban schools with the support of the Texas university and school district. Three software programs facilitated these networks—Daedalus, First Class and TeamFocus—and supported collaborative learning projects. The notion of a learning network premised upon the exchange of best practice is central to strategies such as Navigator schools. The School of the Future model in SA also works through learning networks to develop digital literacies of both students and teachers.

There has also been an increased focus on the centrality of schools as sites of ICT innovation for community renewal. In the UK, *School Plus: Raising Attainment and Expectation* (DfeE 2001) supports a coherent and comprehensive approach to supporting the learning of every child in deprived communities. The focus is on stimulating teaching and learning. *School Plus* argues that it is a matter of national benefit not to have deprived school communities and children who do not achieve.

Learning is seen to be the key for neighbourhood renewal[7]. A case study of transformative schools in deprived areas in the UK illustrates how schools acted in partnership in a locally tailored community approach to *School Plus*.

Community based programs

The Arts provide considerable scope for the innovative use of ICT that can have long term impact on the occupational futures of minority groups. In the Arts and Graphic Design, the new technology offered students with relatively poor motor skills and co-ordination the chance to produce highly accurate work, revising work as it progressed. Higher standards could be achieved at earlier educational stages, and these had implications for pathways and articulation. ICT in this context provides the opportunity for a synergy of inclusive content and process that leads to a cultural product that has value for both the producers and others.[8].

5.1 Libraries

There is a renewed focus on libraries and museums as sites of access to new technologies and nodes in learning networks. As public spaces they provide some opportunities for disadvantaged students who are of school age but out of school, for example, the homeless. The English Department's Superhighway Initiative (EDSI) project in the UK argues that 'public libraries provide a largely free means of accessing, harnessing, sharing and developing knowledge' (Lawson & Comber 1999:11). The main public libraries and museums of international reputation in England are expected under the National Grid to provide access to key collections through the Internet.

In schools, the library is central to the Intranet. The Navigator schools in Victoria found that ICT refocussed the library as a key resource in schools, and was central to the technology planning. In Navigator schools the librarians locate, coordinate, cache and catalogue Internet sites, and CD Rom based material as well as print based materials. Librarians train staff and students in accessing, verifying, evaluating and annotating online information, and developing online materials for Key Learning Areas (KLAs).

Libraries are also logical places for modelling gender-equitable and inclusive practices for the use of technology, as well as providing additional time for students without home computers to access computers. Librarians can work one to one with students to assist in upgrading skills and computer literacy in a problem solving capacity (Farmer 1998).

The cross disciplinary imperative of ICT also poses new challenges for libraries with the need for librarians to form new alliances with ICT and subject area specialists (Nixon 2001).

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[7] In the UK there are 35 per cent of students with Free School Meals (proxy for poverty) and of these around 1200 primary and 200 secondary have more than 50 per cent of such pupils. Many of these schools are in the Education Action Zones or New Deal for Community areas that are targeted for additional government assistance (Dfof E 2001).

[8] The SA School of the Future is involved in a Quality Teaching Project where they look at Arts and Technology rather than just the Internet for communication and information.

6 Indigenous students

‘Indigeneity intersects with poverty, locality, and socio-economic disadvantage to make the chances of poor schooling, participation and performance extremely high’ (Collins *et al.* 2000:2). The IESIP Preschool profile indicated that at age four there are few significant differences between achievement of Indigenous and non-Indigenous students in basic literacy and numeracy criteria and only marginal differences in areas of linking experience to written text and recognition and appropriate use of symbols (Griffin and Raban 2000). By Year 3 there is a marked differential. Retention rates based on data collected in 1999 show that only 32.1 per cent of students stay on to Year 12 compared with 72.7 per cent of non-Indigenous students. This suggests that something happens in schools to shift the achievement patterns evident in early childhood.

Bourke, Rigby and Burden (2000) significantly locate ICT and the education of Indigenous Australian students into a broader framework of influential factors that go beyond ICT more generally. Where schools use ICT as a learning tool without addressing these broader framing factors, then minimal gains in the learning of Indigenous Australian students can be expected. Factors influencing learning include school relations, cultural exclusion and the culture of schools. ICT needs to be contextualised into this wider context.

Henry and Brabham (1994) argue that the culture of schools is highly inclusive of middle class family interests in education. They also show how this same school culture tends to exclude Indigenous family interests. Berry and Hudson (1997:11) make a similar point:

> When two or more cultures exist within one classroom there is always potential for misunderstanding due to differences in attitudes, values and behaviour. Although there is no single Aboriginal culture shared by all Indigenous Australians, it has been recognised that there are definite differences between the worldviews, child-rearing practices and learning styles of Aboriginal and non-Aboriginal Australians.

While critically questioning the reference to learning styles, these differences have implications for the way in which teaching and learning take place in the classroom and the way in which the teaching produces successful outcomes. Where the school culture is not inclusive of Indigenous family interests in education, there is lower school attendance of Indigenous Australian students.

Bourke, Rigby and Burden (2000) suggest that the engagement of Indigenous students in Computer Assisted Learning could have the potential to reduce student absenteeism. But importantly, they also noted that there was a wide range of contextual factors that impact on the attendance patterns of Indigenous students. These factors include: ‘personal factors, expectations, health, past performance … teacher training, the educational programs, school environment and atmosphere. The various factors can be grouped under four broad headings: student issues, systemic factors, school/staff issues, and parent/community factors’ (Bourke, Rigby and Burden, 2000:19).

6.1 Student issues

Individual motivation and pleasure

Computers are expected to improve confidence. This is particularly the case for Indigenous students. The PLUS (*Positive Links between Universities and Schools*) project between a school and university in the Ipswich region of Queensland, involved Aboriginal and Torres Strait Islander students from secondary schools who were tutored one afternoon each week for ten weeks. The aim of the project was to enhance literacy and numeracy skills by using ICT, specifically, the designing of web pages. The results of the project indicated that the Aboriginal and Torres Strait Islander students felt comfortable with computer mediated learning because it enabled them to make mistakes privately, and not be 'shamed' by public correction by a teacher. As well as this, the computer provided space and time for student experimentation, reflection and reassessment. The study found that the teaching of literacy and numeracy skills and the use of computers were directly linked (Kapitzke, *et al.* 2001) and there was positive improvement in performance. There is no breakdown in these studies on the basis of gender.

In a study conducted with primary school children, Darvall (1986) found that using ICT increased the cognitive skills and spelling ability of the Aboriginal students at Weilmoringle SSP. In addition, the use of computers increased the self-esteem of the students because they found them to be more user friendly than teachers who often chastised students for being wrong.

The culture of the classroom affects how students feel in the learning process. The Johnston *et al.* study (2001) noted that Aboriginal students liked working with computers because no one was looking over their shoulder and therefore they were able to take risks. This lack of risk environment requires teachers to be alert to other 'technical' sounds that may indicate success or failure in self paced skill tasks, as some students prefer the privacy of working alone.

6.2 Learning styles

Although some of the literature cited in this study refers to Indigenous learning styles as a theory to support the researchers' interpretations of their positive results, our view (e.g. Folds 1986, Fryer 1987) supported by Henry and Brabham (1994), is that this psychologising of Aboriginal students by researchers is flawed. The underlying issue for this study is the link between so-called disadvantage at school and the culture of the school as a western institution as experienced by Indigenous children. Learning styles are themselves cultural products. The central element here is not Indigenous learning styles but the teaching style that dominates this environment and ultimately establishes the norms of behaviour within this teaching/learning space.

When we look at leading practice later in this report, it is evident that the projects that have had successes for Indigenous students have been the ones where the teachers have changed both the culture of their classroom teaching and their teaching styles to accommodate the needs of the students.

There have also been indications that Indigenous students like working on word processors because the students have creative control over their work. 'Computers allow for self-correction that ensures a "perfect" end product. Risks can be taken and mistakes made without any "shame" associated' (Johnston, K. *et al.* 2001).

The findings of O'Donoghue (1992) in East Kimberley schools indicate that some of the reasons for success in using ICT with Indigenous students include the fact that the 'computers are friendly and encourage, rather than chide; they offer colourful graphics and quick dynamic action; there are many programs that do not depend on reading skills; the absence of spoken words remove the difficulty of listening to and understanding what is being said by a non-Indigenous teacher' (O'Donoghue 1992). While this study makes important points, it does so in ignorance of the need for teachers of Indigenous children to be critically reflective of their routinised practice and the assumptions that support this. Is it enough to develop merely one mode of literacy when students need to have access to multiliteracies of which multimedia is one aspect?

Instructional materials

Finally, McLoughlin (1999) highlights the need for culturally appropriate design of materials online as current instructional design models do not fully contextualise the learning experience, and are themselves the product of a particular culture. McLoughlin proposes the adoption of a multiple cultures model of design based on Lave's model of communities of practice. While this does take up issues of different learning styles, there is recognition here that learning styles are not cognitive attributes as much as social constructs. McLoughlin and Oliver (2000) in the university context discuss culturally inclusive constructivist learning environments based on a bi-cultural model of learning that recognises diversity and different learning needs.

6.3 Literacy and numeracy

Books and computers are both technologies in the field of communication. These technologies are currently not in most Indigenous students' homes. However, the mastery of computer literacy will become the key precondition of successful to schooling as are text literacies. Indigenous students, already disadvantaged with respect to text literacy will be additionally disadvantaged with the growing emphasis on digital literacy. The levels of 'book literacy' of Indigenous children are significantly behind that for the norms in the general Australian society. Literacy education for Indigenous students has been sadly lacking and 'it can be seen then, that the kind of literacy education Aboriginal people received has essentially maintained the status quo—a position of powerlessness in contemporary Australian society' (Dunn, M. 2001:679). Our expectation, though we could find no research to either confirm nor deny this, is that as is the case for book literacy, the levels of computer literacy of Indigenous Australian students will be lagging behind that of the mainstream Australian school population.

Scott (1990) found that teacher and Indigenous staff intervention in the learning process is vital for successful outcomes with ICT. He conducted a study using three schools in the Brewarrina and Bourke school districts with 30 Aboriginal and non-Aboriginal students. The project was undertaken over a ten week period and a control program was also established. The schools were categorised according to three levels of computer use: for interest value only; partly supervised; and totally supervised. School A was designated 'interest value only' and the students were motivated by novelty value and worked at their own pace; School B was 'partly supervised' and a teacher was in close proximity and could motivate the students when their interest waned; and School C was 'totally supervised' with each pair of students being assisted by a resource teacher or an Aboriginal education assistant, with regular homework set and marked. Each student had a workbook and worked in pairs with a set of work

related to reading. At the end of the project, the reading age of the students in the control group had increased by 2 months. In School A, (interest value only) the reading age increased by 2.4 months and there was no impact on the attendance rate of the students. In School B (partly supervised) the reading age increased by 3.6 months and the staff felt that the students with poor attendance had benefited. In School C (totally supervised) the reading age increased by 8.4 months, the attendance rate for all of these students improved, and after two weeks on the project, they became self-motivating and could work without supervision.

This project indicates that it is not only the use of ICT that will enhance learning, but that teacher intervention plays a key part in successful outcomes. While the study was only conducted for a ten-week period, it is significant that the learning of the students increased in every situation where they were able to access computers. The study supported the contention that computer assisted reading remediation (CARR) has merit in assisting and motivating students The study also found that improving self-esteem and confidence could be one of the major benefits of the program (Scott 1990).

This study is intriguing because of its silences on the level of involvement of the Aboriginal education assistant in School C, which showed the greatest improvement in reading age. Also because Scott does not factor out the effect of the study on the Aboriginal student participants we have no clear data on the degree of improvement in reading for the Aboriginal students.

6.4 Computer studies and computing as a career

While there is increased use of computers by Indigenous Australians, they are poorly represented in post school courses. The explanations range around:

- complex environmental (economic, social and cultural) factors;
- familial and peer relations;
- gendered and culturally biased notions of competence;
- expressions of cultural difference; and
- gendered and racialised classroom and peer dynamics.

It seems that students learn about possible occupations through their friends and families. Given that many Aboriginal parents and families are not accessing ICT, there is little knowledge about ICT as a future career, and many families favour more traditional and well known occupations. The sense that ICT is culturally exclusive adds to a process of self selection out of ICT courses and occupations, a process exacerbated by lack of access and familial use.

6.5 Indigenous parents and communities

Communication between school communities and Indigenous communities continues to be limited. There are few examples of positive initiatives to breach the gap.

When technologies are introduced to Indigenous Australian communities, they are accommodated into people’s lives when they are seen to fulfil a recognised need by the people themselves. The need is identified first and the technology, when available, is applied. The reality is, of course, more complex as there is a dynamic interaction between the new technology and how the need is constructed, and how technology is used. Indigenous Australians have adopted and adapted technologies in culturally specific ways, using them to produce cultural products. Technologies that have been

‘colonised’ by Indigenous Australians range from mobile phones, videotape and film productions, rock musical instruments and audio production equipment, audiotapes and CDs. We have also clear examples of the same process of technology appropriation by Indigenous Australians in the use of the printed text—books, plays, poetry and film scripts. The same process is occurring with the Internet as Indigenous organisations begin to explore the usefulness of websites for the expansion of their own community interests. ‘As a virtual space for cultural production and reproduction, the Internet and the World Wide Web in particular can assist Indigenous peoples to reframe old knowledges and construct new ones’ (Kapitze *et al.* 2001).

These processes of appropriation give rise to possibilities for the emergence of Indigenous forms of cultural enterprise that can lead to economic independence through cultural production utilising ICT, an area that requires development through school and community based activities.

Indigenous Australians are not technology afraid. For them to become interested in the use of the Internet as a learning tool, they need to be able to access Indigenous websites that have been produced by Indigenous people, are culturally inclusive of Indigenous issues, and that provide opportunities for Indigenous initiatives and innovation. This suggests a link between the schools and the Indigenous Australian community whereby teachers and students can have access to culturally inclusive resource data bases for content.

The above discussion has crucial implications for Indigenous students. Given the fact that most Indigenous students are from low-income families, it is highly unlikely that they will be able to access computers at home. Therefore, in order for them to have quality time on computers, they have to be able to access them at school. Even if students are able to access computers at school, there are other issues to be considered, including the amount of time the students are able to spend on computers at school and the quality of the instruction they receive when they do have access to computers.

7 Students with disabilities

Much of the earlier research into the use of ICT with students with disabilities (mid 1980s–mid 1990s) compared Computer Assisted Instruction (CAI) as it was commonly called, with instruction using traditional teacher directed methods, the most common methodology being to compare learner performance of groups with and without computers. Research at this time tended to look at skill development and skill practice in decontextualised learning experiences. With the introduction of hypermedia, there was increasing interest in linking information and using multiple media to deliver contextualised learning experiences.

However, the following findings from this period are significant. Fitzgerald and Koury (1996) identified research findings in relation to the use of CAI in reading mathematics and social and physical sciences.

They found that the contribution of the studies in the science areas was the emphasis on overall instructional design and integration. Here ICT was viewed as an 'instructional enhancer' and factors that supported student learning were viewed within the total learning environment.

Computer simulations extended student learning by providing problem-solving applications for existing knowledge. Technology was integrated into the body of knowledge and based on direct teaching and mastery learning, both of which have long been thought of as essential in effective teaching for students with disabilities.

The early research paradigm attempted to assess student learning by comparing CAI to traditional instruction. Studies found that overall, students with disabilities learn as well or better through computer-assisted approaches. In addition, students continued to express preferences for computer-delivered instruction over all other forms.

There was a shift in the mid 1990s from comparative research to investigations of instructional practices and integration. Researchers attempted to define those learning conditions that optimised the use of technology-assisted instruction. The research questions broadened to include those related to curriculum, pedagogy, grouping practices, and student variables. Findings overwhelmingly supported the role of the teacher in arranging, facilitating, and extending effective technology-based learning.

Fitzgerald and Koury's (1996) review of the research literature documented that:

- Prior scaffolding instruction and ongoing scaffolding are necessary for students with disabilities to independently use as computer programs.
- Periodic maintenance and follow-up activities ensure skill application.
- Strategy instruction is critical to enable students to generalise problem-solving skills from simulations to new situations.
- Students can work effectively in homogeneous dyads to improve reading comprehension, but that heterogeneous dyad groups are more effective in improving written expression.
- Instruction can be delivered effectively to entire classes using networked, individual response systems with individualised feedback.
- The design features of ICT that enhanced learning for students with disabilities were also identified and included the provision of:
  - immediate feedback;

  - learner options to use hypermedia enhancements and speech synthesisers to support understanding; and
  - prior instruction in building declarative knowledge before students engage in fluency building practice.
- Technology provides effective instruction when well designed and used under teacher control, and when teachers can effectively modify content in computerised study guides to enable students to learn content at appropriate levels.
- The use of contextualised problem-solving materials in stimulating prior knowledge and skill transfer is effective in achieving learning outcomes.

Technologies with some empirical validation included:

- speech feedback in basic skill areas through speech synthesis;
- hypermedia textbook enhancements;
- multimedia composition (Fizgerald & Koury 1996);
- onscreen keyboard programs (Clicker 4 and Wordbar) (www.cricksoft.com) providing scope for both curriculum innovation and access technology;
- software programs with inbuilt switch access and automatic programming of adaptive devices (e.g. IntelliKeys) (www.intellitools.com); and
- software utility programs that include a combination of tools, including text-to-speech, voiced spell checkers, thesaurus, word find and word prediction features (e.g. WordSmith, TextHELP! Read & Write) [www.textHELP.com].

Whereas the early technologies tended to be computers for simulations, word processing and drill work, the most commonly used technologies today are CD-ROM, interactive video, local area networks, and satellites for distance education (Lewis, 1997).

There is evidence that technology assists students with 'procedural tasks such as recording assignments and note-taking and with cognitive tasks such as calculating, spell checking, and synthesising information' (Anderson-Inman, 1999:240). This is particularly important for students with sensory and learning disabilities who have found it difficult or impossible to produce work that could be accessed (e.g. read, viewed or listened to by others).

As the impact of ICT on the learning of students without disabilities became known, researchers became interested in looking at its impact on disadvantaged students within the whole school context. In a 1994 study (Lewis, 1997) administrators and teachers agreed about the benefits of technology use for students with disabilities. These were: the ability to proceed at own pace; and improved attitudes (self-concept, compensation for the effects of disabilities, and improved academic performance).

Forty-one per cent of administrators saw use of computers as a high priority for students with disabilities, and 71 per cent of teachers saw this as a high priority. The features regarded as important by teachers and administrators (with higher ratings for teachers) were:

- students proceed at own pace;
- instruction can vary for individuals;
- immediate feedback provided;
- increases enthusiasm for school in general;
- improves self-concept;
- increases engaged time, time on task;

- helps compensate for communication disorders;
- students learn about things they otherwise would not be exposed to;
- improves academic performance;
- students better able to participate in mainstream activities;
- provides socialisation opportunities;
- increased range of leisure activities; and
- enables better discipline.

Blackwood's findings in special school contexts (1999) supported many of these positive features with these additions:

- engagement of students in creative activities;
- playing of games to learn and to develop cognitive skills such as cause and effect and remembering;
- helps learn life skills that support independent living; and
- students learn more quickly.

As the capacity of technology to meet a range of human needs increased, the impetus for the design of Adaptive or Assistive Technology (AT) increased. There is considerable research now into the effectiveness of this technology for students with disability and this research informs design. For example:

- Students with vision impairment and students with learning disabilities both use screen reading software, large screen monitors and voice recognition software (Fichten, Barile, & Asuncion, 1999).
- Different types of adaptive equipment need to work together; software and hardware and additional 'add-on' technology (Fichten, *et al.*, 1999).
- Increased use of AT for individual users, e.g. trackballs, alternate keyboards, etc and adjustment of some features for individual users, e.g. acceptance rate for keystrokes (Bayha, 1998).
- Use of software that includes accessibility features and can be used with AT, e.g. on-screen keyboards, word prediction, screen reading, and voice recognition (Bayha, 1998).
- Use of adaptations to keyboards including stickers to help students remember function keys, use of a keyguard or alternate keyboard, e.g. Intellikeys, for students with dexterity difficulties (Bayha, 1998).
- ICT Technology used in Special Education includes telebraillers, voice recognition software, word prediction, multimedia programs with synthesized speech, and real-time captioning (Lewis, 1997; Fine, 2001). ATs used most frequently were speech synthesis, touch screen, and three expanded keyboards: IntelliKeys, Unicorn Expanded Keyboard, and Muppet Learning Keys (Lewis, 1997:3).
- In 1994, 88 per cent of special education teachers had a computer in their classroom in this study. Increased use of voice recognition software, synthesized speech, assistive technology that were 'add ons,' CD-Roms. Availability increases the likelihood that computers will be used. (Lewis, 1997);
- Students' use of AT can also assist teachers with access, e.g. teachers of students with vision impairment can share floppy discs with students in Plain Text format, computerised braille can be translated into English text, and screen readers give access to both for assessment or for consideration of task requirements (Fine, 2001); and

- Access to technology does not guarantee that students with disabilities can use it (Fine, 2001). The technology does not always match students' requirements.

Classroom and home technology solutions for students with disabilities include providing access to computer hardware and software, possible use of additional AT such as screen reading or scanning software, and use of web sites that are accessible for everyone. Compatibility of AT and special software with computing equipment is also important for many students with disabilities. An ideal situation would be one where computers, software and AT were accessible to all students and worked together seamlessly. This would increase access for students with disabilities and decrease the amount of different equipment required for computer use, further reducing cost. Essentially, this involves universal design, that is, design for all.

Home-school

There are positive outcomes for inclusive education for the students with disabilities, their families, the teachers and the schools when ICT is a feature of home life.

As with the other groups of students affected by disadvantage, the involvement of the family in technology use supported its successful use in the school. Inclusive education is emerging as good practice for teaching students with augmentative and alternative communication needs (Erickson & Koppenhaver, 1998; Sturm, 1998). Studies looking at the factors that are essential in the use of ICT in inclusive schooling for these students confirm the importance of:

- collaborative learning;
- educational and technological support;
- parental involvement;
- support for development of social supports (e.g. friendships); and
- behavioural supports for students with disabilities (SWD) with challenging behaviours (Soto *et al.*, 2001).

8 Who benefits—how and why?

The following myths were debunked in this review:

- Working class students don't have computers at home;
- Indigenous students always prefer working in groups;
- Girls benefit from working in groups;
- Girls are less competent at computers than boys;
- Indigenous students do not like computers;
- Computer games are bad for boys;
- Teachers are being replaced by computers;
- Teachers are technophobes;
- Computers are not anti-social;
- Computer mediated communication is culture and gender free; and
- Students who cannot read, also cannot work effectively with ICT in ways that improve learning.

Learning

This literature review indicates that the use of ICT in classrooms does impact on student learning in general, but with significant qualifications. There is some evidence (large scale statistical studies, smaller experimental studies and case studies) that there was improvement in standardised tests in foundational literacy and numeracy for all groups with the use of ICT, but often only marginal. There is little mention in most studies of the quality of the hardware and depth of integration of ICT into classroom practices. Most teachers in most subjects indicated an overall sense that students were more engaged with learning, but could not comment on why and what effect this had on the cognitive outcomes of learning.

There is equivocal evidence that ICT can only enhance learning in specific subject areas when a range of other factors converge to promote this aim. Moseley & Higgins (1999) found that professional development of teachers in computer literacy contributed to substantial gains in students' attainment in the short term under the following conditions:

- clear subject-focused objectives had been identified;
- it was clear that the teacher could use the ICT activity to deliver those objectives;
- the teachers ensured that students had ICT skills that were sufficient to enable them to achieve the subject-specific objectives; and
- students were given sufficient access to ICT to achieve the learning objectives.

However, and this is particularly important for particular groups who are not as academically inclined, ICT did enhance learning in the area of developing multiliteracies. Students were engaging with the more sophisticated multimodal uses of multimedia to acquire aesthetic literacies (design), aural literacies (music), visual literacies, as well as digital literacies (technical expertise in computers and Internet). In that sense, computers are no longer either toys or tools, but playing and learning occur both in schools and at home. Thus this broadening of what we understand to be

successful outcomes to incorporate the full range of multiliteracies is an area that requires further exploration, particularly with regard to possible benefits for non-engaged students, particularly boys, and Indigenous students. There is a need to consider how the visual literacies and images can lead on to developing verbal and textual literacies.

Attitudes to learning

There is some evidence that use of computers changes patterns of learning (cognitive processes), and attitudes to the organisation of learning for both mainstream and students with disabilities. Students using ICT were more organised and began to understand meta-cognition (i.e. learning how to learn). Indeed, for all equity groups, the use of computers and the Internet increased motivation, particularly for students who did not like reading or students who had physical difficulties with books (Delzell & Hamill 1996).

At the same time, these benefits are more overt for students with academic predispositions, and any students with learning difficulties often require more structured scaffolding, more explicit teaching of prerequisite skills, and more frequent practice to attain the level of success that then allows them to move onto authentic and creative use of digital literacy. This is not ‘dumbing down’ the curriculum. Rather it is making explicit the habits of learning that are often implicitly assumed and enculturated. Possible connections between metacognition and ICT use needs to be explored.

Psychological and social effects

There are other psychological and social benefits perceived by students, teachers and parents. This included students’ improved capacities to work collaboratively, to undertake longer term problem solving and tasks, to undertake independent learning, and to articulate their processes of problem solving. In most instances, working in groups around computers provoked discussion between students. CMC online also provoked interaction but at a more professional level among teachers, and at a more social level amongst students. Again, there is a need for studies of students working with computers that focus on these social and psychological outcomes.

There is quite consistent evidence that students with disabilities, Indigenous students, and students from low income homes, experience growth in their sense of self and agency, and autonomy in their learning, when given reasonable access to up-to-date computers at schools. This was particularly evident when students otherwise marginalised could be seen to be experts in the use of ICT, as in the case of students with physical disabilities (Delzell and Hamill 1996). What is not known is whether this new sense of agency for these groups develops into longer term social, psychological and cognitive learning effects.

At the same time, this study emphasises that it is the quality of the social interaction and relationships, and in particular student teacher interaction, that occurs once computers are fully integrated into classrooms that impacts most on student learning. All students, particularly students with learning difficulties, need prior and ongoing scaffolding, the metacognitive aspects of learning how to learn, that teachers provide in order to work effectively with computers. Computers are often a catalyst to radically changing what is happening in classrooms as they facilitate moves towards student centred learning, but such changes are less reliant on ICT and more reliant upon teachers’ approaches to pedagogy and learning.

The positive outcomes of ICT listed above are conditional. Most of the significant positive ‘computer effects’ were contingent upon students being in technology rich classrooms or action research based projects with researchers reflecting on practice. Students showing the greatest effects were immersed in classrooms over a period of time where teaching has been transformed along student centred lines with cross-disciplinary authentic curriculum and assessment tasks. Certainly, ICT can be a stimulus to reform classroom practices. But the most productive use of ICT is more likely to occur in transformed classrooms.

9 Gaps in the research

This wide ranging review of literature on disadvantage, ICT and learning has found that there has been a significant research focus on class and gender and ICT in areas of literacy, maths and science, with an emerging interest in the arts. However, in the areas of access for students with disabilities, and the ongoing cultural exclusion of Indigenous students, there are significant gaps. There is little research and few case studies which consider the following issues:

- How ICT works for different groups of NESB students disaggregated by gender and location, e.g. How does English as a second language impact on their attitudes and use of computers; and how do the dominant Anglo-cultural texts affect their understandings?
- The lack of access, participation and success of school-aged 'out of school' youth or those 'at risk' of being early school leavers; and what ICT and the web can do to increase their access, participation and success.
- Rurality and isolation. There is a tendency in Australian studies to collapse rurality and isolation into issues for Indigenous learners.
- The implications of ICT for outcomes and assessment. In making possible a range of performances and presentations that are problem based and cross disciplinary, the integration of ICT into the curriculum will require broader understandings of learning outcomes and new forms of assessment.
- The impact of ICT on the learning outcomes for students with disabilities. Much of the research has been on the impacts of access and the social benefits of inclusion rather than on cognition.

We will address these in more detail in Section G, *Issues and Further Research*.

Section C Leading Practices and Strategies

There is a complex interaction between school resources, infrastructure, teacher expertise, student attitudes, student access to computers at home and in schools, family background, and cultural and linguistic differences. This influences how teachers and students access and use ICT. Successful practices are not readily emulated or transferable as contextual factors come into play. What is identified as 'best practice' often tends to occur under extraordinary conditions—a particular combination of school environment, change cultures, teacher expertise and motivation, and most often, additional funding and dedicated programs.

Most schools and classrooms do not have ideal conditions, particularly schools and classrooms that have high levels of disadvantaged students. For them, it is not just a matter of replication of practices that work in other sites. Adoption of models usually means adaptation. We therefore use the term 'leading practice' because it indicates where schools, teachers and students display initiative and creativity working within their particular contextual constraints.

There is now a range of projects, pilots and developments underway across national systems and in Australian schools, which are beginning to focus on how technology can enhance learning (eg Cuttance 2001). The following vignettes have been selected from those practices that have been documented in research reports and on websites. These vignettes arise out of programs that have funded innovative schools, innovative teachers or have specifically focussed on disadvantage. They therefore are not necessarily exemplary according to predetermined criteria but exemplars of what people can do in specific circumstances. They have been selected on the basis that they provide rich descriptions of context, content, action and strategies with comments about successes and problems of programs where available. They tell stories of how teachers and schools, through trial and error, work to improve the learning of all students and disadvantaged students in particular when using ICT. They support the view that proactive teaching is a critical to how ICT can best benefit students who are disadvantaged.

The vignettes are drawn from case studies written by teachers (eg in WA), from ethnographic studies (eg Nixon 2001), and from government reports in Australia and overseas (eg Lankshear *et al.* 1997, Means and Olsen 1995). As yet there are few cross-site or longitudinal rigorous evaluations, particularly those that focus on academic outcomes. The vignettes and the strategies suggested illustrate the possibilities available to schools and teachers about how to adopt and adapt ideas and models about learning with ICT to meet the individual and group needs of their students.

The first section of the chapter will be organised around whole school approaches in primary and secondary schools as the context in which teachers take up and integrate ICT effectively to improve learning for disadvantaged students. The second section focuses on curriculum and software, with exemplars and strategies appropriate to different year levels-— preschool, early years, middle years and post compulsory. The third section will focus on leading practices and strategies seeking to address more specific forms of disadvantage. The last section addresses the types of systemic support that can facilitate what teachers can do.

1 Setting the context

Much of the research and many of the vignettes focus on disadvantaged schools rather than particular social groups. Such schools are often isolated, difficult to staff, and distant from ongoing professional development. They are likely to have a high cultural mix and are often located in low socio economic neighbourhoods with less of a community capacity to provide technology expertise and financial support. These are the factors that mediate how ICT works in individual classrooms for individual children.

The research also points to the need to change the practices of schooling if students who are disadvantaged are to succeed. This requires whole school and systemic reform. There are now key examples in the USA, UK and Australia that see the integration of ICT into schools as a possible catalyst for whole school and systemic reform. The following exemplar of an American school that is technology and resource poor, with a diverse social mix, and high levels of NESB students, indicates how important creating a whole school context for reform is to teachers to enable them to improve student learning.

Vignette 1 Primary school (low SES)

Nathaniel Elementary School

Context: Low income western USA city, has 1400 students in grades K-6.

Challenges: The area is surrounded by crime, drugs, and gang activity. It has an influx of immigrants annually that has increased numbers of students with 59% with limited English or no English. There are 9 main buildings with special education and computer lab, and 18 portable classrooms. Over 85% students are eligible for free or reduced price lunch, 709 students in special education. There are a mix of African American, Asian Pacific Island, Hispanic and a small number of Caucasians. 1% of students have computer access at home.

Important elements: The school has an active reform program, Computer Supported Intentional Learning Environments (CSILE) (see also Vignette 13), to reduce drop out rate and increase social and affective needs. It receives numerous grants. It became a demonstration school with intensive resources from funds to encourage racial mix to implement technology supported schoolwide change. This involved 10-15 days of additional professional development, extended instruction of students at risk and integration of technology (CSILE). Each classroom was given three computers, with the teachers focusing on word processing, drawing and maths. A take home computer program and computer based literacy class provided parents with technology access and training. Special projects were brought in to fit with whole school reform and ICT integration approach. The CSILE approach was collaborative problem solving, group investigation and knowledge building. The CSILE software consists of a communal data site with texts and graphics that can be accessed through a LAN. The school had a full time on site technology coordinator who participated in planning trouble shooting for technical problems, selecting software for teacher and student training in technologies.

Classroom environment: Grades 5 and 6 focused on an interdisciplinary project in which students participated in a hypothetical ancient culture, and produced

buried artefacts of that culture, undertook an archaeological dig in the other classes' sites, making inferences about the culture from the materials they uncovered. Students communicated through email across groups working on different aspects of their culture and built large data bases describing and illustrating the language, food, art, and religion of their ancient civilisations. In the Galaxy project, funded in part by the Hughes Aircraft Company, students viewed weekly video segments in different languages on science or language arts topics.

Each segment presented issues and problems to solve and students worked between segments and in groups. They shared their responses and research findings with other classes linked to the Galaxy Institute.

For the CSILE report and case studies see
http://www.ed.gov/pubs/EdReformStudies/EdTech/dig.html

This vignette exemplifies a number of key strategies undertaken by teachers, schools and systems to create environments using ICT conducive to enhancing the learning of these students disadvantaged by multiple factors such as location, race, socio economic and NESB background. These include:

- university – school action research partnerships;
- targeted programs using ICT as a catalyst for school reform;
- additional funds from public and private sector;
- a focus on whole school reform;
- school based ICT policies;
- strong principal and teacher leadership teams focusing on integration of ICT for improving student learning as a means for changing teaching practice;
- significant professional development support for teachers that focuses on how ICT can assist students at risk;
- full time technology coordinator on site to troubleshoot, plan, develop websites and online curriculum, improve communication channels;
- dispersed networks of computers equitably distributed across classrooms;
- student centred classrooms with a focus on independent and self paced learning , problem solving and inquiry based learning, authentic curriculum and assessment tasks;
- a focus on affective, social as well as academic outcomes;
- gender and culturally inclusive curriculum;
- cross curriculum / cross classroom focus;
- mix of virtual / real classroom interactions;
- take home computer program;
- parent ICT literacy program; and
- community based networks.

These elements of effective integration of ICT, elaborated on through the vignettes, form the basis of this chapter.

2 Whole school reform

Means and Olsen *et al.* (1995:183–5) in their study *Technology's Role in Education Reform: Findings of the National Study of Innovating Schools* identified five features associated with successful implementation of ICT in low socio-economic schools. In summary these were:

- school wide vision;
- curriculum leadership;
- active involvement by teachers;
- time taken for teachers to learn to use the technology and incorporate into curriculum and pedagogy; and
- easily accessible technical support.

Consistent with these features are strategies associated with whole school policy, planning, leadership, resource distribution, and professional development.

2.1 Whole school policies

For schools, ICT has led to a radical rethinking of school organisation, priorities, decision making processes, teaching and learning strategies, and home/school/community relations. Whole school ICT policy needs to address how to integrate infrastructure and fairly distribute ICT resources across the school, determine appropriate professional development, provide technical support for teachers, encourage ICT integration across curriculum and across year levels, and inform teachers about relevant software. Schools need to develop consistent and convergent curriculum and assessment policies, school planning, and teaching professional development that incorporates digital literacies. These plans should be flexible given the way context shapes possibilities and the need for schools to work within constraints.

In *Digital Rhetorics*, the four keys to effective integration of IT across the curriculum were seen to be the development of a whole school policy that dealt with these issues:

- teachers first: put professional development before the students;
- complementarity: skills taught at the same time as technology introduced;
- workability: question whether it improves teaching and learning, and whether it works for teachers and students; and
- equity: ICT leads to re-allocation of resources and steps must be taken to maintain equity.

Below is an example of whole school policy that appears to be support improvement of student learning for all students. Bendigo Secondary College in Victoria is one of the seven Victorian Navigator Schools specialising in ICT (see Vignette 37).

Vignette 2: Secondary Technology School

Bendigo Secondary College (Victoria)

Context: Bendigo SSC is a single campus senior secondary college of 1,787 students enrolled in Years 11 and 12 in eight KLAs and VET courses. It is a provider of accredited programs of CISCO, Microsoft and Aries courses (commercial technology related courses). BSSC has 113 full time teachers and 46 support staff with an annual budget of $8.6m. Bendigo is Victoria's fourth largest city and regional centre for Central Victoria, and this is the only state secondary school for years 11-12 in area. The school has a high proportion with Education Maintenance and Youth Allowance and low proportion of NESB, and therefore not perceived to be a likely high performing school. Over the past 7 years the school sought to become a leader in the use of new learning technologies.

Important elements: ICT was made integral to all aspects of school organisation administration, teaching and learning. For example, part of the whole school policy was to:

- review and evaluate teaching on the use of ICT in each learning area;
- provide professional development in ICT based on current research;
- provide evolving electronic network infrastructure for administration and information services;
- establish a comprehensive wide area network infrastructure to share information across Bendigo, Australia and globally; and
- provide notebook computers, appropriate software and professional development to staff.

BSSC has sought to be accredited with the European Council of International Schools (ECIS) so as to benchmark itself against international criteria.

Comments: The school mean compared to its own performance in English, Mathematics Methods and Further Mathematics has improved by over I point in VCE results and has increased its mean over like school and state means from approximately 1 to 2 points.

For the report on Bendigo SC see Toomey *et al.* (2000)
http://www.bssc.edu.au/research/bssc_ict_report.pdf

For the whole school policy go to: http://www.bssc.edu.au

Equity should be a key element of school based ICT policy frameworks. Such policy frameworks should establish processes to identify specific student abilities and needs, and prioritise funding to provide a specialist technology teacher focusing on students with learning difficulties.

Essential in ensuring equity across all groups and individuals are strategies to equalise technology access. This means being aware of the differential access to types of technologies in the home and then establishing classroom policies that monitor the time and type of use of ICT by different students. Such policies can assure equal access to computers (eg 30 minutes a day), or establish that some students may need more time as they lack computers to complete work at home. This can be achieved by scheduling students into the computer labs, with additional opportunities for students to

go to the labs after school and in lunchtime. Special access needs of students with a disability are discussed below.

School policies should be built on democratic decision-making and recognition that disadvantaged students need be part of the requirements in the design stage, not as a target, but in the development of whole school programs.

2.2 Managing ICT and equitable resource distribution

The management of learning technologies in schools must be incorporated into whole school policies. A key principle of management should be the equitable distribution of ICT for staff and students. The management of computer distribution within schools can focus on providing the greatest opportunities and best practice for the most disadvantaged students depending upon school resources.

Equity requires that access for teachers and students can be established through prioritising those most in need—through on demand, booking systems, rosters, and timetabled access eg specific dedicated access times, classroom or library priority to students without home computers. These problems decrease if computers are dispersed, as is the trend, so that they can be fully integrated into classroom practice.

Student access has numerous possibilities—individual use on demand, students working in pairs, groups of students in collaborative projects, whole class activities with sustained access for all, and access for students with mobility difficulties and disabilities.

For schools with few computers, there are limited ways to organise ICT resources: technology mini schools; computer laboratories; dispersal into classroom pods; an incremental roll out as teacher skills develop; and distribution to innovative projects (eg focusing on equity), or mobile laboratories.

As laptops and wireless computers become increasingly common, management issues will focus on multimedia provision. The convergence of technology mediated communication (videoconferencing, teleconferencing, interactive TV, computer conferencing, chat rooms and email) requires some form of school ICT resource reorganisation of current technologies in order to facilitate multimedia capabilities. The first step is to undertake a resource audit for ICT to evaluate whether it is being used optimally and with maximum accessibility.

In technology poor schools, principals and teachers have made use of ‘free’ forms of communication and information on the net to develop a technology rich culture. The web raises possibilities of accessing resources (expertise, data, debates, cross cultural) previously unavailable due to location or lack of curriculum resources. There are increasing possibilities for schools to negotiate cheaper rates for access to broadband digital communication (Kelso 2002). These can be achieved by pooling with local government, local schools in a wide area network in the immediate future with whole of state / government network as the more long term and equitable solution. The average secondary school requires bandwidth of 1.5Mb/s currently excluding video services, and will require 100Mb/s if real time video is contemplated (Kelso 2002:2).

Free email (eg Hotmail) can become the main mode of communication to encourage teachers to become familiar with email as a primary mode of communication. Use of communication through computer conferencing and email as well as accessing the range of free discussion spaces, websites and data bases has significant potential for students who are isolated or in less resource rich schools.

ICT can lead to an expanded role for the library that can be accessed from classrooms and home, including the establishment of multimedia centres and cyber-libraries. In the Victorian Navigator schools the librarians now locate, coordinate, cache and catalogue Internet sites, and CD Rom based material as well as print based materials. Librarians train staff and students in accessing, verifying, evaluating and annotating online information, and developing online materials for Key Learning Areas (KLAs).

Libraries are logical places for modelling gender-equitable and inclusive practices regarding the use of technology. Librarians can work one to one with students to assist in upgrading skills and computer literacy in a problem solving capacity (Farmer 1998).

2.3 Planning and prioritising

Effective integration of ICT into classrooms to address the specific needs of individuals and specific equity groups requires planning and therefore time. Staff and space can be used differently as this example shows.

Vignette 3: Middle School

Innovative scheduling and staffing in a Middle School (Toronto)

The strategy was to reduce the number of periods and timetable so there are greater time periods for planning. Staff have four periods a day, three of which are teaching, and the fourth period is for planning and collaboration. This allows them to do training and developmental work. It also encourages greater flexibility and opportunity for cross curriculum and cross group teaching as well as demonstration of possibilities in use of ICT.

Means and Olsen 1995. CSILE p. 87

Found at http://www.ed.gov/pubs/EdReformStudies/EdTech/csile.html.

Increasing the independent learning of students, peer teaching and group work using ICT can also free up teachers more for planning.

The following example was written by one of the 100 innovative teachers funded through the WA *Learning Technologies Projects*. While small in scale, this vignette indicates the slowness and complexity of change but how planning and prioritising can produce change.

Vignette 4: Primary

Lesmurdie Primary School, WA

Context: This is a K-7 school 30 minutes from Perth with 280 students in which teachers tended to leave computers up to the students. The school went through stages of development in integration—first consolidating converging technologies into an integrated system and establishing a coherent policy with regard to software, a coordinated approach to professional development. Teachers had little time to plan or experiment and teachers resented spending time on computers when there was little evidence of improvement. Students used computers at home- for games, word processing for studies and finding information- but lacked technical expertise.

Important elements: A specialist computing teacher was appointed part time with a focus on children with learning difficulties. The new computer coordinator supported those teachers with expertise by improving the reliability of the equipment and providing examples of best practice.

Results: In one year the teacher completed a computer audit and register, student survey, identified pathways where problems occurred, made computers accessible, created an intranet and introduced policy guidelines. Teachers were asked to become experts in specific areas and to work in teams.

Whole school policies, as this study indicates, require site specific and student specific information. Strategies to develop such a policy are to:

- appoint a technology coordinator;
- undertake an ICT audit;
- undertake a student survey of home ownership and use;
- establish intranet information and idea exchange;
- review software to assist in determining appropriateness for particular student needs;
- identify specialist skills within teaching teams; and
- identify specialist skills amongst parents.

2.4 Technology support

As ICT is integrated into curriculum, pedagogy, school organisation and administration and curriculum and school communication goes online, dedicated specialist technology support is critical. This requires teacher coordinators who can focus on cross curriculum activities and the development of school policies as well as coordinate resource distribution.

Vignette 5: Secondary

Progressive School—(Toronto)

Apple was involved in introducing a large number of computers into schools, supplying the human infrastructure as well. For six years they provided a full time on site technical coordinator. His most important role was working with the technology with teachers in curriculum development to align with teaching goals and student needs, while thinking how to enhance their learning. He was a former teacher who provided teachers with support and ideas. Apple also paid teachers as consultants to develop class materials eg the *Hypercard* application that combines young students' writing with their drawing and a teacher provided rewriting in standard English. This was recognition and tangible demonstration of the worth of their professional knowledge.

This idea could be extended to focus on curriculum development for targeted groups.

Means, Olsen *et al.* 1995
http://www.ed.gov/pubs/EdReformStudies/EdTech/csile.html.

There is also need for technical support. Teachers are less likely to take the risk of integrating ICT if there is a threat of technical breakdowns without backup. Schools need to provide on site support for a dedicated ICT appointment. As schools begin to focus on how to use ICT more effectively in teaching and learning, these technology experts will need to combine curriculum, design graphics and technology experience for online curriculum and pedagogical development.

Such support can be gained through schools clustering to cover costs, which are returned if part of the role of the IT specialist is facilitating exchange of ideas between schools and development of expertise.

2.5 Leadership

For disadvantaged schools, effective integration requires staff commitment to improving access and quality of ICT experience for their students. For school leaders it means prioritising equity through policies. Innovation requires not only teachers reducing their levels of control in the classroom but also principals sharing control of the school by encouraging dispersed leadership that recognises that all teachers can be leaders in innovation. The role of the principal is therefore to facilitate encourage, reward and support teachers who are prepared to take risks to develop programs that address issues of equity.

Principals and systems need to provide a structure within which teachers can innovate. Most teachers do not have skills, time or desire to create new curriculum or pedagogies unless supported and rewarded. Opportunities need to be made for teacher collaboration. Collaborative projects tend to be more innovative and ambitious and allow teachers to combine different expertise and skills. Curriculum leadership is important to ensure innovations fit into whole school planning and pedagogies. Teachers cannot be forced and they come along at different speeds.

There are a number of possible strategies for achieving teacher change:

- creating a core group of ‘early adopters’;
- providing teachers with computers for personal use;
- rewarding teachers for designing good instructional uses of technology; and
- setting goals for developing technology skills.

The patterns of best practice with respect to integration of ICT occurred when the projects were designed by pairs of teachers or a teacher in cooperation with an outside researcher or trainer. It requires new ways of using teacher experience and time.

The integration of ICT can result in fundamental changes in classroom practices when teachers are prepared to be flexible in their organisation, to plan and in particular where there is significant leadership support, for teacher risk taking.

Vignette 6: Early Years

Castleton: Computer basics makes for competent, confident

Year 1 students (NSW)

Context: This large school, located in a relatively low socioeconomic area of Sydney, has a focus on technology. The principal is keen to integrate the use of computer and information technology throughout the curriculum. The computer coordinator, whose Year 1 class is the focus of this study, has the benefit of

continued support from the principal and school executive together with access to relatively new hardware and software. The thirty students in the class spend each day with their peers from the adjoining class, the dividing wall folded back to make one large area with sixty students and two teachers. A striking feature of this arrangement is the orderliness of the students as they move from activity to activity throughout the day forming and reforming groups across the two rooms.

Important elements: When all students interviewed tell you that they use the computer all day in their learning it is obvious that much careful work has gone into planning and programming. Teaching has changed considerably since the class teacher began teaching. Ten years ago it was doing mostly drill and practice and rote learning. This approach was exemplified by a dependence on commercial texts and on whole class work including copying from the chalkboard. Although commercial software has taken the place of some of the commercial texts, unlike texts the software is modified to meet class needs. However, it brings with it the need for a different set of basic skills. The teacher now includes keyboarding in the curriculum. To support the changes, and partly as a result of using computer technology, she also involves peers and parents as tutors for her students.

The teacher's enthusiasm for new technologies has come to some extent from teacher development programs, colleagues, and a husband who has similar interests. But without the principal's vision of the role of computer and information technology in student learning, the teacher would not have had the opportunities to pursue her own exploration of technology in the classroom (a theme that resonates with many of the other site studies).

Results According to the students interviewed, like play, the computer provides an environment *free from the fear of being wrong*; it is *intrinsically motivating*; *they can set their own goals and make up the rules*. There is *active engagement* in the task and, in many instances, students select with whom they use the technology and for how long.

Lankshear *et al.* (1997) *Digital Rhetorics*, Vol 1. pp. 55-6

Good leadership means that teachers also can get it wrong, take risks, and be autonomous and self managing.

2.6 Sustainability of innovation

Often in under resourced schools with a concentration of low socio economic students, innovation occurs through the work of individual or small groups of teachers. Successful programs can disappear as innovative teachers are difficult to attract and retain.

To sustain innovation that may begin with an individual or small group, it is necessary to develop teams based on a mix of specialist skills. These teams then disperse these ideas through the school through mentoring and hands on practice/advice, thereby training others and undertaking succession planning.

The following strategies can help to retain innovative teachers in the use of ICT in disadvantaged schools:

- professional development that focuses on innovative pedagogy addressing difference using ICT;

- encouraging risk taking;
- systems of rewards/benefits to recognise innovative teachers eg international conference, visits to other innovative schools etc;
- succession planning in innovative programs;
- dispersed leadership to encourage bottom up innovation;
- planned directions for the school with clear and explicit statement of principles and outcomes, of which equity is integral;
- providing opportunities (virtual and real) for teacher exchange to both disperse and gather ideas; and
- use of shared data bases within and between schools using LANs and WANs for clearing house about successful strategies.

If classrooms are going to change, teachers must be put first. Teacher initiative needs to be supported, encouraged and rewarded.

3 Transforming teaching

Good pedagogy utilising a repertoire of teaching and learning approaches to address individual and group difference is a precondition to the effective use of ICT in classrooms. A major conclusion of this report is the need to prioritise teacher professional development that addresses innovative pedagogies using learning technologies that address difference and that focuses on all levels of ICT literacy-operational, cultural and critical.

3.1 Changing attitudes

The effective integration of ICT into classrooms requires changing the attitudes of teachers and students to both ICT and to teaching and learning in ways that recognise and focus on individual and group difference. Attitudes and beliefs have an impact on the way teachers, schools and students accommodate change and innovation in relation to technology and learning and also how teachers view students at risk. Successful programs using ICT in disadvantaged schools (eg ITLED, Comber and Green 1998) highlight the commitment of teachers to equity. It stresses how schools that are successful with their students foreground disadvantage as being key aspects of that success.

Many of the reform programs focusing on ICT and disadvantage emphasised that many teachers have to reconsider their attitudes and beliefs about the capacities and knowledge that students labelled as different or disadvantaged bring to school. The resilience of students in disadvantaged contexts can be developed by building on their strengths not their deficits. This can be achieved if teachers and schools communicate to students the belief that all students can succeed and have high expectations of all students. Maintaining high expectations of all students in their use of computer based technologies can be achieved by:

- using computer based technologies appropriate to the abilities and interests of students (cultural dimension of ICT literacy); and
- encouraging students to examine critically the use of computer based technologies and how these technologies will affect their future lives, ie the critical dimension of ICT literacy (DET, NSW 1997).

Changing teacher beliefs is most likely to occur when teachers are involved in small action research projects in their school and classroom, often with an outsider or critical friend. Such projects should focus on exploring how ICT can enhance the learning of different students and different groups within the classroom. This needs to be supported by professional development and school support that focuses on specific ICT and pedagogy needs of teachers but also encourages teachers to expand their pedagogical repertoire and how ICT can enhance that repertoire in ways that benefit particular equity groups.

3.2 ICT as a catalyst for transforming classrooms

ICT can be used as a catalyst for changing teaching practice, facilitating a shift away from teacher centred (traditional) to student centred (transformative) classrooms. Such a shift leads teachers to work with students in a more individualised way. The following vignette indicates what can happen to pedagogy and teacher's role when ICT is fully integrated into a science classroom.

Vignette 7: Upper Secondary: 9-12

Technology Enhanced Secondary Science Instruction (TESSI) Classroom–in–action (Canada)

Context: This was a seven year longitudinal study of two Canadian science classrooms—one a lower socio-economic culturally mixed school and the other a middle/upper class Anglo school. The students were in Years 9 through to Years 12.

Important elements: The classrooms were technologically rich-with multimedia computers, printers, laser disc players, printer, data acquisition that allowed for computer simulation, multimedia presentations, digitised images, video as well as the Internet. These non traditional sources were supplemented with textbooks, laboratories, demonstrations, problem sets and field work.

Classroom environment: As technologies were added to this traditional repertoire of teaching approaches, the role of the teacher changed. Teachers facilitated learning by working with small groups of students, directing them to useful resources and helping with problem solving activities. Traditional lecture based teaching diminished over time and was replaced by:

- just-in-time mini lectures.
- direct instruction was limited to short introductions to new units, revising concepts that were difficult and end of a unit.

Comments: This study indicated that the combination of technologies and new instructional strategies led to a 'classroom-in-action'. Students entered the classroom with a clear sense of purpose and set to work without teacher direction. Typically, different science activities were occurring simultaneously. Students could elect to work in pairs, individually, or in small groups and determine their own path of learning. Student discourse and collaboration were encouraged to discuss science principles and how to use technologies. The students believed that these classrooms were special, and were extremely positive. Yet the technologies were not the focus of the discussion—the emphasis was on the different modes of teaching and learning that occurred. Both males and females had similar experiences in these technology enriched settings.

Students identified a number of features they found to be valuable for their learning: *self pacing, flexibility, choice and activity oriented, self monitoring and working with peers*, ie *student centred*. They said that the project focused them on *learning how to learn*. Those students who did not enjoy the unit pointed to the lack of teacher direction, having the expectation that teachers as experts should tell them what to do and therefore felt the course was too computer based.

The project concluded that technology improved motivation, gave students some freedom of self-paced learning and saw technology as just another form of information transferral. More significant second level changes occurred as teachers' beliefs and practices were changed and student outcomes improved. These occurred most often in classes where teachers were getting a balance between direct instruction and teacher centred practices (traditional pedagogies) and collaborative, inquiry driven knowledge constructions strategies (learning technology pedagogies). New technologies acted as a catalyst in this traditional classroom in terms of encouraging different interactions between students and teachers, engaging students systematically with high order cognitive tasks, and

prompting challenges to teachers' assumptions about teaching and learning.

Mayer-Smith (2000)

As identified in this vignette, ICT can, when teachers are willing to give up control of the classroom, shift the focus of teaching towards learning through problem solving, group work and independent / self-paced learning. The focus shifts towards learning about learning or metacognition, becoming more hands on and activity oriented. Mayer-Smith (2000) depicts a classroom-in-action as having a balance between interdependence and independent learning, time for student talk and interaction, self pacing and well established and discussed rules of operating in communities of practice, between teacher talk and student talk.

Shifting the focus from teacher centred to student centred classrooms requires significant social re-organisation of the classroom, with teachers adopting new roles as learners and tutors, independent student learning, and problem solving approaches.

Some of the more effective teacher professional development, student learning and inclusive curriculum and pedagogy that had achieved this have been premised upon the principles that teachers and students:

- learn about ICT as they learn to use ICT;
- deal with content (curriculum) and with process (pedagogy) simultaneously; and
- address all three levels of digital literacy—the operational (the what and how to), the cultural (appropriate use of particular ICT in specific contexts and for specific audiences), and the critical (why and with what effect).

Possible strategies that can address all dimensions of ICT literacy are:

- teacher practitioner research asking: "what did I do that was successful for those particular students", and "how do I do this again but better?";
- university school partnerships based on continual improvement cycles of action research and informed decisions; and
- multidisciplinary collaborative projects that draw upon multiskilling of students and teachers and focus on authentic problem solving.

A comprehensive approach is to create a 'classroom in action' through the use of a combination of available technologies, but with the focus on instructional strategies that are student centred but not necessarily technology dependent. Here the focus is on changing pedagogy rather than utilising ICT, although ICT can be used where possible to enhance student independent and collaborative learning. Again, the technologies that are used may be those most available at home eg audio.

Another instance of where students have developed their own cross curriculum projects without significant ICT infrastructure is at Wheeler's Hill.

Vignette 8 Secondary: middle years

Wheelers Hill Secondary College (Victoria)

Three students in middle years built a complex intranet that consolidated everything from the library's catalogue to ordering lunches online. One of them wasn't even studying computing at the time, and the whole thing was done as an

English project. No special software and little new hardware was needed—The whole thing runs on Windows NT. Most of the operative coding and HTML was done by hand.

http://www.sofweb.vic.edu.au

The following example points to key aspects of a successful early years literacy program that were successful for Indigenous students. It offers a way of developing greater familiarity for pre-school children with computers as a way of learning. Reading and writing were developed through the use of aural and visual capacities of multimedia (computer, digital camera) to make this learning authentic, fun and stimulating. At the same time, the teacher and teacher aide substantially improved their skills and in integrating ICT into their practice and reflected on the language program. The use of computer encouraged creativity, imagination, listening and discussion skills in the students. An important outcome was a 'cultural product' that was relevant and imparted a sense of ownership to students. Students became familiar with basic operational skills of ICT.

Vignette 9: Pre-school

Integrating the computer into the pre-primary classroom to improve language learning.

Mullewa District High School (Western Australia)

Context: Mullewa is a small wheat belt town situated 450km north of Perth and 100km east of Geraldton experiencing the drop in population and consequent withdrawal of services occurring in many rural centres in WA. The community has a high proportion of Aboriginal people, many experiencing an extreme degree and concentration of socio-economic disadvantage.

An old BBC computer was the only hardware until 1996 until replaced by a new computer funded by the Commonwealth Government through the Aboriginal Student Support and Parent Awareness (ASSPA) program. The Technology Innovations in the Classroom Project provided the professional development necessary to give the teacher an understanding of how to use the technology effectively and some hands on practice at using the technology too.

Important elements: The aim of the project was to provide students with increased access to reference materials (eg CD ROM), information (eg Internet), a wider range of subject options (eg Telematics) and opportunities for teachers to be more flexible and responsive to student needs through the use of individual programs and group work.

Technology in years Kindergarten and Primary

It is increasingly important to teach children through ICT early in their schooling to give them mastery over the equipment and the attitude that technology is a tool for learning, just as is paper and pencil. Mullewa District High School has one pre-primary class that provides for both four and five-year-old children.

The challenge was to integrate the technology into the teaching/learning program and to monitor its effect, a process the teacher was confident in as the First Step Focus Teacher (First Step is an early years literacy program).

Classroom environment: Through the frequent use of the computer and other technology (eg the digital camera) to enhance language learning, the pre-primary students demonstrated movement along the Reading and Writing First Steps Developmental Continuum (oral language, reading, writing and spelling). The first step was to identify current level of understanding in language learning. For almost the whole of first term, the children only had access to one CD-ROM (*Playdough Creations*). The students never grew tired of it. This program provided the opportunity to develop confidence, attain mastery over the technology and mastery of the content of the CD-ROM. Technology was used in the term 2 program to develop the following areas: reading, the features of books; writing; developing awareness that writing communicates a message; and a focus on alphabet knowledge.

Reading behaviours were developed through the making of class books. The digital camera recorded the events of the daily routine or outings, and the group then created the text to accompany the pictures. The books were then laminated, spiral bound and placed in the reading corner for the children to read. As well as enjoying reading the texts they had created themselves, they developed the concepts of front cover, back cover, spine, page, author, and illustrator.

The writing behaviours were developed through the use of CD ROMs. For example, *Dr Seuss's ABC* was a favourite for increasing alphabet knowledge. The children also enjoyed using *Fine Artist* to create drawings and limited amounts of text for their friends and family.

The choice of software was based on recommendations from other early childhood teachers and reviews in educational technology magazines and journals were the only avenues available. Both of these sources of information were useful but imperfect as different people have different expectations and different students to teach.

To begin with the teacher used the CD-ROM *Playdough Creations* by Playskool to teach the children how to use the mouse, how to navigate their way around a game and how to correctly shut down the computer at the end of the session. It was excellent because it was fast, colourful, had voice prompts and sound effects to guide the children and once it had been loaded, the children could not accidentally get into any trouble with it. It taught skills such as imagination, creativity, listening and problem solving and concepts such as colour, colour mixing, and a limited amount of letters and numerals. Other purchases included: *Fine Artist*: Microsoft, *Blinky Bill's Ghost Cave Adventure*: Roadshow interactive, *Dr Seuss's ABC*: Random House, *Sammy's Science House*: Edmark (unfortunately British content), *Colours and shapes workshop*; *Letters workshop*: *Vtech soft*, and *Numbers workshop*:

Comments: The majority of children demonstrated more progress on the Reading and Writing First Steps Developmental Continua than the pre-primary class at the same time in the previous year. It is difficult to attribute all of this improvement to the use of the computer due to the many variables in the teaching/learning cycle. Using ICT caused the teacher to critically reflect and focus on the language program. There was a significant increase in the quantity and quality of peer tutoring and this has resulted in improved oral language outcomes. The four-year-old children are more likely to interact with the five-year-old children at the computer than in the block area, reading corner or puzzles. The computer usually

operated during busy indoor activity sessions when the only assistance available was from other children. This has also resulted in improved oral language outcomes for both K and P children.

The children who did not have access to a computer in the home (85% of the class) were instantly motivated and very excited about using the equipment. The majority of the five-year-old children had mastered the use of the mouse within a week of the computer being in the classroom. A small group of children demonstrated risk taking and curiosity to a level, which was not previously observed. There were improvements in the children's ability to share and take turns. After a semester, at least six children could independently boot up the computer and load software and all five-year-old children could shut down the computer correctly. The Aboriginal Education Worker's computer skills and confidence have increased significantly. A whole school technology plan was developed as a result of discussions with project partners and other interested staff (including administrative staff).

WA Technology Innovations in Schools,
http://www.eddept.wa.edu.au/centoff/tisp/JulieFreeman.htm

Similar pre school and early years programs could focus on schools with high proportion of students from low income, rural, NESB and Indigenous backgrounds so that the early scaffolding about learning with and about ICT is established and in so doing develop foundational literacy and numeracy skills. This could be facilitated by clusters of pre school agencies developing learning networks that also can share resources and be support network (DETE WA 2001).

As indicated in this last example, the move to more individualised student focused learning made possible by ICT addresses individual difference and benefits particular students. The characteristics of ICT that can be exploited to provide more differential learning experiences and that will engage students include:

- Independent learning and the flexibility of ICT use in and out of school provides significant advantages for many post compulsory youth who are disaffected from schooling, often due to the lack of a sense of adult independence and poor social relations with teachers.
- A wider range of abilities, aesthetic, visual skills, can be displayed, developed and recognised through the capacities provided by ICT so that non academic skills can be identified and valued.
- Language and literacy skills of students can be enhanced by adapting computer based technologies to classroom based learning activities to ensure that they are culturally appropriate to the needs of all students.
- Interdisciplinary curriculum approaches can be facilitated by formulating interdisciplinary programs based on mandatory equity policies and programs utilising computer based technologies that make linkages between the various subjects and KLAs.
- The gaps between experience and abstraction, authentic and relevant curriculum can be bridged through access to visual images, models, and data bases.
- A range of techniques can be used to draw on different ways of learning and thinking eg visual, aural, learning with others.
- Individuals are encouraged to listen to other students as partners in learning.

There are numerous case studies of the Technology in Schools Project on the website for the WA Department of Education, some in disadvantaged schools, others that provide examples of strategies that can be adapted (http://www.eddept.wa.edu.au/centoff/tisp).

3.3 Engaging learners

The integration of ICT changes the social relationships of the classroom. Teachers also become learners and students act as tutors. Increasingly the focus of what schools and teachers do with ICT is less on the operational technical skills and more on the social interaction around how ICT and how it is used ie pedagogy and content. The issue for teachers is how pedagogies can address individual difference, engage students and be inclusive of all. Teachers need to consider inclusive curriculum and pedagogies simultaneously.

Computer mediated learning and communication in rich multimedia environments can enhance traditional methods of teaching and communication based on print through the capacity to write, edit and publish. ICT also has strong interactive capabilities that create new possibilities for teachers to enhance the learning of students previously disengaged with writing and print based learning materials. ICT also provides new data bases, access to different knowledges, and multiple modes of transmission that are more able to cater for difference.

Vignette 10**:** Early Years: 3-4

Endangered species

Context: Developing an understanding of endangered species and the effects of communities' actions on their ecosystem was the aim.

Classroom environment: Each student wrote a report on a chosen plant or animal species and these were collaboratively developed into a class webpage. Children also produced *KidPix* slideshows of narratives with a message written from the point of view of the endangered species.

The majority of learning technology work was done individually in the classroom computer room or library while webpage contributions were created in pairs.

Challenges: Most students had done basic web searching and Word publishing before but it was found more help was required on Word and so explicit teaching of these skills was needed as well as peer help. Correspondingly, the time taken on reports was longer.

Comments: This use of learning technologies was found to motivate and encourage the less able students, some of whom found it easier to do editing using the computer. All students' information was presented in a way that was accessible to others and of a similar standard, therefore imparting pride. Also having it published and set out really gave a better concept the of the report format compared to their own written word. The production of the web page led students into further discussion of classifications of animals and extended their learning about the reasons for species being endangered.

Barnes *et al.* (2001) Embedding Learning Technologies in Teaching Practice P.

19.

For specific units with content appropriate to different year levels and integrating ICT refer to the Case Studies available online in the SA Embedding Learning Technologies in Practice report (2001) at http://www.tsof.edu.au/LT.SA/research/warriparriindex.htm

This vignette exemplifies a number of key pedagogical strategies that have been employed that benefit less able students and elaborated on in this next section.

Independent learning

One of the major benefits of ICT integration cited by students, teachers and parents of ICT is the move towards more independent learning of students. The needs of students should drive the uptake of technology and students should be involved from the very beginning of ICT planning (Fichten *et al.* 1999). This is particularly critical in the Middle Years when many students are at risk of leaving school as they are alienated by teacher centred pedagogies and dependency model. Teachers who work most successfully with children in poverty focus on problem solving and persistence; they protect learners so they can learn; put ideas into practice; move from action to reflection back to action. ICT provides students with a capacity to undertake self paced tasks, inquiry and problem solving.

Play, performance and practice

Play, performance and practice are three foci of learning that can be enhanced through use of ICT that addresses the interests of early years and middle years students (Downes 1995). Play provides a blending of ICT as a toy as well as a tool, bringing home developed skills and recognising them in the classroom. This is important for many boys disaffected by schools.

Performance (virtual or real) through the development of multimedia ‘cultural’ products and provides opportunities for students to display their different abilities to others in ways that can be self-affirming and provide them with a sense of success in non-academic areas. Students through such recognition can develop a sense of confidence, identity and a capacity for agency.

Practice is important because it builds on basic skills of foundational literacy, numeracy and ICT literacy. This leads to a sense of competence and achievement. In particular, the process and product of word processing allows for practice, editing, review with a ‘clean’ well-presented product.

Bede (2000) lists the features of successful programs integrating ICT . While many of these approaches are not dependent on the integration of technology, they can be enhanced and adapted more flexibly to meet the needs of specific groups and individuals through the use of ICT.

- centring the curriculum on 'authentic' problems;
- involving students in virtual communities of practice, using tools similar to those in workplace;
- facilitating guided, reflective enquiry through extended projects that inculcate sophisticated skills and concepts;
- utilising modelling and visualisation as a powerful means of bridging between experience and abstraction;

- enhancing students' collaborative construction of meaning via different perspectives and shared experiences;
- including students as partners in developing learning experiences and generative knowledge;
- fostering success for all students through special measures to aid the disabled and disenfranchised; and
- ensuring access to technologies as they are integrated across the curriculum in schools.

Curriculum design and classroom practice should concentrate on thinking skills and heterogeneous grouping (Levin 1988, Slavin 1989).

Means and Olsen (1995) in *Technology's Role in Education Reform. Findings of the national Study of Innovating Schools* identified that in classrooms effective implementation of technology based-learning relied on:

- good content, both discipline-based and cross curricula;
- teachers and students being comfortable with notions of project based learning;
- cross curriculum and across classrooms use of technology;
- use ICT that is purposeful and has relevant content; and
- curriculum packages with general goals that provide teachers scope to adapt and make relevant to students through local content.

Collaborative learning

A key aspect of learning about and with ICT is that it provides new possibilities to encourage collaborative learning between students both in real and virtual time. 'At risk' students are more likely to stay on if curriculum integrates high order thinking, with authentic tasks, and involves them in mixed ability collaborative groupings, where they are judged on their thinking about a problem rather than performance on a test.

One example is that of the development of critical literacy skills, including learning to write for particular audiences and with particular intent.

Vignette 11: P-12

CSILE: A Computer-Supported Intentional Learning

Context: CSILE was developed by Marlene Scardamalia and Carl Bereiter at the Ontario Institute for Studies in Education. It has been used in a research program within Toronto schools for over five years. It reports on numerous case studies that can provide ideas about integrating ICT. These can be found at http://www.ed.gov/pubs/EdReformStudies/EdTech/csile.html.

Important Elements: CSILE functions as a collaborative learning environment and a communal database, with both text and graphics capabilities. This networked multimedia environment lets students generate 'nodes', containing an idea or piece of information relevant to the topic under study. Nodes are available for other students to comment upon, leading to dialogues and an accumulation of knowledge. Students have to label their nodes in order to be able to store and retrieve them; over time, they come to appreciate the value of a precise, descriptive label. In addition to receiving writing practice as they create their own

nodes, students get practice reading the nodes generated by others.

http://www.ed.gov/pubs/EdReformStudies/EdTech/dig.html

This use encourages students to learn from each other, to write for each other, but within the 'safety' of the anonymity of a virtual environment while utilising a range of multimedia capabilities that do not focus only on text. Such a network is conducive to engage students who are uncomfortable with public face-to-face presentations, and whose strengths lie in the visual and non-print mode.

Strategies to encourage the norms of cooperative technology work in the classroom include:

- working in pairs, sharing and learning to take into account each others differential skills and different experiences;
- peer and cross age mentors (eg linking older students of similar backgrounds in relation to ICT skills with younger students, linking experienced and 'no experience' ICT users, making the student the expert in a teacher student 'upskilling' arrangement, making the underachieving student with home grown computing skills a high achieving teacher of ICT in the classroom).

Problem solving, interdisciplinarity, and cross curriculum literacies

ICT can be utilised strategically to develop foundational ICT, literacy and numeracy skills in authentic and relevant ways at the same time that the curriculum encourages an awareness of cultural and linguistic difference.

Vignette 13: Middle Years: 5-6

The DIG Project

Context: Two 5/6 CSILE classrooms at Hawthorne Elementary School in Oakland, California organised their curriculum and a series of project-based activities around the interdisciplinary theme of ancient civilisation. For the initial extended project, they drew from a simulation curriculum called DIG (developed by Interact), in which students invent their own ancient civilisation, creating artefacts, symbols, and values.

Classroom environment: The project began with the class discussing what makes a culture? Working in small groups, students in each classroom created their specific cultural universals based on the overall values and the geographic location that was decided on by the class as a whole.

Once these aspects of the culture were decided, students began generating their cultural universals. Using CSILE as a shared database, students wrote text and created graphics that described and depicted their cultural universals. They created links between entries that were conceptually connected (most often linking a text with a corresponding graphic image).

Many of the Spanish-speaking students entered their notes in their primary language, which they then linked to an English translation.

Throughout this process, students read and responded to one another's emerging

plans and ideas using helpful thoughtful comments.

ttp://www.ed.gov/pubs/EdReformStudies/EdTech/dig.html

This exemplar indicates how a teacher utilised a range of software, simulation tools, data based, the net, together with careful attention to the social interaction using a blend of both non traditional and traditional (groups work, classroom discussion) that matched the appropriate task. Inclusivity was addressed by attention to bilingualism of the students, but also to the need for NESB students to be able to communicate in English. The task was one that required planning, reflection, and feedback from other students.

With respect to pedagogy, effective strategies emphasise:

- the increased importance of teacher planning and active involvement in facilitative rather than supervisory roles that focus on individual needs;
- that teachers need a mix of curriculum frameworks, models, strategies, assessment approaches, hardware and software that provide some direction without prescription and that can be adapted in ways that meet needs of specific students, classes and school contexts;
- that content should focus on contextualised and authentic problem solving;
- team work in teaching to reduce intensification of labour and allow for space and time for planning and innovation;
- greater use of multimedia to provide student choice;
- maximising student capacity to play, perform and practise their work;
- students' success and self-esteem can be enhanced by setting realistic tasks; providing reinforcement; and
- giving students the confidence to explore, adapt and shape technologies (DET, NSW 1997).

ICT is a tool to support and enhance a repertoire of teaching approaches that teachers can mobilise to address individual difference.

Some strategies to do this could be:

- Develop student individual plans that identify ICT needs eg home use; and that chart progress and the skills students acquire (similar to Pathways Planning for school work transition).
- Develop programs in which teachers and students are supported to develop collaborative learning across the curriculum that will extend student learning to include a wide range of multiliteracies.
- Through cross curriculum activities using ICT, require teachers to take responsibility for numeracy, literacy and computer literacy in all subjects.
- Map at each level of the school independent learning using project based approaches and team teaching. Consider their implications for student social, psychological and cognitive outcomes and for specific year levels.
- Provide time release for teachers to collaborate and plan with a focus on inclusive student centred pedagogies and curriculum using ICT.

Inclusive curriculum

The focus on greater participation of girls in science, maths and technology and boys in reading and writing, improved participation and sense of success for Indigenous and NESB students and those with disabilities, means making the pedagogy, curriculum and use of ICT more inclusive. Learning is more effective when the curriculum connects with students' culture and prior knowledge; when students participate in meaningful and engaged learning; and when they construct meaning in collaborative learning environments. This means:

- working on both content and process simultaneously incorporating different learning styles;
- recognising and valuing difference in creative ways through representations made possible by visual and aural medium; and
- making the content relevant, inclusive of, and valuing a range of experiences.

Inclusive software

A primary focus of concern is the lack of representation or stereotyped and discriminatory representation of particular social groups – Indigenous, women and girls, and different cultural / racial groups-in software. Most software does not address the interests of many students, being games oriented with an emphasis on violence. Teachers therefore need to:

- analyse the validity, accuracy and appropriateness of the content of software (considering cultural, linguistic, gender, age and socio-economic factors);
- undertake deconstructive critical analysis with students of software that does offer inappropriate representations;
- encourage students to produce multimedia work that is inclusive or that represents different experiences;
- work with students from a range of socio economic, cultural and racial backgrounds in schools to develop software and online materials, possibly with private providers, that are culturally and gender inclusive. Such projects should view teachers and students as cultural producers, and recognise their intellectual property gained through accruing commercial benefits for their school; and
- work with experts in technical and pedagogical aspects of software development to develop materials that are based on local knowledge with authentic assessment for students.

With the proliferation of software, teachers have little time to audit. Useful ways of assisting each other includes a website that provides teacher reviews of software, and school policies providing guidelines about the use of software.

Teachers often have access to only the more popular software. One piece of readily available software is *KidPix*. In the following vignette, the teacher sought to develop topic matter that was both gender neutral and of interest to most children. The task was authentic, in terms of relating to the context of students and the school. Children are expected to learn both collaboratively and also individually.

Vignette 14: Primary

School Animals — Year 2 (South Australia)

Important elements: Animals are the starting point for this Year 2 unit of work. It was directed towards finding a suitable animal to be encouraged to live in the

school grounds. Children collected information from the school library about animals that live or previously lived near the school In pairs they decided on an inhabitant that they would like to encourage and presented relevant facts to the rest of the class through a *KidPix* slideshow.

Classroom environment: The learning technology part of the unit began in the computer room with a demonstration and revision of *KidPix* features. The rest of the time students worked in the classroom in their pairs, individually producing slides. The technology enabled them to edit and prepare a professional presentation of their knowledge and ideas for a range of audiences, using persuasive arguments and paying attention to meaning. The process enables many points of engagement for teacher and students where modifications and improvements can be immediate.

Comments: Students generally showed increased confidence after working with *Kidpix* this way and were more enthusiastic to find out further information. Less capable students were more motivated and spent greater time on task than usual. Their learning and level of understanding were extended and the standard of the work they produced was much better.

Barnes *et al.* (2001:19) Embedding Learning Technologies in Teaching Practice.

http://www.tsof.edu.au/LT.SA/ltproject/bodyltproject.htm

Some curriculum development is more specifically focused on making the curriculum using ICT culturally inclusive. This is equally important for students who are in rural and isolated as well as urban environments who do not have similar experiences of cultural, racial diversity. Cultural understanding can be developed through a range of global networks that lead to intercultural exchange.

Vignette 15: Primary school

Multimedia support for multicultural students (New South Wales)

Context: Two teachers in different classrooms at Carlisle Primary, a large, multicultural public school in western Sydney, embarked on a study of the role and status of technology in literacy and language teaching and acquisition. Over 90 per cent of the school population comes from non-English speaking backgrounds.

Classroom environment 1: The first class, Year 2, prides itself on ownership by students as much as by the teacher. Doug, their teacher believes that computers are tools for students to access information and present their own information. He believes that they are an important part of the future and help develop divergent thinking strategies; that they provide access to different ways of writing and reading and investigating; and finally, that these technologies should be made available to students as a normal integrated part of their lives as they are another way of extending the knowledge they have and ensuring equal access to opportunities beyond the classroom

Comments: The study shows the students engaged in using computers to prepare a slide show with an emphasis on problem solving through negotiation. It is a study in which students are seen to be involved from the initial planning phase,

including identifying the audience, through to the drafting and editing phases which will yield a completed text.

Doug, a teacher of nine years experience, remembers a time when computer technology was virtually nonexistent in classrooms and has now a firm commitment to investigating and implementing ways for students to use computer information technologies to access and present information (New London Group 1996, Lankshear 1997).

Classroom environment 2: The second class, a Year 5/6 composite class, encourages students' 'unselfconscious use of home languages' and fosters pride in bi or multilingualism. Kathy, the teacher, acknowledges changing her pedagogy to accommodate the changing literacy demands experienced by her students.

This study shows one way that a teacher organised a teaching-learning program to integrate computer technology throughout the day and to have students take control of their own learning. Throughout this process the students experiment, change things, incorporate new ideas and reach agreement on the final version. Within the parameters of the set task there is room for play. As in play, students are in control of the process and product; they make their own rules for participation and choose with whom they will participate. They play until the game is finished and express great satisfaction with their end product. The activity brings with it intrinsic rewards. Kathy hopes to show students that computers and information technology will be an integral part of their lives. She expects her students to make responsible choices about the use of technology and to share access to scarce resources. Students make decisions about how they will present work to an audience. This could be through a *Kidpix* slide show or presentation from their easel including word processed texts.

Comments: This site study illustrates issues involved in ensuring access for all students to computers. Students often have control over when computers are used, for what purpose, with whom and for how long. Those with computers at home can continue learning in a play environment—experimenting, exploring, learning the language and culture of the space as well as learning the skills necessary to participate. However, those with access only at school may well learn that computers are for something else—final copy of the report, or the constructing of a data base in history—school tasks, an intellectual exercise with little relevance to the outside world

Lankshear *et al.* (1997*) Digital Rhetorics*

Strategies that arise out of these vignettes include schools promote in house curriculum development with different communities to raise students' and teachers' cultural awareness ' using computer technology as a means of ongoing communication and mentoring through cross cultural and cross community projects and curriculum.

Useful websites that provide examples of innovative curriculum.

ITLED project at http://www.literacy.unisa.edu.au/ITLED

See also for other innovative curriculum projects:

http://www.union-city.k12.nj.us/

http://www.simcalc.umassd.edu

http://genscope.concord.org

http://www.virtual.gmu.edu

http://www.letus.nwu.edu

Teachers now need, to utilise the capacities of ICT learning to enhance the learning of disadvantaged students.

Three dimensions of ICT literacy

It is critical that such students acquire skill based of operational digital literacies, but expand this repertoire to include the cultural and critical dimensions in the use of ICT. The following case study is one example of where teachers and students take up the critical dimension of literacy work with ICT.

Vignette 16: Primary: K-7

Whole school literacy (South Australia)

Context: At Westview secondary (or primary) school, a disadvantaged school, teachers sought to address the lack of home computers.

This school stood out because it foregrounded social justice and worked openly to deal with issues of access (or lack) to ICT. They took the view that the integration of ICT required whole school change. This was a school that was already working within a critical literacy framework. They saw competence with computer mediated technologies were of equivalent importance to their working class students as literacy and numeracy in terms of accessing powerful modes of learning and operating. ICT could be a useful resource for addressing disadvantage because it brings closer the discourses of the schools and everyday contexts 'saturated with electronic media and popular culture'. ICT could interest a diverse range of students in schoolwork and help them to experience success. Access to and proficiency in ICT were keys to equity and social justice as students were located in suburbs with lowest computer ownership (ABS Statistic 1996).

Important Elements: An important aspect of critical literacy curriculum was to treat children as creators and producers of cultural texts for other audiences. Literacy and technology were tools of cultural production. Year 7 students constructed a multimedia history of their school The principles on which the curriculum was developed were that:

- Multimodal texts are central to making meaning and the communication of meaning in society.
- Multimodal texts are a major part of students' out of school lives and home literacy activities.
- Mass media and/or multimodal texts are important resources for the construction of a permeable curriculum in which children's representational resources developed outside school are valued as useful resources for their engagement with school curriculum.
- Students are envisaged as both authors and designers of multimodal texts.
- The construction of multimodal texts is understood to be central element of any critical literacy curriculum.

This curriculum was premised upon whole school change that involved:

- deployment of resources and personnel

- avoidance of the expert model
- structuring in teams to set goals
- building a learning culture
- publicly describing the culture of curriculum change
- structuring curriculum reform into the budget, timetable and organisation of teacher release time.

(Nixon 2001:199-201).

In this following vignette, while students did not have the high tech computers readily available, the focus of the teacher was not on the operational aspects of digital literacy, but on the critical ICT literacies – the third dimension that will be necessary for all students in a knowledge society.

Vignette 8

Integrating ICT into English units

Context: This was a case study of two schools—one in which students had laptops and another where the students did not. The tasks at the laptop school required students to build on digital literacy abilities (eg search the net for a review, incorporate columns and graphics into their own review) as well as utilising more traditional word based forms.

Comments: Discussion at the non-laptop school showed a sophisticated understanding from many students of aspects of the structure and marketing of games, and of debates about media effects. It resulted in a more considered preparedness to see games as texts and constructed, inviting a consideration of such issues as ideology and player positioning, as well as inter and intra-textual elements such as wit, narrative and iconography.

Beavis, C. 1999, 'Literacy, English and Computer Games — The Power Of Language' International Federation for the Teaching of English, Seventh Conference, 7-10 July, University of Warwick, Coventry, UK http://www.nyu.edu/education/teachlearn/ifte/beavis1.htm

Addressing difference through ICT

The above vignettes of what is happening in schools and classrooms to assist students who were disadvantaged cover a number of themes.

First, the focus on foundational literacy in the early years that can be integrated with a wider range of ICT practices that engage students who already indicate some learning difficulties. Teachers indicated a capacity to adopt and adapt software, even when limited in its scope, to supplement their literacy teaching, eg used software as an intervention both for skills development, but then augmented it with more creative and independent learning tasks that were culturally relevant. Boys in particular seemed to benefit in literacy because of their interest in hands-on computing, and teachers were building on this motivation. What is also evident is that there are fewer examples of leading practice in mathematics to provide similar interventions to address girls' performance in maths.

Second, also evident that ICT provide some diagnostic and mapping facilities that assisted in monitoring individual students. Teaches were expanding the ways they thought about learning outcomes and how to reward students.

Third, students gained a new range of literacies through the use of ICT - visual, aesthetic, aural, and not just verbal. They were more were engaged because of the multi-dimensionality of ICT that provided them with a sense of success in one area before they moved on to another. In that sense, authentic tasks that valued their particular expertise could be translated to success in areas where they had learning difficulties.

Fourth, ICT could provide different ways of moving students out of their own comfort zones and into new areas of learning, eg. From drawing and the visual uses of ICT, boys and girls could be drawn into areas of greater discomfort and underachievement eg text based work and communication for boys, games and design for girls. ICT therefore made it possible to expand their learning across all dimensions. Those with high levels of anxiety about public performance were able to feel safe with the anonymity, and still get recognition for their work publicly, particularly important for girls in maths, and Indigenous students. They learned to take risks and understand that there were different learning communities eg email allowed more risk taking than web development in terms of text correctness.

Equity principles

Many of the strategies required to maintain equity in the classroom are those that can be met by asking the following questions:

- Have you identified the diversity of students in your class?
- Have gender issues been considered?
- Who determines or benefits most from computer-based technologies?
- Have the language and literacy needs of all targeted groups been considered?
- Have you considered the need for additional time and access to resources for targeted students?
- What are your expectations of the targeted groups?
- Are you planning or consistent success while increasing the levels of competence for each student?
- Will your planned strategies address a range of learning styles within your class?
- Were you aware of the computer-based experiences your students are having in other subjects?
- Have you ensured that your assessment strategies do not disadvantage students in targeted groups? (DET, NSW 1997:29).

While the above strategies are appropriate to enhance the learning of all students who are disadvantaged, the following section focuses on specific exemplars of leading practice and strategies that can address the specific needs of different social groups.

Students from Non English speaking background

Vignette 17 Primary: 5-7

Learning Technologies in the Design Make Appraise (DMA) Process Year 5 to 7

Denise Lynch, Blackmore Primary School, Girrawheen, WA

Context: Blackmore Primary School with 250 students is located in Perth's northern suburbs in a low socio-economic area with a high transient population and a mix of Aboriginal, Asian, European and Australian-born students. Many of these students do not have English as the main language spoken at home. The school has two ESU units and an ESL teacher and Vietnamese aide one day a week. The current Year 7 students were particularly weak in literacy and a high number of these were boys.

Important elements: In 1997, Blackmore had a literacy/ technology focus. They coordinated the technology role with a dual purpose (i) to introduce students and teachers to computer technology for research purposes (ii) to incorporate a hands-on approach to design and technology. This seemed particularly relevant for the year 7 class who were weak in literacy skills and co-operative skills but who had skills for making and getting things done. The project ran for four one hour sessions for nine weeks.

Classroom environment: Each session began with a brainstorm designed to extend children's thinking beyond the obvious. The following steps were taken: Students in pairs researched an innovator or inventor. The whole class then discussed what all these people had in common, attributes like persistence, creativity, stubbornness etc. These attributes then were charted as skills and attributes that were necessary to 'invent' something.

The year 7s were given a very structured Design, Make and Appraise (DMA) process to work through. As this was their first DMA activity and considering the nature of the students, the task was explained—design a toy for a younger student. As a group the class discussed this broad design and developed a set of criteria for their toy design. The design was then expanded to design a toy for a year 2 student, which is innovative, appealing and safe to use. The class already had year 2 buddies and so they were chosen to be the recipients of the toys. The students developed suitable questions to ask their buddy about what toys they liked, why they liked/ didn't like them etc. Questions were generated in small groups the class as a whole developed the best set of questions.

Students researched what design options would interest both them and their buddy. They did this using the Internet, library texts and *How Things Work*. This section took much longer than envisaged. Some students planned toys on a grand scale; others wanted to copy something already available; others were reluctant to make a decision. This led to much discussion about copyright, brand names and innovation. One of the requirements was to make a prototype. It was an unpopular part of the process to begin with, but the class reviewed our research that many innovators had made prototypes and corrected any glitches. (Another reason was to conserve money!) The relevance of prototypes became obvious as students couldn't make or do what they had planned, eg the dimensions they had chosen for their toy did not meet up as expected. Modifications were planned and tried and fixed before the real make. The

actual making of the toy followed. Some students who had poor literacy skills were indeed very handy and competent. Students had to submit a list of required materials and the source of the materials. Wherever possible the students recycled, reused and borrowed. Some, like balsa wood and calico, fabric paint were bought. The library took on a factory appearance with a sewing machine in one corner and a balsawood and hot glue guns in another. Prototypes hung on boards on and around the room.

Part of the process/contract included the class evaluating each other's toy. Student presented their finished product to the class, with each summarising the process they had followed. That toy was then assessed by the rest of the class as to how well it met the criteria in terms of innovation, appraisal and safety.

The next part of the process called for students to make a card in a *HyperStudio* stack (a multi media learning tool) as a record of what they had done for a wider audience. This use of *HyperStudio* provided an opportunity to extend both their literacy and computer skills. This group ran out of time. Similar units of work with different themes finished with the *HyperStudio* stack presentation. These were enthusiastically worked on by the children and shown to other students, teachers and taken home as well. When the time came for the students to hand over their toy, many were reluctant to do so. Some extensive discussion and negotiation followed. The student's commitment to the process had made their product very valuable.

Comments: As a result of the project, students:

- developed their use of research skills using CD ROM encyclopaedias, text and the Internet
- developed their cooperative working ability with their peers and younger students.
- developed some strategies in learning to problem solve and use thinking skills.
- displayed a positive attitude towards the process of DMA and their product.
- developed some proficiency in using different tools like the sewing machine and carpentry tools.

While this project did not specifically focus on multiculturalism, it worked from the strengths of the students (practical, hands on) to move on to developing English literacy skills. The focus was also upon the social, in terms of negotiation and discussion with buddies, group work and public presentation that required verbalising in English. ICT provided a realistic way of designing the toys, problem solving, revising, recording and reporting.

The following exemplar comes from the First Families Project established under OzProjects, which was intended to provide online learning activities for students and teachers.

Vignette 18: Middle years: 9

First Families in Cooper Pedy Area Schools

A Global Discovery School, (South Australia)

Context: This program was initiated by the ESL teacher for Year 9 ESL students. She changed the program to make it more inclusive for the needs of aboriginal students as well as first generation students from NESB. The program was used as the basis of a unit of work on families with student in Primary and Middle Years using the concept across SOSE, Languages, Arts Mathematics and Technology.

Important elements: The aim was to produce a piece of artwork in the form of an appliqué to be displayed in the school gymnasium. Each class had an area of fabric on which they created their own individual or collective concept of family with the support of the Home Economics and Arts teachers. They used ICT to complete their design. Students also utilised computer date bases and the Internet to develop their concepts of families and cultures. The images were enhanced and digital cameras were made available.

Comments: The cultural product was presented and displayed, imparting a significant sense of achievement and pride within the community and school. The students benefited from the cross curriculum focus, and saw their teachers in a new light.

http://www/cooberpedy.sa.edu.ay/firstfamilies.htm

Another need is to develop a sense of students as cultural producers through the arts. This gives them scope for independent learning, appreciation of own and other cultures and development of visual literacies that are relevant to their interests.

Gender

Gender permeates the social relationships and dynamics of every classroom. It is therefore important that teachers and schools create a learning environment that is safe and free from prejudice and discrimination, but that also encourages individuals to take risks in learning. On the one hand, there is much to support the view that there are gender differences or socially constructed preferences in learning styles that need to be addressed. On the other hand gender interacts with socio-economic, linguistic, racial and ethnic background in ways that indicate that there is often more difference between boys and between girls within a class or school than between boys and girls. Different masculinities and femininities coexist and are constructed in relation to each other in schools, with differential outcomes. A safe learning environment is one that:

- recognises prior learning and skills;
- ensures that students in each of the targeted groups have access to time and resources; and
- provides opportunities for girls and boys to work in single sex groups at particular times and in particular subjects.

Gender also is a factor in attitudes and behaviours of boys and girls with respect to ICT. There are now clear patterns in terms of preference and usage; boys play with computers, learn at home and have a preference for games; girls use computers less, tend to use them as tools for school work and communication on email and Internet. Computer based technologies also have the capacity to address a range of learning styles. Teachers therefore need to build on strategies to cater or individual learning

styles, but also to encourage boys and girls to acquire the full range of ICT skills. The focus of the following vignettes is on boys disengaged from school and literacy in particular, and girls disinterest in computer studies.

Disengaged boys

The issue for boys is the disengagement of many of them, but not all, with reading and writing. There are two approaches that are seen to be working well with boys in terms of their engagement with learning through the use of ICT. The first is premised upon the transferral of their knowledge about computers gained from game playing at home into school. Another is to identify positive experiences and interests that can motivate an interest in a project The aim is to allow underachieving boys to gain a sense of achievement from non academic work that can then be possibly translated into more traditional academic achievements.

The following case study in a Queensland secondary school exemplifies an ideal situation for improving literacy, with one-on-one teacher/student ratios in a technology rich environment, and with teachers and students working with each other in a shared research project. There were no hierarchies of power that often confuse learning in classes of one teacher to numerous students. What it did was allow the boys more autonomy, they made decisions about the skills and techniques they would learn and when they did it, they consulted with each other and the researchers about lay out, design and moves as they needed to work with range of multimedia equipment. The project allowed them to behave differently, be recognised for that, and for the teacher to see them in a different light.

Vignette 19 K-12

Cultural apprenticeship model

Context: The aim of this action research was to work with students with serious reading and writing problems, using the 'cultural apprenticeship model'—as learners together with teachers and researchers working on a real task (Rogoff 1996). An authentic task provides students with a context for using digital literacies better. The product was 16 interlinked pages, each with 3–4 pages, varying in style and emphasis.

Classroom environment: Given their interest in motorbikes, the decision was that they should use this as the 'real task'. Already the boys had developed a magazine project in which they had collected information from the Internet, and from interviews. This magazine was to become the basis for the web page version. They began using Microsoft's *Moviemaker* (1995) followed by an exploration of *Front Page* to train them in web page construction. The boys then moved on to the tasks of designing, and testing out the pages with support from their peers, the researchers and teacher.

Comments: The tasks had required them to do various versions, demonstrate, model and also to instruct each other. They knew their role later would be to be as instructors to other students. They also saw the teacher, a female, as a computer novice, and in teaching her realised what operational skills they needed to be able to teach their peers later.

What was evident in this project was to change the boys' attitudes and behaviour

through three strategies:

- providing the boys with opportunities, choices and power not usually ascribed to troublemakers;
- providing the boys with consistent and clearly articulated feedback concerning their abilities to display those in school—in literacy and technology—which they are routinely expected not to possess; and
- demonstrating a way of thinking about responding to boys in schools that saw them in a positive and not a negative way, that moved beyond stereotypes.

(Rowan *et al.* 2001).

The aim in this approach is to capture the motivational aspects of ICT and boys' interest in play and hands on activities in order to mediate the relationship between the reader and the text.

A second aim is to encourage boys to display different communication competencies through a range of performances using multimedia. This means moving away from an emphasis on literature and print texts, and creating opportunities that call upon boys' preferred forms of reading to then articulate towards more varied texts.

Vignette 20: Early Years 3

Shannon and William, Year 3

Shannon has attended seven schools in three years, and has significant gaps in his learning and behavioural problems. Using the computer with a focus on words and pictures suing *Paintbox*, and publishing in the newsletter in which he received feedback from Norwegian students, combining the visual and verbal literacy means he is now moving towards literacy learning.

William similarly has excellent spatial conceptual skills that mean he is superb at problem solving—a skill utilised in the wordless, mechanic/physics computer game called *Incredible Machine*. He is now doing E track (a global collaboration email project in the NT). Having watched others doing email, he now wants to communicate and therefore has to write text. In particular, in developing a Webpage, he was forced to write html tags that then generate on the screen and the text appears. This was wonderful for a non text literate student. He saw the underlying structure that led to the final web page but that was invisible. This produces a different type of literacy that students are now appreciating.

For students labelled as disadvantaged, a train-the-trainer model implicit in the cultural apprentice model can shift such impressions amongst peers and teachers, by making students into experts, and providing such students, their peers and teachers, with different perceptions of themselves.

At the same time, the integration of ICT with all its multimodal forms and emphasis on all the multiliteracies raises questions for teachers about how to assess the products of their students work. The following is a case in point where a teacher who seeks to re-engage boys by working from their interests and the motivational aspects of ICT to enhance their writing.

Vignette 21: Upper Secondary

Teacher: Charles Morgan (Tasmania)

Context : Charles Morgan had been doing some work with reluctant Year 10 students in a country school. He has found that, with a digital camera, a lesson outside from a skateboard expert and Microsoft PowerPoint, these same boys can create their own texts that are appealing to a wide audience, while challenging their own writing skills in the process.

Challenges: Assessment is significant with respect to the pedagogy underpinning on line learning, and types of formative assessments that can be utilised. Multimedia provides students with a range of performances that indicate what they have learnt—combinations of audio, visual, as well as different versions of text. Morgan had to develop new ways of thinking about assessment and what comparable criteria across a range of performances and presentations might mean.

Comments: These were the boys most disengaged in middle years, and most at risk. The increased focus on the use of ICT as integral to teaching and learning with the rapid shift to online learning and to assessment raises important pedagogical issues regarding assessment.

(Leading Learning Conference Proceedings 2001, Dept. Education, Tasmania)

A third approach is to draw upon the interest of boys in computer based games to capture their interest. This can be done by encouraging boys to undertake in school analysis of games in terms of their genre, to get them to create games, to use games that have a wider set of educational issues eg SIMCity as an environmental and design tool. These strategies can also be used to address the third level of critical ICT literacy that considers the wider social and environmental issues about ICT.

Disinterested girls

Girls are competent in the use of ICT when they are as experienced at ICT as boys, but use ICT differently with a focus on communication modes (email, Internet) rather than games. The issue is the lack of interest of girls, that increases with age into the middle years until the mid twenties, and their consequent under representation in computer studies (and teaching) at the post compulsory level. This trend is worsening.

Current strategies to counter under representation of girls, rural and ATSI students in computer studies focus on the macho culture of computer classes, the tendency of boys to dominate the equipment, and the violence and male images that permeate most software, in particular games. Teachers can be supported in developing and integrating ICT into maths and science in ways that utilise the multimedia and mulimodal possibilities created by ICT to make these subjects more attractive and inclusive for many equity groups.

One strategy is to deconstruct representations and challenge stereotypes on the web in communications online, on websites and in software. For example, computer games can be deconstructed to highlight stereotypical images and responses to problems.

Another proactive position is to use multimedia images of women and members of different ethnic groups in a science curriculum to discourage stereotypes about

computing as a career for white males, with the intention of encouraging minorities to enter computing as a career.

A third approach is to develop classroom and school cultures that are supportive to girls and encourage them to undertake ICT courses. This can be achieved through mentoring by women who work in ICT and forming good peer interactions with female teachers. ICT can for example, facilitate this through telementoring (online mentoring) of high school girls with women in ICT in the workplace. See http://www.edc.org/CCT/telementoring/

There is a Telementoring Website where adult women who are experts in ICT and other work mentor girls in the classroom http://mbhs.bergtraum.k12.ny.us/mentor/

Mentoring guidelines are laid down that indicate what the successful role of teachers can be in this process. As with other projects it is problem based with clear sets of expectations.

Finally, girls and boys can be more involved in developing their own software, websites and games that are based on their interests. This would promote them being more active in creating in the production of ICT rather than use, to work against the current gender division of labour. For example, this can be achieved through the development of a computer mediated literacy product, such as a journal or newsletter on line. This requires editing, selection for appropriateness, negotiation skills to achieve a final product, thus operating within the cultural and critical dimension (ie appropriateness of content, style and effect).

Computers mean that students can undertake quite complex tasks but keep within their 'proximal zone of development' in which they can take risks and still feel comfortable (Vgotsky, Lave and Wenger 1991). The publications of online materials and webpages also foster a sense of independence and responsibility, of being proactive and not just as consumers and users of the web. Students also learn to engage within this learning community with other communities – locally and globally (Lankshear *et al.* 1997, Vol 2:36-39).

3.4 Social relations of gender

Any approach to either of the above gender problematics have to take into account the social relations of gender and how they work in classrooms. How teachers organise a classroom in terms of grouping should not be accidental but planned as it can impact on learning. For example, mixed sex pairs often leads to boys dominating the mouse. Single sex female pairs tend to discuss, reflect, negotiate and work for a consensus about moves and decisions. Single sex male groups tend to lead to non-reflective rapid action without negotiation and little verbalisation of the problems being confronted. The girls indicate lower risk taking tendencies and an emphasis on the relational; the boys indicate high risk taking and individualised and competitive behaviours. Both the relational focus and risk taking behaviours are valuable skills for all students. There is therefore a need to adapt specific tasks to ICT use to encourage:

- risk taking and more independent learning in girls: and
- attention to personal, social and more sharing relationships and verbal skills amongst the boys.

Similarly, in the cultural apprenticeship model, there is a need to take considerable care not to reinforce gender stereotypes that associate masculinity with technology expertise. Care has to be taken that similar approaches are utilised that position novice female users as experts in a specialist technical skill, and for boys to be encouraged to

work more collaboratively. This means matching the task set with appropriate organisation around and use of the computer.

The issue here is that both boys and girls need to extend and enhance the ways in which they use computers. Boys need to be set tasks that encourage their negotiation, communication and collaborative skills in more cooperative and non competitive environments. Girls need to be encouraged to be proactive in the production and design aspect of ICT content, eg software.

3.5 Students with disabilities

Teachers also need to understand what inclusivity means in both how curriculum and pedagogy is presented. In teaching students with disabilities, teachers need to have ownership of the students' efforts and have a philosophical commitment to inclusive education (Soto 2001). Teachers need to have awareness of students' additional needs in regard to the time needed to plan, organise information, and develop strategies to engage in and complete school work (Anderson-Inman 1999).

For many students with disabilities, and for the majority of those in Special School settings, the use of assistive technology is a basic requirement. Human supports are also vital for students as they learn about and use ICT (Blackwood 1999).

Although gains have been made in the development of accessible products based on universal design principles, today's teachers and parents will find that numerous assistive technology products are also available which are used to customise access to hardware and software. Examples of these are provided at the conclusion of the discussion on effective strategies below.

The following are examples of Victorian special schools using ICT in effective ways. Other examples are detailed in *Technology for Learning: Students with Disabilitie*s, the report of the Ministerial Advisory Committee: Students with Disabilities, South Australia (DETYA 2000).

Vignette 22

Naranga School (Frankston, Victoria)

Challenge: Students attending Naranga School have challenging behaviours and learning difficulties. A focus over the years has been to provide opportunities for problem solving and living skills so as the students can be exposed to a range of experiences in a safe and supportive environment.

Important elements: The software used (*IntelliKeys* and *Boardmaker*) promotes literacy and numeracy. The facility for risk taking promotes confidence in being able to learn in a structured situation where mistakes can be made without negative feedback. Software simulation packages provide a range of experiences that can be used to enhance the students' understandings of their world and help them to cope and participate more equitably.

Vignette 23

Vermont South Special School (Victoria)

The school offers a wide range of technologies to their junior school-aged students. Traditionally an Apple Macintosh based school, they have added a number of PC compatible computers running MS Windows. Sections of the school now have fast access points to the Internet. A large range of curriculum based software for both platforms is used in classrooms as well as in a central computing area. Students use both mainstream and specialised software with touch screens and *IntelliKeys* resources. The thrust is on skilling, immersion and use of software packages to complement the classroom experiences.

Students are encouraged to maintain and extend their computer skills. A broad selection of curriculum, theme and topic based software complements the ongoing curriculum initiatives that are closely matched to individual student IEPs (in full) and the Victorian CSF. Teachers are all encouraged to use ICT in their classrooms, with a Technology Coordinator allocated to taking specialised classes. The school has access to technical advice and services to help maintain the hardware and peripherals.

Vignette 24

Nepean School (Frankston, Victoria)

The students attending Nepean School predominantly have physical disabilities. They rely on the use of keyboards that can be programmed (*IntelliKeys*), symbol based software (*Writing With Symbols 2000* and *Boardmaker*) Touch Screens, switches and other assistive technologies that afford them efficient, timely and equitable access to Apple Macintosh and MS Windows based computers. Over the years the school has upgraded stocks of computers and devices so that the students have increased learning opportunities. Students who cannot write or who have difficulty using a standard keyboard or mouse have keyguards and trackballs. The main thrust is to provide the most efficient access method so that they can more fully participate in the classroom.

Vignette 25

Shannon Park School (Geelong, Victoria)

Creative and innovative use of *MS PowerPoint* in designing, creating and publishing talking books with students has witnessed a change in direction for this school. Staff work with students in writing stories, developing projects and publishing media using digital cameras and scanners. Various multi media elements are incorporated to create high quality electronic productions that are printed as well as saved to the school's Intranet. The major focus on literacy skills has been very successful in promoting the use of ICT to staff as they immediately use the benefits and learning outcomes.

What these four exemplars indicate is that ICT considerably enhances the educational opportunities and learning of students with physical disabilities as it provides them with the capacity to write, read, produce reports and other multimedia products. Such advances and the capacity for more independent learning make integration into mainstream classrooms possible. It also promotes student sense of success and self esteem.

Vignette 26

Frankston Special Development School (Victoria)

The school has recently embarked upon a three year Technology and Learning Plan. In 2001, the communication theme was introduced across the entire school. The use of ICT was matched to all learning areas and modalities. The use of computer software, communication devices and switches was deliberately targeted to help consolidate skills and develop greater integration of technologies to provide a more cohesive framework for staff and students. Goals and outcomes documented in student IEPs are the main thrust in determining how best to implement the ICTs so that consistent and sustainable practices can be realised. The whole school plan provides a focus for the delivery of learning and access requirements when using conventional/traditional teaching aids as well as in the time spent with communication devices and ICT equipment. A central technology area is used as a training and skilling area for both staff and students. All resources are located in this room and borrowed through a formal booking system. A part-time teacher (3 days) coordinates the ICT program and an external consultant was employed in 2001 to help write and formulate the three year plan, and inservice staff.

Vignette 27

Mount Evelyn Special Development School (Victoria)

The school has a large population of students who use switches and touch window technologies. Therefore a comprehensive number of switch-based programs for access, learning and communication outcomes have been acquired. Teachers, aides and support staff have been trained in using various input methods with MS Windows computers.

Students interact with cause and effect, communication, literacy and elementary numeracy programs daily in their classrooms. The high incidence of ICT usage has seen an improvement in students' attention span and ability to be on task for longer of periods of time. At first, staff members were quite reluctant to utilise the technologies as they had experienced technical difficulties and poor success with devices. After some professional development in 2000 with adaptive devices on how they connect and interface, the school culture has gradually changed. Less reluctance by staff and a greater awareness of the advantages of technologies used with the students in classrooms is now evidenced.

Vignette 28

Anadale School and Rossbourne House (Victoria)

Students with learning difficulties are provided with literacy and numeracy packages used to assist students with learning and writing. Programs such as *WordShark 2*, *Clicker 4*, *All My Words* and *First Keys* are used alongside mainstream programs. Students are encouraged to develop skills in process and creative writing using talking word processors that display pictures, symbols and clip art. A number of numeracy programs also support the students IEPs with various genres and maths software.

The next cluster of exemplars indicate how familiarity for students and staff, with professional development and technical support, has led to significant educational improvements for the students in terms of literacy and numeracy. The range of software allows students to participate in mainstream projects and across more of the learning areas.

Vignette 29

Concorde School (Bundoora, Victoria)

The introduction and progress of the Digital Memories project in 1999/2000, general innovative use of ICT, Internet and current implementation of learning technologies in the newly built Technology and Learning Centre has progressed the cultural change in this setting in how and why ICT is used. Staff have had ongoing Professional Development over a period of three years.

Technology has been a driving force in changing the culture of the school. The Principal has allocated resources to extend the use of ICT so that students are empowered to negotiate learning at their own level. The school has built a dedicated Technology and Learning Centre on site. The entire school is networked and cabled, with state-of-the-art computer systems. The introduction of *Clicker 4* software in 2001 has further developed the strong literacy component where students independently create their own learning resources with guidance and direction by the teachers. Files created by the students are burnt onto CD ROM and published in book form.

Vignette 30

Belmore School (Balwyn, Victoria)

Context: Belmore School has newly introduced their own intranet.

Important elements: This has meant greater usage of digital camera and scanners in order to create talking books. Many students have physical disabilities and rely on adaptive technologies such as *Discover Keys* and *Discover Switches*, trackballs, enlarged keyboards and modified switches. Classes have access to the Internet and students can use web sites as resources for research and learning. The school

resources of clip art, sound and movie files are centrally available on a server.

Comments: Perceptions of staff have changed with a more positive attitude to ICT as a daily occurrence rather than an infrequent experience in a computer room. ICT is now more closely related and integrated into students' experiences and learning outcomes that enhance and complement their IEPs.

Vignette 31

Sunshine Special Development School (Victoria)

The school has part time enrolment in local mainstream settings. Over the past four years, a range of initiatives in the use of ICT in local primary and secondary schools has been a major focus in providing students with opportunities to more fully integrate. Programs such as *Writing with Symbols* 2000 have been introduced into the mainstream and children of all abilities write stories with text-to-speech and symbols. Teachers at the host schools have seen specialised software being used by all of the students, which changes the orientation of the ICT programs in general. Students on campus at the special school use a range of devices and software that accommodate their skill and age levels, with a conscious effort to build staff confidence and abilities. A teacher has the responsibility to accommodate the needs of all students, coordinate the ICT program and locate and resource each campus.

Video conferencing has significant potential for use with deaf students in school settings, particularly given the geographic isolation and small number of deaf students in some locations (see Vignette 29—Indigenous). The successful use of video conferencing is dependent on the availability of telecommunications transmission. For full video conferencing and services a bandwidth of 10 and 100 MB/s is required for a typical secondary school (Kelso 2002).

Some schools that have embarked upon using ICT with students with disabilities have offered training days and evenings to parents. This involves, in skilling with the technologies, the parents of students with disabilities. Importantly, it also raises their awareness as to what the school is attempting to achieve. They are able to participate and learn about the technology. They become more involved in the process of future purchases and choice of resources, especially with reference to fund raising and allocation of funds to projects (cabling of classrooms, purchase of new technologies including digital cameras and scanners). This involvement has the potential to increase the quality and breadth of use of multi media applications for their children.

Using ICT effectively for students with disabilities

The strategies for successful use of ICT noted above are also relevant to students with disabilities both in inclusive schools and in special schools. Inclusive education is emerging as good practice for teaching students with augmentative and alternative communication needs (Erickson & Koppenhaver 1998, Sturm 1998). There are specific strategies for using assistive (adaptive) technology for students with disabilities, and many of these are disability specific. Appendix 3 highlights the kinds of assistive technology available and strategies for their implementation.

Strategies that have been formerly introduced and used with assistive technology in special settings or with integrated students are now commonly being used in mainstream classes. Studies looking at the factors that are essential in the use of ICT in inclusive schooling for these students confirm the importance of:

- collaborative learning;
- educational and technological support;
- parental involvement;
- support for development of social supports (eg friendships); and
- behavioural supports for SWD with challenging behaviours (Soto *et al.* 2001).

All of these general approaches to using ICT with students with disabilities apply to other students. For example, the involvement of the family of a student with disability in technology use has supported its successful use in the school. In particular, the learning of students with disabilities is assisted when parents:

- are involved and have input into the Individual Education Program planning process with reference to ICT equipment, software and training;
- learn to use the equipment at home with their child;
- are invited to training conducted by the school on behalf of their child;
- are invited to Professional Development sessions conducted by the school or in the region;
- can download applications from the Internet (eg utilities, freeware and shareware games and educational programs) and conduct research using the World Wide Web); and
- attend conferences and seminars organised by disability organisations (eg Association for Children with a Disability Inc.).

Software development in particular demonstrates recent efforts to apply universal design principles so that products can be used by the broadest group of people with different physical and cognitive access requirements. There are accessibility options in standard software such as Windows 95, 98, and 2000, which choices to users to make computer access easier (eg MultiWeb Internet browser and the MultiMail email program).

As with technology in general, students using assistive technology need human supports (Blackwood 1999). The schools demonstrating leading practice:

- use mainstream software applications differently to accommodate a range of learning styles;
- use specialised equipment and/or software applications (eg Clicker 4), and then use new skills and understandings to assist mainstream students with these strategies;
- investigate and evaluate the potential for increased learning outcomes for children with disabilities and modify expectations accordingly;
- mainstream ICT to meet the needs of all the students, thereby negating the effect of labelling students and categorising and/or perceiving software as ‘special’;
- develop teacher skills in using ICT in the classroom so that they can cater to a range of learning styles;
- broaden the software application base to include software that incorporates text-to-speech, pictographs, symbols, and simplified navigation for all students to access;

- use pairs or small groups so that students with disabilities are engaged in active learning with their peers thus promoting a change in school culture;
- use mainstream or assistive technologies to enhance the ICT program and introduce a broader range of skills in classrooms;
- provide access to computer hardware and software, possible use of additional assistive technology such as screen reading or scanning software, and use of web sites that are accessible for everyone; and
- ensure compatibility of assistive technology and special software with computing equipment, an ideal situation being one where computers, software and assistive technology are accessible to all students and work together seamlessly.

ICT offers unequivocally an improvement in the quality of the learning experience for most students with disabilities.

3.6 Indigenous students

There have been many policies and strategies implemented in the area of Indigenous education, with the view to enhancing the learning outcomes for Indigenous students. These strategies have all recognised the importance of involving the Indigenous community in the education process. While there is still limited research on how ICT can improve the learning outcomes for Indigenous students, there is anecdotal evidence to suggest that Indigenous students are using ICT more and are finding that it is a medium for learning that is more user friendly than some other classroom approaches. A characteristic of the successful projects documented below is the importance of involving all stakeholders – students, parents and community. A second key aspect is the focus on literacy while at the same time the pedagogies and curriculum are culturally appropriate.

While the Koorie Literacy Links Project is a Victorian based project specifically working with Koorie students, the study has implications for the Indigenous community as a whole because it shows that the use of ICT in this instance has improved the performance of the Aboriginal students participating in the program.

Vignette 32: Early Years

The Koorie Literacy Links Project

Aims: The aims of the project are to:

- build on the proven literacy successes for Koorie students in the early years of schooling;
- extend these models to targeted Koorie student groups;
- improve teacher understandings about Koorie education issues; and
- further extend Project outcomes to curriculum leaders in participating schools.

Important elements: The project uses multi-point videoconferences, point-to-point videoconferences, mini projects, home/school interactions and the development of culturally relevant resources. There are fourteen schools in the project and in each of these schools there are ten or more Koorie students, making a total of 330. Teams have been established with Literacy teachers, Koorie Educators (16 in total), Koorie Education Development Officers (14 in total), and

members of the Koorie community representatives from the Local Aboriginal Education Consultative Groups.

Comments: Extensive data was collected at the beginning of the project in order to establish a base line from which gains could be measured. Student progress and improvement have been monitored on an ongoing basis, including the use of standardised testing that Victorian schools use. The early analysis of the work undertaken by students in the project suggests that the learning outcomes for the Indigenous students using videoconferencing have improved. The outcomes are detailed in Section B of this report.

Available at http://www.sofweb.vic.edu.au/koorie/LinksPro.htm

Here ICT provided a capacity for the development of a data bases and ongoing monitoring of individual student progress.

Vignette 33: Primary/Secondary 2-8

What Works? Explorations in improving outcomes for Indigenous students Project IT2

Context: One hundred and ninety-nine students from years 2-8 participated in the project. The aim was to use ICT to enhance the teaching and the learning of Indigenous students in urban, rural and remote locations. Three groups of schools were targeted and portable computers were distributed to the students to use in their class work.

Important elements: The teaching staff and Indigenous personnel were trained in the online aspect of the program, becoming familiar with computers, and in literacy issues that would be addressed by the project. The project sites were widely dispersed, with a high level of technical problems, and class mobility. Forty-one students were involved in upper primary and project.

The students in IT1 were primary students who spent regular periods of time withdrawn from their classes to computer rooms. The project was designed to improve the students' outcomes in literacy by using software programs designed to develop their literacy skills. They received support from the Aboriginal Education Workers.

The second focus was on secondary urban students in remote areas. The project aimed to provide equitable access to ICTs for Indigenous students and to explore different methods of educational delivery. Five laptops were used across different subject areas.

Comments: In this project, at two sites, the target of increasing the students' literacy by 1.5 years was achieved by 50 per cent of the students. The result of the project indicated improvement in writing and spelling skills of Aboriginal students in primary years. Students in both primary and secondary years were more confident in using computers at the end of the project. Findings from this study indicated that the writing and spelling skills of the Indigenous primary students improved. A high level of success was reported for upper primary groups with 98 per cent Indigenous students achieving the key competencies in the ICT continuum, locating, selecting, analysing, organising, and sharing information. The schools that participated in emailing found that their students were

enthusiastic and that it was a useful tool to practice literacy skills. Comments from the care givers support access to technology for their children because they view computers as a tool to provide skills for their children to access employment.

This project indicated that there were significant attitudinal changes accompanying the use of computers because of the enjoyment. The capacity of ICT to facilitate the three elements of play, performance and practice in ways that promote learning are again central characteristics of successful programs.

Vignette 34: Middle Years

The Koorie Middle Years Link Project (Victoria)

The Koorie Middle Years Link Project began in 1999 and was developed to improve the literacy links for Koorie students in the middle years of schooling. Five schools in Victoria were initially used in the project with high numbers of Koorie students in Years 7–9. A further six schools were added in 2000. There are now fourteen schools in the Project from years 6-9. They use video conferencing to link students in different schools. Teams were put into place including the literacy coordinator; the school based Koorie Educator, a regional Koorie Development Officer, a representative from the Local Aboriginal Education Consultative Group and the classroom teacher.

The secondary students did not show any significant improvement in their literacy skills. The lack of laptops restricted use considerably. However, both groups improved in their use of ICT and enjoyed using the computers.

Available at http://www.sofweb.vic.edu.au/koorie/LinksPro.htm

The success of the two projects were their multi-dimensionality, the focus on a targeted year level (early years, middle years), teacher professional development, culturally relevant content, home/school relations, teacher teams and community involvement.

ICT and literacy has been the focus of other major initiatives for Indigenous students. In *What Works: Explorations in improving outcomes for Indigenous students*, a report prepared by the Indigenous Education Strategic Initiatives Program Strategic Results Project National Coordination and Evaluation Team (2000), four projects were undertaken in the area of Information Technology. The report comments, 'emerging research evidence suggests that, in the right circumstances, the use of ICT can enhance the quality of teaching and learning'. Two of the projects, IT1 for 64 primary students, and IT2 for 199 primary and secondary students explored the value of using ICT to support literacy development.

This project demonstrated that when the students had limited contact with school literacy it took six months to develop their knowledge and skills to use the software. However, the use of the Information Technology allowed the students to work at their own pace, and provided a stimulus for learning. Other factors that resulted in the achievement of these results were the smaller class sizes for the project, the value of the work of the Aboriginal Education Workers, the special circumstances, and the whole school approach to the project.

In New South Wales, the *Koorinet* project is undertaken outside the school and classroom setting, but it does relate to Indigenous students because it highlights the way in which Indigenous students engage in the learning process by using ICT. It also

looks at a way of engaging the Indigenous community, through their organisations in the learning of the Indigenous students, and provides a model for how schools can utilise the net to provide culturally relevant resources between and within schools through an inclusive network.

Vignette 35: K-12

The Koorinet Project (New South Wales)

The Koorinet project came about because of the need to provide a quality computing facility for the Indigenous students at the University of Sydney in a culturally appropriate environment. Prior to the project being implemented, the Indigenous students had to access the mainstream computing facilities in the University. At this stage, there was very little utilisation of the computing facilities by the Indigenous students. There was a perception by the students that the computing facilities were 'culturally and socially hostile environments' (Hobson 1997) and the equipment was outdated and unserviceable.

Important elements: The Koorinet began with a local network being established to meet the needs of the students in word processing and printing. The new facility was successful and students brought their family and non-Indigenous friends to the opening of the new facility, claiming an ownership and pride of the facility. The students then proved that "Given a supportive and identified environment and quality facilities, Indigenous students were just as keen to utilise technology as their non-Indigenous counterparts" (Hobson 1997:4).

As a result of the increased usage of the new facility, the Koorinet project then implemented an Internet service. At this stage, "it became apparent that there was very little available on the Internet of relevance to Indigenous Australian students" (Hobson 1997:4). As a result of this, the Koorinet offered a Koorinet Internet Sponsorship Scheme, where non-profit Indigenous organisations could obtain free www site design and hosting services. The Koorinet now has a directory of 400 Indigenous websites many that are designed, produced by Indigenous people, with Indigenous content.

Available at: http://www.koori.usyd.edu.au

Community based early childhood education programs for Indigenous students have meant that the community has achieved positive outcomes in aligning the significant differences of basic literacy and numeracy required before entering school. Specific reference to Indigenous communities is made on the Apple Learning Interchange K–12 [http://ali.apple.com/].

Cain and Tingay (2001) suggest that Koorie as other Prep students, despite individual differences, indicated a preference of oral expressive, none verbal and non print language, for visual stimuli, for group work and discussion rather than individual responses, valuing of personal experiences, use of spontaneous and intuitive thinking, flexible activities, resistance to risk taking associated in particular with problem solving , open ended challenges, different use of language eg Koorie English with less confidence in Standard English, and learning through demonstrated and tactile experiences.

Vignette 36: Pre-school

Woolum Bellum Early Years Program (Victoria)

Context: At Woolum Bellum, a P–12 Victorian school, many children had not attended preschool programs prior to starting school. Three forms of language are used and valued-Koorie English, traditional Ganai and Standard Australian. An early years program was established.

Important elements: Koorie Educators used Hypercard programs to develop stories that were retold with a theme linking art, video, photography and audio, traditional stories based on local knowledge. ICT was a learning tool that provided student ownership. Personal ownership was achieved through developing webpages that were based on relevant local issues, that were constructed and posted by the children and that showcased their work. Electronic messages through 'epal' exchange provided anonymity for children, encouraging risk taking. An email partnership was set up with similar aged children leading to personal exchange of letters and snippets about their culture. The I*EARN Global Art Project meant children showcased their cultural products and provided opportunities for them to explain Koorie art while maintaining anonymity. Software packages were used to develop literacy. *Wiggleworks* promoted audio, visual, and computer based learning, self pacing, addressed various levels of competency, allowed for oral and visual presentation of words and sentences, picture clues and multiple extension folders. *KidsPix* facilitated animation of stories and text, integration of literacy through KLAs, and children generated text writing ideas. *Living Books* offered audio and visual representation of words, sentences and context. *Typing Tutors* provided letter and keyboard recognition, work and sentence structure familiarisation, and challenges to improve on their work. *Clarisworks for Kids* promoted free typing and expression, spell checking and word shaping while *Orly's Draw Story* generated stories with illustration and text, adding text for context and meaning.

Comments: Teachers noted an increase in students' enthusiasm, a willingness to undertake literacy and technology centred tasks as well as increased risk taking using ICT. There was a willingness to do drafts and review writing, collate data, and develop different literacy styles.

The program was based on community partnerships. They sought advice and knowledge from the community, Elders, Koorie Educators, Local Aboriginal Consultative Group; visited families; became acquainted with local organisations; identified culturally appropriate literacy resources to integrate into the mainstream programs, and practised and modelled proactive behaviour.

ICT can in such ways be used to promote the basic principles of Indigenous pedagogy (Blitner *et al.* 2000:28-49) through its capacity to:

- focus on student / teacher relationships;
- maintain continuous teaching, learning and assessment;
- create a community of learners recognising elders as knowledgeable and respected teachers;
- develop independence and mutual respect between Indigenous teachers and children;

- focus on real life experiences and exploration as a culturally appropriate pedagogy;
- use informal learning experiences such as exploring through play and observing;
- have high expectations of achievement of all children;
- use Indigenous teachers to model behaviour for children;
- have flexible and adaptable teaching and activities to respond to incidents;
- integrate Indigenous children across groups.

ICT works through multiple forms and texts print materials, videos, taped stories and songs, CD Roms.

Other examples of planning for access for Indigenous communities are at http://www.une.edu.au/trdc/sumRTIF.html.

ReachOut that is a suite of classroom activities and community based activities to involve community at Lockhart River. At http://www.schools.ash.org.au/reachinreachout

In summary, these case studies, vignettes, exemplars, stories and networks indicate that new technologies can act as a catalyst to change classroom practices of teachers and learners to benefit Indigenous students. There is a range of websites, ejournals and e-networks that provide examples of innovative practices utilising ICT that can become valuable resources for teachers in specific subject areas. In particular, these networks and websites provide resources that are not available to many schools and students that are disadvantaged, and can be used by teachers and students to enrich their curriculum and pedagogy. These are located in Appendix 2.

Isolation

ICT has produced considerable benefits for isolated students. A focus of how ICT can reduce the impact of isolation on student learning is through the development of community based programs in which the school is central and through the formation of virtual learning communities.

Vignette 37 Primary

Caldwell Primary School (Northern Territory)

Context: At Caldwell Primary School, 25 students and their two teachers have created a community of practice that might be identified as fitting comfortably into Rogoff's (1990) notion of guided participation.

Important elements: The methodology comprises a mixture of structured teaching tasks and group and individual work that facilitates the transfer of peer knowledge and skills. Basic skills and literacy levels are terms that are heard regularly in the office building. The difference between this school and many others with a similar focus however, is that here there has been a deliberate attempt to shift the students' and indeed the whole community's perception of how technology might feature in achieving success in such programs, though not in a technologically determinist manner (Medway 1993). While actual school tasks do not appear to translate into real life activity (McCormick 1995), there is genuine enthusiasm for learning activities in this school, and a strong sense of what schooling means for the students' futures. Initial resistance to the introduction of computer technology to Caldwell Primary School was from parents who felt that their children would know more than they did about the

technology. While this fear has been allayed to some degree, a number of parents still remain wary about the educational benefits of their children's access to computers. Teachers believe that informational technology will increase reading skills because students are motivated to use the technology, which then requires reading skills to operate it. While continuing to instil traditional literacy skills in students, Caldwell's teachers employ the new technology to achieve this and think this kind of blending of the new and the old is quite successful. They note that process writing has gone ahead in leaps and bounds since word processing was made available and there has been a dramatic increase in student writing output.

Comments: The Caldwell case highlights the problems of many Australian schools that are geographically isolated. Teachers must overcome the difficulties of collegial isolation and distance-provided professional development support. On the technical side, the installation and maintenance of equipment, especially the telecommunication line needed, is a constant problem—expertise in the technical aspects of the latest ICT is often difficult to access in these regions.

Lankshear *et al.* (1999) *Digital Rhetorics* Vol 1 pp. 59-60.

The examples that follow show how teachers find ways to select ICTs to work against the educational disadvantage that arises from isolation or living in a rural community without the population density or wealth that allows for diversity in services through Wide Area Networks (WANs) and Local Area Networks (LANs).

Vignette 38: Upper secondary: 11

Rural Networks for Year 11 Pilot I (Victoria)

Context: Dianne Gallagher, a teacher in Barham High School, NSW, evaluated the development of virtual classrooms in English and Information Technology in Year 11 across three Victorian schools separated by 150 kilometres.

Important elements: The program was conceived as a means of providing opportunities for students in isolated areas, in schools with small numbers, where without this opportunity courses such as Extension English and ICT might not be offered. Dianne argued that over time, teachers became familiar with pedagogical demands in terms of content and assessment. She saw the need for rethinking assessment and how content was presented. She referred to three constraints: time and energy for teacher learning; how to use new technologies; the need for high level of access to technology, particularly for students at home; and the need for technical support. Other concerns included the avoidance of materials that may infringe copyright, and the respective roles of participant teachers.

Comments: The chat room made a considerable difference to the discussion, and she learnt new forms of communication online that did not follow grammatical rules. The issue is whether other than creating a general sense of excitement and student interest this enhances student learning. It certainly increases student choice and participation (Gallagher 2001).

Another strategy is to develop wide area networks between clusters of schools that can then enable more flexible and cheaper use of teacher and other resources. ICT provides, despite distance, a sense of proximity that enables new forms of learning communities to develop between similar schools and classrooms.

Vignette 39: K-12

BushNet Schools—uneven potential

Context: This site study is unusual in being less geographically bounded than others. As a wide area network it links up more than twenty schools scattered across 6000 square kilometres of Far North Queensland rainforest and dry bushlands. The BushNet schools range in size from small single-teacher schools to a rural school with 600 students. The network not only links up schools to one another; it also provides a website for the school and access to the Internet.

Important Elements: BushNet enhances communication and connects the policies and practices relating to education in individual schools. There are marked differences between one school and another (single teacher to Mareeba State with 600) and between one classroom and another within the same school in terms of the socio economic make up and also the extent to which teachers have taken up the opportunities. Most schools have a single modem and dial in Internet access.

Three schools, two primary and one secondary, some of whose teachers have most actively taken up the opportunities provided by BushNet. Each has given a rather different spin to the opportunities offered by the online technology in doing exemplary work with students.

Lankshear *et al.* (1997) *Digital Rhetorics* Volume 2.

A typical example of a Bushnet school is provided here in abbreviated form

Vignette 40 Senior Primary

Mareeba State School (Northern Territory)

Context: Mareeba has 600 students. In this multi-age classroom (Years 4-6) the teacher shares in team teaching with the Extension and Enrichment teacher and the Special Education teacher. The classroom is linked to an adjoining room with a computer with a CDROM and Internet link. The main room has a laptop borrowed from LOTE that is used for maths games. An Aboriginal boy with cerebral palsy has a specially adapted computer with printer.

Before school, many of the students socialise. In the adjoining room two Year 5 students have logged on to the web and accessed the site for the Solar Car Race, at the time it is in progress from Darwin to Adelaide. They are checking the progress of the cars with keen interest, because they have entered a contest and hope to win the $300 prize to put toward the class computer fund. The website tells them the first cars have got through a checkpoint. But there is no map site, so they later look for an atlas and find the station.

The following day, the race is over. Before school, two girls are searching the web site for the winners' times, to check how close their calculations were. However the unofficial results have not been updated since yesterday, and the official results link ends in a blank page. The teacher suggests that one of the girls, Breanna, could email the website manager, which she does.

The teacher is reading aloud from *Sophie's World*, by Jostein Gaarder. This is a

challenging novel for adults, combining as it does a mystery story with an extraordinary tour through the history of Western philosophy. The teacher is feeding it to the class in digestible mouthfuls and setting the students to write their thoughts in response to selected statements.

One of the students won the Solar Car Competition, and after consultation agreed to donate the computer software and equipment to the school.

The next day, the Year 6 students were revising their html tags for the home page each is preparing. Students copy codes and consider the size of images. The students are enthusiastic. Three students with literacy difficulties are working with another teacher to write up with pen on paper their self descriptions for their web pages. The chalk and talk, teacher centred focus is because the primary school does not have a lab of inter networked computers. They will go to the secondary school the following evening with their parents to type the copy. This is making use of parents as teacher aides, but also encouraging parents to become more ICT literate.

The class works in a multidimensional way, in groups, whole class activities and year levels. Students share their email diaries with their Canadian Travel Buddies or compose a new paper report. A girl will assist a boy how to use the Outnumbered, a maths game on the laptop. In science they use the library and the Internet to select experiments. The computer belongs to the Aboriginal community, and therefore students are not dependent on it. Members of the local community come in and access the computer to put up art work on the community web page. This has mutual benefits.

Comments: While there is some irony that chalk and talk has to be used to construct webpages, the use of the computer in this classroom was constructive. The cerebal palsy student, Stephen, had shown significant improvement and pleasure in using his computer. He could not write, but could do everything on the computer. Within days of getting the computer his writing had moved from level 1 to 3 and he is doing tests. He is now able to draw, his real passion.

Jessica, a year 6 student, could not spell or read. Her mother worked in Cairns and had access to email. So a daily message was sent in which the mother received and corrected her messages. Jessica now reads novels without remediation. Heather had no confidence in writing because of her fear of misspelling works. She joined into conversations on Bush MOO. When she saw the poor spelling of other students, she became less fearful and now writes well.

The BushNet study shows the potential of the new technologies to enhance, extend, and redefine students' literacy when they are used in sound ways by innovative teachers. The special education teacher, Sarah, was particularly cognisant of the value of ICT for publishing her students work—her home page was linked to special needs resources (collection of art and craft activities, cooking ideas, Intellikeys overlays, software reviews, thematic ideas and select links). Her primary computer project pages had a selection of best teaching practices, strategies and projects.

See Sarah's webpage: http://www.bushnet.qld.edu.au/%7Esarah/spec_ed/

Lankshear *et al.*, 1999, *Digital Rhetorics*, Vol 1:52–5.

These examples indicate how students learn about literacy through communication and social (interpersonal) practices that are facilitated in less threatening ways by ICT. Other projects in the Bushnet are E-tracks. This focuses on global collaborative learning. The notion is to indicate that this type of global communication is normal. Students in the Bushnet are linking to other schools in Canada and Norway, in similar small towns. They do interviews, set up email discussions and share projects eg local endangered species, in which they also include an expert.

The E tracks project is used to develop in students an awareness of content but also processes and effects of electronic communication. They are taught about the differences between private and public communication, between formality and informality (and when to worry about spelling and grammar). The emphasis is on communication and content not correctness of style. By contrast, web pages have to be correct because they are more permanent and a form of formal presentation. There are numerous cultural and critical aspects of ICT literacy that are being developed in this Bushnet. Planning and conducting interviews online, writing editing and publishing text, learning html tags to publish on web, using the browser to find sources, making links and capturing images. These are meta skills of literacy that are not visible in the final product but that are critical to developing cultural dimensions of ICT literacy practices.

A second aspect of Bushnet is the capacity to support literacy remediation. Many students in need of assistance have benefited from word processing capacities to write, edit, review and then publish on the web. In so doing, students can also learn about writing for particular audiences. At the same time their self esteem is enhanced.

ICT has produced opportunities that are not bound by space and time and that have considerable benefits for isolated students. As online curriculum, resources and pedagogies are becoming just another mode of learning for mainstream school students, such advances provide new possibilities for isolated students. Any advances in instructional design for students and improved communications have significant benefits for teachers, families and communities. The Leederville Interactive Television Centre in Western Australia is such an example.

Vignette 41 K-12

Leederville Interactive Television Centre (Western Australia)

Leederville Interactive Television Centre (LITC) presents and/or produces programs for SIDE, the Education Department as a whole, other government agencies and community groups. Some programs are interactive, enabling viewers to phone in questions on a freecall number. In 2000 the LITC delivered, via the Optus B3 satellite, nearly 300 hours of television for learning and teaching, professional development and corporate communication. Education Department of WA and other government departments are increasingly using the LITC as a cost-effective means of information dissemination and training. Over 200 students from Years 8 to 10 receive weekly teleconference lessons. Of these students, 80 are based in 30 schools across the state and the remainder is home based. Lessons using video conferencing, which involves two way sound and vision through an ISDN link, are being delivered to Kununurra DHS, Toodyay DHS, Merredin SHS and Manjimup SHS.

SIDE is supporting a video conferencing trial, which provides for the delivery of certain subjects from Geraldton Secondary College to small

groups of students at Eastern Goldfields SHS and Carnarvon SHS. These students would not normally be able to study these subjects because specialist teachers are unavailable or low numbers prohibit the formation of a class. The subjects being delivered from Carnarvon SHS are Year 11 Mathematics and Year 12 Applicable Mathematics while those being delivered to Eastern Goldfields SHS are Year 11 and 12 Aeronautics and Senior Science (Land Care).

There are also a number of initiatives that are currently being utilised to teach international students that have some potential for isolated students. These include the development of online learning materials that focus on pedagogical underpinning and utilise a range of computer conferencing and telecommunication possibilities.

Vignette 42: K-12

Open Access College (South Australia)

The college, established in 1994, is government funded to offer schools and units of distance education schooling from junior primary to Year 12 and a range of educational services online. The college provides teachers and students with databases and shared resource systems. The focus is on learning strategies that best use teacher time, using both synchronous and non-synchronous learning. The program provides a framework for developing curriculum with particular constructivist pedagogies in mind for an online learning environments (http://www.oac.sa.edu.au)

These online learning environments provide opportunities for students to engage with each other without teacher involvement, to produce materials, texts and multimedia presentations that can be delivered online, that then become resources that can be archived online in data bases for future student use.

Vignette 43: K-12

Facing the challenge in a remote rural region

Context: This study investigates three geographically remote schools—two primary classes (Tipping and Manjerra Schools) and one Year 9/10 setting (Danton High School) within a single administrative region. The schools form a loose cluster in that they are served by the same Learning Technology Education Adviser (EA) who was working with students and teachers using *Hypercard*, CD ROMs, email, video, digital cameras, and word processing / publishing software.

Important elements: The account focuses particularly on how participants faced the challenges of limited local knowledge and equipment, unreliable Internet access, and restricted access to the EA — who served a very large area, and upon whose great energies and commitment each site relied heavily.

At Tipping, the Year 5/6/7 class produced a *Hypercard* presentation of biographies of Olympic athletes. The Year 5/6/7 Manjerra class undertook a Hypercard project structured as an information report on an environmental issue. At Danton, a group of Year Nine and Ten students worked with the Business Studies teacher and the EA to produce a *Hypercard* prop for the Principal's end of year speech. Georgia (the EA in this study) also provided technical advice about

software and hardware owned by schools, conducted lessons for students and teachers on how to use particular software and hardware, arranged swaps and exchanges of equipment and advice between schools, and conducted in-service sessions for teachers at the support centre. All three teachers, and other teachers at the schools visited, relied heavily on Georgia for professional development and technological advice. The fragility of this relationship was underscored, at the time of this study, by the news that Georgia had been transferred out of the region, back to a classroom teaching position for the next school year.

This study documents a pedagogical approach that is common to multi-age classes, especially in small schools where there may be only 15 to 20 students in a Year 5/6/7 class. Learning is largely self-directed, with activities designed by the teacher for individuals or small groups of students. These groups are not necessarily based on year levels. More often they are determined according to individual students' needs and abilities. Peer tutoring is encouraged within these groups, in accordance with the knowledge and prior experiences of group members. The teacher works as facilitator. There are few whole class lessons. In primary classes, a unit of work is developed, which centres on a common theme and activities and lessons appropriate to each are then designed around such a theme.

Comments: This approach requires handling of the different learning objectives (content, skills, processes) from the different syllabus requirements for each year level within the class. The Manjerra students took the use of new technologies for granted. Many have had computers in their classrooms since preschool. Whether computers were used for skill and drill games, publishing stories, or for downloading information from the web seemed to matter little to the students. They saw them as quick, efficient, and accessible tools. The students saw the purpose of the new wave of technology—especially CD-ROMs and Internet access—simply being to provide information that was more accurate and up to date than that found in library books and equivalent resources.

Mary, the teacher, and the students saw a hierarchy of values among sources of information. Mary directed students to books in the library as the first source of reference. But the information was often out of date and irrelevant. In such cases, the commercial CD-ROMs (eg *Encarta* and *Australian Endangered Species*) are the references to be explored. Further, specific or up to date information could then be found by way of the Internet, either via websites or through email. The learners make their choice, opting for the computer where they believed it offers the most up to date information.

This site study documents positive aspects of practices that produced impressive levels of enthusiasm and dedication. These included: the use of word processing at all levels of text production rather than reducing computers to a mere publishing tool; explicit use of key features of the English syllabus within projects; and the attempt to use presentation software in ways that resembled mainstream uses. Questions were raised about complementarity with respect to developing and adopting critical perspectives toward information gathering and the use of information technologies. There was the tendency for participation to appear fragmented at times, as a consequence of teachers and learners having to work to tight schedules associated with limited availability of the EA and specialised equipment.

Lankshear *et al.* (1999) *Digital Rhetorics*

The vignette above displays the characteristics of learning online that can supplement and enhance what is done in classrooms. The advances being made in online curriculum and pedagogies mean that all students will access to these multiple approaches to learning.

On line learning

All students, not necessarily those who are disadvantaged, but particularly girls Indigenous students and those from rural areas, need to regard technology and self-directed learning as a life skill that is valuable to acquire.

One strategy is to use telementoring with people working the field to expand their sense of the possibilities of work. Another is through utilising networks and websites to have students working on authentic tasks with scientists, geographers, environmentalists and communications experts to indicate their capacities to work in such fields.

Students also need to believe in ICT as a regular means of solving problems. Students need to have a healthy regard for the procedural and cognitive tasks for which ICT can be used for (Anderson-Inman 1999).

Cross cultural understandings can be developed through local, national and global networks. For example, interactive student contact across school sites has proven to be beneficial with Indigenous students being engaged in technology-enhanced collaborative ways of learning.

The Internet is a powerful learning tool to enhance access, to collect data, analyse and organise information, communicate ideas, plan and organise activities, work with others, solve problems and gain cultural understanding. It can be used to develop virtual communities of practice within the classroom, the community, nationally and globally.

Teachers can utilise online learning to provide opportunities for students in the following ways:

- School–work links can give relevance and authenticity to learning activities;
- Individual learning plans can help students to develop portfolios; and
- Students can work from home when family requires their assistance or when they are ill.

There are numerous websites that offer units of work that are inclusive as examples to modify: http://www.tsof.edu.au/LT.SA/

Strategies for online learning can be downloaded from the NSW Online Learning Project 2001 http://www.gdu.uts.edu.au/pdf%20documents/NSW2ndPrincOnline.pdf

Strategies for web based learning an be downloaded from University of Queensland site at http://webclass.cqu.edu.au/Resources/Pedagogy/index.html

There are some national and international examples of cooperation between schools, education systems and school communities to increase access to learning for students through virtual learning networks. At a system level, an excellent example is the *European Schoolnet*, a comprehensive website that provides access to best practice between Ministries of Education in 20 nation states in the European Union at http://www.eun.org/eun.org2/eun/en/index_eun.html. On this site there are examples of resources for curriculum pedagogy http://www.eun.org/eun.org2/eun/en/Resources_eschoolnet/entry_page.cfm?id_area=77

3.7 Home–school links

Parental involvement

Homes are the third node of the home-school-community web of social relationships that can promote successful learning for many students who are disadvantaged. Computers offer new forms of interaction between home and school that can improve communication between parents and students. On the one hand, the introduction of a home computer leads many other members of the family to make use of it for learning (eg online courses) as well as for leisure. On the other hand, the implementation of ICT is more effective when parents and community members are involved in school decisions and in student learning. Familiarity with computers in the home where most computer skills are learnt develops predispositions in children towards their later educational use in school. How parents use computers at home informs how children use computers.

Much of this is dependent upon access to a home computer. There have been a number of schemes that have sought to supply computers to low income families eg home computer schemes, sponsored laptop schemes, e-Learning foundations or low cost leasing schemes through schools.

Vignette 44: Primary

Student Take-Home Computer Program (Toronto)

Context: Fewer than 1% of students at Nathaniel Elementary School have access to computers at home. Nathaniel staff were determined to give all students the same opportunities as those with home computers had.

Key elements: Seventy-eight Mac Classics were purchased for a special parent/student take-home program with funds from a district sponsored restructuring grant. Families had the computers for a four week loan. Participation in the program was self-selected. Parents were required to attend a six hour training session covering computer basics prior to taking the computer home. The school's technology coordinator reported that the program was highly successful, especially for students who used the on loan computers for a wide range of personal and school created activities.

Means, Olsen 1995:75
http://www.ed.gov/pubs/EdReformStudies/EdTech/csile.html.

Central to such schemes is for parents to improve their ICT literacy as well as students. Results of laptop schemes being leased to families have produced positive results in terms of student attitudes to ICT, to school and diligence.

Vignette 45

District Six Laptop Project (New York)

Context: This was a program in New York City District Six Schools that had over 95% Hispanic, most on free lunch, and a wide socio economic range. Three programs were developed implementing the use of laptops—one in a selective

school, another in a non selective school, and the third on a 'student as expert' model of dissemination undertaken through a summer school.

Important elements: Comparisons were made with non laptop cohorts on student achievement scores in literacy and numeracy, and student, teacher and parent evaluations of impact. Laptops improved the learning outcomes of high achieving student group compared to the cohort, while they seemed to maintain the achievement of the non selective school students (in contrast to a decline in scores of the no laptop cohort).

Comments: As in other studies, this program indicated that in all three cases, students, parents and teachers perceived increased diligence in doing homework and less leisure time watching TV or on the phone, improved organisational skills and presentation, and more positive attitudes to homework and school. Teachers in particular felt laptops encouraged them to undertake more cross curriculum and enquiry approaches that were already underway, and made them into facilitators not providers of knowledge.

Metis Associates (2000) Program Evaluation: The New York City Board of Education Community School District Six Laptop Project AERA presentation, Montreal.

As the significance of the advantage of learning ICT at home becomes evident, there are a range of strategies that can be developed to make ICT available. In order to encourage development of habits of digital literacy there is the need to establish early patterns and habits of digital literacy early. This may mean opening up schools to more community use of ICT so that parents become involved in the school and value use of ICT prior to student enrolment. Schools can:

- Extend the use of computers in school to after hours.
- Encourage local industry to supply home computers to families, or to offer low cost leasing arrangements for families unable to afford computers.
- Provide opportunities for parents and community members to participate in workshop activities on the learning technologies.
- Lend well designed games and Internet activities for home use.
- Encourage community, family and student use of local school technology resources by extending school hours and making ICT to be more 'family friendly'.
- Enhance relationships between home and community through parent and community ICT training programs.
- Provide online information and data bases, curriculum etc. to students and families; as well as guidelines for purchasing and borrowing software for home computers and information about protection of students online (eg NETALERT).

Specialist schools in the UK are developing webpages and online curriculum and data bases that parents and students have 7-24 hour access, although this requires a specialist webpage developer. Other alternatives to encourage student use for those without home computers are through structured programs, such as computer clubs.

Vignette 46

The Fifth Dimension (Queensland)

In informal collaborative context of an after school computer club, students would meet once a week. Students who used educational software in this environment focusing on problem solving learned content knowledge about computer literacy, became skilled in focusing on salient aspects of instructions, developed planning strategies for learning new games and also made gains in basic academic skills. The students in the program also improved their performance on basic reading and maths achievement in standardised tests. This is consistent with the idea that participation in an educational computing environment results in transfer, that is, learning that goes beyond the simple retention of specific computer facts and procedures.

Yelland, N. (2001) *Teaching and Learning with Information and Communication Technologies for Numeracy in the Early Childhood and Primary Years of Schooling'* DETYA, Canberra http://www.detya.gov.au/iae/fellowship/docs/Teaching%20and%20Learning%20with%20ICT.rtf

Other approaches focus on utilising community skills to build up school capacity. This can be achieved by valuing what is in the home and parent's skills. This may mean valuing home literacies in school, or for teachers to consider how to use older technologies, such as television, audio cassette tapes and popular texts more available to students. These can be used to lead to developing skills of multimedia.

The DETE, NSW (1997) *Computer Based Technologies in Primary KLAs* suggests that resources funded by the school or parent groups can be made available to the wider community (eg evening classes, Internet kiosks, adult training seminars). Furthermore, parental expertise in community can be utilised to act as mentors, visiting experts, in policy making and trainers in parent workshops.

Teachers call on the expertise of parents and develop workshops to enable parent helpers in class to utilise technology better eg early reading. In this environment parents can:

- assist small groups of students with software packages;
- work as troubleshooters to solve technical and reading problems;
- function as tutors;
- present talks and demonstrations using software; and
- assist students with research tasks and information skills.

While the assumption here is that the parents have ICT skills, these programs are also ways in which parents who do not have ICT skills can, through working with primary students in particular, become technologically proficient. In turn, this can translate into changing their patterns of computer use at home in ways that can support their children's learning. In particular, schools can offer computer literacy programs for parents.

Community resources can be tapped into through strategies that:

- Establish mentor schemes for teenagers with ICT experts in workforce.

- Encourage ICT experts as volunteers to train students. A technology skills register can be created in the school for parents and local community members to sign up.
- Make strategic links with other educational and ICT providers to share infrastructure and expertise.
- Identify and mobilise low cost possibilities to purchase within a network (eg the ACTU scheme that provides lower rates for Internet access and computers to members).

Home electronic

E-links between home and school have a powerful impact on learning environments. In particular, they facilitate students working from home through illness or disability administrative support, locally and at district level and a capacity to link into classroom activities and communicate with teachers and classmates.

Some schools that have embarked upon using ICT have offered training days and evenings to parents of students with disabilities to become skilled with the technologies. Importantly, it also raises their awareness as to what the school is attempting to achieve. They are able to participate and learn about the technology. They become more involved in the choice and purchasing of resources. Devices previously used for students with disability that are now mainstreamed include

- Membrane keyboards such as IntelliKeys and Concept Keyboards provide literacy and numeracy learning outcomes as well as providing access opportunities for students with disabilities.
- Touch Membrane windows that are affixed to the monitor or retro-fitted to existing screens are popular in junior primary classrooms. Children learn alongside their peers using the same technology.
- For preschool and early primary learners, literacy and numeracy software is motivating, available in a frameworks curriculum format, and is fairly inexpensive (Blackwood 1999).

Community renewal

Schools are also increasingly becoming more open to local communities and to being linked to other agencies. Learning networks are becoming major strategies of educational and community reform eg Victorian School Networks 2002 that will consider ICT infrastructure and technical personnel as one support facility between clusters of schools. This trend can be facilitated by ICT both to create virtual communities and facilitate actual communications between local communities.

Education Network Australia (EdNa) has funded a Schools Pilot Project Facilitating Community Access to IT through Schools (CAITS) in rural areas and those with socio-economic disadvantage. This is achieved by:

- extending hours of access to develop familiarity;
- encouraging use of Internet to support lifelong learning; and
- strengthening the role of schools as learning centres.

The main benefits of such project activity can be summarised as facilitating community members' ability to use computers and the Internet. This provides opportunities for the community to develop new skills; to access and use information that is relevant to their lives; and to enhance relationships between the school and the local community.

Vignette 47: K-12

Schools as Community ICT Centres

The project models operated according to community needs. They varied across location, disadvantage, degree of collaboration between school systems, familiarisation and strategies regarding access and training, community involvement. The most common strategy was to invite community members for training in ICT eg word processing.

Three models of access existed:

- *Open access*—from a room separate from school grounds that networked computers. Community could use at specified times when technical assistance was available.
- *Virtual access*—supply of equipment and Internet connection enabling participants to access and use IT and online services from home
- *Limited access*—provision for members to use IT services on an ad hoc basis when staff available with training after school hours. No specialist assistance provided.

Comment: Benefits noted in individual projects included fostering the information literacy of the community, enhancing community cohesion, and promoting new learning opportunities. Participation rates in programs varied according to a range of factors, most notably the amount of funding received. All completed projects have reached significant audiences. Through their activities schools are also fostering relationships with local communities. These activities appear to be enhancing the role of schools as community centres and through the educational focus of the projects, as learning centres. They did improve school-community links.

CIRCIT at http://www.circit.rmit.edu.au/projects/index.html

The community network model is particularly important to students who have left school and have few places to go if they are not in employment. Such networks can develop technology plans and guidelines at network and school level that specifically address the educational needs of students in all equity groups, including monitoring of distribution of ICT resources across and between schools sites in deprived geographical areas, the provision of computer hardware and software to equalise resources, and the establishment of school networks for teacher professional development and shared curriculum.

Schools and networks need to identify access issues for those school age students outside school, including those with disabilities or early school leavers with no access or 'thin' access. They can then develop coordinated community policies that support the out of school learning of these students and develop programs that extend after-school access, creating links to local networks or local community organisations eg neighbourhood houses, TAFE colleges, local libraries or Internet cafes. Such networks can facilitate access to key data bases (eg libraries, museums, local networks and community based organisations) so that they can become resources for less well resourced schools. They can provide access for out of school or homeless young people to Internet and computers as well as training focused on specific issues of interest.

Resources funded by the school or parent groups can be made available to the wider community. Schools can become central to learning in communities through evening

classes, Internet kiosks, and adult training seminars or shared use of library facilities and computing facilities.

Vignette 48: Secondary school

Parafield Gardens High School (South Australia)

In the Parafield Gardens High School in South Australia, two teachers / community workers sought to assist students in the local community who were not usually successful in traditional schools. They used the principles of community based learning to assist low achieving and reluctant middle school and post compulsory students. The aim was to increase student retention, attract students back to school and develop opportunities for student to exercise just-in-time and need-to-know learning. They sought to reconnect their students with their local communities through links with local businesses, community services and resources ie tailor made curricula. In turn, there were more flexible ways in which these students' qualifications were certified. The students developed the notion of a digital portfolio and enjoyed working with ICT even if not happy working back in schools. They continued in their education and training, and learnt new skills that were work related (Nixon 2001).

http://www.tsof.edu.au/LT.SA/ltproject/discovery schools/index.htm

Community partnerships can also be nurtured through the multimedia and communication facilities provided by ICT in schools. This can feedback into the school new expertise, develop and improve student community relations and also lead to significant cultural agency on the part of students who do not relate well to schools. ICT provides the flexibility such students can work outside the cultures of schools in ways that indicate how they are valued.

Vignette 49: Post compulsory

Strong Voice for Youth—online newspaper

Context: This project by Howard and Scotton (Nixon 2001:12) was an online newspaper similar to the HighWired online newspaper in the US

Important elements: For many disengaged post compulsory age students, this online newspaper had productive possibilities. Students' texts and essays were published and a journalist was paid to do weekly workshops with the student. In turn this led to sponsorship by local businesses. This is one way in which teachers can work across institutional structures to build new partnerships with communities on and off line.

Comment: It is significant for students living in poor and relatively isolated suburban and rural communities to see the local stories they wrote headlined in a global newspaper such as HighWired (Nixon 2001:13–14). In turn the newspaper is a means by which youth take on social responsibilities and publicity of local achievements, for example interviews with refugees, with local aged care, aboriginal footballers etc. This expanded their social skills as well as their confidence and writing ability. Many students gained a sense of confidence from becoming active cultural producers and skilled in ICT.

HighWired at: http://www.highwired.com

An important aspect of this type of community based project was that students were encouraged to be innovative by working towards becoming economic members of the community through using ICT to make cultural and commercial products. ICT has the capacity for students to learn about entrepreneurship modelled on real business practices, as in the vignette below.

Vignette 50: Middle school

A Student-Run Manufacturing Company (Toronto)

Students in Northbrook Middle School's industrial arts class form companies and produce products such as wine racks, cabinets, or folding wooden stools for sale. Students elect company officials and divide into work teams to enact the various operations of a company. Many of the team activities are supported by technology. For example, the Finance team uses computer spreadsheets to find the lowest-cost materials and to create financial statements for the company. The research team uses drafting software in drawing up their design plans. The marketing team uses the word processor in creating advertisements and product descriptions. A video camera is used in creating commercials for the product; the commercials are then aired over the school's broadcast system. Most products require use of a computer-controlled lathe or mill. Final production is conducted assembly-line fashion, with the parts laid out in specific locations and some students acting out the parts of robotic arms to place the parts on the line.

Products are sold within the school community. Students buy and sell stock in the company and after the product is sold, stockholders get their share of the profits.

http://www.ed.gov/pubs/EdReformStudies/EdTech/manufacturing.html

Communities and networks can seek sponsorship and projects from government and business to develop a high profile focus on geographical areas that are seen as underprivileged (rural/isolated and outer suburban areas) through dedicated programs in which schools become the centres of community renewal through ICT.

Community capacity building can involve parents, local business or big business, other community agencies and universities. Liaisons with stakeholders can develop solutions for disadvantaged students. Many schools look to community sponsors to develop a specific high profile program that can assist disadvantaged schools or students. For example, Northland Secondary College in Victoria, a school with high number of Indigenous students and a mix of post compulsory students in a Year 13 Arts and Design in a low socio-economic Northern Melbourne suburb, gained commercial sponsorship for a Music Program. Now the school has a computer laboratory for music linked to a number of performance studios in a wing of the school. Students make CDs and video clips, undertake local performances and art shows.

A number of sites linking school, community and pedagogy and discussing a range of community networks with schools are available on http://www/ilt.Columbia.edu/k12/livetext/readings/commped.html#comm

4 School systems

Most Australian and international school systems have developed clear policies, national and regional, on the integration of ICT into classrooms. A number of models exist that frame how school systems disseminate knowledge about how to integrate ICT into schools and classrooms.

One approach is to establish schools specialising in ICT and innovation that can then provide examples of good practice eg Navigator schools (Vic), Science and Technology schools in New South Wales and the Northern Territory. These schools are given additional funding for infrastructure, or allowed to look to industry for funding of specialist programs. In return, they are expected to lead in developing new models of learning and provide teacher professional development for systems and networks of schools. They are expected to innovate and develop models of best practice and then disseminate and share best practice at professional development centres.

The Navigator schools for example, were launched in Victoria in 1995 in order to:

- create a network of exemplar schools with accessible models of new learning environments where there is access to technology in every classroom;
- share with others what is learnt in creating these environments;
- provide evidence of additional teaching and learning outcomes in a technology rich environment; and
- provide premium professional development resources for teachers and principals across the state.

The assumption was that such programs would enhance student learning outcomes—achievement, engagement, motivation and understanding; to extend beyond classrooms and into communities, real and virtual, local and global. The project subsidised principals and project officers' overseas research in leading schools. Focusing on Apple Classrooms of Tomorrow, Co-NECT schools, River Oaks Public Schools and the Telematics and Global Classroom Project in Victoria (48 staff in total were supported by seven schools). The Navigator schools received significant initial central funding, professional development and technical support from the centre. Since then the Project has been funded out of global budgets at 4-7 per cent per annum (EkinSmyth 1998). The evaluation of the Navigator schools project attributes their success to:

- effective planning;
- the use of computer networks to provide infrastructure to enhance learning;
- the use of the Internet as a powerful learning tool to enhance access, collect, analyse and organise information, communicate ideas, plan and organise activities, work with others, solve problems and gain cultural understanding;
- school intranet capacity to coordinate communication and organise access ie resource bank, enabling sharing and encouraging collaboration;
- the expanded role of the library that can be accessed from classrooms and home;
- the ways in which ICT challenged teachers' philosophy of learning;
- the integration of ICT as a whole school process;
- the way ICT enhances collegial culture and stimulates reflective practice;

- how ICT changed classroom practice, and, combined with strategic use of learning technologies, how ICT enhances student outcomes in terms of achievement, engagement, motivation and understanding;
- electronic links between home and school impacting on learning environments; and
- students' flexibility to work from home.

Another model is to focus on dissemination based on shared experiences across all schools. The Le@rning Technologies under the $85.4m South Australian DECStech is based on a partnership between schools, preschools, Universities and research foundations and is aimed at increasing the uptake and purposeful use of technologies to improve learning outcomes. Its objectives are:

- research models of best practice;
- provide professional development for teachers;
- equip principals to be leaders;
- develop resource materials; and
- measure changes in students learning outcomes attributable to the use of learning technologies.

These are exemplified by the Technology School of the Future and the six Discovery Schools and three Global Discovery Schools in South Australia. This model reflects the norm in terms of infrastructure and staffing and therefore has greater transferability across more school situations to disadvantaged schools. The focus is on how teachers infuse ICT into learning. Funding was provided for a coordinator to manage the school program. Various research reports on the effectiveness of the School of the Future and the Discovery schools are provided as research reports and case studies that can be found on http://www.tsof.edu.au/LT.SA/research/casestudiesindex.html

In the UK, there is a self-select model of specialist schools similar to the science and technology schools in NSW and the Northern Territory.

Vignette 51

Specialist Schools (United Kingdom)

Specialist schools in England give pupils a broad secondary education with a strong curriculum emphasis on technology, languages, arts or sports to be extended by 2006 to include engineering, science, business and enterprise. In August 2001 there are 536 specialist schools and 313 technology colleges. They charge no fees and any secondary school may apply to be considered for specialist school status. There are also 15 City Technology Colleges in England and Wales set up by the Government with the help of business sponsors who finance a proportion of the initial capital costs and develop on-going links. These parallel programs are expanding, with the view that specialist schools will become the centre of community based learning. They are expected to be a resource for other schools and their local communities, equipping young people with the skills they need to progress into employment, further training or higher education, according to their abilities, aptitudes and ambitions. In particular, these schools are seen to be a key role in revitalising education in disadvantaged areas.

The alternative model in the UK has schools that are linked through partnerships to industry. These are more vocationally oriented and seek to attract youth back into

school. The City Technology Colleges based upon school- industry partnerships are an example.

Vignette 52: Secondary

A Sharing Enterprise: Thomas Telford School (United Kingdom)

One of Great Britain's top comprehensives, Thomas Telford School in Shropshire is now happy to share its successful practice and help others. It has sold its course in information technology to an ever widening audience on the Internet. The school will put the impressive sum of $1.68m (£1m) into the formation of a new City Academy on the West Midlands region of the United Kingdom. The online General National Vocation Qualification (GNVQ) in ICT which the school runs through its company, Thomas Telford School Online Ltd., will be used by 1 000 other secondary schools from September this year. At Ä4 884 (£3 000) a piece you don't have to be top of the maths class to work out that this is now a teaching institution with spending power!

As a City Technology College, Thomas Telford School was established with a clear remit in relation to achieving educational standards and sharing effective practice. The School has a very wide portfolio of projects with other schools. One of these projects, Project 40, has provided a good income and the Governors have decided that some of the profits can be used to support other schools.

Comments: There is no doubt that the overwhelming interest in their GNVQ project comes partly from the success that Thomas Telford School has had with Vocational Courses. Since it was set up as a CTC in 1991, Thomas Telford School has put in place a number of innovative teaching methods over its short history. It has implemented and extended the teaching day giving a study week of 35 hours. Its classes are equipped with electronic whiteboards and there is an online curriculum. In addition, the school has been developing the use of online learning for its own pupils for some time. These resources have helped play a large part in enabling the school to achieve a 100 % pass rate at GCSE level (age 16 years). The UK Office recently awarded Thomas Telford outstanding school status for Standards in Education (OFSTED). www.ttsonline.net/tts/

The underpinning strategy here is for innovative schools to develop, model and undertake research and evaluation of effective use of ICT. But this is contingent upon universal access for students, teachers and even parents.

Various strategies are being developed internationally and within Australia that seek to improve access to marginalised groups. Universal access to the Internet and computers is increasingly being seen by governments to be a precondition for more inclusive use of ICT that has individual and collective social and economic benefits in a knowledge based society (Funston and Morrison 2000). In the US, various reports indicated the urgency for national policies to develop initiatives that reduced the digital divide. The *Falling through the Net II (1999*) report underscored the importance of such programs as *E-Rate* (a program that will allow schools and libraries to establish Internet connections at discounted rates) and the Telecommunications and Information Infrastructure Assistance Program (NTIA) (Appendix 1).

When access is made possible, there is significant take up within low income households. For a given level of education, central-city households had the lowest telephone and computer penetration and rural households with computers had the

lowest modem penetration. Participation in online courses was highest among those with the lowest educational attainment. That is, when online courses are provided together with access, this enhances the learning environment for families. The most likely users of online classes were low-income users in all areas. Minority groups surpassed whites in percentage of classified advertisement searches, taking courses, and accessing government reports.

As summarised in Appendix 1, national responses have varied considerably depending upon political systems and intrastate differences. The UK is an example of a highly integrated centralist approach.

UK: A case of integrated national policy

In the UK, the Education Department's Information Superhighway Initiative (UK 1995) aims to provide universal access for all schools to computers and the Internet by 2002 as well as links to community resources and key national information data bases, eg libraries and museums. By 1997, 1000 schools and 30 colleges of further education were covered. The initiative involves a diverse range of projects, including provision of Internet capable multimedia portable computers for teachers (including some working towards the National Professional Development Qualification for the Headship), fully networked projects involving provision of content to schools, advanced networking technology to enhance particular aspects of curriculum and projects involving home school links.

Two key strategies arising out of the Superhighway Initiative are the National Grid for Learning (NGfL) and the Specialist Schools Program.

Vignette 53

National Grid for Learning (United Kingdom, 1996)

Context: The NGL aims to enhance 'standards, literacy, numeracy, subject knowledge' in association with strategies outlined in the White Paper Excellence in Schools. The aim of the Grid is to provide advice about use of the net, to be a curriculum resource for students and teachers, and to provide teachers with advice as to effective ways to utilise ICT.

Important elements: The Grid focused initially on teacher development and the schools sector and now seeks to extend to lifelong learning, home based learning, and training, further and higher education institutions, as well as to other strategies. It links to plans for ICT training funded through the National Lottery, and to university and industry strategies. It also looks to national and local museums, galleries and libraries to play an integral part.

The Grid is premised upon the access to free information on the net. Critical to the Grid will be the development of teachers' and librarians' skills and sharing of expertise on what works in the classroom will be facilitated by the Grid network. This is in a school system of 32,000 schools and 450,000 teachers and 9 million pupils. The aim is to be comprehensive, relevant, differentiated according to need. The readily accessible network takes into account the linguistic and cultural heritage of home countries, but has a national approach as a network of private and public providers. The first phase is to set the target for ICT in education that addresses national targets for literacy and numeracy.

The aim is to extend the National Grid for Learning (NGfL) to Colleges of Further Education and other community organisations and public institutions as a strategy to ensure lifelong learning and reduce disadvantage. The UK has negotiated with British Telecom and the cable industry for free connection in schools at low rates online. Also set up a Public Access Task Force for reducing costs to wideband. This is to reduce rural school disadvantage. Learners with special needs will also gain from the Grid, particularly those with visual impairments, as it can provide information access for students in integrated and special settings.

These integrated national strategies converge to provide for all ages a gateway to information and quality educational resources on the Internet. In 2001, 98 per cent of all secondary and 80 per cent of all primary schools and 92 per cent of special schools in the UK were connected to the Internet. Substantial funding programs of support are being made available to provide both for networking infrastructure, hardware, software and training to enable UK schools to connect to the Grid. Up to 2002 over £700 million has been made available through the Standards Fund and other means for training teachers in ICT to enhance their competence and confidence to use ICT effectively in their subject teaching. The National Lottery monies are providing £230 million up to 2002 from through the New Opportunities Fund.

National system ICT initiatives reflect the wider purpose of reducing the effects of disadvantage on schooling by improving access. The National Learning Grid, for example, was developed to:

- provide a national learning resource to help raise educational standards, and to meet the Government's literacy and numeracy targets and improve the quality of life and Britain's international competitiveness;
- provide high quality educational software and services to teachers, students and other learners through public/private partnerships;
- remove barriers to learning to ensure quality of access for all, including those in isolated rural areas, those with special educational needs or those in areas of urban deprivation; and
- provide information and learning resource for teachers to improve their ICT skills.

The British Educational Communications Technology Agency (BECTA) and the Scottish Council for Educational Technology (SCET) evaluate and promote the use of educational and information technology in all aspects of education and training. They support ICT in schools through a range of activities including a program of training courses, an information service, and the production of material for ICT in the curriculum (*Learning in the 21st century)*. The National Grid supports strategies for effective use of ICT in that it:

- enables students to work from home and get feedback;
- allows students to participate in projects that are too expensive for school to undertake eg science, videoconferencing with French students in language classes, designing technology in teams;
- helps students to access worldwide sources in history and geography, for example, that will enrich their studies; and
- enables parents to access general school information and to communicate with schools.

Strategies that emerge out of the nation wide responses to the consultation process on the National Grid, included suggestions about cheaper and wider access to the Grid particularly for teachers from home, but also for students and families, through cheaper

rates, as well as site licenses of software for schools. With regard to special needs and minority groups, the response was for equality of access and widespread usability. There was support for additional resources as a poorly funded grid could widen not reduce disparities. Organisations with particular responsibilities for disadvantaged students argued that social inclusion means:

- disadvantaged students need to be part of the requirements in the design stage, not as an add on;
- specific knowledge could be available to students and teachers relevant to their geographical location or experience;
- access issues be addressed for those with disabilities eg longer after-school access;
- cheaper software, and standard interactive learning systems; and
- software that can be adapted and used by teachers to increase interactivity.

This example of a national system initiative, among others such as in Canada, confirms the following national policy strategies for Australia:

- importance and effectiveness of a national framework;
- national frameworks mixed with the promotion of community oriented action at a local level ie linking up other initiatives such as Learning Towns (eg Ipswich in Queensland);
- national incentives for innovation in teaching and learning;
- innovative use of learning technologies to develop national strategies;
- effective dissemination of good practice on a national basis through clearing houses; and
- on-going monitoring of what works.

These are key factors in systemic dissemination of leading practice.

Conclusion

We have provided a range of examples of leading practice where teachers, schools and systems are working with rapidly changing circumstances and technologies and where what constitutes best practice one day has changed tomorrow. Much of what is presented here, as leading practice has not undergone any form of evaluation other than teachers' own sense that it works for their particular group of students. There are few longitudinal studies of classrooms in which ICT has been fully integrated over a period of time. This is the next phase of the research on ICT integration. There are even fewer longitudinal evaluations of instances where equity has been a primary focus in the use of learning technologies.

Furthermore, each example of leading practice provided arises out of a particular set of conditions—staffing, funding, equipment, students, leadership, school culture—that made the initiative(s) possible. While such conditions are not readily replicated, this should not deter other schools, teachers or systems adopting similar approaches. Rather, by recognising how context works to shape what is possible and workable, and by recognising the complexity of introducing innovation and of the change process, there is a better chance of adopting and adapting such ideas across numerous sites.

Section D Teacher Professional Development

ICT requires better trained teachers. Governments are investing heavily to equip schools with computers and the rate of technological change is rapid. Yet funding for teacher professional development does not appear to have kept pace. The literature review indicates that the capacity to integrate technologies into classrooms to meet the learning needs of specific groups is highly dependent upon high levels of teacher competency in using appropriate technologies. It is also evident that teacher professional development and increased expertise in ICT means teachers are more likely to use ICT and in turn this will impact on classroom practice and student learning (Despot 1992). Recent Australian reports on the integration of new technologies have similarly argued 'to put teachers first' even before the needs of the children (Lankshear & Bigum 1998:67).

Incorporating new technologies has also a considerable impact on the nature of teachers' work. Information and communication technologies, now in the hands of students at home as well as at school, challenge teacher professional judgement over what constitutes valued knowledge in schools and confront teachers over how to organise classrooms and curriculum. In both instances, teacher professional identity is under challenge. ICT impacts on teachers' professional development in a number of ways, by:

- offering new forms of pedagogy;
- providing new models of curriculum production,
- new models of classroom organisation; and
- providing a new mode of teacher professional development, particularly amenable for teachers without time or at a distance.

Teachers are therefore ambivalent about new learning technologies. On the one hand, they see them as just another of a spate of reforms that have been instigated over the past decade that have often not improved teaching and/or learning. On the other hand, learning technologies also offer new ways of 'doing things around here' that challenge their assumptions about teaching and learning, creating an exciting opportunity for professional renewal and also creating new opportunities for their students.

Yet the extent and effectiveness of the professional development supporting the implementation of computer applications in classrooms varies greatly across and within systems nationally and internationally. There was a clear trend for many teachers in all systems internationally to be self taught in ICT (Smerdon et al 2000:iii; Comber & Green 1999). US teachers in the *Teachers Tools for the 21st Century* report cited independent learning as the primary way they learnt to use ICT. That is, 93 per cent learnt from friends, family or were self taught, 88 per cent from professional development and 87 per cent from colleagues. As with students, social networks and learning at home were key features. Only 50 per cent indicated that initial teaching training prepared them, although this was greater for less experienced teachers (Smerdon et al 2000:iii). Importantly, those teachers with most professional development were more likely to use ICT more often in the classroom (Smerdon et al 2000:iv).

Much of the teacher professional development focuses on operational literacy. Yet teachers have more complex problems. 'Teachers face a double challenge in learning how to use information technology and in learning how to teach with information

technology' (Comber & Green 1999:78). For some teachers involved in the ITLED project, new stresses were brought into play when ICT was introduced into their classrooms. They reported feeling that:

- they knew very little about the relationship between literacy acquisition and ICT;
- they lacked knowledge about the most appropriate uses of IT in different school subjects;
- they needed increased access to ICT and professional development in how to use it; and
- they were uncertain about where they could turn to find answers to the questions they had (Comber & Green 1999: 77-102).

[Full report available at http://www.literacy.unisa.edu.au/ITLED]

Often there is no follow up or advanced training from one off courses. There was little attention in professional development on how to adapt or adopt ICT to meet the needs of specific groups or even how to improve learning (Kenway, Blackmore et al 1999).

Yet close classroom observations of teacher practice in Queensland discussed in the New Basics Evaluation indicated teachers were weakest in addressing individual difference in classrooms (Ed Queensland 2001). The most effective teachers had a wide range of pedagogical tools they could draw upon to deal with a range of student needs. They were those who promoted reflective dialogue, de-privatisation of practice and collaboration among teachers.

Similarly, the ITLED project in SA, an action research project premised upon university–school partnerships and reflective practice, produced considerable benefits for teachers. Involvement in the project developed the leadership potential of some teacher researchers for the first time, developing teacher leaders. Because of its focus on disadvantaged schools, there was a focus in teacher professional development on difference and disadvantage. The ITLED project recommendations also pointed to the importance of supporting classroom teachers in working through the consequences of introducing ICT through a range of school wide and class based teaching practices: curriculum planning; lesson preparation; research; professional networking; communication with colleagues and parents, and classroom teaching.

Bigum and Lankshear (1997) in *Digital Rhetorics* suggested that putting teachers first also means supporting teachers in their personal work before they make use of ICT in their teaching. Studies that have observed classrooms when ICT is introduced indicate teachers need more than an understanding of the operational dimension of digital literacies. They also need knowledge of the cultural dimensions (selecting what is appropriate for what students in what contexts), as well as judgment in the critical dimension (ethical and wider implications of the use of technologies).

Apart from the above reports, issues of disadvantage and difference have not been evident in the focus of professional development on ICT. Instead, the integration of ICT has coincided with a trend to school based professional development. Despite this apparent devolution, system wide priorities still tend to dominate how professional development funds are spent and schools lack the discretionary funds for professional development for school based priorities (Kenway et al 1999). While ICT has been a system focus of professional development in recent years, schools that are disadvantaged lack the funds to support teachers. Schools are often expected to pay from locally raised funds (of two dollars for every one provided in grants) in buying computers. School Councils in Victoria use locally raised funds to match if not exceed system professional development funds devolved to schools. This means that teachers in disadvantaged schools with greatest need for intensive professional development in using ICT and exploring how to work with a wide range of student needs are doubly

disadvantaged due to poor equipment and less availability of professional development.

1. International approaches to teacher education in ICT

In her review of teacher education (pre-service and continuing) for ICT programs in seven countries, Downes (2001) identified common issues:

- access and equity;
- infrastructure;
- quality of digital content and software;
- provision of systemic and in school support and the development; and
- use of student outcomes and teacher standards.

The differences between and within countries lay in terms of political, policy and resource frameworks, the strategies used and the degree of connectedness between pre-service and continuing professional development.

Downes depicted two dominant approaches to teacher pre-service and in-service in ICT: the 'care' approach in which teacher education programs sought to integrate ICT into existing practices; and the 'courage' approach which led to significant transformations within teacher education programs, in schools and with teachers' pedagogical practices and disciplinary approaches.

The UK, through its Initial Teacher Training National Curriculum and other initiatives, has dramatically increased the use of ICT in subject teaching. Teachers are required 'to improve their own professional efficiency' (Davis 1998:155). It is highly prescriptive with little reflective practice asked of student teachers and the emphasis was on technical skills, thus falling into the 'care' approach.

The Netherlands PIT Project aimed to stimulate the increased, effective integration of ICT in curriculum-area instruction in lower-secondary schools. The project has used the key strategy of teacher networking to bring teachers together to share and learn from each other. As a result of the project, teacher networking is supported as an important new strategy for teacher in-service and professional development. According to Collis and Moonen (1995:8):

> The PIT pattern differs from 'normal inservice' in four important ways: (I) allowing time for tryouts in the classroom between sessions; (2) increasing the opportunity to increase one's professional circle; (3) giving opportunities for responsive adaptation of the face-to-face sessions by the theme group leaders; and (4) providing the opportunity to arrange visits or subsequent face-to-face meetings in the participants' various schools.

In the US federally, *Goals 2000: Educate America Act* and the *Improving America's Schools Act* have made professional development a priority to address the common problem in the US of resourcing schools with computer hardware and software in order to satisfy system demands. Harrington-Lueker (1996:33) suggests that policy makers, technology specialists, and school officials are coming to recognise that 'there is little point in acquiring hardware but making no provision for teacher development and support'.

The US had a wide variety of programs that influenced nationally through strategic funding of programs. The US model of federal intervention through specific programs produced diverse models that were not easily replicable across different sites. This suggests a possible model for Australia and would allow strategic intervention in the areas of professional development.

The three types of grants included:

- capacity building grants that supported consortia integrating ICT into teacher education;
- implementation grants that supported consortia initiating organisational change to transform teacher preparation into 21st Century learning environments; and
- catalyst support grants that provided technical assistance and leadership to support transformation of teacher education with modern learning technologies.

The grants focused on what are seen to be key issues:

- Bridging the Digital Divide;
- Dissemination;
- Faculty Professional Development;
- Online Delivery of Distance Learning; and
- Creating Learning Communities.

In New Zealand there has been a commitment since 1990 'to a major upgrading of teacher professional development and support and advice for school communities and Boards of Trustees in the use of information technology across the curriculum' (Sallis 1990:4). The English Online project exemplifies this approach.

> English Online is part of an ongoing English professional development contract between UNITEC Institute of Technology and the New Zealand Ministry of Education. In 1998 and 1999 it involved 100 primary and secondary schools per year. Each school nominated a lead teacher who developed a unit of learning which was posted on the Internet site as a permanent resource for New Zealand (and international) English teachers. The units are the main part of the site, which also includes many links to other Internet resources and projects as well as a discussion list for English teachers. Some of the units have been developed by English Online staff, the rest by contract teachers. Currently there are over 120 units on the site. These units are written to support delivery of the New Zealand English Curriculum, integrating ICT wherever appropriate and possible. Many units have exemplars of students' work with ascribed curriculum levels and commentaries.

In all models, there was less focus on generic approaches to ICT. Any evaluations focused on outcomes and not on organisational or teacher change other than the USA grants. The literature suggests any evaluations of programs should specifically focus on all three aspects.

2. Australian approaches to teacher education in ICT

2.1 Teacher pre-service education

There is now the expectation that teacher education graduates will enter the teaching workforce as competent and creative users of learning technologies.

The MCEETYA *Joint Statement on Education and Training in the Information Economy* (March 2000) argued that Pre-service ICT programs should:

- ensure that the education and training sector is providing all learners with opportunities to develop their ability to use technology confidently and creatively, and to develop the specialist skills needed to service the needs of the information economy;
- support education and training workers, especially teachers, to acquire and maintain the skills needed to take full advantage of the potential of ICT to transform learning; and
- share leading practice and research on ICT issues.

Downes (2001b) suggests that there have been few new programs or research into existing programs that indicate how ICT is being integrated comprehensively into pre-service teacher education. Australian approaches to integration of ICT into teacher education range from:

- focusing on subject areas;
- generic skills;
- online teaching and learning; and
- use of CDROM resources.

Australian research on teacher education is focusing at this stage on attitudes, types of computer skills and the experience of pre service teachers. Survey data indicate that students enter pre service teaching training with a wide variation in skills, and with their increased exposure at school tending to reduce the 'whizz bang effect'. Most felt either anxious or confident, and this was largely dependent on skills level. Again, gender differences emerge, with males being more confident than females, seeming to confirm males as more 'technophilic' and females 'technophobic'. But Teague et al (1996) also indicate that males tend to have a misplaced assessment of their own ability while females depiction is more accurate of their ability. This gap is decreasing with time.

Teacher education students varied from having confidence in word processing through to feeling less confident in multimedia and web development. Again males' self evaluation indicated higher levels of competence in multimedia, web and graphics. Younger teacher education students were more competent than older, reflecting increased use in schools (from 34 per cent in 1999 to 47 per cent in 2001) and teacher education students who took special computer subjects rising from 11.72 per cent to 15.46 per cent. Male students tended to have home computers (less than two years old), dedicated to home use, and were also more likely to use computers at schools. Females were more likely to learn computers at school or in outside training. This confirms other Australian studies such as *Real Time (*Meredyth 1999*).*

Policy responses to professional development tend to focus on establishing professional standards, with ICT competency as a key element (eg *Schooling 2001*, 1997, Ed Queensland). There is little research on innovative pedagogies in teacher education, although recent system wide reforms in curriculum, school organisation and assessment have significant implications for teacher education. Many Australian education faculties are currently going through a stage of rethinking their programs, and ICT is considered to be a core feature. Some faculties (Gore 2000), are

undergoing a re-orientation of teacher education pre-service programs based on pedagogical principles (eg Newcastle) or with the introduction of specialist subjects eg Learning with Information Technology (Griffith University) that is 'founded on the 3 Ps—pedagogy, politics and practicality' (*Changing Patterns* 2001). Flinders University, in conjunction with Technology School of the Future (TSOF) is trialling an online course under the Quality Teacher Program. This program embeds ICT into classroom practice and incorporates information from teachers and units of work that address South Australian Curriculum.

Other initiatives are the 1999 APEC workshop and case studies of innovations http:/www.cmec.ca/international/forum/csep.Australian.en.pdf

Strudler and Wetzel (1999) suggest several factors that enable successful integration of technology into pre-service programs. These include the existence of faculty leadership, vision, training and support, access, pedagogical fit and acknowledgment of personal issues. Furthermore, ‘all programs had a required educational technology class for pre-service teachers that were usually designed for students to take early in the sequence of courses’ (Strudler and Wetzel 1999:74).

How ICT is being integrated into teacher education programs is therefore in many instances a ‘work in process’. *Changing Patterns* suggests that the production of a specialist subject that is compulsory and meets state education departmental requirements about graduate attributes is one way of approaching the issue of professional standards, but it is ‘pedagogically preferable to integrate ICT throughout the pre-service program’. The subject approach ensures all students attain the basic competencies but the integrative policy is more haphazard. Scrum (1999:84) argues that:

> Learning about technology is a non trivial and life changing event, and it is qualitatively different from learning other new skills, knowledge and activities. Anyone who has struggled to learn about new technology, or who has taught others to use it, is aware that brief exposure does not provide sufficient training or practice to incorporate technology into a classroom.

A new area of discussion is around the use of online pre-service education, improved communication during the practicum and the mentoring of students by student teachers using email (Le Cornu and White 2000, Johnson 2001). An example of this approach is the Glow Project at Thomastown Secondary College in Victoria.

Glow Project, Thomastown SC
DEET Middle years project

Student teachers set up an online conferencing program for student writers at Thomastown SC in year 8 to mentor them in their writing. Pre and post testing using DART materials found that students' literacy improved over the period. The student teachers would correspond with the students over a piece of work, acting as a mentor but also learning different aspects of computer mediated communication. The evaluation listed as effects: greater concentration and engagement, an interest because of the novelty, and the relationships between the form and the medium it was written in. The task helped school students become more fluent, more aware of genre conventions, and more interested in having something to say. The features of the GLOW project were university—school partnership and mentoring of students by student teachers. It engaged student teachers in having to understand more about the problems faced by students and taught students and trainee teachers about online communication. This linked both process and product. It is generalisable in that teachers and student teachers can also be similarly mentored, and university staff can mentor student teachers who are in isolated settings.

Johnson 2001

What is missing in the pre-service reforms is the capacity of students to gain the range of experiences required for them to develop the sophisticated teaching repertoires needed to address disadvantage in schools. There were few programs that specifically focussed on either disadvantaged schools or disadvantaged students.

What is required for teacher education is greater institutional support and infrastructure, a more overt focus on the integration of ICT into curriculum and pedagogies in teacher education programs, and the development of partnerships between systems, schools and universities grounded on the integration of ICT into teacher education (Downes 2001b).

2.2 Continuing teacher education

According to Downes (2001b) there were four purposes underpinning continuing professional development programs.

- Level 1 sought to add ICT skills by teaching ICT as a separate subject.
- Level 2 focused on integrating ICT into daily work of teachers—either into existing pedagogy and curriculum or to change approaches.
- Level 3 was transformative aiming to change the nature of the classroom—content and pedagogy.
- Level 4 was about transformation at the systemic level, leading to organisational and structural changes of the school.

All levels seem to occur in some programs, but the emphasis in most courses was largely on Levels 1 and 2. A number of approaches have emerged which use ICT to both enhance teacher professional development and also to model the use of ICT in student learning.

School based professional development

The school based professional development model in which 'expert insiders' work with colleagues in and across schools tends to focus on the acquisition of skills and classroom use through large groups, small tutorials, and workshops. As Kenway *et al* (1999) comment, while these in house models of professional development provide immediate 'hands-on' activities, mentoring and technical advice, they tend to become introspective, and rely too greatly upon innovative individual teachers who are in great demand.

Professional development schools

This model assumes that there can be dispersion of best practice through encouraging innovations within particular schools that can then be transferred, adopted and adapted by teachers who visit the schools for professional development experiences. The Victorian Navigator schools provide professional development for 1700 teachers. The South Australian Discovery Schools aim to disseminate best practice through three day courses that demonstrate and share with other schools their curriculum, pedagogy, school organisation and teaching methodologies.

For content of unit go to
[http://www.tsof.edu.au/LT.SA/ltproject/discoveryschools/index.htm]

LATIS Professional Development Stream supports the development of Lighthouse Schools and associated LATIS Learning Centres which offer a range of workshops, courses and three day practicums. The Navigator school teacher practicums are three to five day professional development programs which provide teachers with opportunities to experience, discuss and reflect upon practice of using learning technologies to enhance student learning. There are also one day leadership seminars on planning. These approaches rely upon other schools being in reasonable proximity, and can have limited transferability because of wide variations in computer infrastructure and skill. They are not ongoing and are expensive in terms of long term effects as there is little follow up.

For LATIS, go to http://www.latis.nt.edu.au

For discussion of Professional development schools go to
http://www.uakron.edu/education/outreach/barberton/
ProjectStructure.html

Learning networks

The *Learning Technologies Project* in South Australia in 1999–2001 had four primary and two secondary schools delivering professional development to teachers. This involved new Discovery Network teachers sharing units of work and involved in Discovery visits. This was a successful initiative by DETE and research confirmed considerable uptake of ICT by the teachers involved.

For numerous sites and case studies in the Learning Technologies Project go to
http://www.tsof.edu.au/LT.SA/ltproject/discovery schools/index.htm

Leadership

Leadership is seen to be critical to the integration of ICT—both principal and teacher leadership. The Schools of the Future has been running (as part of DECStech Program), a Leadership Professional Development Program called Principals' Development Program where principals are subsidised to attend courses. The program provides access to a range of courses that have been designed specifically for principals, deputies and assistant principals who are pivotal in the development and management of school change. The program encourages leaders to have personal proficiency in ICT use, and a commitment to creating a school culture that fosters exploration of new techniques in teaching, learning and management. The Principal Program consultants, through the principal associations, are involved in the course refinement and delivery aspects, keeping the program relevant and current. Since 1992, The Australian Principals' Association Professional Development Council (APAPDC) has explored the possibilities of using the new technologies to provide in-service for principals across Australia using a range of converging technologies including ITV, teleconferencing, fax and email (Kenway, Blackmore et al 1990).

For the APAPDC site go to http://www.apapdc.edu.au

In the Learning About Technology in Schools program (LATIS) in the Northern Territory, leadership is a key focus.

Leadership Program: Classroom Leaders
Technology Enhanced Curriculum (TEC) Classroom Project

The Technology Enhanced Curriculum (TEC) classroom project is designed to encourage and broaden the impact of teachers who are already improving learning outcomes through exemplary practices with ICT. Each school in the NT is able to nominate one teacher for 12 months or two teachers for six months each within the three-year period. There is a program of professional development for these teachers based on an action learning model in which they develop skills and understandings to suit their school contexts. An allocation of the equivalent of 0.2 teacher release time is available for each TEC teacher in government schools. They are able to access a total school environment of 40 days relief to support their own professional development and that of other teachers at their school or in their cluster. The teachers involved in this key network will be given access to a desktop computer for use during their term in the project. These computers will be included in the school allocation during the LATIS rollout. They will then share their models of best practice by hosting visits by other teachers, speaking at conferences, conducting workshops, publishing, providing online peer support, and developing teacher resources.

What is important here is the recognition of teachers' innovation through the sharing of best practice. This again is based on such successful programs in professional development as the PEEL (Project Enhancing Effective Learning) that arose out of a pilot project in which teachers inquired into their practice. The assumptions underpinning PEEL were that teachers lack the vocabulary and structures to talk about their practice. Teachers' practice is very complex, but they do not have good ways of describing it. It needs to be collaborative. The value of academics and teachers interacting, providing that it was not done in a top-down way, came from the capacity of the academics to help mirror to teachers what they heard them saying about what they

were doing. One of the strengths of PEEL has been that teaching strategies have been informed by a view of what effective learning is. This model of professional development can be developed through teacher-academic partnerships.

Laptop programs

This approach works on the principle that providing teachers with cheap leasing arrangements of computers will lead them to integrate ICT into their classroom practice.

The Laptop scheme was initiated at Bayswater Primary school Victoria in 1996 and introduced to all 37,000 teachers in 1999.

For their website go to http://www.sofweb.vic.edu.au/navschls/

The National Council for Educational Technology (1992) in the UK and Apple Classrooms for Tomorrow Project in the US indicated that laptops would become the norm. The low level of teacher technology skills compared to those in other areas of the workforce was identified as a major issue.

Go to ACOT at http://www.ascd.org/readingroom/edlead/9404/dwyer.html

Ramus et al (1998) reported that supply of laptops enables teachers to develop their own skills in a non threatening manner and thus helps them to create readiness for student access (McDougall et al 2001).

EkinSmyth (1998) in evaluating the success of seven Navigator schools in Victoria in 1998 in improving educational achievement, stated that teachers' access to their own laptops has been a pivotal agent of change because they feel they have been treated as professionals, they have learnt technical skills from people they are comfortable with when and where it suits them. This has led to a train-the-trainer model of in house professional development. The Evaluation report is available at http://www.sofweb.vic.edu.au/navschools/

School–university partnerships

Downes' review of teacher education (*Teacher education and the use of new technologies for teaching and learning,* 2001), and that of Kenway, Blackmore et al. (*Teacher Professional Development in a Devolving School Environment*, 1999), agree that successful federal interventions have occurred through strategic funding of national projects such as the National Professional Development Program and National Schools Network. There are various university-school projects in progress, such as the Australian Research Council Linkage grant between University of Technology Sydney and NSW Department of Education, which is considering the ways ICT can be integrated into schools to enhance learning.

Professional development online

Online professional development is a new delivery mode for teacher professional development. This has been appropriate for school systems with widely dispersed student populations such as Queensland, the Northern Territory [LATIS] and Western Australia [http://www.eddept.wa.edu.au/t2000/lt.htm]. Professional development online was also a basic assumption of more devolved systems where professional development was also devolved to schools, such as Victoria with Sofweb. Systems are grappling with ways to use ICT systemically both to enhance teacher professional

development in general, particularly for teachers who are isolated or less mobile and also to encourage online professional development. Each system uses a range of professional development models, for example, the Learning About Technology in Schools (LATIS) project in the Northern Territory.

The LATIS Professional Development Plan is a systemic initiative that includes the supply of hardware, networking and telecommunications services to schools across the Northern Territory. There is a commitment to support that infrastructure with a professional development program that meets the emerging needs of schools. The direction that the Northern Territory Department of Education is taking is to move resources as close to schools as possible. The principles, strategies and outcomes of The Plan on a Page are a guide to the shape and type of professional development and how that should be delivered. The plan includes school and cluster based professional development and support resources and people. This means that schools will be able to respond to local needs in a timely manner. The access to reliable online services and resources will also change how professional development can be accessed and delivered to urban, rural and remote schools. It will affect each school in different ways but will, in general, allow greater interaction, more flexibility and wider choice. Online communities provide an ongoing support network for teachers where they can access 'just in time' professional development on demand rather than 'just in case' professional development.

The concept of a connected learning community

Teachers across the NT will be able to access a range of online and face-to-face resources, services and events to meet their learning needs in relation to the classroom use of information and communication technologies (ICT). Opportunities to see models of exemplary practice in action will be supported with online and face-to face courses followed by local advisors who can assist during implementation.

Cluster LATIS advisers will be the local, cluster-based professional development staff who link ICT professional development and classroom practice. They are not technical support people. They assist teachers to plan, implement and assess programs that enable student-centred classrooms that use technology to transform teaching and learning. They will take a leadership role in Lighthouse Schools and associated Professional Development Centres through active involvement in the development and delivery of programs. As well as providing follow up to the practicums at the Lighthouse schools, they will also support participants in tertiary short course during the courses and afterwards as these teachers implement their classroom projects. It is expected that these positions will be advertised in the near future.

Online courses

A range of online courses will be offered to NT teachers allowing them to develop skills and knowledge, and enabling access to global communities of educators at a time and place which is convenient. Online courses will include a variety of ready-made and customised courses to meet the identified needs of NT teachers. The Team will also work in cooperation with tertiary institutions, teacher professional associations, other education departments and systems, schools and commercial organisations for resources and people to meet the needs of teachers.

Tertiary short courses

As part of the overall plan for teacher professional development, NTDE is supporting teacher participation in short tertiary courses. Each NTDE teacher will be funded to participate in one course over the three years of the project. Course costs are supported by LATIS and require only a $50 contribution by schools or teachers (+GST). Courses have a range of face-to-face and online elements. Courses are being selected for primary and secondary teachers and a range of special interest groups including teacher librarians, computer studies teachers, special needs teachers, Indigenous teachers, teachers of Indigenous students and teachers in advisory roles.

In the following example, the aim was to model the integration of ICT into pedagogy through an online unit based on use of converging technologies and multimodal communication. It was particularly valuable for teachers who were itinerant.

Art-E-Mus Project

In this National Professional Development Project undertaken in 1996, a professional development unit was developed that modelled the use of innovative pedagogies online using converging technologies (Interactive TV, teleconferencing, computer conferencing, email, Internet etc.) to art and music teachers. The unit was available in modules or as a unit that could go towards accreditation in a university course. Teachers and schools were recruited around Australia. The pedagogical principle was based on school clusters with hi-tech schools and facilitator trainers giving technical help to groups of students. While the teachers found they had little time, and difficulty with transport to get to clusters, and a preference for downloading all the online materials, the program was seen to have a great deal of flexibility, with innovative ideas about how to use ICT in classrooms. It was particularly suitable for art and music teachers who were often working as casual teachers with little other professional development support. The model also provided a ‘pedagogical shell’ or instructional model into which content could be ‘poured’ for delivery of similar units of work and has become the basis of a Masters Unit at Deakin University.
Blackmore 1997. *Art-E-Mus A Year Before Its Time.*

Such models of delivery of professional development with intensive use of converging technologies are contingent on teachers having the time and technology rich school

environments. This applies particularly to teachers in rural schools who lack the time to travel to key technology centres or other forms of professional development (Blackmore, 1997).

Another example of professional development online is in the Apple Learning Interchange [http://www.computerlearning.org/articles/TTT.htm]

> Professional development will work on-line if it meets the needs of the teachers—not just as solution for the provider. It can be cost effective. My view is that it will work only in a rich technology environment multimedia—not just text-video clips etc. Teachers need to understand the concept of e-learning and e-assessment and how to authenticate e-learning, eg qualities of good online facilitation/e-moderating and tracking e-learning. Furthermore there needs to be evidence of the effects on interaction that occurs with good quality multimedia. Also it can meet the need for 'just in time' professional development … get it when they need it—and we can do it better than we do now (General Manager, Professional and Leadership Development Centre, Department of Education, in Blackmore 1997).

Most professional development providers saw on-line professional development as one of many options. But its primary potential was for rural and isolated teachers and those who currently cannot access face-to-face delivery. Some teachers' situations favoured on-line professional development more than others, for example, contract teachers moving between jobs. As the Coordinator of the Geelong Technology Centre stated:

> The chance in many schools, small rural schools, for interaction is limited. You may not be interested in the same field. So they need a range of technologies: video conferencing or group e-mail to distribute information; CDs for data bases; www for information. Can even put radio on-line—using old technology in new technological frame. I believe we need to provide the sort of virtual world for people … to be able to gain the learning experiences … they can't because of isolation. Interestingly, isolation in the city is probably more rampant than geographical isolation (Kenway and Blackmore 1999).

Many professional development coordinators in the Navigator Schools felt that online was particularly suitable for individual computer-assisted learning because it allowed teachers to upgrade their skills in a specific subject area. Early developments included EMERGE's On-line Professional Development System (*PDAccess*) in Victoria promoting on-line teacher professional development.

But online professional development does not necessarily emulate staffroom chat. It tends to take on particular forms of communication and requires quite structured arrangements to be effective. The following example of online learning focuses on collaboration.

City to Surf. An online peer to peer model

The school-developed model of online collaborative mentoring described in this paper was developed at Bayswater Primary School (one of Victoria's ICT Navigator schools) in order to meet the perceived needs of teachers and schools. The City-to-Surf project was a pilot of the Bayswater professional development model that was conducted between a suburban and a coastal school some 120km apart. The aim was to change the classroom culture. The model addressed Desforges' criteria of providing:

- a standard and stable model of learning,
- coherent, organised, well-established findings,
- vibrant working examples of success.

It focussed on being peer driven and context specific. The C2S model is built around whole-classroom interactions (Figure 1) in which (at least) two classrooms synchronize their timetables and curricula for a defined period to allow them to work collaboratively on a particular topic or theme, and to simultaneously give, or receive, tutorial assistance and mentoring support. This is a complex management task. What makes it worthwhile to the school providing the program is that its staff and students can also benefit from the knowledge, skills, and experience of the staff and students of the recipient school, as well as gaining further expertise in tutoring and mentoring.

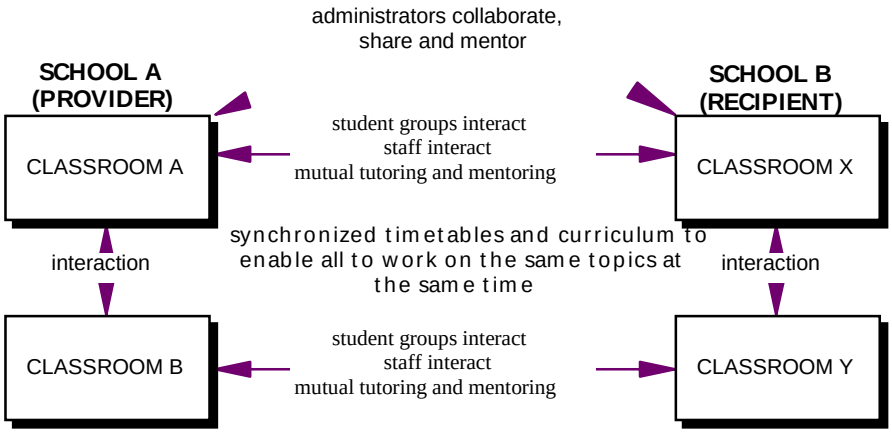

Figure 1. Core structure of the City-to-Surf model

The model used in C2S pilot is designed to ensure that all levels of both participating school communities—teachers, students, and administrators—are involved in the project in an attempt to maximise engagement and active participation. Students in each school work in groups using NetMeeting to provide text-messaging, whiteboards for sharing ideas, and web-based video to enable them to see their partners in the other school. This creates significant logistical and infrastructure challenges when there are some 60 students online, all working interactively with NetMeeting, using its Share and Collaborate functions to manipulate the remote computer, or to demonstrate particular aspects of the work. The findings were that:

- The teachers' 'learning curves' increase significantly for both the mentor and mentee as both cognitive demands and social learning models impact on time, demand new skills, and require new interaction models.
- Having online support at all times means pressing questions can be answered on the spot, providing a form of just-in-time professional development that can address some of the issues in the previous point.
- Student engagement has increased for most students.
- On-line communication techniques and practices are being developed at both schools.
- Student use of a range of technology has improved markedly due to the real life nature of the project.
- Problem solving techniques to deal with technical/group frustrations are being documented in student and teacher learning journals.
- Close association is being developed between the educators at the two schools Nicholson and de Wacht (2001).

While online learning is not perceived by many teachers to be preferable to face to face interaction, the Internet and online professional development offer a number of features that can provide teachers with access to materials that they could not normally have due to lack of resources, for example:

- on-line global course materials and networks;
- www sites that make links internationally enabling disadvantaged schools to benefit from work of other teachers and schools;
- networking to share experience of best practice globally and locally; and
- appropriate tools for online work.

Again, while online professional development provides opportunities for teachers in disadvantaged schools (isolation, resources), teachers have to undertake professional development to be able to adapt to a range of new possibilities about the organisation of their work that will assist their particular students.

3. Effective professional development for integrating ICT

Downes (2001) and Kenway et al (1999) confirm that professional development to integrate ICT is most effective when:

- pre-service and in-service professional development are interrelated;
- teachers are involved in negotiating their professional development dependent upon their need but also with expectations they move out of comfort zone;
- there are negotiated partnerships between universities and schools;
- there is a focus on learning; and
- there is a focus on building up a repertoire of approaches that deal with difference.

3.1 Computers and disadvantage

The research shows that many teachers, particularly those in secondary schools who are not English teachers, are uncertain as to what is meant by educational disadvantage. Comber & Green (1998:89) found that teachers understood disadvantage with respect to ICT as lack of access to computers for any extended time (home or school), and what was done with computers. The ITLED action research based project indicated that while teachers believed that computers could ameliorate disadvantage, their own investigation in relation to their disadvantaged communities unsettled many of their assumptions about their students and ICT. This suggests the need for greater focus in teacher education programs upon both what the 'new disadvantage' might mean for teachers and the strategies that can be used to address it.

3.2 Learning about and learning to use technologies

Much of the research suggests that 'learning about' and 'learning for' is not a useful binary, and that indeed it is preferable that workshops integrate ideas about substantive curriculum and pedagogical issues into the processes of learning about how to use the technology. That is, start with a problem solving focus about how to engage with students at risk and then bring together curriculum and pedagogical ideas informed by ICT. Lawson and Comber (2000:423) indicate that teacher 'training in technology has often been separated out from training for implementing the technology in the classroom' on the assumption that you need to know an application before you use it. This assumption goes against studies of how children learn computer literacies in home with friends and through experimentation. Casey (1996:15) likewise suggests that teachers do not learn from demonstrations 'unless it is connected to use of curriculum', that technology training has to have an educative component.

At the same time there is little research on how teachers learn to use ICT. David Moseley & Steve Higgins, *et al* (1999) considered these aspects of ICT and professional development:

(i) Developing more effective teaching

Teachers' thinking and beliefs about teaching and learning are linked to what they do in the classroom and affect the choices they make. Therefore, the suggestion to increase

the range of teaching approaches using ICT of individual teachers may be useful in the areas where teachers have a preferred approach or are already confident in their pedagogy.

(ii). Developing ICT skills and subject effectiveness

Teachers are likely to identify issues associated with ICT such as lack of access, fragility, lack of relevant programs, and poor computer skills as preventing them from using ICT in their teaching. To overcome this, it would be better if teachers could see the relationship between using ICT skills and teaching rather than developing ICT skills in isolation.

What is required is the need to see the application of ICT skills to extend student thinking and planning. Authentic tasks that instigate research, and anticipate what "turns students onto learning", and make use of prior knowledge and experiences become core elements in planning where ICT will engage and extend.

(ii) ICT for teaching

Some teachers identify students' ICT capability as a key feature in their planning of activities involving ICT. This may exclude from their consideration other activities where ICT contributes to subject-specific teaching objectives but where students' ICT capability is not being directly developed.

Each of these points has relevance for ways in which equity can be addressed and prioritised in teacher professional development.

3.3 Other factors influencing teachers' 'take up' of ICT

Digital literacy and professional identity

Teachers' sense of professional competence is challenged by their sense of lack of technical expertise (Blackmore and Johnson 2001). The baseline Australian study, *Real Tim*e (1999) investigated the levels of computer literacy (basic and advanced) of teachers and students. The study found in the 222 schools and over 1258 teachers surveyed across Australia, that teachers' basic skills levels were equivalent to most students, but on average less than students' advanced skills. Those who most lacked basic skills were females over 50 years old in primary schools, and teachers in Catholic schools more generally. Here the links between size of school, school resources and technology support are most obvious, indicating an area of need for increased professional development.

Secondary school teachers had more advanced skills, and teachers of SOSE; English and Technology integrated computers into classrooms more than in Maths and Science and considerably more than in Arts; TESOL, Physical Education and Health Education. The UK 1996 *Survey of Information Technology in Schools* (DfEE 1997) came to the conclusion that there was a decline in both primary and secondary schools in teacher confidence in the use of ICT except in specialist IT subjects, and particularly in English geography, modern languages and science. The report documented a decline in the number of teachers attending short technical training courses, and the number of teachers who received no training had also increased. This raises the issue of what is discouraging teachers.

Much of the research on teachers' receptivity to the use of ICT focuses on their sense of uncertainty and lack of competence. Teachers often feel the need to fully understand the software and hardware and to be proficient technically (operational literacy) before they experiment with learning technologies and take risks in the classroom, finding out what matches student needs (ie cultural dimension of digital literacy). This desire to be fully operational before teaching with ICT goes against anecdotal evidence that the way in which students and teachers learn is by working with friends and colleagues on the basis of 'need to know' or 'just in time' (Comber & Green 1998, Kenway et al 1999, Blackmore & Johnson 2000).

There is little research on what is effective professional development to support teacher techno-literacy learning other than the common sense understandings that teachers learn best when 'doing technology', having someone to ask, and with time to 'try it out'.

School / home tensions

The leasing of laptops to teachers was seen to be an innovative move that would extend teacher use. But the Laptop Evaluation by McDougall et al (2000) that undertook a stratified sample of 79 schools, focus groups and online journals found that females appear to feel less competent than males, while new teachers were more competent in use both generally and in classroom. Word processing by teachers and students was the most frequent application in classrooms and there was a low use of multimedia and other technologies. Males reported significantly higher use than females in all nine areas[9]. Many teachers saw the laptop as merely extending their work hours into after hours as they took home the computer for more schoolwork.

Time

Central to professional development was the need for time, time to learn about the new technologies, to learn about their appropriateness, to search the net, to prepare and plan. Teachers reported 'lack of time to explore digest and experiment' (Schrum 1995:226). Also evident were growing differences between the ICT rich and ICT poor schools, those in which teachers had low access to technology. Time is at a premium as these schools lacked the discretionary funds to free teachers to undertake professional development. The ITLED project spoke of how teachers perceived as a problem having substitute teachers in classes while they undertook professional development. They felt that this could lead to behaviour management problems later. Comber & Green (1998) questioned teachers' beliefs about students' lack of ability to cope with a change of teacher. They felt that professional development that could in the long run benefit learning of these students should be given priority.

Pedagogical shift

Teachers in the Discovery Schools in South Australia rated their top three requirements as being:

- access to 5 or more computers in near vicinity , preferably in classroom;

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[9] Prior to receiving notebooks, 81 per cent of teachers used computers at home more than once a week; 42 per cent routinely; 84 per cent used them at school, 51 per cent routinely. Males used the computer for more hours each week than females both at home and school (46 per cent males for 6 or more = hours); teachers with 6-10 years experience reported a lower rate of use with Principal and Leading Teacher more frequent.

- Internet access in the classroom; and
- teacher computer with Internet access.

They felt that if there were too many students, it was difficult to fully integrate computers into lessons. Secondary teachers had to ‘give up too much instructional responsibility to the computer software’ (Barnes 2000:7, *Teacher Data*). Teachers in years 3–7 where there was greatest usage and demand felt more confident.

This report on the Discovery schools confirmed that if teacher professional development needs are met, teachers focus on infrastructure first, then their skill base.

It also signals that teachers are challenged by the need to adopt new mindsets and that letting go of control in classrooms requires fundamental shifts away from teacher centred towards learner centred pedagogies (Blackmore and Johnson, 2001). Teachers are threatened by the shift in relations between students and teachers if ICT is fully integrated into classrooms. In student centred learning classrooms teachers are no longer the primary determiners of what constitutes knowledge or indeed how particular tasks may be achieved. “The difference between learning technologies such as projectors and video is that now the expectations are higher and it is not up to the teacher, it is up to the students as to what they use in terms of choice” (General Manager, Professional and Leadership Development Centre, Department of Education, in Blackmore 1997).

Teachers can learn with students through exploring the possibilities of new technologies. Nixon (2001:10) cites the importance in the Westview case study [*Leading Practice vignette 38*] of the type of mutual learning that can occur when ICT is fully integrated into classrooms. Teacher development resulted in changed teachers’ beliefs, attitudes and skills and consequent changes in curriculum and outcomes for students.

3.4 Teacher professional judgement

Blackmore and Johnson (2000) found that the issue for teachers is how to make professional judgements about which learning technologies can enhance the learning of which students and in what ways. Yet they found that it is in the classrooms with higher levels of cultural diversity and low income students that teachers tended to focus on drill and practice rather than innovation. This requires professional development that focuses on the cultural and critical dimension. ‘Too often technology training is discontinued after teachers acquire rudimentary computer literacy or are taught the basics of using computer software. It is one thing to be able to open up a piece of spreadsheet software and quite another to have a repertoire of instructionally useful activities for students to learn mathematical concepts using spreadsheets and grappling with data’ (*Using Technology to Enhance Engaged Learning* 2000:3). Few teachers, even in those focusing on disadvantage, worked with learning technologies in a socially critical sense. Teachers had a sense that the answers were somewhere else, when indeed there is not ‘educational blueprint’ for how to integrate technologies into teaching and learning (Comber & Green, 1998).

Familiarity

Lawson and Comber (2000:429) argue in the Evaluation of the Superhighway Initiative (EDSI) project that the stereotypes of ‘technophobes’ and ‘technofreaks' amongst teachers collapsed with familiarity. The enthusiasts and resisters were particularly attracted to the relevance of the Internet:

> It was the sheer salience of the Internet to their pedagogical concerns that acted as a transformative catalyst in many cases. There were numerous examples of teachers who began the project with some degree of reluctance, but ended up as enthusiastic advocates of the Internet … and who were also beginning to explore the other potential uses of electronic communications in the classroom.

The Internet provided solutions to teachers' problems of resources. The EDSI examples indicate that the Internet differs from other computer based technologies—spreadsheets, databases—that require a reasonable level of proficiency. An English teacher was able to get hold of example of Old English poetry, access up-to-date materials, practise in another language, and show illustrative animations of a process.

Likewise, the Apple Computers for Tomorrow project (Dwyer 2001) found that teachers were not technical illiterates but personally appropriated the technology to suit professional and personal needs. Even when there was limited software, as there was for Apples in 1980, teachers led in the imaginative integration of technology across the curriculum, using word processors, graphics programs, databases, spreadsheets, and Hypercard, for educational uses. Again, this was in technology rich classrooms in which use of ICT was the norm.

Sustainability

Various reports and research pointed to the unevenness of reform, the random spread of sites of professional networking and activity across systems, and the hotspots of professional development within schools (Comber & Green 1999; Kenway, Blackmore et al 1999; Lankshear & Bigum 1998). They concluded that the enthusiasm of colleagues was critical to the integration of ICT. But this same reliance upon the few enthusiastic teachers for professional development in some schools leads to the fragility and lack of sustainability of good practices in the use of ICT. Full integration of ICT into curriculum requires whole school cultural change. For example, with team work and dispersed leadership in technology rich classrooms teachers reduced their use of drill practice and increased interactivity (Mayer-Smith 2000, Dwyer 2000).

'List communities' or learning networks

The Internet and Computer Mediated Communication (CMC) has meant that there are new possibilities for teacher professional development through lists, chat rooms, data bases, websites that act as clearing houses of best practice, and teacher learning networks built on subject areas, professional associations and shared interests. The Internet and CMC provide a level of interactivity that has significant possibilities for teachers to develop collegial partnerships that can inform their teaching and learning both locally and globally. This can be done on twinning arrangements between high tech and low tech schools, so that there is an exchange of ideas and issues; or by developing networks amongst a range of disadvantaged schools to provide program support. At the same time. CMC is a different form of professional communication, is favoured by some and neglected by others, and cannot supplant face to face. It does provide a lifeline to teachers who cannot access other forms of professional development due to isolation.

The Navigator School evaluation (EkinSmyth 1998) concluded that teachers need emotional, technical and pedagogical support in the integration of learning technologies. This support should include routine access to computers and appropriate

software at school and home and ongoing professional development programs These should included pedagogical development to enhance teaching and learning methods, skill development in learning technologies and development of skills in using learning technologies for planning and administration.

3.5 Teacher professional development—Indigenous students

Professional development for teachers who teach Indigenous students should incorporate exploration of the potential of ICT to enhance the opportunities for Indigenous groups to use culturally favoured modes of communication—music, word and visual graphics through converging technologies. Teachers should have ongoing access to professional development to develop their understanding of the needs of Indigenous students and what is happening in Indigenous communities Bourke et al (2000) reinforce this point:

> It is crucial that pre-service training provides teachers with knowledge and understanding of the culture and history of Indigenous peoples and their contemporary lifestyles; knowledge and skills necessary for teaching in cross cultural, bilingual situation; and a greater awareness and understanding of Indigenous students' linguistic background and the cognitive and linguistic versatility they display in switching between Standard Australian English (SAE), Aboriginal English and other Indigenous languages in response to the demands of the situation (Bourke, *et al* 2000:33)

Another important issue relates to Aboriginal languages, including Aboriginal English. Every Indigenous community has a first language other than Standard Australian English. Pre-service and in-service training for teachers needs to address this.

There is a need for pre-service and in-service programs that support teachers to move toward inclusive teaching practices for Indigenous Australian students.

TSOF has a Quality Teacher Program that looks at the Arts and Indigenous groups, and which focuses on the use of communication, visual and aural to enhance literacies. We have found that ICT skilling is secondary and that Aboriginal Education workers, teachers and students have focussed on communication and use ICT only as the tool that caters for their interests. What is required is the understanding of how ICT enhances the opportunities for Indigenous groups to use culturally favoured modes of communication—music, word and visual graphics through converging technologies.

3.6 Teacher professional development—students with disability (SWD)

There is a clear indication that there is a need for greater support for teachers in the area of disability. This is another layer of technology that has another set of specific requirements. Generic ICT skills are required by all teachers but additional skills are required for teachers of students with disabilities, their aides, and support staff (Blackwood 1999). Furthermore, this means that additional teacher training and in-servicing about technology is required. In 1994 the majority of teachers (46 per cent) were self-taught, 26 per cent attended formal classes or workshops, and 22 per cent received assistance from colleagues (Lewis 1997:4). Teachers need to be aware of "how technology can be used by SWD to enhance their learning" (Blackwood, 1999:2), including knowledge of adaptive technology that is available and compliance with accessibility standards (Fine 2001). In addition, teachers need to be able to use

technology more flexibly in the classroom and to customise the use of different types of technology to an individual student's needs (Blackwood 1999). Pre-service education and on-going training are required.

Specialist services such as the Adaptive Technology Service in Queensland, Vision Australia or Comtech in Victoria provide at least one means of specialist assistance. Locally-based support has been recognised as a requirement for teachers, even when they have been motivated to meet the initial technology requirements of their students. As upgrades are required, teachers need support—"when teachers want to progress to the next level, there is no one there to show them how" (Blackwood 1999:371). Employment of a technology officer is occurring in some special schools where IT is a high priority, but is not yet a widespread practice. The technology officer's role includes:

- installation of software and hardware;
- advice about equipment and software; and
- advice about IT related curriculum goals.

There is the need to incorporate the issue of mainstreaming and integration of students into the classroom. It is not the software and hardware that is always the issue but professional development for school support officers to understand what multimodal literacies are about, what are the tools that assist students who are working with generic software, eg value of visual graphics, sound etc.

Common themes underpinning teacher professional development for inclusive use of ICT

EkinSmyth (1998:16) lists the following criteria for effective teacher professional development in ICT:

- Content builds on what teachers already know;
- Learning can immediately be applied in classroom;
- Technical skills are introduced in the context of how they can be used in the classroom;
- Teachers have hands on guided time and access to technology to experiment;
- The professional development involves teachers in collegiate teams;
- There is time to consolidate experiences;
- Reflection time is encouraged; and
- Professional development is tied into professional recognition programs.

These are important features provided that the following are also taken into account. While 'just in time' professional development is important, teachers require follow up on all professional development. Professional development often begins at the operational level. In order for teachers to progress to higher order skills and to develop their own advanced skills in using learning technologies, they need assistance in how to move ICT across the curriculum through problem solving approaches or integrated curriculum, and to develop criteria about judgement of appropriate use of ICT and evaluation of effects, as well as wider social justice implications. Teachers best learn how to use computers most effectively when technical and substantive curriculum and pedagogical issues are woven around a problem eg focused on issues of equity, student difference, learning styles etc. This requires a different type of support by individuals who have both training in curriculum / pedagogy and technology.

In order to address issues of disadvantage, there needs to be a greater focus on the cultural, (the context and content as well as pedagogy in which ICT is used), as well as the critical. The critical dimension seeks to help teachers become more reflective on how the particular use of technologies impacts on students in their classrooms, and asks the question 'Who may be included and excluded by this approach?'

The recent Australian report on the *Impact of Educational Research on Policy and Practice* (DETYA 2001) produced clear data that exemplary teachers were those who drew their professional knowledge from a range of sources, including:

- their early training;
- their colleagues;
- their professional reading;
- in-house professional development;
- their own reflection on practice through experience and experimentation;
- post graduate courses;
- university–school partnerships; and
- action research projects.

It stressed that exemplary teachers were particularly active in post graduate courses, external professional development and action research projects with university partners or research based curriculum development. This confirms understandings of best practice as depicted by CERI (1998) as being:

- experiential;
- grounded in equity, reflection and experimentation;
- collaborative and interactional;
- connected to and derived from teachers work with their students;
- sustained, ongoing and intensive supported by modelling, coaching and collective problem solving; and
- connected to other aspects of schools change and integrated as part of wider change process.

The notion of teachers as reflective practitioners, as researchers of their own practice, is now seen to be the way in which professional development must move as there is no ready blueprint for teachers when ICT is factored into their daily practice. Teachers will confront an ongoing need to be responsive to the diversity of their students and the rapidly changing nature of ICT as a mode of teaching and learning.

This report indicates how the use of ICT is predicated not just upon teachers having a repertoire of strategies but equally upon teacher beliefs and practices. Yet much professional development impacts on the use of classroom space and activities and less so on teacher beliefs and practice. This is the dimension in which there is need for greater focus of professional development related to students who are disadvantaged. Teachers impart their own beliefs, practices and ways of learning ICT to their students. They too readily transfer their expectations regarding perceived student abilities academically onto students in terms of their ICT capacities and use. Thus teachers when using ICT for students perceived to have a literacy or numeracy difficulty, continue to work on basic levels of skills through drill and practice on computers rather than using ICT to enhance student experience in the same way 'gifted' students learning is extended and enhanced. This is the area in which professional development has to move.

To extend the notion of digital literacies required by teachers, there needs to be professional development that encompasses the three dimensions of digital literacy:

The **operational dimension** requires the development of a repertoire of pedagogical approaches that meet individual needs. There is basic and advanced operational levels, the latter involving the use of multimedia.

The **cultural dimension** requires identifying the specific needs of individuals and groups of students. This means understanding home technology environments; gaining professional knowledge in order to make judgements about the appropriateness of particular approaches for specific students; working through interdisciplinarity and cross curriculum projects.

A **critical dimension** for digital literacy requires being able to:

- judge whether ICT enhances learning; assist with information overload;
- assist teachers to deal with unfulfilled expectations with respect to practical applications;
- deal with the lack of scrutiny about new sources of information made possible with ICT;
- re-focus on form rather than content in pedagogy; and
- encourage reflection on their practice to build a knowledge base for teachers.

This positions teachers as active agents and cultural producers. At the critical level, teachers need to have understood and debated the issues about the use of ICT in order for them to apply 'reflective adaptation' (Dede 2000:298). Teachers have to mediate the policy prescriptions of the technology innovators and incorporate them into feasible pedagogical practices in their classrooms.

To do this, teachers require school and system support through professional development that focuses on how to identify student needs, and appropriate technologies that serve particular purposes. The new learning technologies themselves provide possibilities as far as their capacity to support teachers in that they can:

- enhance the capacity of teachers to provide multiple pedagogical approaches in classrooms to address individual need;
- provide alternative learning paths for teachers themselves that assist teachers who are in isolated or rural communities;
- extend teacher learning networks in order to create links with teachers who face similar issues: students who are disadvantaged;
- 'fast track' through access to the Internet, dissemination of creative ideas about teaching for difference;
- use technologies in smart and more economical ways that do not overburden teachers; and
- link professional development for ICT to issues of disadvantage and integrated this school development plans.

The following example from the ITLED Project sums up many of the issues discussed in this chapter.

Year 5 student teaching Internet access to her class teacher

This project involved the Year 5 student researcher, Nadia, teaching me, her class teacher, to use the Internet. Nadia had first to develop skills with the computing teacher, as a member of the school's Internet Group, all of whom were eventually going to be tutoring other students and hopefully teachers. The plan was to give Nadia very little guidance as to how to instruct and just see what she did and whether she used the language the computing teacher uses. We wanted her to use her language and find out whether she would simply give instructions or develop another discourse pattern. To what extent, for example, would Nadia do as her computing teacher does in making sure the learners are feeling comfortable and confident about what they are doing?

Would she ask me things like "Do you understand what I'm saying?" or "How do you feel about doing that?" One focus was to develop skills in information technology for both the student researchers and the teacher researcher's skills to use the Internet and provide the student researcher with the correct terminology. The oral literacy focus involved identifying the types of talk needed in order to effectively explain the use of the Internet, identifying the types of talk used by the Aboriginal student researcher, and looking at the correlation between the types of talk needed and the types of talk actually used.

A third focus arose from seeking to work out new ways of learning in socio-economically disadvantaged communities that valued the role of students as educators, providing an opportunity for an Aboriginal student to develop competency in Standard Australian English in a meaningful and real context, providing an opportunity for students to act powerfully in information technology, and valuing the preferred ways of learning of students.

The computing coordinator was setting up the Internet group as a potential resource for developing whole school skills in using the Internet. Nadia and Christopher, Year 5. Students from my class, were involved because they were reasonably articulate, confident students. They were both enthusiastic participants in whole class discussion and were always very willing to help other students in the class. This made them ideal candidates. Nadia had also already accepted the position of student researcher. The project provided an ideal opportunity for me to develop skills in using the Internet and also to let the students know that when I talked about us all being learners. It was for me a less intimidating scenario. The students are really good at making you feel comfortable about what you don't know. It was really important when setting up the student tutoring that the students saw it as a partnership and that they were always very aware of where my inabilities lay in terms of the Internet.

The initial process was the class sitting down and saying, "Look we've got these people looking at information technology, but what is it?" As a class first of all we came up with a common definition for us all as to what information technology was. At first the students had the definition that it was "something with moving parts, something that made our lives easier and something that had been created." That led to some of the students saying that teachers were information technology, because we had moving parts, we made their lives easier, and we had been created by God. After more discussion we refined the definition and it became: "It is something that makes our lives easier, something that is created or manufactured, and something that provides us with a range of specific or general information."

We also sent home a survey because we felt it was important that we had an idea of the sorts of information technology that the kids were exposed to and

working with at home and in the wider community. As well as that, in class we were looking at oral language and the purposes for using oral language and we started trying to make some distinctions between the way you talk in an informal situation compared with the way you may talk in a more formal situation. As much as anything, we started to see that there was a vast array of situations which we needed to understand.

She used terminology like homepage, startpage, website, email. But we didn't do a lot of talking about the processes she used. She didn't say a lot about what she was doing during those chats, but sometimes in the yard she would come up and talk about things like some of the boys, thinking she couldn't do what they were doing because she was a girl. Once it was getting close to us actually getting together on the Internet then instead of just accepting a general answer I would actually ask her ‘Well how did you do that? What did you do to get you to that website?' And she would say "Well, I pressed the house thing at the top of the screen." But later, when she was more familiar with the terms she would use them, and not her own made up phrases. So she would talk about ‘back’ and ‘home’, or putting in passwords.

Another teacher, Cathy, had taken a few extra weeks to make absolutely certain that the kids were going to be set up for success. So I thought it would all be fairly straightforward and that Nadia and I would be surfing in minutes. And then came the first hurdle—an unfamiliar Start Page. Nadia didn't know what to do, and I didn't know what to do. So Nadia began by working with the familiar. She tried the Home icon in the hope that we had just missed the page, she tried to go Back to a previous screen, and she attempted to exit, which we did and then went through the process again.

Once she had tried some really familiar things, she started to doubt her competence She wasn't negative, she didn't want to stop, but she started reverting to a novice position. So when I asked her what she would have done on the other Start Page, she just pointed to things and said "I would have pressed that." So she began relying heavily on the visual cues that the screen gave her, and stopped using the terminology. She began to ask what I thought she should do, and I tried to counteract by saying "What do you think would happen if we tried this?" in the hope that some of the knowledge she had gathered would come flooding back.
But it didn't.

Reflections

After this Cathy and I sat back and re-assessed, and really reflected on some of the assumptions that we had made. We had assumed that if kids had developed some level of competency using the Internet that they would be able to transfer that knowledge and would have the skills to just sit back, ponder, and then logically work through the problem. We had also made an assumption that because Nadia and Christopher had some previous experience just playing on the Internet, and because they were both students who happily took risks using the computer in general, that they would take those risks and experiment on the Internet. What we actually found was that there was an element of nervousness, I think because the Internet had seemingly limitless boundaries. In a sense it was like going on an excursion. The moment they were hooked onto the Internet they had, in a cyber way, left the school. And Cathy had done a lot of work with the Internet group about the importance of critically analysing the websites that were on offer, and understanding that some of the websites that were being offered sounded innocuous enough, but they needed

to be really careful about choosing things that specifically linked with what they wanted to find. If it sounded a bit nebulous they were better off leaving it. For example, they were better off going for Spice Girls website as opposed to Spice Up Your Life. Another assumption that we made was that by Cathy using the terminology constantly and the kids being asked to use the terminology together when they were working on the Internet, that they would always use it, and that they would also use a lot of the instructions the way Cathy used them. But what we found was that the moment there was an element of doubt in Nadia's mind her oral language would be replaced by pointing and gesturing and identifying visual cues that I could use, eg press this.

And so one of the big things that we learned was that the skills that are needed can't be taught in isolation. What really needed to happen is that while Cathy was teaching the kids how to use the Internet I needed to be teaching them about how to talk about how to use the Internet. And that in fact there needs to be a strong link and a support between what is happening in IT and what is happening in the classroom. And, looking beyond IT, I think that has real implications across the curriculum areas, we talk in science about hypothesising and about recording procedures, and we may have done a lot of work on procedures two terms before, but what our kids need is those skills working in parallel, a sort of cross-germination almost. So that when you want them to be able to predict in science, you are teaching them what it is and how it sounds and how it is structured, and you are doing that in explicit lessons, as opposed to part of the general package in science. We need to be more explicit…particularly in things like IT because we make an assumption that IT is a doing thing, not a talking about thing. But in actual fact there is a lot of talking that is required. For example in trouble shooting, when the printer is not working, Cathy has got to be able to pin point the problem, articulate what that problem looks like, orally compare for somebody what it was like before compared to what it's like now, and use terminology that the person is familiar with. And had Nadia had those skills, it may have been easier for us both to explore, and to say let's just give this a go and see what happens. Kids can do it on the word processor. And so consequently it is about them having that language that will allow them to explain it to anybody, from the techo down the road to the kid who has just got his own PC.

(Comber and Green 1998 ITLED project)

Section E Barriers

This section draws upon the earlier discussions and case studies to identify the barriers that confront systems, schools, teachers and students seeking to enhance learning through the use of ICT in the classroom. The barriers are multilayered, with classroom, school, system, home and community factors highly interrelated as the teacher's story below illustrates.

Peter's Story

Using technology to change the dynamics of the Year 8 to 10 English Classroom

The class was to use Multi-media, Internet, CD-ROM information and more traditional processing and publishing technology to learn about and through language use. Students were to have a wider variety of information sources for their writing, such as Web based sources, email list servers, and reference information from local libraries. The teacher's objectives in using technology were to:

- Improve student literacy through familiarity with different types of non-linear text, to individualise learning through multi-media programs and enable quick feedback about the texts.
- Improve independent learning skills. Students will become more self-reliant and self-motivated and willing to see other students as experts.
- Improve the ability of students to use and assess the veracity and appropriateness of Internet based information (lists, libraries etc).
- Increase the profile of Multi-media and Internet within the English Department to disperse learning across other classrooms.

Peter sought to use small groups as English teachers stressed the use of oral language as both a step in the learning process and an important skill in itself. He thought that technology might facilitate the simultaneous undertaking of different group tasks, encourage self-control and enable access to alternative sources of knowledge from students and web resources. He also feared losing control.

The following problems were associated with hardware:

- Only one phone line was connected to Internet.
- The teacher connected into the library network with eight machines linked through Windows NT network and through Wingate to a server. It meant access to a CD ROM stack with Encarta and some other information services. This took time as it required 20 metres of cabling. The two technicians who set up a small hub couldn't identify why the connections were not working.
- The network card in the Peter's new computer then didn't work, causing further delays.
- Once the machine linked to the Library's network, the net wouldn't connect to his machine.
- There had to be access to the same classroom, and this required waiting until Year 12 level had left.

Peter's Story (continued)

> Peter found that game based learning which involves interaction is best in groups of four or five. The search and information based activities work better when the groups are smaller. Preparation of assignments was also better done individually. But one machine in a classroom was a very difficult configuration. A multi use classroom with three or four computers and students engaged in different learning activities could have produced more meaningful learning tasks. He felt there needed to be more PD courses on designing flexible classrooms and multimedia for English. He started to explore drama programs such as Hollywood High and Opening Night and Storyspace. This small project indicated key features of an integrated classroom and identified the urgent need for better whole school and subject department technology plans. The evaluation occurred after his promotion to another school and he did not know whether the ideas had been sustained. http://www.eddept.wa.edu.au/centoff/tisp/PeterWilson.html

While there has been considerable expansion in use and improvement in the quality of ICT in the past three years since Peter wrote this story, there are still significant barriers to the full integration of ICT into classrooms in ways that can improve the learning outcomes of students. While the same barriers exist for all students, they have more severe ramifications for students who are disadvantaged.

The vision for technology-supported reform-oriented classrooms is one in which student groups work on long-term, multidisciplinary projects involving challenging content that is interesting and important to them with the support of technology tools for collecting, analysing, displaying, and communicating information. Making this vision a reality poses many challenges (Means *et al.* 1995). These challenges relate to the social dynamics of the classroom through to patterns of computer use, and issues of infrastructure.

This chapter is organised to indicate the barriers in the classrooms, schools, systems, homes and communities. Issues more specific to Indigenous students and students with disability are addressed in the final sections.

1 Classrooms and schools

1.1 School design

Schools have not been designed to integrate ICT into classrooms. While there is agreement that it is pedagogically better to disperse computers around the school and into classrooms rather than locate them in computer labs, this creates significant financial, staffing and architectural problems in terms of space, networking, maintenance, supervision of use, and vandalism. Most schools do not have the funding to be radically redesigned to meet the demands of fully integrated ICT. Many Australian schools have little capacity to provide:

- sufficient up to date hardware to be dispersed across classrooms and libraries;
- full network infrastructure such as intranet; and
- recurrent costs of a fully networked school linked to community and homes.

Furthermore, these problems are exacerbated if schools are to extend their hours and make ICT facilities open to the public or to their students out of hours to increase student access.

1.2 Thin access

The kind of technology-supported project-based instruction that does impact on student learning most as described in Section B requires a high level of access to the sorts of technology tools that researchers and other professionals use on a daily basis to support their work.

Technology cannot become a meaningful support for students' work if they have access to it for only a few minutes a week. The Real Time baseline report (1999) reported that, in 1998, 75 per cent of schools listed had a student-to-computer ratio of 15 or more, 40 per cent having 10 or fewer (50 per cent in Victoria or Queensland and 24 per cent in NSW) and a student to computer ratio of 5 or less in Independent schools, whereas Catholic schools had more students to computers.

Because of the cost, horizontal integration of computers (i.e. computers dispersed throughout the school for ready access) tends to be more possible in wealthier schools. The norm in many schools is one computer per room and a computer lab largely occupied by senior students (Motley 1999).

Horizontal integration has its own organisational problems. For example, when things go wrong technical staff are required for ‘troubleshooting’. Furthermore, increased access means increased recurrent costs. But restricted access to the Internet to stop students reaching unsuitable sites also has cost implications (Lawson and Comber 2000:427).

1.3 Lack of access to Intranet

Few schools in the *Real Time* study (1999) had information sharing networks with other local schools, communities, businesses or with international schools. Where it existed, it was more likely between government schools. Again intranet resources are better in

higher or middle class schools, less so in country and rural schools. Independent schools had more dedicated IT support, personnel and technology learning resources, and the Catholic school systems less so.

1.4 Lack of up to date multimedia equipment, computers and Internet

Merton *et al.* (2000:iv) found that secondary teachers, teachers in larger schools and teachers in city schools were more likely than elementary teachers, teachers in small schools and in rural schools to report that the insufficient number of computers was the major barrier to their use. Teachers in schools with high minority enrolments were more likely to report that computers were outdated, incompatible, or unreliable. In turn, these teachers were less likely to assign students to use computers more extensively, more likely to assign them to practice drills, and less likely to encourage word processing or the creation of spreadsheets and problem solving than teachers in schools with more 'adequate' computers.

Access and availability to up-to-date computers, while not in itself leading to integration into teaching and learning, does encourage teachers to explore and take chances. Lack of access makes it all too hard for many teachers. *Computers and the Classroom: the Status of Technology in US schools,* (US Department of Education 1996:8) found that minority and poor students not only had significantly less access to computers than the more affluent students, but the difference was greater when computers with interactive video capabilities and graphics were counted. 'The kids with the most needs are getting the least access'.

1.5 Technical support

Lack of technical support means that teachers can be quickly discouraged by equipment failures or software behaviour they do not understand. Schools attempting to implement technology on a wide scale need on-site technical assistance. Increasingly knowledgeable teacher volunteers, part-time regional or private technical services are unsatisfactory. Teachers need technical help on demand. The use of technology requires flexibility and skill. If technical problems arise frequently and teachers have to wait hours, days, or weeks to get them resolved, they will abandon their efforts to incorporate technology. This is even more the case for experimental systems where extensive use is made of computer networks.

Schools have a number of different and contingent problems to solve in terms of taking up new technologies (e.g. telephone lines), such as accessing the Internet or developing Websites (Comber and Green 1999).

1.6 Lack of computer culture in schools

Hickling-Hudson's (1992) review of research on computer use in Australian schools indicates how wealthy schools can utilise their greater material and human resources (libraries, telecommunications and hi tech employment possibilities in the community) to create sophisticated computer education cultures compared to poorer schools. This impacts on technology poor schools in terms of their image, the morale and practice of teachers and students, and the schools' capacity to attract students or to make links with actual and virtual learning communities.

2 Curriculum and pedagogy

ICT cannot break down subject and department boundaries that are driven by curriculum and assessment. Student and staff usage was also bounded by subject requirements (Dwyer 2001). In secondary schools, where teaching is more content driven, disciplinary focused, examination and assessment driven, computers are used more for word processing and information gathering rather than problem solving, particularly as the content in particular subject areas meant teachers were more dependent on available software (Lawson and Cowper 1999). This encourages secondary teachers to use computers more at home for preparation and administration (Wenglinsky 1998; Pepper 2001).

The maintenance of the discipline boundaries and high stake testing leads schools to focus on academic work. Assessment drives curriculum and classroom practices and therefore can be counterproductive. Assessment is the biggest barrier to technology integration because it narrows curriculum and what constitutes good outcomes. This has implications for students who are at risk of dropping out, as these students are more likely to be engaged with authentic 'real world' tasks.

Interestingly, assessment has been largely ignored when considering how ICT enhances learning outcomes, but this a particularly problematic issue for many students who could display a range of abilities using ICT if these abilities were being assessed.

2.1 Culturally and gender biased curriculum

Mainstream curriculum, particularly in ICT, tends not to reflect the experiences of all students, most particularly Indigenous students and often girls. There is little recognition in professional development of teachers or in teacher practices of the possibilities that ICT opens up in terms of cross cultural learning. Many of the basic principles of gender inclusive teaching promoted through gender equity policies are not used in classrooms integrating ICT.

Cultural barriers remain as an integral part of the system and result in the tendency to exclude Indigenous knowledge, thereby presenting a barrier for the full participation of Indigenous students. This is evident in their lower retention rates, lower literacy and numeracy levels and lower employment levels (Collins *et al.* 2000).

2.2 Unequal use of ICT

In addition to the challenge of providing adequate access to technology generally is the further challenge of ensuring that different kinds of students get equal access. Many reports focus on the more assertive behaviour of boys in ‘claiming’ computer time or control of the mouse, others describe girls and low-SES students opting out of activities in which they do not expect to excel. Even when students from low-income homes or girls are in classrooms with technology, there are many anecdotal reports of their having less time with the technology than do boys from more affluent homes.

2.3 Social dynamics of the classroom

Once computers and the Internet are available, the culture and social dynamics of the classroom and the processes of teaching and learning have significant impact on how computers are used and with what effect for different students. We have already pointed to how computer use and effects are premised upon factors ranging from teacher attitudes towards particular groups of students, their assumptions about learning and computers, their capacity to address issues of difference, and their disciplinary area. Further factors influencing ICT use are student attitudes and use of computers, their cultural backgrounds, their gender, parent attitudes and cultural values. These tend not to be addressed by teachers or in teacher professional development. Equity is equated to equal time and use of ICT rather than considering how ICT changes the social dynamics.

3 Teachers and teaching

All research on ICT and how it can enhance learning emphasises the importance of teachers.

3.1 Emphasis on the operational dimension of ICT

There is an emphasis on technical aspects of ICT (operational dimension) rather than curriculum and pedagogy (cultural dimension). Teachers do not learn how to use technology pedagogically and how to integrate it into the curriculum.

The use of ICT together with other educational reforms requires fundamental changes in teaching practices on the part of most teachers, particularly when teachers need to focus on special needs and individual differences. The introduction of technology adds another level of difficulty to what is already a daunting task. How does a school get all or almost all of its teachers on board, particularly when many of those teachers have little experience with technology (Means *et al.* 1995). Placing technology in classrooms does not ensure that it will get used appropriately, or even that it will get used at all.

3.2 Teacher attitudes to ICT

There is clear evidence that teacher attitudes have a significant impact on student use of ICT and also on student learning. The US research indicates a high correlation between schools with a high concentration of minority students, high poverty schools, low teacher professional development, and low levels of ICT and Internet availability. Teachers in schools with high numbers of minority groups were confronted with the double problem of having to learn to use ICT and having to meet a wider array of student needs than wealthier schools with low numbers of minority students. The US data suggests that teachers working under these conditions tended to restrict the range of Internet and computer uses and to focus on basic rather than advanced computer literacy, i.e. skills development rather than Internet search, drill-and-practice programs on basic skills rather than ICT as a tool to support students working on their own projects.

3.3 Teacher attitudes to students

In the South Australian ITLED study, many disadvantaged schools' teachers recognised the need to develop ICT skills as critical to increasing the opportunities for their students. But they felt inadequate because of the lack of training and ready access. On the one hand, teachers frequently found that they had under-estimated students' access to new technologies in their homes and communities (ITLED). They did not expect lower SES students to have access to computers at home, and so did not expect them to display computer skills at school. On the other hand, teachers often over-estimated students' competence and/or over-generalised that 'all' young people would be attracted to new technologies (Comber and Green 1999).

3.4 Teacher focus on the technical

The adoption by teachers of computers as a learning tool is often delayed because of the misplaced belief that one has to be technically competent before one can utilise technologies n the classroom. Toomey *et al.* (2000) indicate that teachers and students become more comfortable with use when they realise that learning of technical skills comes with experimenting, failures and successes. It is about enhancing teaching and learning and not automating the process.

3.5 Lack of expertise and leadership

Teachers find watching and learning from other teachers helpful in their own adopting of technology. Learning about the capacities of new technologies occurs most often when there is some immediate problem and available hands on expertise to resolve it. Teachers gain confidence from seeing their colleagues innovating with technologies and in discussing how to address the specific pedagogical and curriculum issues that arise, particularly from teachers who have similar difficulties such as dealing with diverse student abilities and needs. There is little time for teachers to observe, visit or do professional development or to be involved in team teaching or planning.

There is a lack of expertise and leadership in innovative use of ICT. There are significant indications that school principals are not computer literate beyond the basics. Principals can be poor role models for teachers and students, meaning they are also unable to realise the needs of the teachers, respond to issues, or develop a vision about the innovative use of ICT. The report on Professional Development in Devolving Environments (Kenway *et al.* 1999) suggested that principals were not yet used to working with on-line materials.

Schools have very different levels of expertise (‘warmware’) in their staff profiles in the areas of information technology, literacy and educational disadvantage (Comber and Green 1999). Many teachers keenly feel that their own lack of competence and experience with new technologies is a major stumbling block.

Teachers face a double challenge in ‘learning how to use’ information technology and ‘learning how to teach’ with information technology. Given that little conclusive research has been done on the impact of information technologies on literate practices in communities, workplaces and schools, teachers are to a large extent operating without a blueprint. Teachers developed their own expertise in using new technologies during the course of the project (Comber and Green 1999).

Teachers do not know how to use the Internet, how to undertake searches, multimedia curriculum development, or how to cope with overwhelming information overload. They are not always able to make informed judgements about appropriate materials and technologies for different purposes and to judge effects. Software manufacturers often make claims about educational benefits for programs, and teachers can be as receptive to the persuasive tag of 'educational’ as parents are.

Web sources can be severely flawed and students and teachers need to be taught the capacity to make critical judgements about their value. ICT is not always the solution to the problem. Students and teachers need significant guidance. E-learning and multiple information and data sources do not make up for poor skills. There is a tendency to equate downloading to learning.

3.6 Teacher responses to fragility of ICT

Teachers respond to the fragility of ICT. The fragility takes two forms. One is the fragility of ICT in terms of the technical hitches that can occur in classrooms. Schools with high levels of students at risk, low income and high cultural mix are often more likely to have low levels of technical support and high teacher turnover. Technical fragility leads to high levels of teacher anxiety over use of ICT and this leads to avoidance behaviour rather than adoption activity. The greater the unreliability of the system the less likely teachers are to take up or continue to try and integrate ICT into lessons except in one off instances where reliability is guaranteed (Blackmore and Johnson 2000).

The second is the fragility of innovation that can disappear with the teacher, as in the case of Peter in the vignette above. Innovation fragility leads to intensification of more innovative teachers' work. More innovative teachers are also more mobile because they are likely to be in high demand.

Teachers and principals noted the importance of staff continuity in disadvantaged schools in implementing their school-wide professional development and enhanced curriculum and assessment practices (Comber and Green 1999).

3.7 Teacher resistance to change

The unpredictability of ICT is a factor in teacher resistance. Comber and Green (1999), and *Digital Rhetorics* (Lankshear, Bigum *et al.* 1997; Lankshear, Snyder and Green, 2000) suggest that for teachers new to using ICTs in the literacy curriculum, there are several common themes:

- new issues of behaviour management arise;
- demands of classroom organisation change;
- difficulties caused by unreliable hardware and networks; and
- unpredictable changes in teachers' and students' work.

For teachers working with disadvantaged students and in classrooms where there are high levels of disruption, this is an added dimension of uncertainty that requires significant risk taking on their part.

The use of ICT is now seen to change classroom dynamics and teacher and student relations. To fully integrate ICT into all aspects of teaching and learning, teachers have to adopt different approaches that encourage independent student learning, student rather than teacher focused learning, and problem solving rather than content oriented approaches. Computers, particularly for older teachers, challenge their sense of professional identity in terms of feelings of competence about the technical aspects of ICT, the changes in pedagogy, and the changes in their sense of classroom control. Teachers' sense of professional value is therefore challenged by these shifts in practice (Blackmore and Johnson 2000, 2001). Toomey *et al.* (2000) refer to initial response to ICT as being promoted by ignorance, fear of technology and non-acceptance of need to change. Learning about ICT requires a readiness to change.

Additional requirements to become skilled in the application of adaptive (assistive) technologies for students who have disabilities clearly challenges teachers and classroom aides who may already feel uncomfortable and lacking in competence (Blackwood 1999, Fine 2001, Lewis 1997).

3.8 Lack of time

Merton *et al.* (2000:iv) reported that lack of time release to learn to use technologies was the major barrier for 82 per cent of teachers in their implementation of ICT.

Schools have little time to encourage teachers to work collegially with ICT in ways that can benefit them in class. Yet studies indicate the effective use of ICT requires teachers with different skills to work together in planning. Planning and consultation is most important for dealing with students with particular needs.

Time is required to surmount logistical difficulties in schools such as timetabling, access to computer rooms, and the need for extra technical equipment for data projection, though none of these is insurmountable (e.g. Beavis 1998).

There are time, cost and copyright problems in producing on-line materials and CD ROMS. A great deal of time is needed to do sophisticated 'techno- presentations' (e.g. eight hours for a good *Powerpoint* presentation). Cost and time increase with level of interactivity of IT and complexity of the final product. Yet the key to maintaining interest is to be highly interactive.

4 Teacher professional development

While many teachers see the new technologies as providing much potential for both their own professional development and for their classroom practice, there are still significant barriers for many teachers, principals and schools.

4.1 Unevenness of professional development provision

The provision of teacher professional development is uneven and highly reliant on location and proximity to ‘professional development schools’ e.g. Discovery, Navigator and Learning Technology Centres. For many rural and isolated teachers this means that they are unable to observe other teachers or develop collegial networks.

Inadequate teacher training in ICT in poorer schools means that teachers focus on what they can do, that is, basic skill levels. Students in low income schools therefore tend to use computers more for rote learning and drill exercises. Wealthier schools can afford teacher professional development so that computers are used more often for complex learning activities. Consequently, economically disadvantaged students who often use the computer for remediation and basic skills learn to do what the computer tells them, whereas more affluent students learn to tell the computer what to do.

There is a need for systemic and systematic programs to upskill teachers, which go beyond the capacity of individual schools to deliver. This is particularly the case for mid and late-career teachers (Comber and Green 1999, Meredyth *et al.* 1999).

4.2 Content and focus of professional development in ICT

While there is general widespread professional development available to most teachers in basic skills in ICT, these are often only in short courses and there is insufficient follow up to consolidate skills, and move from skills to a more creative pedagogical use (Smerdon *et al.* 2000:iv).

There is less availability of teacher professional development for advanced skills development such as multimedia for multimodal teaching and learning.

There is virtually no professional development that focuses on the critical dimension of computer literacy, encompassing the political, cultural, ethical and social aspects that are most important when it means dealing with gender, socio-economic, cultural, and race difference in classrooms. Teachers identify a key issue their lack of knowledge about how to make professional judgements about the use of appropriate technologies for particular groups of students, and how to assess the outcomes i.e. how to deal with difference in the classroom. Such issues tend not to be covered in ICT professional development.

4.3 Teacher preferences

Teachers prefer using the Internet at home as schools have restricted access ('firewalls' installed to protect students form unsuitable sites). Even when access is possible, they lack the time at school and tend to do a lot of their professional development work online at home. As yet, there are few schools that provide 24 hour seven days a week online access to teachers or students, although this is a trend in some UK schools.

While online work is seen to be a solution for teachers in isolated and distant locations, the response is not totally positive. The loss of the social networks, due to overwork and distance, means that the notion of individuals undertaking on-line professional development in physical isolation from other teachers was not seen to be desirable. Teachers' preferred learning styles are face-to-face and print. If provided with online learning technologies (ITV (in full), e-mail, on-line etc.) they tend to download materials on the Internet, make hard copies, or video ITV sessions, in order to have portability and capacity to use the materials in their own time.

5 Systemic factors

Recent research exploring connections between pedagogy, ICT and learning outcomes indicate there are a range of systemic issues:

5.1 Lack of access

A key barrier identified in the literature review is the lack of universal access to ICT at school and at home for groups that are already disadvantaged educationally. This puts these groups further at risk given that universal Internet access will be become a basic precondition for equal opportunity in education and full participation as citizens and workers in a knowledge economy. Numerous international government and non government reports now map the growing digital divide between students, schools, regions and countries that are computer rich and computer poor. This divide is expected to widen without systemic and systematic interventions (Hoffman and Novak 1999). First order patterns of exclusion arise from lack of access to the Internet or computers. Second order exclusion arises from distinctions between ‘thin’ access (to poor quality ICT, out of date hardware and software) and ‘thick’ access.

5.2 Lack of integrated networks

Various strategies are being developed internationally and within Australia that seek to improve access to marginalised groups (Funston and Morrison 2000). These aim for greater availability (in terms of extent of use) and reliability (See Appendix 1). But there is not a national strategy that provides an integrated network providing access to all students, parents and teachers.

There are clear patterns of inequitable student access evident in Australia (Meredyth *et al.* 1999). Funston and Morrison (2000:41) in a study of *Young People's Access to IT* in Australia found that ABS data indicated that there was reduced access to the Internet / ICT according to family status (single parents), age (older), region/location (non-capital cities), cost (higher), income (low) and education (low). Students’ use of ICT was lower according to family incomes (low), school sector (Catholic and government), school location (rural and low income areas), school size (small) and gender (female). They concluded from their Australian investigation of 12–24 year olds’ access to ICT that 'few government initiatives target disadvantaged young people and most are focused on regional areas, even though there is a higher population of disadvantaged young people in the cities'. They indicate that projects aimed at interventions are uneven in distribution, uncoordinated, with some States having more comprehensive policies than others, but that the basic level of training available was expensive. Finally, there are some community-based organisations working in areas of technology services for young people, but they lack the long term support necessary for sustainability.

5.3 Low technology infrastructure

Areas of socio-economic disadvantage are further disadvantaged by lack of public and private technology investment. The demise of manufacturing and the capacity of information technology industries to outsource and be mobile have taken away jobs in the very areas where schools and communities are poorest. Lack of adequate technology infrastructure makes areas less attractive to business, further reducing employment opportunities. Added to this is the slowness in establishing necessary

technical infrastructure connected to schools. Students with disabilities from low socio-economic backgrounds are particularly disadvantaged in their use of advanced telecommunications (Meredyth *et al.*1999; Heaviside *et al.* 2000). Computer penetration tends to be lowest among rural and central city seniors and the youngest rural households (Goslee and Conte 1998, Cameron 1998). Educational attainment is related to telephone, computer, and modem penetration. The information poor will be further impoverished as government bodies, community organisations and corporations place resources from ordinary channels of communication onto the Internet. Neighbourhood organisations most likely to be assisting those in poverty are also impoverished and less able to invest in new technologies.

5.4 Remoteness

Poor quality and high costs of existing telephone lines to remote areas have prevented the residents of many communities from making use of specific forms of electronic communication such as electronic mail and Internet access. This is dependent on access to broadband. The unevenness of access is particularly evident for isolated students, such as those enrolled in the Kimberley School of the Air, who find it difficult to undertake what are relatively simple tasks of communication (email) due to poor availability (limited time and bandwidth), reliability and consistency across platforms.

In 1998 there was no coordinated approach to the development, or the use, of technological infrastructure in Aboriginal communities in the Northern Territory (Spiers 1998). While the NT Learning About Technology in Schools Project (commencing in 2002) seeks to address some of these concerns, the issue is wider than an education issue. In Australia, and most particularly for remote Aboriginal communities, ‘geographical limitations translate into educational deprivation, as it is the poor who are the most unlikely to own or have access to the means of program reception. It is inappropriate to assume that all learners have access to technologies including physical proximity’ (Doring 1994:69). There are issues about Internet access for remote communities and the barriers to access for remote communities. Poor telecommunications leads to breakdowns, delays and therefore access. Maintenance of equipment is essential for its ongoing use. Spiers (1998) talks about the poor quality of the equipment that is available to remote communities and the high cost of telephone lines. It is noted that ‘concerns were raised that there was, to date, no coordinated approach to the development or the use, of technological infrastructure on Aboriginal communities in the Northern Territory’ (Spiers, 1998).

5.5 Cost

Cost is a major barrier to connectivity. The high cost of hardware, software, network connections and telecommunications has considerable impact on poorer schools and families. Disadvantaged communities have high ICT costs, reduced public access, and limited transport to access sites such as libraries, Internet cafes, and educational institutions (Funston and Morrison 2000). Poorer schools have to restrict use of the Internet due to cost (Lawson and Comber 2000:428). Small schools tend to be more isolated yet in greatest need of access to information and learning networks.

The current trend towards pods of computers dispersed across schools is expensive with respect to Local Area Networks The alternatives, wireless computers, are even more expensive.

Schools spend significant time and energy on fundraising to buy equipment, network and maintain computers. This takes away time for innovation in pedagogy and curriculum.

The organisation of infrastructure is an issue. Any high bandwidth telecommunications delivery to schools requires pre-existing local area networks (LANS) of adequate bandwidth capacity local area networks. While the LAN requires only access to one service provider, any move to Wide Area Networks (WANs) often means low bandwidth capacities, making the WAN performance worse than the LAN capacity. Dark fibre can resolve this issue more cheaply in the long run, but requires a significant initial outlay. The area of greatest possibility is that afforded by wireless technology that produces tetherless LANS, although this cannot occur as bandwidth demand increases over a distance (DETYA 2001). There is an exponential expansion with increased use of different technologies e.g. videoconferencing, telephony, data sources and internet that makes this an exponential rather than incremental problem.

Cost and lack of funding are also significant barriers for students with disabilities and impacts on access to appropriate hardware, software and assistive technology and on ICT support for these students, their teachers, and school administrators (Blackwood 1999, Fichten *et al*. 1999, Leung *et al*. 1999, Lewis 1997, Soto 2001).

The different approaches used to secure funding for ICT equipment and assistive technology for children and youth with disabilities create confusion for schools and for parents. There are several sources of funding (Education Departments, Department of Human Services) and ways to have needs assessed (by staff from Education Departments, occupational and speech therapists from facilities such as Yooralla—Comtec and the Spastic Society). A clear, streamlined approach to securing funding for appropriate assessment, equipment (with a 'loan' or 'trial' period), and evaluation of needs over time is required (Heaviside *et al*. 2000, Soto 2001).

5.6 Technology rich and technology poor schools

The expectation that voluntary contributions largely fund computers and even professional development of teachers has meant that schools in low socio economic communities—often small rural or isolated schools with high numbers of Indigenous students, or large city schools with high levels of low income families and NESB students—are more likely to be technology poor. At the same time, there are increased expectations that good schools are ‘hi-tech’. Bigum and Lankshear (1998:68) comment on this compounding effect:

> The use of ICTs in schools always involves choices about resource allocation, often made more difficult because of the concentration of new ICTs in particular curriculum areas. Often this is driven by prior access to information and current technology resources, in order to upgrade and re-equip the school…Thus schools that are technologically poor in resources tend to get less, while those with some get more. The equity principle recognises this tendency and attempts to rethink the allocation issue in order to even unfair distribution across different schools sites.

Specialist schools

The take up of new technologies in schools is uneven because of uneven distribution of resources between schools within systems (Comber and Green 1999). Targeted funding to individual specialist schools can exacerbate the

digital divide further because these same schools are more likely to gain additional funds through specific projects from government and large corporate sponsorship that readily equates if not surpasses any additional equity funding that goes to schools with a higher concentration of students who are disadvantaged. Other schools can be discouraged as much as encouraged by technology rich schools being presented as models of best practice.

Specialist technology schools have more opportunities and dedicated policies, time and resources to develop best practice; the conditions under which they operate are exceptional in terms of staffing, ICT infrastructure and funding.

5.7 Sustainability of innovation

The sustainability of innovation is closely tied up with lack of infrastructure or ongoing systemic support. Short term funding prompts significant innovation in schools, with innovative projects such as the Information Technologies, Literacy and Educational Disadvantage Project (ITLED) and the Queensland School Reform Longitudinal Study (QSRLS) being extremely generative in terms of teachers' learning and professional renewal. However such projects take a toll on the staff not involved and create discontinuities for students (Comber and Green 1999). The lack of ongoing funding means that any immediate benefits disperse and any long term second level change in a school do not eventuate. There is heavy reliance upon teacher good will to put in the extra effort that can in time dissipate.

Furthermore, departmental priorities and policies produce competing demands on teachers' time, and they are often unable to focus on developing innovative pedagogies (Comber and Green 1999).

Inadequate ICT infrastructure in many schools makes it too difficult to initiate, least of all sustain, the types of curriculum projects they had designed to meet the needs of their disadvantaged school community.

While there is an increased expectation of implementation of new ICT, there is a lack of appropriate technical support from qualified people for an appropriate amount of time each week. Technology support is also required for skilling and supporting teachers in use of new or updated applications (e.g. MarkBook, MS Office and student profiling packages) and equipment and for maintaining equipment (Soto 2001). Support is also required to meet the special technology needs of students with disabilities (Blackwood 1999, Heaviside *et al.* 2000) and ICT staff are needed who have skills in this area (Bayha 1998).

6 Home, community and school links

Home school links are now seen to be critical in terms of which students use computers and the Internet, how they use them and with what effect on their educational achievement (Somekh 2001, Furlong 2000). Home access is dependent on school location, sector and SES, as rural communities do not have broad band access (Meredyth 1999, Somekh 2001). Student achievement is closely related to parental involvement and support and how students and parents of different socio-economic, cultural and linguistic backgrounds relate to schools and to the use of computers in schools. Familiarity gained through ready access to home computers encourages particular dispositions and habits that will have significance for later educational and employment opportunities and achievement.

6.1 Homelessness

Funston and Morrison (2000) identified a clear group of youth aged between 14 and 19 in Australia who lack access to ICT/Internet. In particular, many at risk youth, particularly homeless youth, do not know about alternative access and lack the confidence to use the free alternative access points even when they know of them. This is a key issue identified in this report.

6.2 Technology poor home environments

Attewell and Battle (1999:1) suggest that ‘pre-existing forms of social inequality may modify the frequency of home computer use and/or the ways computers are used, and hence affect the educational benefits derived from home computing’. The more technologically rich home environments become, the more opportunity students have for using computers. The pattern and level of use inside and outside home is closely linked (Meredyth 1999:xxvii). Students from higher family income and from areas with greater population density are most likely to begin earlier and have higher level of advanced ICT skills. Higher skill levels of students at school are linked to computer use at home.

6.3 Home advantage

Another barrier identified is the habits of computer use within the home. Parental acquisition and use of computers and peripherals, most often middle class parents in professional jobs or self employed, and their frequent access to the Internet for work and leisure, make computers part of the daily habits of life in some homes. This gives some students a distinct ‘home advantage’ in terms of developing the types of attitudes and dispositions towards the use of computers in schooling. Lack of parental support has been shown to actively inhibit students (particularly those with disabilities) from engaging in technology use at home (Anderson-Inman 1999).

6.4 Differential home use

Students from low-income homes and ethnic minorities are less likely to have computers in their homes. Although the differences are smaller than those for ethnicity and socio-economic status, there is also a gender difference in technology access to

computers, with boys having more home access than girls. There is also socioeconomic and gender differences also in use.

6.5 Libraries and alternatives

Funston and Morrison (2000) concluded that in disadvantaged regions in Australia (as identified through ABS Social Map), public access was usually through libraries. The distribution of access through local public and school libraries is exacerbated because of differences between suburban, rural and urban communities. While some provide free access, others charge an hourly rate, often higher in non-metropolitan areas. Services are restructured in terms of number of computers, hours libraries are open and level of usage. There is a direct link between wealth of libraries, neighbourhoods and the ability of a library to service its neighbourhood information needs. These patterns are replicated in schools, where poorer schools have more poorly resourced libraries both in-house and locally. Alternatives such as cyber-cafes are expensive.

Most young people who gain advanced IT skills gain their training through the public tertiary system, private providers or social networks from home. None of these options is available to disadvantaged youth who are most at risk i.e. those who are homeless, living in isolated rural areas, or with a physical disability.

But libraries can also be inaccessible, have limited hours and Internet time, and there is not the same pattern of use of libraries for Indigenous and students with disability.

6.6 Community–school links

Projects that are funded to make schools centres for community access to ICT provide access and training. The main problems are related to security and technical costs. They tend to build only low level technological and information literacy. These projects need long term funding to change community attitudes and improve the targeting of participants.

6.7 Different attitudes to computers at home and school

Most students and teachers are very positive about the use of computers in the home, but the vast majority are very negative about their use of computers in schools. Furlong (2000:9) concluded that this was because of:

- prescriptive use;
- slowness of hardware;
- lack of time for playful discovery; and
- limited access.

Schools do not utilise or value student or family cultural knowledge or ICT expertise but treat school and home knowledge as distinct.

7 Indigenous students

In many ways, both covertly and overtly, the school system is reinforcing the negative stereotypes about Indigenous knowledge, culture and heritage, and passing these attitudes on to Indigenous students. While there are examples of school communities together with the Indigenous elders and ancillary staff, being involved in projects directed at developing strategies that challenge education systems through linkages with community education networks, there are still limited numbers of Indigenous staff employed in schools.

Cameron (2001) sees Indigenous parents as not encouraging their children and girls in particular towards ICT as a career, and that this occurs early in school career. The image is to see ICT to be 'blokey and nerdy'.

The second order barrier as indicated in this report is the culture of the classrooms. ICT can be provided as an additional resource without changing the factors (cultures, literacies, attitudes, expectations), which inhibit the learning of Indigenous students in school classrooms.

Another factor inhibiting use of ICT in classrooms for Indigenous students is the culturally loaded software. There is debate over the cultural messages that are embedded in software and how to address this. This is an area where further research has to be undertaken. ICT is often discussed as if it is a medium that is totally culture free. However, in a lot of different ways, it presents culturally. The interaction with computers is not merely a technical one that is divorced from the culture of the students. Software packages tend to reproduce teacher centred classroom techniques, and a didactic type of learning environment. For this reason, technology can be very exclusionary. The issue for Indigenous communities is that this is another way of excluding them from the system. Hobson (1997) points out that these concerns are to be balanced by the advantages to the community of technology because while:

> the technologies can quite easily promote intrusive, invasive processes which are capable of posing a threat to Indigenous culture, [and which] impede the empowerment of Indigenous people, and attack the general integrity of community life. Equally, they can alleviate the dysfunctions of isolation and produce a more sensitive and interactive relationship between agency and community in which information and opinion is used to better define the terms of delivery (Hobson 1997:10).

In much the same way, there are also issues related to the production of knowledge that can be accessed electronically. Access to the production of knowledge by Indigenous communities is limited. This presents a problem in itself because:

> they must not only be consumers of information, but producers as well. They must contribute their share of content relating to (them), so (they) are represented aptly as the electronic information infrastructure evolves. Given the difficulty in accessing printed information about (Indigenous people), there is a very real possibility that cyberspace will inherit those same roadblocks. Today a surfer may be hard pressed to access substantive, organised information, or (Indigenous communities) may be there, but it will likely be buried under ephemeral or euphemistic descriptions and subheadings. Thus, the literature and cultures of (Indigenous groups) may be lost in Cyberspace (Evans 1995:46).

8 Students with a disability

For teachers of students with disabilities there are barriers related to teachers' attitudes: teachers' discomfort with disability, fear of failure, personal insecurity and feeling undervalued. These are often coupled with teachers' technophobia, fear of the frequent breakdown of equipment, the lack of funding, the lack of availability of technology 'on loan' or 'on trial' and the limits of the technology in terms of what it actually achieved. The following barriers are also identified:

- As for other areas of disadvantaged groups (particularly for Indigenous, girls, rural, and lower socio-economic background students) the lack of opportunity and encouragement from home, school, and community to become familiar with technology (Meredyth *et al.* 1999).
- The lack of access to equipment and to an adaptive technology (Young, 1998, Penney & Associates Ltd., 1996).
- Communication barriers (for example, no verbal language, languages other than English, including Auslan (Penney & Associates Ltd., 1996).
- Attitudinal barriers such as assumptions of what students with disability can and cannot do (Penney & Associates Ltd., 1996).
- Cost of hardware, software, and adaptive technology for students with disabilities as for other students (Fichten, Barile, and Asuncion, 1999).
- Cost of adaptive technology (in addition to initial costs of computers) has been seen as prohibitive in special schools in Australia. Because different students have different needs, principals and teachers feet the number of computers in special schools need to be proportionally higher than would be found in a regular school. Students with speech and vision impairments are seen to be the most expensive groups for which to provide adaptive technology and it is recognised that the larger group of students with learning difficulties also requires expensive assistive technology such as word predictions software. Costs involved in buying, maintaining, and upgrading equipment, are exacerbated by often being required for just one student (Blackwood, 1990).
- Lack of training for special education teachers in use of advanced telecommunications (Heaviside *et al.*, Blackwood 1999).
- Inadequate evaluation and support services to meet the special technology needs of students with disabilities (Heaviside *et al*. 2000).
- Lack of assistive technology (input and output devices).
- Lack of availability of computers to students with disabilities.
- Low socio-economic background and large school size and the resulting negative impact on use of advanced telecommunications (Heaviside *et al.* 2000).

Another concern is that the provision of access to ICT for disabled students from home means that they do not have to venture out and be integrated into schools, a high cost strategy. Any discouragement of students with disability from moving out into mainstream, where possible, can lead to isolationism and poor social outcomes.

Conclusion

The identification of barriers to effective implementation of ICT reveals that ICT can have a multiplier effect on both disadvantage and advantage. The ‘Sesame Street effect’ suggests that while innovations such as ICT promise to help poor children, in practice they can indeed increase not decrease the educational gap (Attewell and Battle 2001). Schools can exacerbate the social, cultural and, in the case of computers and Internet, material capital of individual families, thus magnifying home advantage. Schools reproduce and exaggerate this disadvantage because of the close links between family poverty, racial and cultural mix, and poor schools and neighbourhoods. Disadvantaged schools in this instance are those that lack the material capacity to purchase and maintain adequate technology infrastructure and to train teachers in both the use of the new technologies and their use for improving learning outcomes.

Section F Issues and Further Research

This report undertook a literature review that considered the effects of ICT on the learning outcomes of students who are disadvantaged. We mapped how the focus of policy and practice since 1990 has shifted away from access, funding and operational issues towards the issues of pedagogy, curriculum, and educational policies that focus on equitable outcomes.

We looked at leading practices in the field and strategies arising from those. We found that while they still concern classroom practice, the leading practices and strategies point to a need for coordinated support, policies and practices at school, system, community and national levels that can focus on issues of difference. This infrastructure and support makes innovative strategies using ICT possible in the classroom.

Teacher professional development that takes into account the three dimensions of digital literacy, operational, cultural and critical, and focuses on difference and equity is critical to the successful use of ICT. Professional development is both a major barrier and a major strategy.

We then considered the barriers to the most effective use of ICTs in the classroom, school, system, home and community. We noted the complexities of ways in which gender, socio-economic status, race, ethnicity, Indigeneity, and disability interact when ICT is integrated into teaching and learning.

While the focus of the report has been on what ICT can do to promote the learning of students who are disadvantaged, both researchers and practitioners are only just addressing this question. We found that there is little comprehensive research into classroom practices, least of all with respect to disadvantaged students, although there are innovative practices occurring unevenly and randomly in schools and classrooms that are neither documented nor evaluated. Systems, schools and teachers are only beginning to address ICT and integration into the curriculum, pedagogy and assessment practices.

This chapter discusses those issues that are significant for policy makers and practitioners in terms of present and future effective practice with regard to ICT, learning and disadvantage. The chapter concludes by identifying areas of further research.

ISSUES

1 Universal access

Is universal access a solution to the problem of digital divide? The report suggests that universal access to learning technologies is a first order issue as ICT increasingly becomes a necessary basis for full participation in a democratic society and work. Poverty, low income and isolation are therefore first order barriers because they are about access.

Universal access and national grids have the potential to liberate and strengthen the voice of the dispossessed and poorly represented in society, and to join them in new global networks that might assert more powerful identities and agendas. These same national infrastructures can, on the other hand, also be seen as tools of surveillance, standardisation and mass marketing (Angus *et al.* 2001). The feasible effects of ICT in changing existing social and political identities (and presumably, changed power relations and social transformation), given that ICTs are also expensive pieces of electronic machinery, may lead to the reproduction of existing patterns of social and economic (dis)advantage.

The dilemma is that while ICT can enhance the learning outcomes of particular groups, e.g. isolated and Indigenous students, there is the danger that as ICT is integrated further into curriculum and pedagogy, it becomes taken for granted. For example, mathematics curricula are based on the assumption of easy access to computers. Thus even greater inequities can ensue for students in technology poor schools and families and those with disabilities.

The issue here is how to prevent the escalation of the already emerging digital divide as computers and the Internet become more widely used in schools.

1.1 Commercial partnerships

One approach to the issue of quality access is to encourage partnerships with business to fund infrastructure and equipment. There are major benefits gained from partnerships or sponsorships to assist disadvantaged students and schools. This is not common in Australia, although the ACTU program (Angus *et al.* 2001) is an example. As Mean and Olsen's (1995:148) study of how ICT was a force for reform in nine US schools concluded: 'It was no accident that only one of our nine sites was able to launch their technology intensive reform agenda without a significant level of funding from organisations outside the education system. In eight cases, private corporations and foundations and/or research organisations external to the schools were pivotal'. But ICT also provides the opportunity to package or commodify curricula that are neither culturally or gender inclusive nor based on educational principles of inquiry. Commercial assistance can lead to further exploitation of students who are disadvantaged through programs that encourage them to be consumers rather than producers, and non-critical consumers at that.

The issue therefore is on what basis or agreements should such partnerships be encouraged and established?

1.2 Locational disadvantage: rurality, isolation and the urban fringe

Funston and Morrison (2000) in their analysis of access of young people to ICT not only pointed to rural and isolated students, but also identified Melbourne as having some of the key areas of disadvantage. The report indicated the lack of comprehensive access to ICT or the Internet for disadvantaged groups. They concluded that IT was less accessible to marginalised groups in isolated, rural and outer suburban areas. Although IT skills are important to young people for work, leisure and life-long learning, access is very poor for indigenous young people, with some exceptions. State departments of education are developing strategies. Examples include: desktop video conferencing in SA (Edmonds 1996); electronic learning materials using pdf files in WA (PRISM 2001) and in Queensland for isolated and distance education students (Carter 1998); and the new model of teacher and leader professional development on line in the NT. While there are still significant issues for rural education, there is less attention paid to the significant pockets of poverty with poor infrastructure in and around metropolitan centres. Development of such infrastructure requires significant systemic intervention.

2 Home–school links

First order issues of access are compounded by second order factors around the home–school links and quality of access that impact on the effectiveness of ICT use in school. What is worrying is that there is every reason to believe that it will be the skills and strategies found at home, rather than those currently promoted in schools, that will be essential for the educational success of our children in the new millennium. The increased significance of home–school links when ICT is factored into learning and success compounds existing inequalities. Socio economic and cultural factors produce forms of familial cultural capital that are critical in developing familiarity with computers and predispositions or habits of use that more closely converge with schoolwork and future employment.

While the report argues that there is a need for improving home–school links, and that students benefit from improved quality and quantity of home access to computers and online, putting computers into the home cannot be seen as an equaliser in itself. Furlong *et al.* (2000:108) maintain that:

> With the NGfL, issues at home will be paramount. Yet our evidence is that access at home is anything but egalitarian. A significant minority of young people are denied access because their families cannot or are unwilling to purchase and constantly update equipment. And in those families that can purchase it, the 'socialisation' of the technology means that access to the new vision is likely to be patterned in highly traditional ways. Some young people (those from better off families, those from families with appropriate cultural resources, boys more often than girls) are well placed to exploit the benefits of the promised revolution, and their learning experiences at home will fit them well for the technologically rich but unpredictable world of the future. Others, who for whatever reason are denied that access, … will be excluded.

The review also clearly points to the need to explore home–school links, and to appropriate the skills of parents. The links between learning and familiarity with ICT signals the need for particular equity groups to gain access at home early in their lives and years of schooling. They are then more likely to acquire the habits of digital literacy. This will have longer lasting effects in terms of attitudes to computers and self-confidence, and in the long run could be assumed to contribute to improvement of learning outcomes, although research is not yet available on this.

The paradox is that schools tend not to take into account what digital literacies are learnt in the home and assume that the digital literacies are learnt at school. Research indicated that teachers had very little sense of which or how many students had computers at home (teachers' estimates varied from 'perhaps up to 25%' to 'at least 75%) or of levels of computer competence. Angus *et al.* (2001) documented the disappointment among students in the way computers were used at school. An activity young people enjoy at home could become boring at school because it is incorporated into the typical practices of school life, which they see as boring. Students resented what Furlong *et al.* (2000:103) call 'the need to surrender control to the teacher'.

This requires significant rethinking on how teachers use ICT to tap into student interest for motivational effect and to exploit ICT's capacity for more independent learning and inquiry.

2.1 Schools as community ICT resources

The report indicates the need for schools to bridge the home/school ICT gap through greater flexibility, in order to provide students most in need with ongoing access to ICT. Access can be partially achieved through schools contributing to community based infrastructure, by increasing access to school computing facilities and to libraries, for example. But as indicated, there are significant limitations, given that extending school hours requires increased administrative, maintenance and supervision costs in the very communities and schools that are poorest, most isolated and unable to gain sponsorships.

This highlights the need for system wide focus on educational communities that are technology poor.

3 Literacy and disadvantage

Increasingly, reading and writing practices, conceived traditionally as print-based and logocentric, are only part of what people have to learn to be literate. Being literate also involves understanding the complex ways in which the written, oral and audiovisual modalities of human communication are integrated into multimodal hypertext systems made accessible via the Internet and the World Wide Web (Angus *et al.* 2001:2). Much of what is understood as good teaching and valued curriculum focuses on print literacy rather than visual, aesthetic and digital literacy. There is a tension between what is considered 'proper work' in the classroom, and the possibilities made available through the use of ICT that allow play, performance and problem solving as more authentic learning experiences for many students. This is most evident in the debates over the value of popular culture, including the arts, in the curriculum. To effectively use ICT, teachers need to recognise and draw upon what students do at home and in their leisure, and the types of expertise students bring to school.

There is another dimension to the literacy issue. Foundational literacy skills are essential to the effective use of ICT, and ICT can assist in the teaching of foundational literacies. But often this is where the use of ICT stops for poor literacy learners. Yet the strategies suggested in this report, such as the cultural apprenticeship model, indicate that ICT can have significant motivational effect when it captures student leisure interests and out of school knowledge and skills. In primary school in particular, there can be a tension between focusing on the basic skills in print literacy, and on multimedia, digital, or network literacies (Sefton-Green 1999:146).

Secondary schools are dominated by examinations that similarly are based on print literacy. For secondary teachers, there is a constant tension between disciplinary based curriculum and cross curriculum activities, and also concerns about who is responsible for literacy. When used across the curriculum in interdisciplinary problem solving ICT is one way of encouraging teachers in all subjects to take responsibility for digital and print literacy. These tensions arise out of systemic dispositions that encourage images of good students and good schools as being academic, and performing in a narrow range of print based literacy skills in assessment and examinations. This tends to exclude schools and students which are seen as 'different'.

The question therefore is the extent to which the integration of ICT will force a broadening of curriculum and assessment practices to include a wider repertoire of literacy dispositions.

Teachers need to be encouraged to move beyond a focus on foundational print literacy and numeracy, to avoid the equation of poor literacy with disadvantage, and to encourage the development of higher level digital literacy skills that would derive, for example, from problem solving. The aural and visual, for example, are areas in which students who are disadvantaged can display a range of interests, knowledges and competencies, as Means *et al.* (1995) found:

> Technology, project based learning and advanced skills are not the exclusive province of economically privileged or fluent English speaking students. These approaches are powerful motivators for students from all economic, linguistic and cultural backgrounds. The most economically disadvantaged students in our society can

> use technology tools to support their learning to create high quality products and support collaboration with others (Means *et al.* 1995: 6).

The issue is how can systems recognise the wider range of learning outcomes that disadvantaged students may display if ICT is to be used effectively in culturally and gender inclusive ways?

4 Challenges of change

The integration of ICT has been in many cases a catalyst for reform in disadvantaged schools (e.g. Means *et al.* 1995). The ethnographic studies of how teachers adopt and adapt to initiatives such as the integration of ICT in classrooms confirm the basic tenets of educational change theory and school improvement literature. These are:

- Ownership of the initiative is critical.
- Teachers go through series of attitudinal changes as familiarity increases.
- Phases of change that schools, teachers and students go through means significant length of time before there are significant outcomes.
- Teachers who are enthusiastic about teaching and learning and their students are more likely to take up new technologies.
- Teachers require support and respond to recognition about innovation or implementation.
- Dedicated and strategic funding supports change.
- Teachers respond positively to visible involvement in change projects.
- Teachers as researchers can affect change and implementation of policy.

At the same time, ICT introduces new factors into the change scenario.

4.1 Changing pedagogies

The report points to the possibilities of ICT being a catalyst for change in schools and classrooms. ICT can radically change the habits of teaching away from teacher-centredness and control in the classroom to a student-centred approach. But this requires changes in teacher attitudes to curriculum, pedagogy and assessment as well as attitudes to ICT. This review points, as does other research, to the centrality of teachers and good student interaction in order to improve learning outcomes. It stresses that this is even more important for students who are disadvantaged as it is the social relationships of learning as much as the cognitive demands that facilitate engagement with learning. The report confirms recent Australian, English, and American meta-studies that emphasise the importance of teacher quality, teacher student interaction, teacher beliefs and expectations and teacher professional development as the most powerful contributors to student learning (Ed Queensland 2001; Darling Hammond 1999).

New learning technologies can enhance learning only if teachers begin with good pedagogy. Good pedagogy requires planning, attention to content for issues of inclusion, and awareness of the dynamics of classrooms and student learning preferences. Teachers are particularly important in identifying needs of students who are seen to be disadvantaged, and judging the appropriateness of tasks and technologies. Teachers in high technology classrooms are expected to orchestrate classrooms in which students pursue different questions, work at different speeds, use different materials, and work in flexible groups. Students will be working together with original data sources, unknown to teachers, to produce demonstrable products and performances. ICT is seen to enhance these possibilities of teaching for difference, The report signals that for effective learning that involves ICT there should be use of multiple teaching and learning strategies, multiple modes of

assessment that address all the multiliteracies, and multimodal presentations and performances that ICT makes possible.

This requires teacher professional judgement and autonomy. It also requires teacher support, planning, coordination, and facilitation so that students own their projects and feel responsible for their own learning.

It is because of the complexity of ICT that when fully integrated and resourced it usually transforms the nature of teaching and learning, and human relations by becoming more student centred, problem based and cross disciplinary. It is therefore difficult to disaggregate ICT effects from other effects e.g. innovation and new pedagogical approaches.

This gives rise to the question: can these new pedagogies be introduced without computers? Are computers merely just an 'intervention' that requires teachers to rethink, reflect, evaluate and reorganise their classrooms that can improve learning?

If best practice in using ICT to enhance learning for students who are disadvantaged is just 'best practice pedagogy', then should schools invest more in developing teacher pedagogical repertoires that deal with difference more effectively rather than expend resources on ICT? There are no cost-benefit analyses to point the way.

Alternatively do computers offer social and psychological benefits that more traditional methods do not, such as improved motivation, engagement, sense of success, presentation, and increased independence? While not improving learning outcomes directly or in the short term, these socio-psychological outcomes are more likely to encourage students to stay on, work harder at their schoolwork at school and home, develop a range of multiliteracies that will have later less obvious benefits, and to consider a wider array of employment possibilities.

4.2 Student centred learning

A key theme that emerges is the focus on student centred learning in technology rich classrooms. A reason suggested for students' enjoyment of computers is the sense of their own agency and capacity to make decisions, an important factor in maintaining engagement in learning and retaining students in schools. The ITLED students responded very positively to the opportunity to act as co-researchers, documenting the project and contributing to the data production (Comber & Green 1999). Rowan *et al.* (2001) in their case study (see Vignette 18 in Leading Practices) found that there was increased engagement when students were given greater autonomy over how they learned. Many studies focusing on students at risk (e.g. working class boys) indicated that student achievement and attitudes improve with increased student voice. This confirms research that reports that adolescents at risk of leaving school cite poor interactions between student and teacher and between their peers as reasons for their disengagement with schooling. But ICT does not in itself change social relations. It has the potential to do so if teachers work consciously to reorient their practices. ICT does have the capacity to enhance how teachers involve students in curriculum and assessment, in ways that recognise all aspects of their learning and provides new ways of representing themselves and their schoolwork.

Against the advantages of independent learning run a number of disadvantages. When things do not work, student disenchantment is considerable (Comber & Green 1999). Multi-modal ways of learning leads to increased choices for teachers; they need to consider the purposes, the audience and the expected consequences of these ways of learning. Particularly important is the need to recognise cultural diversity, learning preferences and different physical and mental capacities.

Systems and schools need to develop more sophisticated understandings as to what student centred learning means for classroom practice and for teacher professional development and articulate policies and programs that focus on teaching for difference.

An associated point is that the interactivity of the Internet and software in which content is no longer fully controlled, raises the issue of agency and different ways of knowing, the danger of being overwhelmed and lacking direction. Independent learning needs to be planned for. The core question according to Stahl *et al.* (1994) is the extent to which unlimited information and communication enhances learning. For teachers, it is the unlimited information available on the Internet that poses difficulties, as they have to spend time finding and judging useful sites. For students it creates greater access to more data and information, but it is questionable as to whether this is about the core knowledge required for them to be critical thinkers. To think of themselves as knowledge producers as well as critical consumers is a key element in students gaining a sense of agency through the use of ICT.

Much attention is focused on learning how to learn, but less is focused on how students learn to make choices between an array of truth claims about knowledge (Cusack 2001), that is, critical literacy. What is the role of schooling in a knowledge based economy as information transmission becomes less important and judgements about relevance, credibility, and reliability become critical? As students become knowledge producers and not just knowledge consumers, the notion of students as 'apprentice knowledge workers' and teachers as 'expert knowledge workers' takes on new meaning (Downes 2001). Are computers essential to students becoming cultural producers or do they merely enhance that process?

As the operational dimension of digital literacy becomes more universal, the cultural and critical dimensions of digital literacy become more important. This has significant equity implications. If students who are perceived to be disadvantaged continue to be taught primarily operational dimensions of digital literacies but not the cultural and critical dimensions, then they will not gain the same sense of agency and independent learning.

4.3 Changing assessment

Assessment becomes an issue because of the possibilities provided by multimedia workstations, peripherals and the Internet to students as knowledge producers and disseminators. As the use of multimedia multiliterate presentations and performances becomes possible and more taken for granted, students can demonstrate new learning outcomes such as creative problem solving strategies or collaborative work. What are the criteria upon which such work is judged? Rewarding students for what they do (authentic assessment) requires more flexible and multiple modes of assessment (e.g. digital portfolios). This is in addition to standardised assessment, multiple choice, or examinations. Students who experience failure in standardised tests are likely to be those who will benefit most from a wider range of assessment tasks that take into account all the literacy skills they possess. How will these new literacy skills be assessed?

In particular, the product of much multimedia work is itself a cultural product. ICT indicates that assessment will be more about performances using multimedia presentations to a range of audiences exhibiting a range of multiliteracies. Booth (1999) indicates how digital technologies can facilitate new opportunities for young people to publish for a peer audience as students become cultural producers in their own right. In so doing, children's confidence in their abilities improves because of the significant planning and organisation required.

This immediately raises issues about how to make judgements about what is learnt by students, and how to consider what are desirable outcomes. Meredyth *et al.* (1999:xxiii–xxiv) argue:

> Information technology skills should be conceptualised broadly and should emphases learning how to learn, rather than the acquisition of specific technical skills that will need to be frequently unlearned. Students will need the capacity to cope with change and accept innovation, and their skills in using information technology will be inseparable from their analytical abilities and their capacity for creativity, team work, problem solving and communication skills.

The introduction of ICT into the classroom signals another shift in the assessment paradigm that has yet to be addressed in the research or practice. Young people who use ICT may be learning in quite a different way to that for which traditional measurement tests were designed.

ICT raises issues about how learning is understood as both a process and a product. Does one assess the process as well as the outcome? Sefton-Green (1999) points to the question of teacher evaluation of multimedia work as being central and asks these questions:

- Is it to be evaluated on the basis of the criteria usually used in a subject or on the nature of the production?
- What are the criteria that teachers will use to judge the complex decisions and processes underpinning the final 'product'?
- If assessing digital literacy is left at the operational level i.e. proficiency with ICTs, it would most likely show boys as doing better. Assessing the cultural and critical dimension of digital literacy raises new questions. Perhaps girls would be less disadvantaged, given their interests and the ways they use ICT?

Related to these questions is to explore how teachers can better judge the appropriateness of software, and also how software developers are made aware of issues such as pedagogy, assessment and inclusiveness when developing curriculum materials.

Patricia Broadfoot (1996) argues that there is need to consider the types of assessment more suitable for aesthetic and visual literacies, and that such a widening of assessment practices can be more inclusive of a range of capabilities generally less recognised in current assessment regimes. The international trend towards competency based and criterion reference assessments can also be seen to be a reflection of post-industrial society which needs to encourage 'learners how to learn'. It is a consequence of the realisation that academic results do not indicate a good worker, but that the post-Fordist workplace requires a different set of 'attributes', a new type of multiskilled, flexible and adaptable worker who has a range of generic skills (personal, interpersonal, as well as cognitive).

4.4 Teacher practitioner research

What many of the qualitative projects exploring disadvantage, ICT and learning highlight is the importance of teacher practitioner research in partnership with universities. These action research projects, while expensive and time consuming as a model of professional development, encourage teachers to reflect on their practices and to engage with other teachers and researchers to seek new understandings. Such approaches develop the cultural and critical dimension of

digital literacy in which ICT is no longer the focus but issues of inclusivity and difference are.

This highlights the danger that when ICT becomes the focus of curriculum and pedagogy, that it is very easy for disadvantage to 'fall off the desk'. There is a 'notable absence' in teacher, parent and policy discourses of the role of computers in future society and the importance of understanding the social, ethical and environmental consequences of evolving technologies and their uses (Downes 1996:281, Nixon 2001). This is the critical dimension that has been neglected in professional development with the absorption of all stakeholders in schooling in the operational and cultural dimensions of learning about ICT and learning how to use ICT appropriately.

4.5 Sustaining good practices and innovation

A key school organisation and leadership issue is the sustainability of good practices. Most often, the integration of ICT in schools is uneven, tends to be in locations where there is a particular fortuitous combination of personnel, a readiness to innovate, ICT resources, and parental involvement that can be funded by national programs.

In disadvantaged schools the issue is how to sustain this desire to innovate and deal with difference when often these very teachers who are committed to addressing inequality are those that are most desired by other schools, and/or are often working in poor technology environments and are therefore most likely to suffer burnout. Innovative schools are more vulnerable because of the reliance upon individuals rather than teams. Funding for programs addressing either disadvantage or ICT innovation are generally short term, discouraging long term planning, evaluation and follow through in which successes can be identified and built upon.

It is important that teachers' and schools' energies are not wasted when they make a considerable investment into developing pedagogical uses of different learning technologies. Sustainability of ongoing improvement that focuses on equity issues requires:

- long term support of school administration that will focus on equity;
- retention of a committed core of teachers, who are the leaders and innovators, in the use of technology in pedagogically sound ways for students who are disadvantaged and in schools;
- teacher time: teachers are continuously overloaded in regular duties, they lack time for reflection on own practice or collaboration;
- teacher mentors lack time and flexibility to provide one on one training or classroom assistance to teachers on a needs basis;
- innovative teachers lack time to experiment and develop new technologies; and
- long term support for infrastructure and ICT maintenance.

These factors are doubly important for teachers working to develop ICT curriculum and pedagogies which address individual and group differences. While ICT adds to the repertoire of pedagogies, it also adds a complex dimension that takes more training, planning, energy and reflection as the field is moving quickly and in various directions.

4.6 Time

As indicated above, the use ICT effectively is more not less time intensive, and it requires increased school planning and teacher professional development that is time consuming and expensive.

Many studies of school reform conclude that time is critical to produce second level change and a chance to judge effects. There is little research and few evaluations of generalisability or depth, or that undertake longitudinal studies, which might indicate how long fundamental change takes.

Change theorists argue that fundamental second level change is necessary to fully integrate ICT into classroom practice in any meaningful and equitable way. Time is also necessary before benefits are evident. This is particularly the case for ICT, which requires significant initial and ongoing investment of time, e.g. establishing infrastructure, training staff, school planning and organisation. Case studies that have mapped integration of ICT into schools indicate that early stages are piecemeal and fragmented.

An additional time consuming factor when it comes to students who are not achieving to their ability is the issue of identification of need prior to identification of suitable software, hardware and pedagogy.

Time is critical in working with local communities to develop community based practices that are inclusive of a range of cultural beliefs. Again, for such students, improvement is often incremental, and can be several years down the track before significant effects can become evident.

4.7 Program evaluation

There is the irony that most ICT programs and innovations are initiated at great cost and yet not adequately evaluated. Somekh (2000:1) suggests that ‘evaluation is an essential, integral component of all innovative programs, and is particularly important in the field of ICT because of its complexity and the technical demands it makes on users’. She points to how lack of evaluation has costly effects in terms of promoting ineffective programs. There is a tension between trial and error and time required to make ICT effective and decisions based on cost effectiveness e.g. size. The evaluation should focus on both the products of ICT programs and the processes by which the program teams carry out the work as the focus is on teams (For an example of evaluation, see Appendix 4).

5 Teaching for difference

The report's main finding is that ICT can enhance the learning of students who are disadvantaged only when teachers are taught how to work with difference and how ICT mediates difference within classrooms. The literature tends to fall along relatively simplistic categories of difference—gender, socio economic, race and Indigeneity to the neglect of NESB. The research into the micro dynamics of the classroom does not address the way that ICT mediates the complex interactions between gender, class, race, and NESB. The evidence suggests that it is white middle class boys who benefit most in terms of access, participation, retention and post school occupational success when it comes to ICT.

5.1 Gender

Gender inequality is as much about how gender is problematised. Currently it is problematised as girls' disinterest in computer studies and under-representation in science, technology and maths in school and in future education, training and employment, and boys under achievement in literacy and associated disengagement with schooling. From this analysis, for girls, computers are the problem; for boys, computers are the solution. Neither of these ways of problematising gender is helpful in that they ignore how computers mediate the social relations of gender in the classroom, of how computers become actors and agents in the ways in which their presence constructs gendered behaviours. Indeed, the report suggests that computers have marginal effects on achievement, and even then effects are in some studies seen to be greatest for those already high achievers. Where ICT does have significant effects is in terms of motivation and engagement as well as the organization and presentation of school work; and this is particularly important for possible long term, but as yet not researched, student retention and achievement.

While computers significantly alter the social relations of classroom, the dilemma is that they can exacerbate existing differences between boys and girls. Boys continue to be turned off by content that is seen to be feminine, because of their strong sex stereotyping and sense of masculine identity. They tend to work better with girls than in same sex groups where they are highly competitive and into control, but work in mixed sex groups to the detriment of girls' agency. They are less prepared to work on tasks that are not highly male specific and of immediate interest. They have an over developed sense of their own competence. Girls are 'good students' in that they, despite not being attracted to computers for play and games, are willing to use computers when required for a specific task. They do so with equal competence to boys, they tend to work better in same sex pairs than boys and also in collaborative tasks with high levels of verbal interaction, engagement and negotiation. Their cognitive achievement is the same as same sex boy pairs in collaborative tasks. Girls will achieve the same as boys in tasks that have little relevance to their experience or interests.

Girls and boys see computers as being associated with particular forms of masculinity. The issue here is as much about gender identity formation and what it is to be male and female at particular ages, as seen in the changing attitudes of girls to computers in the middle years. The paradox is that the association between computers and masculinity turns off most girls and some boys as they are not

relevant to their interests and needs because computers studies, games and programs are not girl friendly, but attract most boys because most tasks are associated with male activities such as action games, sport and cars. Boys dominate overall computer use, course enrolments, programming, content, and games.

The issue is not just how to engage girls so that they use computers more like boys but to recognise that girls and boys use ICT differently. This creates the need to develop software programs, curriculum and pedagogies that capture those computers effects e.g. communication and email, that benefit and engage girls more. More broadly, the problem is as much about the construction of particular masculinities and femininities in relation to each other. The educational issue for boys is how to broaden their views about what it is to be male, to both provide boys with more options in their identity formation and to encourage them to recognise girls' capacities and options. It means encouraging boys to be more open to a wider range of content online that is gender inclusive. There is a need for boys to acquire a wider range of skills in communication, negotiation and social interaction when working with computers.

The issue for girls is how to attract them to ICT and the subjects that will provide them with greater occupational benefits, such as technology, science or maths. This will not only that broaden their occupational choices but also address what happens in those occupations once girls enter the workplace. This points to the importance of gender inclusivity in pedagogy, curriculum and assessment. It means offering a range of tasks that provide relevant experiences for boys and girls, while recognising that what may benefit some boys may disadvantage girls and vice versa.

Intersecting these debates are issues of culture and race that are not dealt with in the research literature.

5.2 Ethnicity

There are few studies that consider either the ways in which cultural differences and in particular English language capabilities can impact on the use of computers and student achievement. While many studies were undertaken in culturally diverse with multiple language background student populations, the analyses in most instances did not mention either cultural background or English language skills. The focus tended to be more on class, race and gender.

Of those studies that did deal with cultural difference, largely American, there is clear evidence of cultural differences in access, predisposition to use and outcomes (Hoffman & Novak 1998, 1999). In the US, Hispanic and indigenous populations were low users compared to white, Asian and Afro Americans, although there was a distinct gap in access between white and black populations. In particular, the focus is on how cross cultural and inclusive pedagogies can be utilised on line (Gale 1995) and the cultural appropriateness of particular software, That is, how to include diverse cultural referents in software programs (Timm 1999).

Much of the research focuses on English language capabilities and whether this has detrimental impact on computer use, particularly in the young, as well as the dominance of particular cultural representations in the content of the software. Where cultural differences emerged in the literature, attention focused more on cultural representations in the visual aspects of multimedia and the cultural and gender biases of software. ICT is seen generally to provide significant opportunities for developing

cross cultural understandings amongst students (e.g. Bennett & Walsh 1997, National Endowment for the Humanities 2000). Examples of programs to achieve this include Cultural Connection programs, that focus on teacher collaboration, curricular activities, identity-forming multicultural activities, interactive videoconferencing, multicultural understanding, and students' positive self-concept (e.g. Cifuentes and Murphy 2000). In after school games sessions using computers it was found that minority children learned to master a series of educational computer games through reading instructions, interacting with peers, and interacting with adult mentors. Results show how an informal educational environment can foster problem-solving skills that transfer to learning (Mayer *et al.* 1999). There was some evidence that because computers fostered small group discussions and teams this has a capacity to encourage greater cross cultural sensitivity and more culturally inclusive classrooms (de Voogd 1998). At the same time, cultural myths and stereotypes are more difficult to change through computer mediated discussions amongst teacher education students (Appelbaum *et al.* 1995).

Overall, there were similar findings with respect to multicultural education as in the case of gender and race. Effective teaching of minority children involves them in decision making, challenges them, offers meaningful learning experiences, provides autonomy, and holds high student expectations (Chisholm 1995).

Much of the research in this area is American, looking particularly at Mexican American research, with very little based in Australia. There are some statistics that indicate that NESB students are high users of computers, but because these are not disaggregated by country of background or gender, these figures are not particularly helpful.

There is recognition that socialisation and cultural experiences shape how students understand and learn. Students' perceptions, interpretations, problem solving strategies, and communication styles are the result of their cultural frame of reference. These are all critical when multimedia becomes a major learning tool in classrooms.

Geissinger (1997) refers to the importance of culture (the culture in which a software program is developed and the cultural values brought to it by users) as a necessary part of the social evaluation of computer media. This tends to be ignored by many instructional developers.

Timm (1999) lists the issues that teachers have to be aware of when introducing computer technology into culturally diverse classrooms:

- Socio-economic advantage and prior experience—teachers need to recognise that familiarity leads to greater confidence in use and also that computer use is most readily transferred into other multimedia experiences.
- Cognitive learning styles—context specific learners take more linear than non linear steps in a hypermedia tasks in comparison with issue oriented learners. The field dependent students (former) were more active and experimental than the independent learners (latter).
- Linguistic considerations—particular voice-overs and auditory cues make text more meaningful and can indeed assist weak readers. Voice-over plus visual text could benefit students' learning and working in a second language.
- Cultural transference of the visual images and icons—translators assume that translations are the same e.g. metaphors and menus, instructions need to be short and unambiguous. But pictorial images are not generalisable across cultures. Different stories and histories have significance.
- Culturally sensitive sound signals—some computers have sounds that signal correct or incorrect response. This sends a public message to the class. They may

provoke shame for making an error, and in cultures where individual achievement is not valued, may provoke shame for others. Silence is more culturally neutral.

- Ambiguous tasks—e.g. classification of objects when terms and symbols used are culturally biased.
- Culturally biased tasks can exclude and silence issues of cultural contextualisation.

Snyder (2000), for example, sees hypertext (fully electronic and non-sequential reading and writing), as providing new possibilities in terms of independent and active learning, and challenges assumptions about what constitutes literacy. The use of hypertext can help students to become aware of the multiplicity of their subject positions, that is, male/female; Indigenous/non-Indigenous, NESB/non NESB, disabled or non-disabled. As yet, much of this is under researched although it is significant given the importance that classrooms be socially and culturally inclusive.

5.3 Indigeneity

How can ICT facilitate the learning of Indigenous Australian students? How can computer literacy be developed equally amongst Indigenous Australian students of school age when compared to the general school population? Is computer literacy development amongst Indigenous Australian students influenced by the same factors that influence the slower levels of development with respect to 'book literacy'? If so, what are these?

Our view is that among these factors are those that operate to construct the culture of the classroom within which all children are introduced to literacy, no matter whether it is 'book literacy' or computer literacy. Indigenous pedagogy will create a culture in the classroom that is conducive for learning, in the first instance, for Indigenous students.

Dunn (2000) also talks about culturally responsive pedagogy that incorporates the background history of Indigenous students because it is an important part of their cultural experiences. Culturally appropriate literacy should involve:

- a knowledge of community and the culture of the community;
- understanding of literacy education as a three way process between the family, student and the school;
- observing, recording and acting upon individual and group learning preferences;
- acceptance of the students' primary discourse as legitimate modes of speaking and writing; and
- participation in local community concerns and social actions.

These points are equally valid for all students whose cultural background and experiences may differ from mainstream schooling.

The way in which teachers think and act in the classroom is dependent upon their world view. If this world view is not the same as the students, as is most often the case for Indigenous students, then teachers' actions can cause confusion for the students. Crawford (1988) asserts that changes can occur for Indigenous students if

> teachers are able and prepared to adapt their teaching style and classroom organisation. In particular, collaborative learning is not a necessary condition of computer use in the classroom. However, it does enhance the role of language as a medium for achieving

> consensus about the interpretation of learning contexts and maximises the potential of computers as socially neutral sources of information (Crawford, 1988:5).

5.4 Disability

Truly inclusive schools need to meet the ICT access requirements of all students, including those with disabilities, and members of the broader communities they resource. Many students with disabilities require access to the curriculum through the use of assistive or adaptive technology (AT) which is additional to the standard computers, keyboards, and software typically provided in schools. Provision of AT to children with disabilities is currently administered through state-funded programs. There is no national approach to rapid, quality assessment and provision of AT. Current provision varies state by state and has resulted in inequities for some students.

Having appropriate AT at school is only part of the solution for students with disabilities. Teachers require professional development on the accessibility requirements of the broadest group of students and how these may vary, e.g. information on computer accessibility features that are part of Windows software and provide particular and inclusive access for students with disabilities. Upgrades in hardware and software will, in themselves, create opportunities for teachers to further develop their knowledge-base in this area.

Teachers also require support in their knowledge of and use of particular software or teaching approaches that provides solutions for students in classrooms. Having support from personnel with ICT and curriculum expertise may be necessary for teachers to ensure that particular students' Individual Education Plans (IEPs) include technology goals that relate to curriculum access, to social participation, and to synchronous or asynchronous communication opportunities. Support may also be required so that IEP goals and the interface between home and school reflect the shared responsibilities in the use of ICT.

School curricula also need to reflect the expectations for use of ICT for a diverse group of users within a growing range of life activities. Use of software and creation of web pages and other ICT platforms by staff and students should reflect the accommodations made for all users – e.g. graphics should have Alt tags for students who are blind, language should be in Plain English, text should be large enough to be easily accessible on the screen. The citizens of tomorrow need to have attitudes of inclusivity and accessibility created today.

5.5 'At risk' and 'out of school'

The focus of research is also on schools and not school aged students outside schools. Funston and Morrison (2000) in *Investigating gaps and opportunities: young people's access to IT in Australia,* a report for the Foundation of Young Australians, concluded that there seems to be very little detailed research or other academic writing in Australia on students who are disadvantaged in terms of access issues and what that means in particular for post compulsory school aged students. Girls and boys tend to leave school for different reasons. Boys leave because they are alienated by schools due to the disciplinary frame, focus on written work, relevance and teacher student interactions, usually together with a complex set of individual social and economic factors such as poverty and family conflict. Girls leave because they have negative experiences also of school cultures and organisation, have significant family pressures often associated with specific gender stereotypic expectations (Dwyer and Stokes

1998). Both male and female early school leavers point to reasons for disengagement and alienation as being the failure of schools to treat them as adults, of inflexible school rules and organisation, and irrelevant curriculum (Angwin *et al*. 2001). These are the students who tend to be more troubled, and in turn are viewed as more troublesome by teachers.

Using computers and other new technologies had immediate positive effects on many disenchanted and troublesome students in the ITLED project schools (Comber and Green 1999). Nixon (1998) argues that in longitudinal case studies observing 'at risk' students in computer mediated classrooms that there was significant change in social interaction, and that these students displayed a capacity to use multimodal texts and intertextual discussion. Some case study evidence suggests that computer mediated learning can both be conducive to attracting and retaining at risk students such as early school leavers. There are some studies that look at identifying at risk students while at school and utilising them in ways that give them a significant role as trainers, similar to the cultural apprenticeship model referred to above. The CIRCLE project (Resta 1998) indicated that when at risk students were trained up first and then used as computer mentors for teachers and other students, that this increased their sense of competence, self concept and their achievement, (Resta 1998). Whether and how this engagement is sustained over time and whether it impacts on achievement is not known.

Students who leave school early and who did not immediately enter employment or further education or training, tend to have highly parochial world views and rely heavily on local networks (peers, friends, family) for information about further education, training and employment. They less frequently use the formal structures of careers teachers, local employment organisations or the net. They tended not to travel for pleasure, leisure or looking for work, although many live outside cities and towns where there are few jobs (Angwin *et al.* 2001). Despite multiple and overlapping government and non -government networks that could offer support for these students, many tend to disappear from formal education and training, and even fail to access educational services.

This raises issues about how ICT could provide such youth with access to social networks, education and training, employment opportunities. Again, this is relatively new area.

There are some studies, but not many, that deal with out of school youth and computers. For example, Hall & Newbury (1999) considered what youth do with access to the Internet and computers outside school by undertaking an action research project through an Internet café. The idea was to consider ICT as a new form of cultural production and distribution, and young people's cultural participation. The aim was to find out what motivated youth to use the net. The group included seven women and five men between 14 and19 years, most having some Internet experience through the local library and the Internet café. For many, the use of the chat room was most important because it provided anonymity but also allowed them to contribute—'to add something'. The use of the web was more for researching and reading about pop bands, their major cultural interest. Most of them declined to build their own web pages, even when the workshops provided the opportunity. These studies are highly limited because of the difficulty in identifying and contacting youth once they leave school.

6 Teacher education

The challenge for teacher education bodies is whether they educate the profession for transformation and social justice or reproduction? We know that those teachers who work most successfully with children in poverty, one of the key equity groups, focus on problem solving and persistence, protect learners, and put ideas into practice. They move from action to reflection and back to action, and maintain a professional and personal orientation to students that is about being sensitive and self-aware. These teachers are extremely well organised, informed and prepared to intervene, they focus on teaching and learning, and are gentle, seek to mediate, defuse conflict, cooperate and respect (Brown *et al.* 1992; Thomson 2000). 'At risk' students are more likely to remain at school if curriculum integrates high order thinking, with authentic tasks, involves them in mixed ability collaborative groupings, and where they are judged on their thinking about a problem rather than performance on a test.

Yet teacher education faculties, like schools, are confronted with pressures of overload, expectations to integrate ICT into teaching, to model best practice, to learn about and learn to use ICT simultaneously, without any significant ICT training or research on what is best pedagogy, or the implications of using ICT on social justice. Teacher educators face the same problems of lack of research, few models of success, little encouragement to take risks and lack of time and resources. Currently, much of the professional development is focused on the care rather than courage approach, when the latter is required for addressing disadvantage.

7 Changing learning outcomes

It cannot be assumed that to integrate ICT into the curriculum will necessarily improve learning outcomes in the short or long term. Many of the experimentally designed studies sought to control all other factors so that a direct link could be made between computers and learning outcomes. While these indicated a small increment in standardised literacy tests or perceptions by teachers as to improved quality, qualitative studies indicate that the most important factor is how computers mediate social interactions that in turn lead to different ways in which students view and use technology.

The issue is not about the extent of improvement in outcomes as much as a change in outcomes. Qualitative studies point to how the nature of classroom learning alters with the multiplicity of learning technologies, including multimedia, printed and visual texts. What is different with multimedia is the convergence of literacy and numeracy skills (Motley 1999) and the emergence of new media literacies of multimedia authoring skills, multimedia critical analysis, cyberspace exploration strategies and cyberspace navigation skills as well as visual and aesthetic literacies associated with design (Lemke 1997). Unless students who are disadvantaged are provided with thick access (this includes all the use of multimedia) of rich technology classrooms, ICT will reproduce a new level of educational disadvantage with an inability to fully participate in a digital economy.

If full participation in ICT in school and post school education and training are to be considered to be desirable outcomes, these are critical questions. Girls may achieve equally well in computing and use computers as competently as boys, but they will do this differently. Even then, they still feel excluded from the social aspects of computing. They therefore do not choose to continue this as a field of study or as an occupation. This is in part because the focus has been on the technical and operational dimensions of computers and not on the social, the cultural and critical. There is a greater need to focus both on the pedagogical and the social organisation of the classroom. The studies of Indigenous students also indicate the importance of the changed social dynamics around ICT. Students learn and represent different things in a range of ways when they use ICT (Rowan *et al.* 2001 Ch.6).

FURTHER RESEARCH

The project has identified key areas where there are gaps in the research, policies and practices. There are issues that require further research if disadvantage is to be addressed.

The research to date too simplistically equates technical access with equity and thus neglects the exploration of the differential social effects of computer mediated learning. There has been an overemphasis on academic outcomes to the neglect of social and psychological outcomes of computer mediated learning, and wider understandings of what constitutes literacy. There has been an overemphasis on gender differences and the association of technology and masculinity rather than asking which girls and which boys benefit from computers. Asking this question would require exploring how ICT mediates the social relations of gender, class, race and ethnicity. There has been a focus on classrooms, schools and homes as discrete sites of computer mediated learning, rather than considering how ICT mediates changing relations between home, school, work, community and workplace. There has been a focus on students in school and not out of school. There has been too much focus on learning about computers rather than learning with computers, on process rather than on content.

These proposals for further research focus therefore on more nuanced understandings of computer mediated learning and outcomes that address the social relations of race, gender, class, ethnicity in different learning environments, as well as the ways in which difference is represented through computer mediated form, content and communication.

There is a significant absence of research about the use of ICT for second language learning, about how different cultural attitudes and English language competencies shape particular groups' predispositions to computers and possible success in school; and considerations of the different outcomes for NESB students with respect to ICT use. There are commonsense assumptions that computers are 'culture free zones' and also that particular NESB students are 'good' at computers. Such assumptions need to be tested against empirical evidence that considers how culture, race, class and gender intersect. Hoffman and Novak ( ) suggest there is and to consider racial/ethnic differences in attitudes, use, search behaviour as well as multicultural context on the Web. They ask whether there are different cultural identities in different parts of the cyberspace that maps onto geographical concentration of ethnic communities?

There is much needed research in the ways in which ICT can be used to attract and retain at school 'at risk' students through improved communication and provision of alternative modes of learning. Many youth 'at risk' drop out because of disengagement with learning arising from a range of social factors associated with formal structures and cultures of schooling or demands from home. Further investigation needs to be made about possible community based access to ICT and the role of organisations outside school, and about how to use ICT to facilitate pathways programs, learning networks, data bases and support networks for youth who are often geographically isolated. ICT provides new opportunities through the vocational and recreational use of ICT, which can lead to employment through online courses and the focus on youth as cultural producers. This can be achieved through community based projects for out of school youth that use schools as the site and provision of out of hours access. Research needs to consider the role of technology supported wide area network activities (WANs).

There has been little to no research on other cultural factors, or intersections of gender, ethnicity and socio economic factors in Australian context and how this impacts on learning. The issue is often less about differences between boys or girls and more about the social relations of gender and how gender interacts with class, race and ethnicity. There is the need for more research around the social learning associated with games and Computer Mediated Communication that can lead to patterns of dominance in social interaction. The close association between gender identities and technology is problematic for those boys who are not interested and for most girls.

This research can take a number of trajectories. While there are significant examples of how ICT facilitates the learning of Indigenous students, there is little research on the dynamics of computer mediated social relationships in classrooms or on how indigeneity is inflected by gender, ethnicity, location and class. For example, how do Aboriginal boys work in groups with white girls; how do Vietnamese-Australian and Chinese-Australian boys work with each other in groups? Or for example, what differences are there in the computer mediated learning between a remote Aboriginal community and an urban community-school with high levels of Aboriginal children? Further, what are the differences in maths and science achievement and the use of ICT amongst girls and amongst boys on the basis of racial, socio economic or NESB background?

Further research is required to consider the notion of communicational webs and multi modality and how this impacts on school literacy in ways that can improve outcomes for working class and Indigenous students as well as for students with disabilities. For example, the dominance of visual literacies in the use of ICT may have implications for working class children. How do young people engage with range of media and modes of communication with particular reference to popular culture as a site of practice that can be exploited by teachers as a point of connectedness in emergent literacies? How can visual literacies and images lead to verbal and textual literacies?

Similarly, there is a lack of research on computer mediated learning and students with disabilities with respect to the social relations of gender and group work that might consider how students with disability can be better integrated into group processes through the use of range of technologies.

There is, in relation to the above, the need for teacher practitioner research projects that focus on how learning technologies can support learning of disadvantaged students in culturally and socio economically diverse student communities across a range of sites and longitudinally.

Within classrooms, there is need for more research on group work in different contexts, social mix and subject areas. How can, for example, peer groups work for those students who are low or ambivalent users of computers? How can peer groups and the use of mentors be better used to impart a sense of agency to students who are currently excluded? Can student train-the-trainer or student-as-expert programs in ICT improve the learning of students who are disengaged or underachieving academically?

The possible connections between metacognition and ICT use needs to be explored. How does the use of OCT affect students' understandings of and control over their own learning?

Again, there need to be more comparative studies of students working with computers that focus on these social and psychological outcomes. Does this new sense of agency that ICT provides to many disadvantaged boys and indigenous groups develop into longer term social, psychological and cognitive learning effects?

This research report indicates that ICT can motivate students, change student attitudes and improve presentation of work, but there is still little evidence about how it impacts

on cognitive learning outcomes. Much of the cognitive literature is based on CAI drill based instruction and not constructivist approaches that are considered to be the most suitable conceptual frameworks for innovative pedagogies. This requires contextualised and broad scale studies of such effects on student learning. Can the same types of pedagogy and shift to student centred learning produce the same effects as a technology rich classroom?

These questions highlight the need for comprehensive studies of how school and classroom cultures can enhance or detract from the use of computers in ways that inform student learning for particular disadvantaged students. This could also address issues about how different school cultures and teacher discourses about computing inform student responses, activities and learning and in turn how school cultures impact on teacher attitudes to their use ICT for disadvantaged students.

With regard to what is learnt through ICT, there are also a number of trajectories. First, there is there is a need to investigate the integration of digital literacy across the curriculum, and how difference emerges in different contexts and subjects.

Second, there is the need to consider the implications for different modes of 'performance' and assessment and how they impact on students who are disadvantaged by print based assessment.

A third aspect would be to investigate how ICT is used most effectively in different subject areas. There are strong indications that the use of ICT is not embedded into, for example, maths, and this is an area where issues of social selection and disadvantage for working class, Indigenous and girls impacts on later career opportunities. There is little research on numeracy, ICT and different equity groups. It may be that skills in using ICT can be transferred to those required in maths and the sciences. Investigation of cognition in relation to ICT use and maths and sciences as well as other subjects is required.

Computer mediated learning facilitates the convergence of a visual and verbal modes of representation. As schools move to put more curriculum and communication online, the connections between verbal and visual modes of representation provoke a number of important research questions such as: How do different technologies (email, chat rooms, computer conferencing), as well as verbal and visual representations of difference and communicative modes impact on communicative practices and create exclusions and inclusions? The iconic skills of being able to read certain types of images such as pictures and diagrams are also crucial to scientific and technical thinking. There is little research to back this hypothesis.

There is a need to further explore connections between visual and verbal representations of difference in software, content and pedagogy and student preferences and career choices. Such a study could identify school policies and classroom strategies that encourage girls, rural and Indigenous students into ICT.

There is a significant absence of gender and culturally inclusive software. Few empirical studies addressing these issues although many suggest it is critical.

Research possibilities here would be to:

- Investigate through action research a project with students, teachers and instructional designers and software developers working to develop software that is culturally and gender inclusive. Guidelines for teachers and students could be one outcome.
- Focus on how students respond to computers and understandings of what is meant by student centred classrooms and independent learning for particular social groups.

Closely associated with lack of gender and culturally inclusive software is the dominance of computer games. While there is preliminary anecdotal evidence that computer use is positively correlated with academic achievement, the connections between repeated computer game playing and nonverbal and verbal performance needs to be explored. Also important is the transferability of digital literacies from home to school and vice versa and how these are inflected by family income, race, gender, and ethnicity.

This project and others points to the significance of home school links in giving some students an advantage over students without home computers. There is a need to explore how children learn on the computer at home and school and the differences that arise in the nature of that learning. What is the nature of their engagement—structure, content, meaning or appearance? What digital literacies are transferred (operational, cultural and critical)?

Longitudinal studies are required which consider cohorts of children immersed in technology rich home environments and those in technology poor home environments to yield new understandings of computer-mediated literacy practices and home school relations in the reproduction of educational inequality.

These could consider the implications of children's home use of computers for school use with respect to cultural differences and NESB backgrounds, as well as the impact on the gender division of labour in family literacy work when home computers are introduced.

All research points to the absolute priority to be given to improving understandings about teacher learning and teacher use of ICT. Future research should focus on:

- Exploring the ways in which teachers use and learn about computers, and how that informs the way they teach with computers and their attitudes to computers.
- Encouraging practitioner based research that focuses on how teachers make professional judgements about which technologies to use, when and why. How do teachers assess whether the use of technologies has enhanced student learning?
- Reviewing teacher education literature to identify innovative practices in terms of utilising ICT in classrooms for disadvantaged students and developing action research projects that undertake this cutting edge work.

These research problems indicate the need for an integrated research program that focus on the complexities of difference and disadvantage and how these mediate ICT use to enhance learning, rather than 'one off' projects that focus on a single 'category' of disadvantage. These should be longitudinal where possible, consider a wide definition of learning outcomes, and be based on action research across a number of sites.

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Annotated Bibliography

Abrams, R. 1999, 'Laptop computers in an all girls' school: Hearing the student voice in an evaluation of technology use', Paper presented to AERA New Orleans.

An independent all girls school K-12 introduced laptop computers to develop a technology rich school and classroom environment. The paper investigates how the girls responded to and thought about computers through a constructivist approach. Three types of data were considered—student computer use in ours, student value of use with respect to particular subjects and student understandings of computer technology. There was both increase in use of computers at school and home, laptops increased school use of computers most. Students valued the use in computer, English, history and science above other subjects and less so in art, languages other than English and math, the focus being on academic subjects. The girls saw them as devices for typing because they helped students produce work that was neat and organised. Overall, the evaluation indicated that girls view computers instrumentally in that they enhance what they valued in terms of presentation, neatness, taking notes, efficient, for access to data bases (e.g. Encarta) and capacity to include pictures and graphs in projects. Abrams argues that computers help students organise their work, integrate new knowledge and basic skills. The use of computers in this school was based at the operational not cultural or critical dimension with little attempt to utilise or change curriculum or school organisation.

Anderson, N. 1999 'Using Higher Order Computer Tasks with Disadvantaged Students Spotlight on the Future', NECC '99. National Educational Computing Conference Proceedings, Atlantic City, NJ

A pilot program initially designed for a 12-year-old girl with mild to moderate intellectual disabilities in higher order computer tasks was developed for a larger group of students with similar disabilities enrolled in fifth and sixth grades (ages 9-12) at three different schools. An examination of the original pilot study was undertaken to determine critical aspects that led to its success. This paper discusses why further research is needed into the effects of computer interventions in this area, and then focuses on development of the program for the larger group. The first stage of the intervention involved bringing participants together and introducing them to easy-to-use software. Students' interests and needs were ascertained and recorded along with their levels of prior computer experience. Once students worked through several months of less structured, easier computer tasks, they moved on to more structured activities using Microsoft Publisher. Peer tutoring needed to be continued after different steps were mastered. As skills developed, more emphasis was placed on thought-provoking elements of design and how the overall product related to students' interests. During the final stages of the program, SCALA MM200, a multimedia authoring package, was used to further advance the progress of the group, and the same instructional strategies were used with this software.

Anderson-Inman, L. 1999, 'Computer-based solutions for secondary students with learning disabilities: emerging issues', *Reading and Writing Quarterly*, Vol. 15, No. 3, pp. 239-249.

This article discusses issues surrounding the implementation of computer-based solutions for students with learning disabilities. The benefits of, and hurdles to, using

computers for students with learning disabilities are discussed. These are dealt with in five topic areas: access issues, motivational issues, curriculum integration issues, labelling issues, and funding issues. The article covers the difficulties in the implementation and potential use of computer–based technologies, and provides strategies that may be used to overcome these obstacles.

Anderson, R. E. & Ronnkvist A. 1999, 'The presence of computers in American schools', Teaching, Learning, and Computing: 1998 National Survey, Report No.2.

In order to assess the current presence of computing technology in American schools, a national survey was conducted of elementary and secondary principals and technology coordinators in 655 public and private schools. Results are discussed in terms of: computer density, computer capacity, computer renewal, peripherals, computer location, technology-intensive schools, software; and Internet access, including type of access and Internet penetration. Distributions and disparities of technology presence indicators are then examined in terms of the following background categories: school level; public versus private schools; size of enrolment; percent of minority enrolment, student poverty, community income, metropolitan status, and region. The study concludes that the state of computing capacity for instruction in American schools has improved dramatically in the past six years. Findings also indicate some major deficiencies. Most of the computers in schools do not have the capability to run the large variety of multimedia software currently available, which means the computers are also severely limited in how they can access graphical information on the Internet. Data also provide evidence that disparities still exist across social, economic, and geographic boundaries.

Angus, L., Snyder, I. and Sutherland Smith, E. 2002, 'Cyber-Maxi and the corporate high flyer: A tale of two women, computers and education'.

This paper is an early-days report of a research project in progress investigating home and school computer-mediated communication practices in low socio-economic communities. The project became possible as a result of an alliance forged in late 1999 between Australia's peak trade union body, the Australian Council of Trade Unions (ACTU), a computer and software distributor and training company (Virtual Communities), and an Internet provider (Primus), to provide computers and Internet access to workers at affordable prices. The focus of the study is on four families and the schools the children attend. It examines the ways in which the families use the technologies to engage with formal and informal learning in home and school settings to develop more sophisticated understandings of emerging literacy/communication practices in home and school settings. The relationship between home and school has already been the focus of a number of important studies that emphasise the centrality of the social contexts in which literacy practices occur. This body of work, widely known as the New Literacy Studies (NLS), directs attention to contexts of practice, to contrasts between home and school as sites of practice, and to the relationship between home and school with respect to literacy learning. To date, there has been little research investigating home and school computer-mediated literacy/communication practices in low socio-economic communities. This paper concentrates on two strong mothers who display certain similarities and potentially significant social and cultural differences in their approaches to information technology and education within the family. Its significance is that it considers the importance of home technology environments on how students learn about and to use ICT, how home-school relationships are inflected by class and gender and on identity formation.

Attewell, P. and Battle, J. 1999. 'Home computers and school performance', *Information and Society,* Vol. 15, No. 1, pp. 1-10.

This study assesses the effects of home computers on school performance using the data from the 1988 US National Educational Longitudinal Study. This data is collected from a random sample of US schools, and random sample of eight graders, that is, average students and schools. The study recognises the difficulty of extracting out home computers as producing an effect, and sought to control for race, ethnicity, gender, socioeconomic status, family structure, social capital (supportive activities of parents and community members), cultural capital (family culture in terms of music drama, literature and language). Performance was based on standardised test scores of literacy and numeracy as well as student self–assessment. Found that computer effects were less once SES taken into account as SES is highly correlated with educational success. Most educationally disadvantaged students with severe reading and writing problems gained little advantage from home computers because it is an issue of use.

The study is important because it indicates what students, teachers and parents do with computers, that is the personal interactions. It concludes that home computers benefit higher SES students more than lower SES and girls have lower payoffs from home computers than boys in addition to girls having less access to home computers. Hispanic students get few benefits from home computers in terms of higher reading or math scores. Black students have lower effects than whites and for Asians, no evident effects at all.

The study also considers how forms of disadvantage impact on educational outcomes of different racial and cultural groups. Rural eight grades have higher scores on reading and maths than suburban, while urban children have higher reading scores than suburban. Girls have lower math scores but higher reading scores and higher school grades than eighth grade boys with all else controlled; Asians have high maths scores and school grades than non-Hispanic whites. Blacks and Hispanics have lower scores than whites on reading and maths. The design of the study tries to control for more complex factors e.g. social capital (parental support) and cultural capital (familial environment). Most importantly, it captures parental involvement as a key element in terms of educational benefits of home computer use.

Problems with this study are that the data is 1988 when home computers not as common (only 28% students in NCER survey); there was less access to Internet, and software did not usually include multimedia or range of software. Educational success was defined primarily by standardised test scores, that are themselves often dummy variables for class because of test bias. As with many surveys, the study was not longitudinal. Does not indicate what happens over time when computers in home. What constitutes an effect is small e.g. a 3-5% increase on an average score which is small, and it did not consider how much time spent on computer.

Bailey, R. A. 1995*, Attitudes toward gifted girls' abilities in the use of multimedia computer technology to learn science,* Unpublished MPhil, University of Southern Queensland, Toowoomba, Qld.

In a study of the effect of a multimedia computer technology program in Science, four groups of participants were considered: academically gifted girls, gifted boys, academically non-gifted control groups of boys and girls in a private primary boarding school. The aim was for a computer-based intervention to redress what research suggested was non-assertive and self-limiting behaviours of gifted girls in the use of computer technologies and in science. In the pre-test, both boys' groups were more

gender biased, i.e. assumed abilities more than girls, with gifted boys more so than non-gifted. In science, the pre-test indicated that gifted girls were more self assured and positive towards science than gifted boys. The effect indicated that gifted girls were less biased against computing, that student controls had more positive attitudes to girls' abilities in computing, and gifted boys became more self–assured in science. It is argued that other interventions in the school had equal if not more significance with respect to girls' self-assurance and attitudes about computing and science, that is, girls' identity not as closely tied to computers as for boys.

Barnes, A., Stewart, A., Filsell, J., Hazell, A. & Legge, W. 2001, *Embedding Learning Technologies in Teacher Practice*, DETE, South Australia, Adelaide.

This report considers a number of case studies that were written by teachers about how they integrate learning technologies into their curriculum. The case studies cover the K-12 spectrum and all subject areas in the nine Discovery Schools in South Australia. The report saw the Discovery schools as facilitating innovative practices. The teachers tended to embed technologies into current curriculum aims and content. Where students had the necessary ICT skills, there were considerable benefits. Learning outcomes that could be attributed directly to use of technology was in three ways. Learning was *extended* in the ways that previously could not be done, they were *amplified* because it provided capacity for greater exploration and discovery, and were *transformed* as students were freer to focus on the bigger picture while technology performed processing, sorting and display tasks. For example, work was more structured, at a stage where it could be edited, and showing awareness of different audiences. Students could extend their thinking through computer–assisted planning, sorting, graphing, visuals, presentation or communication. Students were more willing to be creative and fearless and work through trial and error because of quick feedback. Students were able to access information previously inaccessible. They could communicate their learning in new ways, one that they were more comfortable with, such as visually, through animation, by digitised voice and email. Teacher comments were about: students with motor skill difficulties being able to type more easily than write; more instant feedback; those struggling able to focus more on learning than writing; use of various programs as tools; teachers having the flexibility to manipulate variables and situations; being able to use visual forms e.g. concept maps, the intranet within the school; having more sources for information that are up to date; new learning outcomes e.g. in the form of recording and embedding sounds and visuals. They also commented that students were more motivated to take time to 'speak' in their own voices and to develop multimedia presentations and therefore visual literacy skills. The report indicated that some forms of learning were done better on computers—editing and production of high quality texts; teacher engagement with the micro level e.g., charting options, and promoting discovery learning. The learning technologies tended to equalise individual differences particularly for students with special needs, those with poor handwriting and communication skills, and collaborative learning was encouraged. The technologies also promoted authentic learning through access to resources. Students were generally but not always highly motivated when using technologies, but this depended on length of project and as novelty decreased, especially in Middle Schooling. There was an increase in student control and independence and allowed individual preferences in style, layout and tasks.

Teacher methodologies were also changed as they were introducing new planning tools, assessment approaches. Sometimes, teachers planned less and allowed a freer flow within the classroom. The technologies supported collaborative working models such as peer coaching. There was an improvement in communication skills and greater awareness of different audiences. The email was valued for asynchronous

communication. Teachers built on previous effective strategies. Teachers began with identifying weaknesses, promoting fluency, making learning more efficient, optimising personnel and removing logistical hurdles,. Then they moved into more constructivist approaches to learning that was about creativity, self analyses and metacognition, transferral of knowledge to problem solving, group work, multiple and distributed intelligence and new forms of visual literacy, that is, from instruction to construction; from drill and practice to discovery.

This report is particularly valuable because it indicates how ICT can inform the learning of all students, but because it addresses the issues of how learning can be more individualised to meet different needs.

Bayha, B. 1998, *The Internet: An Inclusive Magnet for Teaching All Students,* World Institute on Disability, Berkeley, California.

This is a resource book designed to help educators use the Internet as a tool in the instruction of all students, including students with disabilities. In a section on general guidelines for success the handbook identifies some common access strategies and a variety of ways in which students can benefit from them. It then turns to practical models/success stories from teachers who have taken concrete steps to provide access for all of their students. Some of these stories mention barriers for students with disabilities and solutions on overcoming them. At the end of the book, there are useful sections on resources for finding assistive technology, and a list of web resources. Barriers and solutions, and strategies and their benefits are clearly presented in easy to read tables. Additional marginal text covers topics such as computer specifications, key words, 'what if', 'did you know', bright ideas and other helpful hints.

Beavis, C. 1997, 'Computer games, cultural and curriculum', in Snyder, I. (ed) *Page to Screen. Taking Literacy into the Electronic Era*. Allen and Unwin, Sydney.

This chapter explores how new media forms, in this instance computer games, affects schools and curricula; and second how such forms and young people's engagement with them, challenge and redefine current notions of narrative, textuality and reading. Any analysis of the games 'phenomenon' must acknowledge the sophisticated transnational marketing that has implications for identity politics and cultural changes. These factors raise issues regarding the relationship between education and culture as well as the formation of youth identity. Popular culture is often seen to be oppositional to literature and high culture that is expected to be transmitted through schooling. While 'Downloaded popular culture' poses challenges to this, the issue is not one of culture but the changing nature of literacy. There is a blurring between reading and writing, production and reception. What it is to be literate is changing with emerging multimedia and digital technologies and four new literacies – multimedia authoring skills, multimedia critical analysis, cyberspace exploration strategies and cyberspace navigation skills—are suggested. Images and how they are produced and read as well as texts are more important. Computer games need to be seen in this context and that of the forms of engagement with texts— predicting, checking, revising as well as hand and eye coordination! The chapter suggests how teachers can deal with inter-textuality through class discussions about how students can explore how they position themselves in relation to games just as they do with other texts. This diversifies the types of texts read in school, but also creates continuities between school and out of school reading and pleasure in terms of analysis and critique.

Beavis, C. 1998, 'Computer games: Youth culture, resistant readers and consuming passions', paper presented at the Annual Conference of the Australian Association for Research in Education (AARE), Adelaide.

This paper addresses how digital culture is presented as both seductive and pervasive, and as actively productive of identity and cultural relations. Young people (players) are positioned as uncritical consumers in a context of commodification and internationalisation of youth culture. Increasingly computer texts are seen as other media and popular culture texts to mobilise specific images, discourses and positions, and to construct student identity. Other debates argue that youth take up subversive and resistant ways of playing/reading, and that young people indicate resilience in relation to television violence and video nasties. Another set of debates explore connections between young people's in– and out–of–school textual worlds, with a view to exploring ways in which the curriculum might both capitalise on developing skills and knowledge while also intervening in cultural production and strengthening capacities for critique. Beavis argues the following:

(i) Technology is changing literacy, and that what students need now (and are developing in out–of–school contexts) are 'multiliteracies'. Literacy curriculum and assessment practices should include, but not be limited to, print literacies.

(ii) Schools should attend to the changed nature of literacy, and teach students to be critical and competent in 'multiliteracies'. This means going beyond print literacies.

(iii) Literacy curriculum would benefit from including the study of digital popular culture texts.

(iv) Digital popular culture texts embody multiliteracies and provide teachers with opportunities to understand these better while also teaching students about them

(v) Some students (often boys) who are disengaged with traditional school texts are already interested in popular texts; hence the texts provide a context for teaching both traditional and new literacies more effectively.

(vi) The school context provides a forum for developing critical and reflective perspectives on popular texts, and on the ways in which they contribute to and construct issues of identity.

Beavis, C. 1999, 'Literacy, English and Computer Games' paper presented at 'The Power of Language' International Federation for the Teaching of English, Seventh Conference, 7-10 July, University of Warwick, Coventry, UK.

This is a small case study on the effect of introducing computer games into the curriculum in two schools in English units—one school with and one without laptops. Beavis concluded that the units were seen as fitting readily into existing English curriculum and priorities, providing opportunities to integrate print and electronic literacies and texts, or to study electronic texts in their own right. The units provided opportunities to be both critical and creative, and to utilise 'both' literacy forms. All four teachers were very positive about expanding definitions of text and literacy to incorporate electronic forms. The units generated high levels of enthusiasm amongst students, and provided for ongoing collaboration in a constructive atmosphere. Despite the high level of interest for most students, frustrations arose in relation to particular games. Students in the non–laptop school had less access to the technology, and hence tended to be less involved. For most classes, teachers commented on the higher levels of interest, involvement and collaboration from less strong, less attentive

or less school-oriented boys. Some boys produced their 'best work' for the year so far. The teacher in the non–laptop school commented that students usually less involved in English work became more involved, but that conversely, some of those who were usually participated more actively had less to say. Girls' involvement varied. At the laptop school in one class girls were equally involved and interested with the boys, in other two not. At the non-lap top school, with a higher population of males, some girls responded enthusiastically but others continued to make it plain that computer games were not for them.

For the most part, students produced thoughtful and high quality work, impressive both in the quality of its creativity and analysis and in its proficiency in both electronic and print forms. The tasks at the laptop school required students to build on digital literacy abilities as well as utilising more traditional word–based forms. Discussion at the non-laptop school showed a sophisticated understanding from many students of aspects of the structure and marketing of games, and of debates about media effects. It resulted in a more considered preparedness to see games as texts and constructed, inviting a consideration of such issues as ideology and player positioning, as well as inter and intratextual elements such as wit, narrative and iconography.

Bede, C. 2000, 'Emerging influences of information technology on school curriculum', *Journal of Curriculum Studies*, Vol. 32, No. 2, pp. 281-303.

This paper presents innovative ways in which students, as partners in the production of curriculum, work with ICT through reflective inquiry. The students use simulation and visualisation tools that enable them to reason about physical processes, translate and imagine models. Bede argues that these curricular approaches provide success for all learners and may differentially enhance the performance of at risk students. They are to (i) centre the curriculum on 'authentic' problems;(ii) involve students in virtual communities of practice, using tools similar to those in workplace;(iii)facilitate guided, reflective enquiry through extended projects that inculcate sophisticated skills, concepts;(iv)utilise modelling and visualisation as powerful means of bridging between experience and abstraction;(v)enhance student's collaborative construction of meaning via different perspectives and shared experiences;(vi) include pupils as partners in developing learning experiences and generative knowledge; and (vii)foster success for all students through special measures to aid the disabled and disenfranchised.

Bede argues that ICT impacts in complex relationships between and on curriculum, assessment, pedagogy, professional development, administration, organisational structures, strategies for equity and partnerships. ICT therefore should not be compared with conventional approaches to teaching and learning. He argues that the basic premised of research communities is shifting towards 'knowledge networking' and virtual communities that have communal memories. He provides examples in science education about the use of ICT technology and suggests software.

Belanger, Y. 2000, 'Laptop computers in the K-2 classroom', ERIC, May, [http://ericit.org/digests/EDO-IR-2000-05.shtml]

Reviews the literature on the use of laptops, concluding that the educational benefits are more in terms of student attitudes to school than improvement of learning outcomes in terms of academic achievement. Considers the equity implications of laptops as making computers more accessible and bridging some school gap, but points to the difficulties associated with theft and vandalism, costs of technical support and networking, costs borne by parents and costs of hardware.

Berryman, S. 'Designing Effective Learning Environments Cognitive Apprenticeship Models', Institute on Education and the Economy Teachers College, Columbia University

This article challenges traditional views about learning. It uses cognitive apprenticeship models that take into account different learning environments and theories of learning but ignores vocational/academic distinctions because vocational domains require symbolic activity. It is premised upon the view that learning is about initiating the novice into a community of expertise and works on building blocks of content, methods, sequence and sociology. Schools currently focus on concepts, facts and procedures of a subject. But to operate effectively there are three other types of content: tricks of the trade (problem solving strategies), cognitive management strategies (goal setting and planning) and learning strategies (knowing how to learn, exploring new fields, reconfiguring knowledge etc). Methods associated with cognitive apprenticeship include offering hints, feedback, reminders, making connections or providing scaffolding. Sequencing means that learning is staged so that there is a building up of multiple skills, from simple to complex tasks in different environments and problem solving situations. Sociology is about the technological, social, time and motivational characteristics of the real world where learning will be used, for example, teamwork.

This model of cognitive apprenticeship is useful as a way of thinking about future research and developing curriculum and pedagogies associated with learning technologies. Learning technologies provide the capacity to have more real world situations etc and also require the metacognitive skills of scaffolding. In technology–rich classrooms, more independent cross-disciplinary learning is more likely based on problem solving that crosses the theory/practice dichotomy.

Bimber B. 2000, 'Measuring the gender gap on the Internet', *Social Science Quarterly*, Vol. 81, No. 3, pp. 868-876.

This paper evaluates differences in men's and women's presence on the Internet, testing for the presence of gender-specific causes for different rates of Internet use. It presents new survey data collected by the author in 1996, 1998, and 1999 showing trends in Internet use, and presents regression models of Internet access and use. Two statistically significant gender gaps exist on the Internet: access and use. The access gap is not the product of gender-specific factors, but is explained by socioeconomic and other differences between men and women. The use gap is the result of both socioeconomics and some combination of underlying gender-specific phenomena. Around one-half of the 'digital divide' between men and women on the Internet is fundamentally gender related. Several possible causes may explain this phenomenon.

Bromfield, L. M., Clarke, V. A. & Lynch N. 2001, 'Comparing alternate teaching styles to teach computing skills to girls in their English classes', *Computers & Education*, Vol. 36, No. 4, pp. 285-297.

Low female participation rates in computing courses and careers are a current concern of the education sector. To address this problem an intervention was developed—computing skills were introduced to girls in their English classes using three different teaching styles: peer tutoring, cross-age tutoring and teacher instruction (control) based on the notion that teaching girls computers in subjects where girls are perceived to be high achievers would position them more powerfully. The sample comprised 136 girls from Years 8 and 10 from a single-sex government school. Qualitative data were collected from six focus groups conducted with 8-10 students—one from each of the six classes. Although cross-age tutoring did not yield more positive effects than peer

tutoring, both cross–age tutoring and peer–age tutoring were favoured over traditional teacher instruction. This was judged by achievement of students on class tasks and their attitudes towards computing. Teacher instruction was seen to be more inefficient because they did not have as much time to explain, their explanations were more complex and many teachers lacked the technical knowledge. The overall implementation was confronted with a range of complex problems such as differences between teachers, system failures, students missing and missed classes, lack of communication, and poor selection of computing activities that many saw were boring. Many students felt that age was not a good indicator of who should be a tutor.

Browett, J. 2001 'Critical literacy and visual texts: windows on culture', Leading Literate Lives Conference Proceedings, Australia Association of Teachers of English. http://www.cdesign.com.au/aate/pages/paper_menu.htm

This paper argues that by the construction of their own cultural frameworks, students are able to reach deeper understandings about their personal identity and value. A sense of self and ability allows them to 'engage with otherness'. Visual texts are readily accessible source of information about culture. A critical literacy approach to visual texts allows students to read a widespread range of cultural information, from the symbolic to the ideological, and to better understand power relations. This paper provides an analytic frame as to how visual texts can be understood in terms of context, linguistic structures and features and the types of pedagogic strategies that can be used that could assist students from a range of different cultural and socioeconomic backgrounds.

Cameron, B., Edwards, J., Grant, J. & Kearns, P. 2001, *Participation in IT and Telecommunications in Education and Training*, Final Report of the Project http://www.detya.gov.au/iae/analysis/it_participation.htm

The report investigated the patterns of participation of students in ITT subjects and those leading onto further education, identified and analysed barriers to participation of some groups who were underrepresented in secondary, higher education and VET courses, discussed measures to improve their participation in ITT, and identified further research. The report indicated that there was a low proportion of those selecting IT in school, with higher achiever selecting more traditional subjects and under representation of girls. Those girls who stayed in were high achievers and gained access to tertiary courses. In VET, Females were 50% enrolments and 17% IT courses. Also under represented were ATSI students, rural and isolated students and students with disabilities. These same groups were under represented in higher education in ITT courses. Indeed, these numbers are in further decline from 1992-8. Barriers listed were the nerdy and male dominated images of the industry that inhibits participation by women and girls, inadequate careers information in schools, inappropriate teaching and learning strategies in schools that discourage girls and the influence of home and gender stereotypes. In addition, for rural and isolated students, there were issues of inequity of access and lack of telecommunications infrastructure, lack of ITT industry and role models and negative family influences re the field. Amongst Indigenous students, there was a lack of knowledge of the field, low retention rates, family orientations towards traditional occupations, and low aspirations. Students from low socio-economic backgrounds had lack of access to appropriate computers, family influences re careers and schooling, and the overlap of poverty, Indigeneity and isolation. Policy suggestions include a national framework, community–oriented action at local level, incentives for innovation in teaching and learning re ITT, effective dissemination of good practice, on–going monitoring. E.g. be integral to Learning

Towns program of the Victorian Government. Further research was required in disaggregation of statistics for disadvantaged groups, funding of pilot projects about how to use ICT in schools and building schools as learning communities, strengthen teacher professional development in IT, and develop partnerships with VET, higher education and industry. Concludes that maintaining the employability of women and other equity groups is critical to their lifelong learning and the requirements of an information economy.

Carter, D. S. G. 1998, 'Implementing new generation instructional management systems: a Western Australian example', *Australian Educational Computing*, Vol. 13, No. 1 (June), pp. 22–28.

In the context of planned change it is argued that information management for decision support is crucial to innovation and implementation success. A new generation of instructional information management systems (IIMSs) is now becoming available at affordable prices and some of their characteristics are described in this paper. These computer systems seek to integrate the school community with the web of relationships between curriculum, teaching, assessment and school organisation. Following professional development activities an IIMS user and non-user group of teachers and administrators, in a remote area school in Western Australia, were surveyed in order to discover some of the early implementation difficulties in employing this technology from a user perspective. It is concluded that IIMSs have the potential to enable schools to monitor their performance more effectively, with subsequent benefits accruing to teaching, learning and professional collegiality.

Chisholm, I. M. 1995, 'Equity and Diversity in Classroom Computer Use: A Case Study', *Journal of Computing in Childhood Education*, Vol. 6 No. 1 pp. 59-80.

A case study explored how an effective teacher in an urban multicultural classroom uses computers. It identified effective management and instructional strategies. Results support previous research findings that indicate that effective teaching of minority children involves children in decision making, challenges learners, offers meaningful learning experiences, provides autonomy, and holds high student expectations.

Collins, C., Kenway, J. & McLeod, J. 2000, 'Factors Affecting the Educational Performance of Males and Females in School and Their Initial Destinations After Leaving School', DETYA, Canberra.
http://infocat.dest.gov.au/IE/ViewEntry.asp?ID=109

This *Report* investigates the patterns of males' and females' educational participation and performance at school and their initial destinations after leaving school, the key factors influencing these and the disadvantages that arise from them. While gender was the major factor under consideration, an examination of the relative impact of other independent variables on participation, performance and post–school destinations including geographic, demographic and socio-economic factors is also undertaken. The research comprised several inter-related elements including interpretation of statistical data and literature review, an annotated bibliography, and consultation with key figures.

While the perception has been that girls are now 'doing better' than boys in a number of key areas, most notably retention to Year 12, end-of-school results and competence in literacy, a concern not isolated to Australia, the Report concludes that the differences in educational outcomes are greater amongst girls and boys and not between girls and boys, differences resulting from socio economic status, locality, ethnicity, disability and indigeneity. The report begins by providing a background to current concerns,

surveying preceding gender equity policies and proposing some frameworks for conceptualising gender equity today. The available data on gender differences in school retention, participation and performance is then disaggregated as is the data on overall gender differences. The effects of other factors—such as socio-economic status, locality, ethnicity, disability and Indigeneity— on school performance are described. After this, an overview and analysis of the ways in which gender differences in education have been explained is offered. Finally, the *Report* provides an exploration of patterns of difference in post-school outcomes.

Gender differences: The *Report* indicates that there are indeed major gender differences in educational participation, performance and outcomes. However, it also shows that these do not necessarily translate into disadvantage in straightforward ways with respect to ICT. More girls take clusters of subjects that spread across Key Learning Areas and do not appear as career focused, while more boys tend to take narrow clusters of subjects possibly with potential post-school employment pathways directly in mind. Boys' clusters are particularly focussed on the mathematical/logical formulaic knowledges and/or hands-on technology knowledges. Considerably more boys than girls are taking ICT subjects in the post-compulsory years and, in New South Wales at least; the difference in participation has grown considerably during the 1990s. Girls appear to be falling further behind boys in IT literacy. Girls' low participation in subjects that result in information technology literacy leads them to risk membership of the information poor and exclusion from information society. It also excludes them from a range of emerging and important employment opportunities. Socio-economic status makes a larger difference than gender to Year 12 performance, even in subject English. Indigeneity intersects with poverty, locality and SES disadvantage to make the chances of poor schooling participation and performance extremely high for indigenous students. The *Report* demonstrates that low SES girls and boys are the most disadvantaged students—although their disadvantages may be manifest differently according to gender, race and locality. Throughout the report an approach which take such other variables into account is described as a 'which girls, which boys?' approach.

Gender disadvantages: With regard to males' and females' educational participation, performance and outcomes the *Report* asks when and how do such differences become disadvantages? Overall, the *Report* concludes that concern about gender patterns of participation, performance and outcomes is justified because certain differences do convert into certain disadvantages. But, it shows that the ways in which this happens are more subtle and varied than is usually recognised. On the basis of the data and the literature, the report divided disadvantage into first and second order disadvantages. First order disadvantages relate to participation, performance and outcomes. Second order disadvantages relate to the factors influencing these.

Overall, the Report suggests that an understanding of gender disadvantage needs to be sufficiently comprehensive to address the educational disadvantages that arise from the unequal distribution of resources, recognition and respect both within and beyond education. Addressing such inequalities and specifically the ways in which gender intersects with them is the core business of gender equity policies in education. This Report also attends to gender's intersections with other social and cultural differences. In so doing it suggests that another key focus for gender equity policies should now be on those girls and those boys who are the most disadvantaged. This 'which girls', which boys?' approach leads to a new phase in understandings of trends in educational performance and to new directions in gender equity policies and programs.

Comber, B. and Green, B. 1998, *Information and Technology and Literacy and Educational Disadvantage Project,* University of South Australia. [The ITLED project can be found at: **http://www.literacy.unisa.edu.au/ITLED**

The project sought to develop new knowledge about relationships between information technology (IT), literacy and educational disadvantage and appropriate learning materials. It did this by (i) considering the differing 'points of view of the disadvantaged', (ii) by documenting teachers' learning about and using community 'funds of knowledge' in designing literacy curriculum; (iii) by identifying, analysing and documenting how teachers create a 'permeable curriculum' which allows students to use home, peer and community knowledges and practices as a bridge to school literacies; (iv) by investigating the literacies made available through ICT to students in the different school sites; and (v) by focussing upon the use of new technologies as part of everyday literacy activities across the curriculum. It was an action research project based on university researcher and teacher partnerships considering schools serving socioeconomically–disadvantaged communities. The following outlines ITLED findings.

Teachers took on responsibility that schools provide educationally disadvantaged students with access to information technologies. Yet teachers felt they lacked experience with new technologies, having to learn about IT and how to teach with IT. During the project they developed this expertise, by working without a blueprint given the lack of conclusive research regarding the impact of information technologies on literate practices in communities, workplaces and schools. Teachers underestimated students' access to new technologies in their homes and communities, and overestimated their ICT competence and enthusiasm. They believed that new technologies could solve some problems of students' 'motivation' for academic work and competence with literacy and many re-evaluated their assumptions about the capacities of young people in their classrooms. This PD was new to many, and many learnt new software applications. The integration of ICT fundamentally changed their work. But such changes were experienced differently at different stages of schooling and in different types of schools by teachers at different points in their careers. One major factor was the intensification of their labour. Another was their uncertainty about what is meant by 'literacy' and 'educational disadvantage'. Teachers found it difficult to identify and specify student's new learning using ICT and difficult to embed ICT across the curriculum. The projected highlighted the need for teacher leadership.

Students largely responded very positively to the opportunity to act as co-researchers. They brought considerable media awareness to the project and audience sensitivity to their peer and cross-age teaching, They showed a capacity in learning to act as tutors for their peers and teachers, to take up and use appropriately the language associated with new technologies, to tolerate high levels of uncertainty in learning new software and applications. But there were marked gender differences in students self-selecting into the research project, and in lunchtime or free choice computing activities, with male students far more likely to become involved. Using computers and other new technologies had immediate positive effects on many disinclined and troublesome students, but how or whether this is sustained over time is not known. High levels of engagement appeared to be the norm for most students when in practices involved in new techno-literacies such as reading the Internet, designing a Webpage or publishing with Photo-shop are different than those related to print technologies. ICTs' concreteness, speed and quality of product, and its multi-modal interactive nature, were satisfying to young people. Students required specific literacies to access and make use of what is available via information technologies (e.g. upper case alphabet, key-words for searches, locating appropriate material, critical analysis) and explicit teaching of principles, processes and procedures. Peer tutoring and independent use needs to be planned for. When things don't work, student disenchantment and

disappointment is considerable. A small number of students have access to and expertise in far more sophisticated information technologies than those available at school.

Communities indicated greater use and access to information technologies than the teachers had anticipated, given the low socioeconomic circumstances of the immediate communities. Student access to computers was through extended family, friendship networks and workplaces. For many students computer use outside of school related mainly to computing games. Communities were interested in making use of the school's information technology resources and supported the uptake of new technologies at school.

Schools had very different levels of information technology, in terms of hardware and software (provision may relate to school size, location, primary, secondary, age of school, experience, interests and expertise of staff); very different levels of expertise ('warmware') in their staff profile with information technology, literacy and educational disadvantage and different and contingent problems to solve in terms of taking up new technologies (eg telephone lines), such as accessing the Internet or developing Websites. Burglaries and vandalism hindered the project indicating a school's workplace conditions cannot be ignored in ICT implementation. Furthermore, the IT provision in some schools was inadequate for the curriculum projects they had planned and designed. The placement and use of new technologies, as part of everyday curriculum practice and professional communication, had significant implications for classroom and school use of space. The new technologies produced new problems including demands for 'troubleshooting' staff; timetabling dilemmas in both primary and high schools; and re-shaping the library and the role of teacher-librarians. Staff continuity was critical, as was school-wide professional development. Teachers made good educational use of all information, communication and learning technologies already available in the schools (cameras, video recorders, audio-recorders, fax machines, photocopiers etc).

Departmental support and resources for the project were critical and supportive. Uptake in schools, however, was often ad hoc and unpredictable because of competing demands and uneven resources. It was more difficult for mid– and late–career teachers. The action research approach was extremely generative in terms of teachers' learning and professional renewal, but they take a toll on the staff not involved, while teachers in the project did additional time. Effects are only emerging in last year. They require new models of professional development and research that are less disruptive to their teaching.

This report is significant because it is one of the few that is longitudinal, action research based, and with a focus on disadvantage *and* ICT. It documents excellent practitioner stories of how teachers and schools and students work with ICT that are not idealised but that point to new possibilities and provides a conceptual framework for ICT literacy learning for teachers and students.

Connor, J. 2001, 'Inequitable literacies: Myths and probabilities' AATE/AlEA Joint Conference July, 'Leading Literate Lives'

http://www.cdesign.com.au/aate/pages/paper_menu.htm

Can teachers create conditions for learning and employ teaching strategies that will be effective across and between the interfaces of gender, race and social class? This paper brings together research on social class, race and gender and discusses contemporary perspectives on the impact of these factors on school success generally and literacy learning in particular. In recent years, teachers have often felt

overwhelmed by the volume of information and advice relating to their role in redressing disadvantage, with each of these factors treated as though it required separate and discrete attention. Yet, of course, in reality, the factors intersect and compound for young people as they affect their lives and life chances. The paper utilises the voices of these young people to learn how they are constructing themselves and others as members of particular groups, and how these constructions contribute to educational disadvantage. From these constructions, the paper seeks to identify approaches and strategies that respect individual differences, but open more flexible options for young people's ways of being, thinking and learning. In the process it challenges some dominant mythologies and reveals some probable ways forward.

Crosisca, P. 1994, 'Technology and Learning: Exploring the Potentials', Proceedings of the 1st International Conference on Open Learning, 9th-11th November Queensland Open Learning Network and University of Queensland, Brisbane, Queensland, pp.57-66.

The paper describes the ongoing growth of Off Campus Teacher Education Program (OCTEP) and its development of a community based flexible delivery instructional model. Emphasis is placed on the model's utilisation of 'cutting edge' technologies to enhance traditional distance delivery strategies. The report encompasses the continuing evolution of Computer Assisted Learning (CAL) packages and other information technology.

Delzell, N., & Hamill, K. 1996, 'Global schoolhouse: A special way to meet special needs', *Multimedia Schools,* Vol. 3, No. 1, pp. 71-74.

This article discusses the benefits that the Internet has for students with special needs. Specific examples are given of teachers that have used the Internet with special needs students and have found that it proved beneficial to their social development and work habits, it increased their motivation, and proved to be an incentive to research topics that may have proven too frustrating to look for in books. Teachers also found that special needs students who were very adept in the use of the technology, could be considered equals and even leaders in the eyes of their classmates. Feedback from the viewpoint of the students is also presented. Examples were given of students whose academic performance has dramatically improved through the use of the Internet at school.

Department of Education and Training, NSW, 1997*, Computer Based Technologies in the Primary KLAs. Enhancing Student Learning*. Curriculum Support Directorate.

This is an excellent teacher–oriented manual that provides a range of exemplary principles and practices for teachers about how to integrate ICT into their classrooms. The examples have a primary focus on the recognition of diversity and difference, and provide useful models and principles about how to equalise the use of ICT in schools and classrooms. While focusing on primary classrooms, these principles and examples are equally applicable to secondary schools that adopt cross–curriculum problem–solving and team–based pedagogies using ICT. The manual argues that ICT can provide motivation, increase student interaction and decision making, make repetitive tasks more interesting (relevant for issues of practice), illustrate complex processes and concepts as well as provide access to resources previously inaccessible (relevant for isolated and rural students). The manual points to the need for teachers to recognise diversity of student need, range of pedagogies, meaningful activities and

contexts, focus on social interactions and value prior knowledge of students, critical factors for disadvantaged students. A rich set of examples that link to learning outcomes, curriculum development, student individual learning etc are documented.

DECStech, AA 2001, Learning Technologies Project. 2000: Student Data, Adelaide.

The DECStech Learning technologies project was based on maximising purposeful uptake of technologies to improve student learning outcomes by utilising a network of nine Discovery and Global Discovery schools in SA. One of the strategies involved collaboration between Flinders University School of Education and the Project. They undertook an online survey of students' attitudes towards three domains of school, self esteem and use of technology in learning. It was administered annually to all Year 5 to 10 students in the nine schools. This is the second report. Since 2000, the number of students completing the survey had increased 9% to a total of 1405 and for many students it was their first online experience. Trends in students' attitudes towards school were gender and environment related — improvement in primary and loss of interest in secondary, with girls maintaining a higher regard to schooling than boys. There were general increases in self–esteem except for girls in Year 9-10, but with males having overall stronger sense of self–esteem at the same age. There was overall positive attitude to computers growing over time except for girls that declined with age. Computer experience increases except for Year nine cohorts with males indicating greater expansion. Over 85% all students with access to computer at home. Use of computers is increasing generally. Female students tend to work with partners more frequently, and more by choice. They see themselves as having sufficient access to computers compared to males. The decline in school attitude to computers is possibly due to decreased access.

Despot, P. C. 1992*, Nurturing the Communication Abilities of Second Grade Students by Using Notebook Computers To Enhance the Writing Process*, Ed.D. Practicum, Nova University.

A practicum was designed to provide opportunities for second-grade students from low socioeconomic school communities to use computer technology in the writing process. Staff development training was designed and conducted to increase teachers' knowledge, experience, and attitudes toward using the computer as a tool for writing. Providing collaboration and support for teachers was a major component of the practicum. Six solution strategies focusing on empowering teachers with knowledge and support in process writing were developed, thereby increasing the use of the computer for student writing. Analysis of the data revealed that providing educators with the tools, training, and support increased student opportunities to use the computer as a tool for writing.

DETE, AA 2001, 'Use of information and communication technologies in the early years'. Report of Warriparri pre school cluster 2000-1.

This report undertook a survey and action research regarding access, use, attitudes and skills in computer literacy amongst a cluster of preschool agencies in the Warriparri region in SA. The population included low and high socioeconomic background and the children were aged from three to eight years. It surveyed parents and teachers. The survey found that parents and teachers now see computer literacy as essential. In the SA Warriparri cluster of preschool institutions, the three-year-olds who enter preschool are computer literate with 68% of 3-31/2 year olds and over 85% of 4-5 year olds

having computer access at home, 50% able to recognise components, can turn computers on and use the mouse. Teachers are using computers in the areas of English, Mathematics and the Arts. Most of the software was used for creative processes and word processing. When given the choice, students focused on games and creativity. The internet was not used greatly. Of value for this report is that the cluster developed criteria for selecting equipment that supported early childhood education presented in the Appendix. A range of good software products are described including MidiPads Interactive Performance System, Digital Cameras, Jumpstart software (interactive games with maths, science and social studies, vocabulary, reading and writing), KidPix Studio Deluxe, and My Personal Tutor.

Downes, T. 2000, 'Blending Play, Practice and Performance: Children's Use of the Computer at Home' paper presented at the Annual Conference of the Australian Association for Research in Education (AARE), Sydney, 4-7 December. Available http://www.aare.edu.au/

This study aimed 'to develop knowledge and understanding about the reciprocal relationship which develops between the child and the computer within the socio cultural context of the home'. The discussion considers the co-agency of the relationship between the child and the computer that leads to the children in the study learning through a blending of play, performance and practice. This approach to learning is contrasted to the approaches imposed within schools when children are engaged in learning, either with or without the use of computer-related technology. The significance of these findings go beyond challenging the way we integrate computers into schooling, to challenging the assumptions that underpin current teaching and learning practices in our school. The computers' appeal as 'playable; and children's own predisposition to use and learn through the use of computers through exploratory and learning by doing demonstrates the co-agency of the relationship of computers with children. This reinforces particular approaches to learning–a blending of play, performance and practice. This contrasts strongly with how computers are used in schools. Teachers use computers within traditional frameworks and pedagogical approaches and do not exploit the skills, understandings and predispositions that are developed at home. Children come to school with different orientations to learning and different orientations to traditional texts, literacies and technologies arising out of their cultural, socio-economic and linguistic backgrounds. This suggests new pedagogies that converge learning by doing and children's preferences for control and freedom to explore. This requires significant changes in teacher beliefs that require them to see computing as essential and that goes beyond superficial and surface level engagement with computers and that recognises student home learning.

Downes, T., C. Reddacliff, et al. 1996, *Children's Use of Electronic Technologies in the Home,* Western Sydney University, Macarthur. 18p.

Based on structured interviews with 275 children in grades 3 to 6 in eleven primary schools in Sydney, Australia, this study examined similarities and differences among children who regularly use computers at home, including difference in their families and communities. The following characteristics were identified as key factors that might be associated with differences: gender, age, parental computing experiences, number of computers in the home, socio-economic and cultural factors, and school experiences. Differences were investigated in terms of children's perceptions of their access to and use of computers. Topics explored included children's ways of using the computer, ways of learning to use the computer, and who they perceived as owning the computer. Results indicated that there are a number of children in today's classrooms who are

confident, competent, and regular users of computers in their homes. These children use computers for a variety of purposes and are comfortable moving between playing games and doing work on the computer. While game playing remains the most common activity, many children regularly write, draw, and use information-based programs for leisure as well as school-related work. Generally, these children came from homes where other family members also use the computer for a variety of work-related and leisure activities, most often middle and high income families most able to purchase the equipment or through employment eg professional/managerial.

Downes. T. Gibbons, P and Vickers, M. 2001, 'Teacher education and the use of new technologies for teaching and learning: A comparative analysis across seven countries', Paper presented to AARE conference, Perth, 2-5 December. Available http://www.aare.edu.au/

In 2000-1, DETYA funded a national project on *Models of Teacher Development for the Integration of Information and Communication Technologies (ICTs) into Classroom Practice*. As part of this project an environmental scan was undertaken in seven countries: Australia, UK, USA, New Zealand, Hong Kong, Singapore and The Netherlands. The scan focused on national programs, current practices and recent research and initiatives in pre-service and continuing professional development that related to ICT use in classrooms.

A comparative analysis revealed a number of interesting commonalities and differences. The commonalities mainly focused around the issues that the various countries or systems were facing, and the differences around the frameworks and strategies used. The issues common to all countries related to access and equity; infrastructure; quality digital content and software; provision of systemic and within–school support; and the development and use of student outcomes and teacher standards. The differences related to the political, policy and resource frameworks, the actual strategies used and the degree of connectedness between the pre–service and continuing professional development (CPD) components. This paper explores commonalities and differences. The differences related to the political, policy and resource frameworks, the actual strategies used and the degree of connectedness between the pre-service and continuing professional development components. The report considers pre-service models in UK, Netherlands, USA and Australia and concludes that ICT is not fully integrated into teacher education in Australian programs. Issues are: the lack of institutional support and infrastructure; pedagogies of the various teacher education programs so that student teachers have ample opportunities to observe effective use or participate in developing effective use; partnerships with school systems, local school districts re professional experience that integrates the use of ICTs for teaching and learning and professional support; the knowledge and skills of teacher educators not yet convinced as to need to integrate ICT; partnerships with schools and systems in student and teacher projects that lead to the enhancement of student learning outcomes and teacher development within schools. In-service teacher education is more fragmented and school based. It suggests the need for greater system support and coherence between pre-service and in-service, between states and federal government, and in programs.

Downes, T. 2001, 'Remaining focussed on a moving target: new challenges for the progression of Professional Development for ICT use in primary and secondary education', AARE conference, Perth, December. http://www.aare.edu.au/

The rationale for ICT use in schools and classrooms has been anything but static over the past 20 years. In succession, the target has moved from an early focus on

encouraging the acquisition of ICT skills as an end themselves, to promoting ICTs as a way of enhancing students' performance on the basic skills, to using ICTs to open up curricular reforms that change both how students learn and what they learn. Currently, in some forward-looking innovations, ICTs are being used to support new structures and organisational models for schools themselves. At each stage, new targets for ICT use have emerged, yet at the same time, many of the earlier goals continue to be supported in specific contexts. This pattern of change poses formidable problems for those who provide ICT–related professional development for teachers and schools. New goals emerge, but they do not entirely replace the old goals. In addition to deciding who should deliver the training, and how and when it should be delivered, providers also need to focus on establishing the legitimacy of their goals, since public endorsement for the some of the more recent ICT–supported innovations cannot be taken for granted. This paper provides a model of ICT professional development that provides a more substantial approach to goal-setting and program evaluation. The literature on continuing professional development increasingly links CPD with *improvements in student outcomes.* Teacher development that is embedded in the curriculum and integrated with the assessment of student learning is considered far more likely to lead to changes in teacher practice than teacher development programs that are conducted as isolated exercises. It considers the various approaches and rationales that leads to integration of ICT, i.e. (i) object of study; (ii) tool for learning; (iii) integral to subject matter and pedagogy; and (iv) integral to reform of schooling. These underpin four approaches to integration of ICT into schools that are occurring simultaneously.

ICT skills are added into the school program through a separate ICT subject, while teachers' practices in other subjects remain unchanged.

Integrating ICTs into the daily work of all teachers; in some cases teachers' existing pedagogical approaches and classroom behaviours remain the same, while in others, ICT use tends to change the pedagogical approaches the teacher employs.

ICT transforms the classroom: it changes content as well as pedagogy.

It is also transformative at the systemic level, leading to changes in the organisational and structural features of schooling as well.

These approaches to 'integration' provide schools and professional development programs with a framework about how they might integrate change more effectively in schools.

Durndell, A., Glissov, P., & Siann, G. 1995, 'Gender and computing: Persisting differences', *Educational Research*, Vol. 37, No. 3, pp. 219-227.

This paper reports on a Scottish survey of 429 students in five secondary schools in 1,3 and 5th years. It found significant gender differences in that girls had less experience of using computers at school and at home, that boys were more likely to own computers, but few differences in use of computers out of school for word processing. Boys were more positive towards computers and also had more sex-stereotypical views abut computing that increased with age. Older students became less interested and younger students used computers more out of school. This is one of many studies about gender preferences and predispositions in use of computers, and sex stereotypic attitudes of boys with regard to computers.

Dwyer, D. 1994, 'Apple Classrooms of Tomorrow: What We've Learned', *Educational Leadership,* Vol. 51, No. 7, pp. 1-4
http://www.ascd.org/readingroom/edlead/9404/dwyer.html

Apple's Classrooms of the Future (ACOT) commenced in 1980 to study the effects of computers on learning using seven classrooms representing a cross section of America's K-12 schools as its sample. They gave each participating student and teacher two computers--one for home and one for school. The team worked on a university based long-term collaborative research agenda focusing on the computer as a change variable.

Phase 2 focused on longitudinal studies of in-depth changes in students' thinking processes. Teachers worked more in teams, cross disciplinary, changing schools schedules and classroom organisation, increased focus on projects and tasks with different mixes of learning and communication tools. Teachers found the greatest difficulty was around areas of assessment, as it required the development of new modes. Listed benefits included: significant differences with respect to absenteeism; increased graduation at college; academic awards; and being hired by local business. Students organised and undertook work differently. They used inquiry, collaborative, technological and problem-solving skills uncommon to traditional high school gradates, skills that are close to computational competencies required for use of new technologies in work.

Barriers included a high level of PD for teachers, student and teacher assessment. When students demonstrated new learning outcomes such as creative problem solving strategies or collaborative work, teachers had to translate these into quantitative measures that were entered into grade books. This was counterproductive. Rewarding students for what they did, that is authentic assessment, required more flexible and multiple modes of assessment such as portfolios, for example.

The study concluded that technology improved motivation and increased student freedom with self–paced learning. But technology was more than another form of information transferral. The new technologies acted as a catalyst in traditional classrooms in terms of encouraging fundamentally different interaction between students and teachers, engaging students systematically with high-order cognitive tasks, and prompting teachers' assumptions about teaching and learning. The focus is now on how to encourage teachers to make this shift, eg practicums, clinical teacher education centres.

This report of the overall study did not differentiate between different groups of students, although they were not generally seen to be college aspirants.

Ed Queensland, 2001, *School Reform Longitudinal Study: Final Report* (QSRLS) Vol. 1, May, Department of Education, State Government of Queensland, Brisbane.

This was a study that focused on improving the quality of student learning outcomes undertaken in 24 Queensland schools (10 primary and 14 secondary) from 1997 to 2000. It was based on notions of authentic achievement. The focus was also more equitable student participation and social and academic outcomes in the face of inter-generational family poverty and locational disadvantage. It mapped backwards from student outcomes to classroom practices in Years 6, 8, and 11, school organisational capacity and system support. The report identified productive approaches to classroom pedagogy, assessment, dispersed leadership and positive ways to enhance the professional learning communities of teachers. It concluded that teachers and schools can make a difference in quality learning outcomes, even when struggling with diversity and equity issues, and at–risk students and communities. The report argues that more attention should be paid to teacher professional development. While they see teachers attending to the social dimensions of learning, the report concludes that teachers need

to focus on the intellectual dimensions and also on addressing difference. The demand for 'intellectual demandingness' may be the key to school renewal. They reported that teachers have focused increasingly, due to accountability pressures, on basic skills, but that they should refocus on higher order thinking, problematic knowledge, sustained conversation and more productive pedagogies. They saw productive pedagogies (that included the integration of ICT) that had the above characteristics being used less in lower socioeconomic areas. While teachers are committed to addressing diversity and equity, they found difficulty finding pedagogical strategies to deal with particular student populations. Added to this is the lack of highly sophisticated assessment literacies that multiple modes of pedagogy require. They indicate that this will rely upon increased teacher innovation that requires less managerial tendencies in schools and more professional autonomy and flexibility. This report is important as it is the most intensive Australian–based research that also considers what a curriculum for new knowledge society may require and because it has as central the notion of the integration of learning technologies into everyday curriculum and pedagogy. The report supports the argument that, if equity is to be addressed, teachers ought not focus on basic skills, but should raise their intellectual expectations of students, focus on problem solving and address difference and that ICT can facilitate this process of moving to student centred learning.

Edmonds, R. 1996, 'Teaching and training by videoconference' *SASTA Journal*, No. 96/2, pp. 29-31.

This paper describes how trials of desktop videoconferencing, managed by the South Australia Department of Education and Children's Services, are significantly improving the quality of learning for school students studying by distance education in South Australia. The trials which commenced in August 1995, involved teachers at the Open Access College in Adelaide, Port Augusta School of the Air, and school students (aged 5-17) in rural areas.

Edmonds, R. 1998, 'A new hybrid multimedia/Internet model for distance education', In 'Open Learning 98: Offering New Directions': Proceedings of the 3rd International Conference on Open Learning, 2-4 December, Open Learning Network, Brisbane, pp. 367-370.

This paper shows how the Open Access College is using an exciting new hybrid method of publishing and delivering its curriculum of DE; examples are drawn from a LOTE unit of work. A Year 10 Spanish project 'Los Derechos Humanis' trialed on-line publishing and delivery using the Internet, web browsers and CD-ROMs. The new methodology improves equity of access for students in rural and remote schools and homes, provides reliable and efficient teaching and learning systems, and improves the quality of interaction between teachers and its students. Preliminary evaluation of the trial indicates the students are more motivated, they develop a stronger virtual group unity, their decision making is made easier, and they are keeping more up to date with their course.

Eustace, K. 1996, 'Rural access to the Internet', In *A Meeting of the Minds: ITEC Virtual Conference Proceedings*, edited by L. Hay and J. Henri, Australian School Libraries Association, Belconnen ACT, pp. 139- 142.

As the continual growth of Internet use increases and its subsequent invasion of our culture proceeds in tandem, some rural parts of Australia are not keeping pace. This discussion seeks to collate some of these issues as experienced by the participants

and to define several positions about the practical, technical and social issues around the topic of access and equity of Internet access for rural schools in particular.

Fitzpatrick, H. & Hardman, M., 2000a, 'Mediated activity in the primary classroom; girls, boys and computers', *Learning and Instruction*, No. 10, pp. 431-446.

This article reports on a study investigating whether there are gender differences in modes of social interaction in collaborative learning on computer and non-computer tasks. Specifically, they investigated the proposal that 'girls are disadvantaged when working with boys on computer tasks'. The students were British primary school children ages 7 and 9. The article begins with a review of the literature on gender and computing, noting that the majority of research suggests that 'there is little difference between girls and boys in their appreciation of the importance of computers and in their individual performance on specific computer tasks' (p.431). Nevertheless, 'boys and men demonstrate greater sex-role stereotyping of computers, have more confidence in their computing abilities and enjoy working with computers compared to girls and women' (p.432). Moreover, much research suggests that 'girls prefer a co-operative style involving the mutual sharing of ideas whereas boys tend to show a competitive, individualistic style' (p.433). The results from this study indicated, however, that there were not significant differences in the ways in which all girl and all boy pairs collaborated (p.441). There is also some research to suggest that girls do not enter primary school with strong gender–stereotyping of computers but that this is something they acquire throughout the primary school years. [JEM]

Fitzpatrick, H. & Hardman, M. 2000b, 'Primary school children's collaboration: Task presentation and gender issues', *European Journal of Psychology of Education*, Vol. 15, No. 4, pp. 375-387.

This paper explores the specific characteristics of social interaction during an English language based task in the primary classroom, and the mediational role of the computer in structuring collaboration when compared to a non-computer mode of task presentation. 120 seven– and nine–year–old boys and girls completed a computer and non-computer task, involving the joint resolution of similar language based problems, working in equal ability boy-boy, girl-girl or boy-girl partnerships. Each session was videotaped and the social interaction of the pairs of children categorised. All children were found to offer significantly more suggestions and engage more frequently in reciprocated eye contact when the task was presented as a computer activity. During the non-computer activity task children employed significantly more descriptions, explanations and declaratives. The mediational role of the computer was also observed in relation to gender issues. When collaboration broke down in mixed gender pairs, boys used specific dominating styles of interaction in the computer task (stating intentions, issuing instructions and rejecting partner's ideas without justification), whereas girls demonstrated the same dominating styles when collaboration broke down during the non-computer task. The findings support and further extend the results of previous research, and their implications are discussed in relation to collaborative work with computers in the primary classroom.

Funston, A. & Morrison, M. 2000, *Investigating Gaps and Opportunities: Young People's Access to IT in Australia*, the Foundation of Young Australians in Partnership with the International Youth Foundation and the Lucent Technologies Foundation.

This report provides an excellent overview of young people's (12-24) use of the Internet and ICT, the types of government policies and initiatives that impact on young people, and the types of programs available to disadvantaged young people. The study undertook surveys, focus groups, interviews and audit of provision in 10 disadvantaged areas as identified through ABS data bases. The data draw from 15 language groups, remote communities and dense metropolitan areas. It identified Melbourne as having some of the key areas of disadvantage. The report indicated the lack of comprehensive access to ICT or the Internet for disadvantaged groups. They concluded that IT was less accessible to marginalised groups, both in rural and urban areas, and although IT skills are important to young people for work and leisure, access is very poor for indigenous young people, despite some exceptional models. Disadvantaged youth, who tend not to have home access, can access alternative sites such as libraries and cyber cafes, but these are expensive, with limited hours, and such youth tend to lack confidence to do so. Multimedia and Internet technology for information and education were important. They argue for the Internet and ICT as important for building community and cultural diversity and, indeed, are the basis for significant community initiatives. The Internet and ICT are seen to be necessary for life long learning. Schools, they concluded, were the key resource across the country and inter-sectoral collaboration making use of schools could be expanded. However, the research did not find that school effectively service all people, particularly early school leavers and refusers. They concluded that increasing public awareness and access was a priority at community and government level as lack of comprehensive programs uniformly addressing needs across Australia.

Furlong, J. 2001, Screenplay: an exploratory study of children's techno pop culture. Available: mary.oconnell@bristol.ac.uk

This study considered: who has access to screen based technologies at home, in school and in other contexts; under what social and physical circumstances do young people engage with them; what is the significance of screen based technologies in their lives; how do they use computer technologies; and in what ways do these enhance or transform children's capabilities? The study was of two cohorts of 9-11 and 12-15 year olds and used a survey, family case studies and video case studies, with additional focus groups with 'low and ambivalent users'. The sample included 409 girls, 239 boys; secondary 674, primary 181; Welsh 442, English 413; Inner City 203, Leafy Suburb 266; Examining town 239, rural town 147; high income 143, middle income 450 and low income 89 families. The study only used students in family case studies who were high or moderate users of computers in terms of frequency, non-standard high users e.g. girls and those from lower income families. Student completed logs. Videotapes captured how the computers were used including mouse movements, key strikes and changes plus sound and involvement around the computer. Lower users were included because of concerns about digital divide. The two main themes were (i) access and equity (ii) learning in home and school. Other themes were discourses around technologies within the home, gendered performance of expertise; geography of home use; links between home/school computer use. Thirty percent of sample did not have home access, none reported use in libraries or Internet cafes and more often, use was in friends' homes for games. Each family had a history of home computer ownership, children accessed computers in different homes. Some families had state-of-the-art computers plus peripherals such as multimedia machine with scanners, colour printers. Access to Internet trebled within a year from 20% to 60%. Ownership of computers was directly related to high income, more so with peripherals, and games to low income. In 15 out of 16 case study families, investment in computers was seen to be an investment in children's futures, preparing for work and educational needs. Children were also dependent on family support for learning on computers—some families

having direct expertise, others using cultural capital and social networks to find out. Children who were low users or ambivalent tended to have less family support or lacked equipment. Geographically, computers were often located in bedrooms, but were accessed by multiple family members, so it was, in a sense, in a public space. Software came bundled with hardware, so non-discriminating use, and caution re accessing Internet. 70% students used computer games, while older children accessed a boarder range of software. There were no gender differences in ownership or familiarity. However, there were significant gender differences in usage. 40% primary school aged boys used computers for games, compared to 6% girls. Boys tended to use technology for fun, and girls for instrumental use. Parental rules existed for equal access.

Low and ambivalent users of computers saw them as being in opposition to other activities such as sport. These students not compensated by access elsewhere. Schools were themselves key sites of reproduction of out-of-school inequalities in relation to the computer use and access. Because of the lack of computer skills and confidence these children were less likely to access computer clubs or 'open access' facilities in school libraries. These were the domain of the skilled or highly motivated users. Furthermore, they frequently felt that teachers, lacking ICT skills or resources themselves, compounded their exclusion by giving access in the classroom to more experienced computer users whose teaching demands were low' (p.6). Those students who did use computers tended to do so for leisure, although had similar educational components, although students tended not to be as techno expert as assumed ie few did web pages, programming, email or chat rooms. Student use focused around personal interest ie depth rather than breadth in use. Learning to use the computer was achieved by 'playful discovery', asking someone, usually family member or friend or teacher on 'need to know' basis. For a minority, there was no access to a social and cultural network, parents restricted use or were anti-overuse, or there was no expert member present.

'Whereas the majority of case study people (18) were very positive about the use of computers in the home, the vast majority were very negative about their use of computers at school' because of prescriptive use, slowness of hardware, lack of time for playful discovery, and limited access.

The study concludes that how students learn ICT and use ICT is part of socialisation process arising from existing contexts that reproduces long–standing concerns about social equity and exclusion. It identifies that home computers did impact on student learning. Again supports other research in Australia and elsewhere about the growing importance of home ICT use in creating new forms of cultural capital.

Gallagher, D. 2001, The virtual classroom, Joint AATE/ALEA Conference *Leading Literate Lives* http://www.cdesign.com.au/aate/pages/paper_menu.htm

This paper explores the ways in which ICT can enhance the subject options and learning of students in isolated and rural areas. The creation of a virtual classroom for Year 11 English and Information Technology students across three schools separated by 150 km using a chatroom in Hotline software. It was conceived as a means of providing opportunities for students in isolated areas, in schools with small candidature, where without this opportunity courses such as Extension English might not be offered. A classroom such as this would be able to utilise teaching expertise across the district and remove the obstacles of distance and small class sizes. The proposal of delivering selected Preliminary and HSC courses via technology was intended to extend and develop ideas in current methods of delivery such as Distance Education. It was not seen as another form of Distance Education, which is already operating successfully in

N.S.W. It was intended as an experiment in the virtual classroom whereby the students and staff would interact in a different way to the Distance Education model. There is a suggestion that, in Year 12, assessment could be done online. The real issue was whether it was a worthwhile teaching and learning experience for the students and teachers involved. Gallagher, one of the teachers, comments on her initial responses, her desire for students to read texts and to get to know students. She has since refined her approach. Student work was largely dominated by the technical issues and recording problems of submitting work and this intensified teachers' work around assessment. Indicates how she was learning technical use of computer at same time as dealing with content. The students enjoyed the chat room, but again technical skills (typing) limited use. There were two main constraints. Firstly, it is essential that the schools involved have sufficient computer access for students. This is especially important if a student does not have a computer in the home. One of the motivations for the development of this course was to overcome problems of isolation, and yet isolation is the sole reason for one Year 11 student not having a computer linked to the Internet at home. She is successfully participating in the course by ensuring all tasks are undertaken and completed at school during study periods. Second, schools need technological technical support with software and systems. In this case, they relied heavily on the support of the technology staff at District Office. The issue is whether other than general sense of excitement and student interest this enhances student learning. Their use, in this instance, increases student choice and participation.

Gilbert, P. 2001, 'Redefining gender issues for the twenty-first century: Putting girls' education back on the agenda', *Curriculum Perspectives,* Vol. 21, No. 1 (April), pp. 1-7.

This article locates concern about gender and technology in relation to broader debates about gender equity and education and the current moral panic over the education of boys. There are a number of pertinent points raised in relation to gender and technology, many of which are drawn from and also found in Collins, Kenway & McLeod 2000. For example, in terms of the boys debate and concern about their perceived under performance in some curriculum areas, Gilbert notes girls' relatively 'poor participation and representation in information technology domains within the secondary school curriculum'. Further, women are inadequately represented in IT jobs. Gilbert usefully summarises a report from the North American Association of Women Educators' Educational Foundation Commission on Technology, Gender and Teacher Education (2000). For example, this report found that girls tend to show a lack of interest in electronic game culture; and that 'girls' views of electronic game culture are in keeping with widely held social views about computer violence and the banality of many computer games'. The American Association made the following recommendations: rethink educational software and computer games (make them more girl and socially friendly); redefine computer literacy (includes lifelong application of relevant concepts and skills); change the public face of computing (change gender stereotyping of computing as masculine); and prepare tech-savvy teachers.

Goslee, S. and Conte, C. E. 1998, 'Losing Ground Bit by Bit: Low-Income Communities in the Information Age' *What's Going On Series*

This report examines the technology gap in low-income communities, assesses the barriers that are slowing the spread of new technologies to the underserved, and describes some of the most promising efforts to produce a more equitable distribution. Chapter 1 of the report discusses what is known about the extent of the technology gap and its implications. The technology gap takes a toll on individuals, communities, and

society at large, with disadvantages that stretch beyond labour market access to participation in the fabric of society. Chapter 2 examines the barriers that complicate efforts to close the gap. These include societal priorities, ambivalence about technology, and lack of political clout. Chapter 3 describes policy issues that affect access to new communications technologies. These centre on universal service, federal and state programs and policies, anti-poverty initiatives, and community-based initiatives. In chapter 4, a wide range of community-based efforts is described to illustrate approaches to achieving a more equitable distribution of the benefits of the digital age. Chapter 5 lists 108 additional resources.

Hamston, J. 2001 'Investment in literacy: A profile of boys and parents committed to the development and maintenance of reading practices.' Leading Literate Lives Conference Proceedings 2001, Australia Association Teachers of English.
http://www.cdesign.com.au/aate/pages/paper_menu.htm

The paper outlines stage one of a research project that considers boys aged 11 to 17 who are committed readers and the types of leisure reading they enjoy as well as the role of parents in enculturating reading habits. It also asks why boys with linguistic and cultural capital do not indicate the same predisposition to read. The aim to is counteract 'deficit' theories of boys' choices and see the intricacy of home–school practices. The research was undertaken in a Melbourne private boys school. The report used survey and interview and Luke's discourse analysis as well as Rogoff's notion of guided participation. The data revealed that the boys read widely across a range of books. They reported an increased engagement with masculinised reading practices in terms of the Internet, CD ROM, computer games) as they matured. Mothers continued to play the strongest role in maintaining shared reading practices although fathers took on a greater role, particularly when it came to computers in shared reading as boys matured. The boys could describe their leisure reading quite articulately. They were confident at all levels of reading practices, although few were critical in the sense of how they located their reading within a wider socio cultural frame. There were strong elements of guided participation by parents here. Reading practices were premised around interpersonal relationships, structured collective activity, explicit guidance, tacit guidance, distal arrangements and inter–generational directions

Harrell, W. 1998, 'Gender and equity issues affecting educational computer use', *Equity & Excellence in Education*, Vol. 31, No. 3 (December), pp.46-53.

This accessible article provides a succinct overview of recent research on the impact of gender, ethnic, cultural and social class backgrounds on attitudes to and use of computers in classrooms. It is prompted by a concern that the use of computers in schools 'could serve to amplify pre-existing patterns of social inequality' (p.46). It concentrates on the characteristics and effects of gender differences and social class differences, pointing to the enduring impact of conventional patterns of socialisation on girls' and boys' learning styles generally and attitudes to computers more particularly. Throughout all the compulsory years of schooling, overall girls are found to have less positive attitudes to computers than boys and both girls and boys regard computers as more 'boy appropriate', even when girls express positive attitudes to computer use. In terms of voluntary involvement in optional computer activities (e.g. computer clubs), British research found there to be significantly more boys participating than girls (girls were 10% of membership) (p.47). A similar trend is also evident in higher education

enrolments in computer studies and computer science, and significantly, the gender gap appears to be increasing in favour of boys. An interesting finding is that attitudes to computers appear to change towards the end of primary schooling (about Grade 5), and this is attributed to the effects of sex-role socialisation becoming stronger at this age. It notes research that has found gendered patterns in learning styles, for example that 'interactions among boys are marked by competition [and] females appear to prefer to work in co-operation' (p.47), or boys tend to take more risks and girls tend to be more careful (p.46). Such orientations are shown to have serious implications for computer use in the classroom.

Two points that are particularly relevant are:

- the content and nature of computer software and games (adventures, fighting, weapons) and the extent to which it is more oriented to boys' than girls' interests; and
- the patterns of social interaction around computer use and computer time in the classroom.

It is recommended that computer software be carefully analysed for its gendered assumptions and gender bias. The author advocates the use of co-operative, mixed groups. Teachers should discourage casual groupings around the computer and structure co-operative learning as this benefits all students. Girls are more likely to become discouraged if the learning atmosphere becomes competitive. There are usually no significant differences in competence and interest in computer-based work for young children. It is not the nature of the work that usually causes problems for girls, so much as the social organisation of that work. Harrell notes girls' interest increases when computer based activity is less concerned with computer games and more co-operatively based. The role of teacher expectations is also very important here. The author suggests that when 'girls have access to computers they are often expected by teachers to engage in more drill-and-practice activities that male middle-class white students do' (p.49). An equally significant finding is that 'affluent students are usually learning to tell the computer what to do, while less affluent students are usually learning what the computer tells then' (p.49).

In order to counteract some of the inequalities currently being reproduced by computer use in the classroom, Harrell recommends more widespread and systematic use of 'Computer-Mediated Communication' (CMC). He suggests that this technology will lead to more equitable learning outcomes because social and gender differences are obscured, a more diverse range of students will feel enabled to participate, and social stereotypes are less likely to prevail. In developing a very positive view of CMC, Harrell argues that CMC facilitates active and co-operative learning, enhances teacher-student feedback, provides an effective way 'reaching and educating culturally and linguistically diverse students and other than non-traditional learners'. Moreover, the anonymity can help reserved students and students can respond when they are ready. Harrell concludes that the key to improving girls' attitudes to computers is for them to see the relevance of computers and to not be introduced to computing through 'tedious programming sessions' (p.51).

Heaviside, S., Rowand, C., Hurst, D., & McArthur, E. 2000, 'What are the Barriers to the Use of Advanced Telecommunications for Students with Disabilities in Public Schools?' ***Education Statistics Quarterly [Online]*****.**
http://nces.ed.gov/pubs2000/quarterly/spring/4elem/q4-7.html

This brief article focuses on school reports of access to advanced telecommunications for students who receive special education and related services. It summarises the

findings of a 1996 national survey of approximately 1,000 school administrators about the use of advanced telecommunications in their school. The first question asked schools to report the percentage of students that received special education and related services. This was found to be approximately eleven percent of students attending regular public elementary and secondary schools. The second question asked administrators to report the extent to which five barriers hindered the use of advanced telecommunications by students with disabilities. Findings indicated that students with disabilities were equally likely as those without disabilities to have access to the Internet. The factor schools were most likely to cite as a moderate or major barrier (47 %) was special education teachers not being sufficiently trained in using advanced telecommunications. About one-third of public schools reported the following factors were moderate or major barriers: too few computers available to students with disabilities (34 %); too few computers with alternative input/output devices for students with disabilities (38 %); and insufficient evaluation and support services to meet the special technology needs of students with disabilities (39 %t). The impact that school size, percentage of poor students in the school, and teacher training policies had on the likelihood of the presence of barriers was discussed. Three tables are included providing data on the percent of students with access to the Internet by disability status; the percent of schools indicating specific barriers to use of telecommunications be school characteristics; and the extent of lack of teacher training as a barrier to telecommunications usage.

Johnson, R. 2001, GLOW: 'Learning: Learning Through and About the New Information Technologies', report of 'Good Learning on the World Wide Web' project, Common Ground Publishing, Australia, pp. 71-84.

This paper is a report on the project 'Good Learning on the World Wide Web (GLOW)'. The project seeks to investigate, document, facilitate, explore and research the learning of four groups of participants, namely, school pupils, teacher education students, school teachers, and university teachers in a project that involves the active use of the World Wide Web. School pupils are involved in active learning using the World Wide Web to facilitate communication and access of information. The specific focus of the project is on improving literacy. University–based teacher education students are actively involved in teaching school students via the World Wide Web. They have the opportunity to develop competencies in teaching and learning on the World Wide Web. School teachers manage the school-based part of the project with a focus on developing, maintaining and supporting 'Good Learning On the World Wide Web'. University teachers involve teacher education students in the project and also meet with all parties regularly both on-line and in person, and document and analyse the research project.

Kafai, Y. B. & Sutton, S. 1999, 'Elementary school students' computer and Internet use at home: Current trends and issues', *Journal of Educational Computing Research*, Vol. 21, No. 3, pp. 345-362.

For the past decade, the number of computers in the home has been steadily increasing. Yet relatively little is known about how children are actually using computers at home. This study elaborates on the results of a survey in which 291 parents of an urban elementary school (K-6) participated. Parents reported on their computer equipment at home, the type and frequency of their children's educational software and Internet use, and shared their ideas how better connections between computer use at home and school might be created. The results indicate that most of students' computer use was dedicated to game playing followed by various other

software activities. Students reported more limited Internet activities. While home computer ownership is not necessarily contingent upon gender, some software and Internet use tended to have gender specific activities. Many of the parents' suggestions for connecting school and home focused on the ways in which information about students might be obtained from the school and support through exchanges with teachers. The discussion addresses the ways in which ways these results replicate earlier observations of children's academic home computing. Problematic issues and potential directions in academic home computing are also discussed.

Labbo, L. D. and et al. 1996, *Computers Real and Make-Believe: Providing Opportunities for Literacy Development in an Early Childhood Sociodramatic Play Center,* Instructional Resource No. 26, Office of Educational Research and Improvement, Washington.

Playing in literacy-enriched, sociodramatic play centres is an important component of children's literacy development; yet due to the limited number of available computers in many low-socioeconomic-status urban schools, occasions for children to playfully explore literacy as it relates to technology are frequently absent in the early childhood classroom. Low-socioeconomic status, culturally diverse children's opportunities for literacy development in computer-enriched, sociodramatic play centres during literature-based thematic units in one early childhood classroom are described. When the teacher shared thematically related literature, guided fact-finding field trips, invited children to help design the play centre to include literacy materials and computers (real or make-believe), and engaged in supportive dramatic role-play, the children had numerous opportunities to gain conceptual understanding about the forms and uses of literacy.

Land, M. J. 1999, Evidence of Gender disparity in Children's Computer Use and Activities, Paper presented to Association for Education in Journalism and Mass Communication, New Orleans, August.

A study of male and female computer use in the home of children aged 9-14 found that males spent more time on computer, but not online, than females. Males and females engaged in different computer activities. They play computer games about the same time, but females spend more time on word processing and desktop publishing, males play more games on line, while females spend time on line communicating.

Lankshear, C., Bigum. C et al, 1997, *Digital Rhetorics: Literacies and Technologies in Education-Current Practices and Future Directions,* Volumes 1-3, DEETYA, Canberra.

This was a two–year Australian collaborative study investigating the interaction and relationship between literacy and technology in teaching and learning in school education. It focused on the policies impacting on teaching and learning in literacy, language and technology across the curriculum (Vol 1); an investigation in eleven 'sites' across Queensland, Victoria and NSW and in primary and secondary schools of technology and literacy practices in various contexts using case study methods (Vol 2 and 3); and a theoretical account (Vol 1). The project sought to identify models for teaching and learning new literacies in English and Technology, explore technologies and technology–mediated processes, and technological environments that generate new literacies, to identify how students and teachers perceive these new literacies. The conceptual framework of this report is significant in that it distinguishes between the types of digital literacy taught and learnt. The case studies are not exemplary or 'best

practice', as the study indicates there is no ideal that can be replicated across sites of practice. Rather they are exemplars in terms of documenting what can be done in specific contexts. These constitute, together with the discourse analysis of policy texts, a set of narratives—descriptive and analytic stories that indicate what it means to use ICT in teaching and learning. This report is an exceptionally rich document that maps the complexity around the integration of ICT into teaching and learning. It points to how context (policy, resources, location) shapes what can be done, but also how teachers and schools have agency to mobilise even the most limited resources.

Lankshear, C., Snyder, I. with Green. B. 2000*, Teachers and Technoliteracy. Managing Literacy, Technology and Learning in Schools,* Allen and Unwin, Sydney.

This text draws directly from the *Digital Rhetorics* research project (DEETYA 1997). The book is about how to 'do' literacy and technology in educationally effective ways, but in ways that are careful of discourses about the capacity of the new technologies to improve education for all and the dangers of technologising learning. It identifies the difference between 'getting information' and 'assessing information', between 'seeking information' and 'coming to know something' often lost in the push for the introduction of technologies into classrooms. They present an integrated view of literacy, technology and learning based on Green's 3D model that distinguishes between the three dimensions of digital literacy: the operational, the cultural and the critical. They consider how policy informs and shapes teachers' practices in how they adopt and adapt new technologies into effective classroom programs. There are portraits of school–based case studies that explore the multidimensional aspects of integrating ICT. From this are drawn common practices and principles. They identify five patterns of practice that were evident to a greater or lesser extent in each site: complexity, fragility, discontinuity, conservation and limited authenticity. They saw classrooms as complex systems, and that the introduction of ICT and the Internet produced unexpected and significant changes in classrooms, but these were reliant upon teacher practices, habits, attitudes to learning and technology. The fragility of the technology was itself pervasive and created new uncertainties for teachers, as was the discontinuity of change arising from reliance upon individuals and small groups for innovation. More often, teachers and schools accommodated ICT into their existing practices rather than radically transform those practices. The authors recommend five principles for classroom practice: put *teachers first* (in terms of training in ICT); address *complementarity* and how this new technology fits with others, in school practices and home life; and on the need for *critical* literacy. The principle of *workability* is to ask whether ICT does something better than other approaches, and how do we know? *Equity* is about equitable resource distribution within schools, home-school relations, communities and systems. It is also about attending to what students know about ICT, and recognition of the cultural practices they bring to school. The final chapter provides some practical guidance: ICT integration is a whole school commitment. This means working through school policies, shifting cultures and working together in new ways. It is about dispersed leadership and getting good advice. They suggest four sets of strategies. The pedagogical points are firstly, to think social practice in 3 D, that is, make learning meaningful, relevant, connected and explicit. The second is to begin with the cultural because of the importance of the local, to make links between generic practices and real world situations. This is not about asking for information, but knowing how to ask meaningful questions, to make students into researchers, providing frames of understanding. It is about developing judgements in students and teachers about the appropriate use of specific technologies for particular tasks. Third, take careful note of the operational and the critical. This means that students may have significant technological expertise at the operational level, but little capacity to use the

technology in a critical sense. All the above requires whole school and classroom planning, policies, resources and cross curriculum integrated approaches.

This is a valuable text which can provide teachers and principals with a wider framework of analysis that allows them to consider what it means to integrate ICT into teaching and learning as well as practical suggestions about how to do it.

Lawson, T. and Comber, C. (2000) 'Introducing information and communication technologies into schools: The blurring of the boundaries', *British Journal of Sociology of Education* Vol. 21, No. 3, pp. 419-33.

This paper critically analyses the literature on the impact of ICT on schooling. They review the debates between utopian and dystopian views of whether ICT will transform schooling or merely lead to a 'grafting on' process of technology to traditional curriculum, concluding that neither is based upon empirical evidence. The paper draws from aspects of the research undertaken for the English Department of Education's Superhighways Initiative in 1997 undertaken by the Leicester University School of Education. Their conclusions about the ways to introduce ICT into schools are developed from evaluation of seven projects in 51 schools and colleges. The approach was based on interviews and classroom observation. They argued that there is a need to attend to the 'practical wisdom'' of teachers to better understand how change around technology occurs. Important findings were that the focus of teacher professional development had been training for the technology and not training to use the technology for learning, that is, training to improve teachers skills were separate from training on how to integrate into classroom. In general, the location of computers in labs with restricted Internet access impedes teacher use and discourages teachers. They considered the future lay with more cross curricula and transdisciplinary use of ICT. This pattern was more evident amongst teachers in primary schools and needed to be rewarded, whereas secondary teachers neither recognised nor encouraged cross subject or interdisciplinary use unless specifically required by examination system or curriculum. Clear recommendations coming out of this report are: (i) to focus on technology for learning by having multiskilled professional development on the ground that addresses technical issues alongside curriculum and pedagogical issues; (ii)to place Internet–capable computers into classrooms.

Leidner, H. R. 1991, *Development and Implementation of Activities Designed to Target Uninvolved Parents and Increase Home and School Interaction of Disadvantaged Families*. Ed.D. Practicum, Nova University, Florida. 66p.

This practicum was designed to use training to increase economically disadvantaged parents' participation in their children's academic learning. Objectives were that targeted; uninvolved parents would: (i) increase communication with their children's school; (ii) increase their attendance at school functions involving parents; (iii) increase their involvement in their child's education; (iv) identify family support services they needed to become more involved; (v) demonstrate initiative in educating their child at home; and (vi) check out a computer and software which would be used to provide educational materials to their children at home. A pre-assessment questionnaire was used to determine family needs and interests. Several workshops were developed. During the 12-week practicum, the take-home computer program was used to bridge classroom instruction with parent involvement at home. A post-assessment questionnaire was used to determine the extent to which participants felt the program was successful. All six objectives were met.

Levy & Danon 1991, 'Computers and Class: Computers and Social Inequality in Israeli Schools', *Urban Education,* Vol. 25, No. 4, pp. 483-98.

This article examines computer use in fourteen elementary schools in the Tel Aviv–Jaffa area in Israel. Computer-assisted instruction was once expected to narrow the gap between students from low– and high–SES homes but appears to perpetuate it, because high–SES students have the advantage of computers at home. This study indicated that even when students from low socioeconomic backgrounds were given home computers that, in professional middle class families where there were more taken for granted use of sophisticated array of technologies, together with parental pressure on schools to use ICT for higher–order tasks exacerbates cultural advantages. While parents in lower socio-economic families value the use of computers, they tend not to use them as part of work and leisure, or use them for restricted practices such as games, and tend not to pressure schools in terms of pedagogical use. Consequently, teachers tend to use ICT for more basic skills development in lower socioeconomic schools. This is an earlier report that supports more recent studies that point to the significance of the types of predispositions and ICT literacies that are produced in different home environments.

Lewis, R. B. 1997, 'Changes in technology use in California's special education programs', *Remedial & Special Education,* Vol. 18, No. 4, pp. 233-242.

This research examines changes in technology use in California's special education programs between the late 1980s and mid-1990s, through investigating the impact of five major changes that may have affected the ways technology is used in programs for students with disabilities. Special education administrators and educators were surveyed. Results suggested that there is greater access to computers and other technologies today and they are used more often by staff and students. Education staff surveyed recognised the benefits of technology for students with disabilities and agreed that several factors contribute to the adoption and use of technology. The results also showed that the types of technologies available in special education have undergone change since 1987. It was recognised that although technologies have become more sophisticated and more plentiful, barriers to their full implementation in school programs still exist. Conclusions are drawn and implications discussed.

Lewis. R. B. 1998, 'Enhancing the Writing Skills of Students with Learning Disabilities through Technology: An Investigation of the Effects of Text Entry Tools, Editing Tools, and Speech Synthesis', Final Report.

This final report discusses the outcomes of a three–year project that studied the effectiveness of word processing tools in improving the literacy skills of students with learning disabilities in grades 4-12. In Year 1 (1994-95), four text entry strategies were compared in 132 students with learning disabilities: keyboarding instruction, alternative keyboards, word prediction, and word prediction with speech synthesisers. The Year 2 study (1995-96) investigated the effects of two types of text editing tools, such as spelling and grammar aids with and without speech synthesis, in 106 students with learning disabilities. The Year 3 study (1996-97), investigated speech synthesis under three conditions in 103 students with learning disabilities: when available at all times versus when available only during the text entry or the editing/revising stages of writing. Results of the studies found that: (i) word processing had the most impact upon the accuracy of students' writing; (ii) word prediction was the most promising strategy for improving the text entry speed; (ii) spell checks were effective editing tools, although grammar checkers were not, and spell checks had a more positive effect on students' writing quality and accuracy than synthesised speech.

Light, P., Littleton, K., Bale, S., Joiner, R. & Messer D. 2000, 'Gender and social comparison effects in computer-based problem solving'*, Learning & Instruction,* Vol. 10, No. 6, pp. 483-496.

Gender differences in relation to school children's learning with computers are frequently attributed to a tendency for boys to dominate computer resources in mixed sex settings. However, the evidence relating to children's performance with computers in mixed-sex groups is conflicting. This paper reports two experimental studies in which 11 to 12-year-olds worked on a computer-based problem–solving task. In the first, 62 children worked in either same or mixed sex dyads, but each child had her or his own computer, and no verbal interaction was allowed. Boys out-performed girls overall, with sex differences becoming significantly more polarised in the mixed sex dyads. The second study involved 96 children, with individual pre- and post-tests, compared co-action dyads (as in the first study) with interaction pairs, in which the pair members worked together at a single computer, with no restriction on interaction. The polarisation of sex differences in the mixed-sex dyads was once again found in the co-action condition, but not in the interaction condition. Results are interpreted in terms of processes of social comparison, which appear to be more potent in this situation than any straightforward domination of resources.

Little, J. 2000, 'Kids+Technology+Teaching=Learning?' ***IARTV Occasional Paper No 65,*** **May.**

This paper argues that there is a key tension between the old generation–and therefore teachers–who accommodate new technologies, and the new generation–the net generation of students–who assimilate technology. The paper suggests that the net generation is a new type of student who challenges teachers because they think differently–linearly and non-linearly–are capable of multitasking, technologically fluent, enjoy learning, active learners, do not need instructions but are self–directed and welcome change. This challenges teachers because students can be self-determining in their learning (e.g. on the Internet). Teachers are therefore trying to accommodate to new technologies, while students see them as everyday tools. The author takes an optimistic view of technologies as a learning tool, but tends to homogenise 'kids'. The paper provides an interesting case study illustrating how the themes of multi-tasking, non-linear thought and self-direction can be integrated into a metacognitive task on dinosaurs.

McCann, A. 1997, 'Designing accessible learning materials for learners with disabilities and learning difficulties'*, Australian Journal of Educational Technology,* Vol. 12, no. 2, pp. 109-120.

This article explains how the Open Training and Education Network has addressed the issue of what needs to be considered when designing learning materials that may be used by various students with different disabilities, and how learning materials can be made more accessible for such learners. Recommendations were made in the areas of, providing learning materials on disk, using plain English, having a flexible range of assessments, the use of print materials, videos, audio-tapes and video voiceovers, computer based learning, and teaching learning skills. The author outlines the learning areas in which people with various disabilities have different learning styles and how allowances in each of the mentioned areas can facilitate easier learning. An appendix is included that summarises recommendations, and links which student group would benefit from each suggestion. Although this document is focused on adult distance learning, many of the suggestions are applicable and relevant to schools.

McLennan, K. V., 1999, *Information Technology: Policies and Practices*, University of Melbourne, Victoria.

This paper suggests that policy is the appropriate planning structure through which schools are empowered to act when new conditions arise that impact upon education. Further, that policy on the part of the Government and Departments provides indicators for schools about prioritising those conditions. Policy in action is often triggered by events that pre-empt policy in planning, and that such is the case with information technology. The paper recounts the research undertaken within a rural regional area where access through information technology might be seen to have added value to students and teachers. The purpose was to establish a benchmark of readiness for the impact on schools of information technology. The findings are grouped according to the nature of the schools, the current practices of those schools that did have policies in place, and the expectations and perceived requirements of schools which did not currently have a final policy in place. The paper examines current uses of programs delivered by satellite, and those opportunities offered by the Internet. It also examines the way in which decisions are made about obtaining basic information, seeking assistance and managing the balance between school income and school technology. It seeks information on the needs for professional development, and conditions which affect decision choices. The findings are related back to current literature, and some recommendations are highlighted which should be included in further research.

McLaughlin, C. 1998, 'Participation, cooperation and autonomy: students' perceptions of learning at a distance using technology', *In EdTech '98*: 'Education and Technology: Planning for Progress, Partnership and Profit', Conference Proceedings of the Australian Society for Educational Technology, Perth, Western Australia, July 5-8, edited by Clare McBeath and Roger Atkinson, pp. 166-173, Australian Society for Educational Technology Perth, WA.

http://cleo.murdoch.edu.au/gen/aset/confs/edtech98/pubs/articles/m/mcloughlin1.html

In Western Australia, telecommunications and information technology are being used to provide educational services to students in rural and remote schools. The paper reports on the insights and responses of a group of students who accessed the gifted and talented program via telematics during 1996- 1997, using audiographic conferencing. For these learners, this was their first experience of learning at distance. Students reported a strong sense of autonomy and self-direction, which was a result of having an 'invisible teacher'. In addition, a great deal of feedback was obtained on students' own learning styles, the impact of technology on learning and the growth of cooperative work across geographically separated classrooms. The implications of these findings are analysed in terms of how distance learning settings affect communication styles and how technology serves collaborative learning. It is recommended that recognising and admitting the student voice as part of the planning process is important for educational contexts where technology is used to support learning.

McLoughlin, C., Oliver, R., Wood, D. 1997, 'Teaching and learning in telematics classrooms: Fostering higher level thinking outcomes', *Australian Educational Computing*, Vol. 12, No. 1, pp. 9–15.

In 1996, the Education Department of Western Australia extended the use of telematics for delivery of educational programs to gifted and talented students in rural and remote

areas. The aim of the project was to apply innovative approaches to teaching via audiographics, and to foster higher–order learning in students by linking them with other students participating in the academic talent program. The paper discusses both constraints imposed by the technology and how teacher pedagogies may be adopted to maximise the communicative processes in telematics classrooms in order to foster higher–order thinking skills in gifted and talented students.

Madden, G. & Savage, S. J. 2000, 'Some economic and social aspects of residential Internet use in Australia', *Journal of Media Economics*, Vol. 13, No. 3, pp. 171-185.

This study constructs a profile of the representative Australian residential Internet user from data obtained from a web-based survey. Survey data indicate the representative user is male, 20 to 40 years of age, highly educated, uses the Internet eight hours per week for email and FTP, and has a monthly bill of AUD32. An ordered-legit model relates Internet use to price, socio-demographic and connection capacity variables. Model estimates show the probability of higher Internet use is greater for middle-income households, but declines with age of the user. Policy may be required to enhance access to lower-income groups, and to inform the elderly of the potential capabilities of the new technology. Further, model estimates suggest that Australian Internet subscribers prefer flat-rate pricing (or a combination of flat-rate and usage-sensitive pricing) over usage-sensitive pricing schemes. This result is consistent with Australian consumer attitudes.

Marshal, A., Matthews, R. , Milne, G. and Taylor. J. 2002, *Notebooks for Teachers and Principals Initiative. Final Repor*t, Consultancy and Development Unit, Faculty of Education, Deakin University, Melbourne.

The Victorian Department of Education and Training instituted in 1998 the *Notebooks for Teachers and Principals Initiative*. A notebook computer was leased to each of the 37,000 government schoolteachers in the state of Victoria, over a three–year period, to support and encourage principals and teachers to: integrate the use of learning technologies into classroom and administrative practices; reward and provide an incentive for teachers undertaking significant professional development in the use of learning technologies; enhance the professional status of teachers; improve teacher skills in using learning technologies in the delivery of curriculum; and improve teacher productivity. All schools were expected to implement a Learning Technologies Plan by the year 2001 that resulted in principals, staff and students having access to computers, a range of applications and curriculum products and regularly using on-line information and communications as part of the school's educational and operational program. It was hoped that they would become routine, competent and discriminating users of learning technologies in the daily programs of the schools. The evaluation revealed the increasingly 'routine and competent' use of computers, the increasing level of use and skills with a range of applications, the increasing use of on-line information, the outstanding increase in the use of computers for communications, and the increasing use of computer for curriculum planning and resources. But questions included in the parallel state wide DE&T Learning Technologies study demonstrate that the growth of use of ICT has been greater for Notebook recipients than for the general population of teachers and principals. The study has also explored the types of support and professional development which teachers have felt were needed to maximise the impact of the initiative eg technicians. Teachers' preference was for school-based professional development and self-paced, timely, personal professional development CDs. The reported impact of the program on individual teachers and principals has

been extremely positive and on their capacity to use and apply new learning technologies in their classrooms and in their administrative practices

Mayer-Smith, J., Pedretti, E. & Woodrow, J. 2000, 'Closing of the gender gap in technology enriched science education: A case study' ***Computers & Education,*** **Vol. 35, No. 1, pp. 51-63.**

This case study explores a popular assertion, namely that success in technology–enriched science classrooms is gender dependent. It investigates how students respond to substantive changes that accompany a comprehensive integration of technology with the teaching and learning of secondary science and physics. Specifically, the paper asks: (i) 'Do female students view, participate, and achieve differently than male students in technology enhanced science classrooms?'; and, (ii) 'If not, why not?'. Empirical evidence collected over seven years includes classroom observations, student interviews and questionnaires, classroom achievement records, and journal entries. Findings from the study illustrate that sound pedagogical practices and social organisation in technology–enhanced secondary science classrooms can promote a gender inclusive experience, where women and men participate and perform equally well. Methodologically, the study also illustrates how a consideration of the complexity of classroom environments contributes to rich contextual understanding of the interplay of technology, teaching, and learning.

Means, B. and Olson, K. 1995, ***Technology and Education Reform, Volume I-111 Vol I Findings and Conclusions, Vol II Case Studies, Vol III Appendices,*** **Studies of Education Reform Office of Educational Research and Improvement (ED) Washington DC.**

Educational research shows that technology can enhance student acquisition of discrete skills through drill and practice. This document presents findings of a longitudinal study that examined whether technology could provide significant support for constructivist, project-based teaching and learning approaches. It also identified the elements necessary for effective implementation of technology within an educational reform context. Data was derived from case studies that were conducted at nine sites whose programs emphasised education reform and provided authentic activities for students from economically disadvantaged backgrounds. Technology supported teachers' efforts to involve their students in long-term complex projects by helping them to believe that their work was important and authentic; increasing their ability to deal with complexity; dramatically enhancing motivation and self-esteem; creating a multiplicity of roles; instigating student collaboration; and prompting teachers to act as coaches and advisers. Findings indicate that the most economically disadvantaged students can use technology tools to support their own learning, create high-quality products, and support collaboration with others. The implementation of such reforms is unlikely unless the private sector engages actively, constructively and over the long term with schools. Reform takes an extended period to come to fruition, requires significant resources, and must attend to teachers' needs for support in undertaking both new learning and more difficult roles.

Volume II presents case-study profiles. These were conducted at nine sites whose programs emphasised education reform and provided authentic activities for students from economically disadvantaged backgrounds. The sites—eight individual schools and one network of 462 schools—were selected on the basis of the following criteria: (i) the strength of the site's

education reform agenda over technological use for its own sake; (ii) the involvement of large numbers of students from economically disadvantaged backgrounds, representing a variety of cultures, ethnic groups, and linguistic experiences; and (iii) the use of network and other distance-learning technologies. These case studies provide rich documentation about the contextual factors impacting on the integration of ICT and are useful examples of how schools deal with such difficulties. Volume III describes procedures for sample selection, data collection and analysis, and coding for the software program, Ethnograph. It also contains sample interview guides and copies of the school- and classroom-level debriefing forms. This longitudinal study utilises case studies to indicate the complexity of educational reform using ICT as the catalyst. As with similar Australian studies such as case studies of Learning Technologies Project in SA and the 100 Schools in WA, these document how ICT requires multiple strategies and significant system–wide support to address issues of disadvantage.

Meredyth, D., Russell, N., Blackwood, L., Thomas, J. & Wise, P. 1999, *Real Time: Computers, Change and Schooling: National Sample Study of the Information Technology Skills of Australian School Students,* Australian Key Centre for Cultural and Media Policy.
http://www.deetya.gov.au/schools/publications/1999/index.htm

This national sample study of the information technology skills of Australian school students identified the range of issues requiring attention in policy development and planning for the equitable integration of information into Australian schools. This report considered the patterns of skills acquisition and levels of IT in Australia over a period in 1998. The survey data was from all States and Territories, and it included a sample of 222 schools, 6,213 students, 1,258 teachers and 222 principals from 143 government schools, 38 Catholic schools and 22 Independent schools. Student samples were Years 6/7 and Years 10. The report provides broad definitions of computer literacy. 'Information technology skills should be conceptualised broadly and should emphases learning how to learn, rather than the acquisition of specific technical skills that will need to be frequently unlearned. Students will need the capacity to cope with change and accept innovation, and their skills in using information technology will be inseparable from their analytical abilities and their capacity for creativity, team work, problem solving and communication skills' (p. xxiii-xxiv). The report distinguished between basic IT and advanced IT skill levels. *Real Time* defines basic IT skills as the ability to use the mouse, turn on a computer, use a keyboard, shut down and turn off, exit and quit a program, save a document, print a document, start a program, open up a saved document, delete files, get data from floppy disc, create a new document and files. Advanced IT skills include playing computer games, drawing with a mouse, creative writing, spreadsheets and data bases, WWW, search web using key words, create music or sound, send email message, copy games from CD ROM or web, create program, and make a website or home page (pp. xxvii). The report concludes that there were distinguishable patterns of skill acquisition and level which varied by location, school, socio economic status of family, NESB, gender and for indigenous. They mapped strong links between high population density and SES of family and a technologically sophisticated environment. Familiarity was important to later advanced skills, with an earlier start leading to higher level use later. Most learnt skills at home, but that boys learnt advanced skills more. Independent schools and boys schools had higher levels of skill generally. Independent schools also had higher levels of resources Indigenous students tended to learn skills outside home and school, and to lower skill level. Teachers' basic skills levels were equivalent to most students, but on average

less than students' advanced skills. Those who most lacked basic skills were females over 50 years of age in primary schools, and Catholic schools more generally. Here that the links between size of school, school resources and technology support are most obvious. Secondary school teachers had more advanced skills, whereas SOSE, English and Technology teachers integrated computers into classrooms more than in Maths and Science and considerably more than in Arts, TESOL and Physical Education and Health Education. The report listed that 75% of schools reported they had a student to computer ration of 15 or more to one computer 40% having 10 or fewer (50% in Victoria or Queensland and 24% in NSW) and a student to computer ration of 5 or less in Independent schools, whereas Catholic schools had more students to computers. The report again linked student access and familiarity to confidence, acquisition of higher–level skills, and enjoyment. Lower student–to–computer ratio meant increased use individually and in groups and more sophisticated use across the curriculum. Few schools had information–sharing networks with other local schools, communities or business or with international schools, although this was more likely between government schools where it existed. Again resources were better in higher or middle class schools, less so in country and rural. Independent schools had more dedicated IT support, personnel and technology learning resources, and Catholic school systems less so. The Report also highlights, as do other reports such as *Digital Rhetorics*, the links between policy prioritising of IT and level of resourcing, networking, technical support and PD and the integration of IT across the curriculum.

Metis Associates 2000, *Program Evaluation: The New York City Bard of Education Community School District Six Laptop Project,* AERA presentation, Montreal.

This was a program in New York City District with six schools that had over 95% Hispanic students, most of whom were on free lunch. Three programs were developed implementing the use of laptops—one in a selective school, another in a non-selective school, and the third on a student–as–expert model of dissemination summer school. Comparisons were made with non-laptop cohorts on student achievement scores in literacy and numeracy, and student, teacher and parent evaluations of impact. Laptops improved the learning outcomes of high achieving student group compared to the cohort, while they seemed to maintain the achievement of the non–selective school students (in contrast to decline in scores of non-laptop cohort). In all three cases, students, parents and teachers perceived increased diligence in doing homework and less leisure time at the TV or on the phone, improved organisational skills and attitude to homework and school. Teachers, in particular, felt it encouraged them to undertake more cross curriculum and enquiry approaches than were already underway, and made them into facilitators not provides of knowledge.

Miller, M. D. and McInerney, W. D. 1995, 'Effects on Achievement of a Home/School Computer Project', *Journal of Research on Computing in Education,* Vol 27 No 2 pp.198-210.

The study investigated a home/school computer project and its effects on reading, language, and mathematics achievement on 142 fourth– and fifth–grade students as well as equity issues relating to gender, academic aptitude, and socioeconomic status. Results indicate that participation was not associated with increased academic achievement.

Moseley, D. & Higgins, S. 1999, *Ways Forward with ICT: Effective Pedagogy Using Information and Communications Technology (ICT) for Literacy and Numeracy in Primary Schools,* UK.

This two-year research and development project was funded by the UK Teacher Training Agency in Britain. When the research was undertaken, the status of the use of ICT in primary schools was one of intense activity and rapid change, with new equipment and resources being made available to schools. The research analysed the needs of the teachers and provided support for them in their work with pupils in classrooms. It assisted teachers and IT-coordinators as they planned to add ICT to the repertoire of tactics and strategies for raising literacy and numeracy standards; and targeted training providers, policy makers and wider research community.

The objectives were to: test and develop a generic framework for the functions of ICT, highlighting the potential benefits and pitfalls in using ICT in classrooms, particularly in the areas of literacy and numeracy; help teachers raise pupils' achievements in the areas of literacy and numeracy through supporting informed choice about such use of ICT; and refine and illustrate specific aspects of the framework through detailed classroom case studies of effective teachers' practice and development.

Motely, R. 1999, An *investigation of disadvantaged students' construction of mixed-mode multimedia texts in a Year 5/6 literacy curriculum*. Masters Thesis, University South Australia, Adelaide.

This study examines what happened when one class of students from a low socio-economic setting moved from a traditional literacy curriculum and classroom into a site where they became involved in designing and authoring mixed-mode multimedia texts. The study is set in two sites. The first site, Lakeville Primary School, is a metropolitan school in the inner western suburbs of Adelaide, a complex school with a high percentage of students who live in poverty. The second site, the School of the New Millennium, is a specialist technology education school. This school has no enrolled students but works in a leadership role across the state. Primary data includes field notes from observations and transcripts of interviews of the teachers and students involved. A number of student and teacher artefacts were also collected. The research focused on the literacies that were made available to the students when using the newer information and communication technologies to construct texts. The study concludes that the introduction of information and communication technologies as text construction tools has the potential to disrupt taken–for-granted classroom literacy practices. It makes strange familiar topics. It reconfigures the use of space, the concept of time, classroom pedagogic relationships and even who can be a successful literate student. The study noted the convergence of literacy and numeracy skills and understandings as students went about the business of constructing their mixed-mode multimedia texts. A number of implications of the study are also outlined.

Mumtaz S. 2001, 'Children's enjoyment and perception of computer use in the home and the school', *Computers & Education*, Vol. 36, No. 4 (May), pp. 347-362.

This paper seeks to examine the nature and experiences of children's computer use in the home and school. Past research suggests a growing gap between computer use in the home and the school. This study was conducted to find out how children perceive and enjoy computer use in these two environments. Using a sample of Year 3 and 5 pupils in three primary schools, qualitative and quantitative data were gathered. The results suggest that children make more use of the computer at home than at school. The most popular activity on the home computer, which all children enjoyed, was playing games. The most frequent activity at the school computer was word processing which pupils considered boring. Interesting gender differences showed that boys spent more time playing computer games whereas girls spent more time on the Internet emailing friends. The study concludes that schools should learn from what works at

home and enable children to work on activities they find valuable, motivational and worthwhile.

Nachmias, R., Mioduser, D. & Shemla, A. 2000, 'Internet usage by students in an Israeli high school', *Journal of Educational Computing Research*, Vol. 22, No. 1, pp. 55-73.

This study examines the extent and characteristics of Internet usage among 384 junior-high and high school students in Israel. Its focus is on the purpose and patterns of Internet usage by twelve- to eighteen-year-old youngsters, and on the linkage between Internet usage and school activities. The findings show that the Internet is being used by about half of the research population, with the main use being for communication. Search for information comes only in the second place. There was little connection between the level of Internet usage and school practice. The results show significant sex differences. In general, more boys are using the Internet, and more extensively than girls. Surprisingly, only some differences among age groups were found. The results of the study are discussed in terms of the range of Internet use among youngsters and its emerging role as an alternative knowledge resource outside school.

Neumark, N, 1991. 'Girls, computers and computer culture', *Contributions to the Sixth International GASAT Conference: Volume One, Schooling,* edited by L J Rennie, L H Parker and G M Hildebrand, Key Centre for Teaching and Research in School Science and Mathematics, Perth, Western Australia, pp. 135-143.

This paper describes research undertaken with Year 7 secondary school girls to consider different approaches to involving girls in computer culture. The project involved devising a prototype resource, in the form of a comic, and trialing it. The comic was intended to be a non–didactic, positive intervention into computer culture. It was aimed specifically at non-English speaking background girls (NESB) and Aboriginal girls. This paper outlines the research, production and evaluation stages of the comic. The project confirmed the importance and the possibility of 'girl–friendly' intervention into computer culture.

Nicholson, P and deWacht, P. 2001, *City to Surf: A Peer-To-Peer Model of Online Professional Development: A Collaborative Mentoring Model,* Deakin University, Melbourne.

This project explores the potential of electronic communications to support peer–to–peer interaction between separate whole-school communities as a means of providing both authentic, situated, professional development for teachers, concurrent with the development of enhanced student learning outcomes, and the intentional sharing of school 'culture'. The intense use of telecommunications by both teacher and students in a 'many-to-many' manner provides rich opportunities for teachers to rethink their pedagogy, reconceptualise their classroom culture, and for students to see teachers as learners 'in situ'. An extensive trial between two schools some 120 km apart has demonstrated the basic functionality of the model. This paper discusses the origins of the project, findings from the trial, and the nature of the changes to be made to the model to enhance its effects. The paper reports significant positive effects arising from the use of peer-to-peer online professional development and provides a useful model of how schools can work collegially on line

Nixon, H. 2001, The book, the TV series, the web site. Teaching and learning within the communicational webs of popular media culture, AATE /ALEA conference, 'Leading Literate Lives',
http://www.cdesign.com.au/aate/pages/paper_menu.htm

The paper focuses upon the implications for literacy educators of the concept of communicational webs. The focus is on the changing media modes of communication and meaning-making processes most likely to be engaged by children and adolescents within the communicational webs of the popular media culture structured around books, magazines, film, television and websites. She considers the seamlessness with which students move between the various modes of communication-books, computer, TV, that is, between what Kress calls 'communicational webs', webs that differ, for example, along gender and age lines. She discusses the type of literacy teaching that will be required to address the new work order and the new communicative order. She suggests that children's differing access and dispositions towards the media and ICT related communication and culture may provide different challenges in developing an inclusive curriculum. Nixon points to the possibility that interest in popular culture can engage students in literacy learning, and how teachers could use the communicational web to transfer this interest into more educational pursuits, from websites and chat rooms talking about books, for example, to reading the books. She cites instances of how this approach can engage student interest for students otherwise disengaged with reading including working class students and boys. She points to how children's shows such as *Teletubbies* are educational, but also how they are about televisions incursion into online educational provision of school curriculum. Such programs, she suggests, have educational role as inductors into capabilities in the use of computers and online multimedia. The games and activities are interactive, multimodal and introduce the manipulation of graphics, sound and movement. That is, there is pedagogy of online communication underpinning these websites. *Dawson's Creek* and *Teletubbies* are prime examples of communicational webs.

Ohio SchoolNet Initiatives 1996, 'The Role of the Ohio Education Computer Network', *Ohio State Legislative Office of Education Oversight*, No. 74, Columbus, Ohio.

Ohio's Legislative Office of Education Oversight (LOEO) evaluates education-related activities funded wholly or in part by that state. SchoolNet initiatives seek to increase Ohio K-12 schools' access to computers, networks, and other technology, with a particular emphasis on low-wealth districts. This report addresses the gap between the expectations of SchoolNet and what actually can be achieved given current technology and the amount of district and state funding available for this initiative. The report also examines the advantages and disadvantages of using the existing Ohio Education Computer Network (OECN) to provide public schools with access to the Internet and other online information resources once the network wiring purchased with SchoolNet funds is installed. An explanation of the technology of computer networks and distance learning and their associated costs is also provided. Conclusions and recommendations are presented.

Orleans, M. & Laney, M. C. 2000, 'Children's computer use in the home—Isolation or Sociation', *Social Science Computer Review*, Vol. 18, No. 1, pp. 56-72

The researchers examined social interactions of children using home computers. The main concern was whether computers tended to isolate youthful users. Adult anxiety regarding the damaging effects of computers on children was assessed. Parental involvement, orientation to computers, and gender were the main independent

variables. A case study approach was employed to gather observational data regarding the variety of interactional networks that framed the computer experience of 32 participants. The findings challenged the notion that heavy computer users experience social isolation. It was found that the interpersonal lives and computer activities of children reflexively amplified each other and that boys were more likely to socialise in relation to computers than were girls. The findings were explained as consequences of context and gender-based differentiated styles of world-creating activity. Recommendations made to parents and teachers encouraging a less apprehensive and more integrative/ developmental view of the social effects of children's computer use are included.

Passig, D. & Levin, H. 2000, 'Gender preferences for multimedia interfaces', *Journal of Computer Assisted Learning*, Vol. 16, pp. 64-71.

This article reports on a study of gender differences among kindergarten children's responses to computer interfaces with a view to determining which style of interface (and hence incitement/desire to learn) is more appealing for girls and which is more appealing for boys. Interfaces were classified into four main aspects: '*display* interface (seeing the information, *conversation* interface (communications between user and system), *navigation* interface (movement from place to place) and *control* interface (use of icons)' (p.66). The study found that there were significant differences between boys and girls in their preference and responses to the different aspects of interfaces. For example, 'as a first priority boys preferred learning interfaces that deal with navigation and control…where the reference is to buttons and control of the game' and 'as first priority, girls preferred learning interfaces dealing with display… where the reference is to colour and appearance' (p.67). Further, 'boys gave a low priority to getting help from the computer' and girls gave a low priority to control of the navigational buttons' (p.67). In summary, the findings indicated the following gender patterns: 'Girls emphasised writing, colours, drawings, help and calm-moderate games; boys on the other hand emphasised control over the computer, sharp moves and many movements on the screen' (pp.67, 69). On the basis of such findings the authors conclude that compared to boys, girls are 'in an inferior position concerning their image of control of technologies and do not reach their full potential' (p.70). This constitutes, it is argued, a wastage of 'human capital'.

Phillips, L. 2001, 'Computer literacy, the Internet and interactive assessment: One teacher's experience', AATE Conference, 'Leading Literate Lives', http://www.cdesign.com.au/aate/pages/paper_menu.htm

This is a case study of a teacher's use of interactive assessment in a project on the Mabo Decision in a Year 10 class in an independent girls' school, and an Australian Studies class of fifteen. The teacher, in seeking to undertake a range of assessment task decided upon one assessment task being to make web pages. Phillips, the teacher, reflects on the process as well as her own lack of technical skill, students' lack of enthusiasm unless in pairs, difficulty about judging length of project, and whether the investment of a term's work was worth the outcomes. The unexpected benefit was that it led her reconsider many aspects of learning and assessment. What facts had the students learned? Why did they need to know them? Could they communicate their knowledge to a wider audience? Why take the time to transmit learning on computer when an essay would serve quite effectively, albeit for an audience of one? These questions needed new answers. She maps the change in the role of the teacher as the students became independent learners with assistance of technical expert. 'The traditional skills were automatically applied: introduction, development of theme, logic,

fluency, conclusion and appraisal. My role became to support knowledge application and communication through questioning and encouragement. The situation was unequivocally one of learning, rather than of teaching.' While the class was informal with discussion, all were engaged. 'The students seemed to be working for themselves and their peers, not just for the teacher'. She reported increased confidence and a sense of empowerment as impressive individual web pages were constructed. The assignment was multi tasked with a considerable design component including illustrations, colour schemes, layout as well as content. However, overall there was a distinct feeling that students owned and took responsibility for the information disseminated. Assessment was based on criteria based on content (knowledge about Mabo) and presentation (with criteria suggested by a technical assistant). The teacher in assessing the website felt it was an experience of alienation, distance and lack of involvement, lacking the social involvement that characterised its production. Therefore she needed to develop a new mode of assessment to capture that social interaction. She developed an interactive assessment in which students explained aims and decision-making processes, negotiated criteria of assessment. She described the project as 'a melding of the more traditional literacies of research and analysis, and computer-assisted mass–communication literacy'.

Powers, S., Rafferty, C. and Eib, B.J. 2001, 'The role of technology for learning in the reinvented middle school' in T. Dickinson (ed), *Reinventing the Middle School,* Routledge Falmer, London.

This chapter provides a rationale for why the use of new learning technologies if appropriate for middle years of schooling. Powers et al. use Tyner's notions of traditional text or alphabetic literacy, representational literacy and tool literacy to develop a framework on how ICT can be integrated in order address three key areas of middle years schooling-learning process, personal development and content knowledge. The paper includes ways of evaluating the level of integration, as well as three American cases studies of successful integration of ICT into middle school programs. These case studies indicate a variety of ways that ICT was used by teachers as students as central to classroom organisation, school organisation, curriculum and assessment. This is a useful article about whole school planning and organisation of middle schooling.

Reynolds, D. 2001, *Primary Schools of the Future: Achieving Today,* BECTA, DfEE (May)

This study followed from an earlier report by BECTA that concluded that 'On average, schools with better OFSTED grades for adequacy of ICT resources in 1998/9 achieved better grades in English, maths and science in 1999 national tests at key Stage 2'. The second study sought to establish whether 'a clear link can be identified between schools' use of ICT and standards of achievement in those schools?' by establishing whether it was a 'hidden' variable such as socioeconomic background of the school. The data was derived from the OFSTED inspections of 2110 Stage 2 schools, QCA data on standards in English, maths and science, and DfEE benchmarking data of schools survey 2000, surveys analysing the professional judgement of teachers about effects of ICT on outcomes, and research that investigates causal effects, trying to control for SES background, 'good schools', subjects areas, amount of usage, resourcing. The report focuses on whether professionals using ICT see it as having positive benefits, and whether there are identifiable factors that indicate ICT contributes to improved learning outcomes. From the statistical data on schools, significant findings for this Report are: (i) schools with good ICT resources tended to have better

achievement at Key Stage 2 than schools with unsatisfactory ICT resources, and that this improved attainment is seen over more than one year—even when benchmarked with schools of a similar type; (ii) schools that use ICT to support a subject tended to have better achievement in that subject than schools that do not make such use; (iii) schools that have good ICT resources and use them well tended to have better standards than schools where good ICT resources are not well used; and (iv) schools that made good use of ICT to improve standards generally had high quality teaching of ICT, a favourable school ethos in relation to ICT, good pupil access to ICT resources, high pupil ICT skills, and have developed in their pupils a positive attitude to ICT. In the professional judgements of teachers and heads, the majority in 'high ICT' schools believe that ICT has been important in raising standards in the last two year. Where very good ICT resources are present in schools, they are extensively used and head teachers report that they impact positively on standards. 'High ICT' schools are using ICT to support the core subjects of English, maths and science. Opinions about the impact of ICT on subject standards were positive. The subjects where greatest use was reported were those in which a greater impact was reported to have been made. In 'high ICT' schools, ICT was seen to have an impact on those factors which research outside the area of ICT identifies as having a direct impact on learning: motivation 98%; subject knowledge 96%; teaching 93%; pupils' effectiveness 90%; school effectiveness 89%; home-school relations 77% as well as key areas. Significantly, teachers with personal access to ICT spend significant amounts of time using ICT with their pupils and also saw ICT as having an impact on those factors which research outside the area of ICT identifies as having a direct impact on learning: motivation 99%; subject knowledge 91%; teaching 92%; pupils' effectiveness 79%; home-school relations 52%. The study sought to control for the 'innovation effect, that is, any innovation with additional resources has some effect in the short term that tends to dissipate. The Report argues that the ICT innovations had sustainable effects.

Roberts, D. F. 2000, 'Media and youth: Access, exposure, and privatization', *Journal of Adolescent Health*, Vol. 27, No. 2 (Supplement S), pp. 8-14.

A cross-sectional national random sample of 2065 adolescents aged 8 through 18 years, including an over-representation of African-American and Hispanic Youth in USA completed questionnaires about use of television, videotapes, movies, computers, video games, radio, compact discs, tare players, books, newspapers, and magazines. It confirmed that US youngsters are immersed in media. Most households contain most media (computers and video game systems are the exception) with the majority of youth having their own personal media. The average youth devotes six and three-quarter hours to media; simultaneous use of multiple media increases exposure to eight hours of media messages daily. Overall, media exposure and exposure to individual media vary as a function of age, gender, race/ethnicity, and family socioeconomic level. Television remains the dominant medium. About one-half of the youth sampled uses a computer daily. A substantial proportion of children's and adolescents' media use occurs in the absence of parents. American youth devote more time to media than to any other waking activity, as much as one-third of each day. This demands increased parental attention and research into the effects of such extensive exposure.

Ross, J. A., Hogaboam-Gray, A., Hannay L. 1999, 'Predictors of teachers' confidence in their ability to implement computer-based instruction' *Journal of Educational Computing Research*, Vol. 21 No. 1, pp.75-97.

This study investigated the effect of selected personal, school, and district factors on K-3 teachers' confidence in their ability to implement computer-based instruction: before (N = 128 teachers) and after an infusion of Information Technology (IT) (N = 135 teachers). Increased IT resources changed the strength and structure of teachers' confidence. Confidence in teaching various student uses of the computer increased and the sources of information that teachers used to determine their expectations changed as teachers used the technology. The strongest predictors of teaching confidence were teacher cognitions, especially confidence in personal computing skills. Other personal variables (frequency of personal computer use, gender, teaching experience, and computer ownership) dropped out of the regression equations when teacher cognitions were introduced. After the IT infusion, but not before, self-reported instructional practice and contextual factors (shared sense of purpose of the school with its community and experience with district amalgamation) also contributed to variance in confidence about teaching with computers.

Rowan, L., Knobel, M., Bigum, C. and Lankshear, C. 2001, *Boys, literacies and schooling. The dangerous territories of gender-based literacy reform,* Open University Press, Buckingham.

A number of myths are questioned. First, the tendency to see boys' predispositions towards ICT use as inherent and 'natural', and that more use of computers is the solution for a 'literacy problem' for boys. The corollary is that there is a gap between boys and girls' attitudes towards the use of ICT; although there is disputed evidence which suggests girls attitudes to computers do not reflect their capacities in using computers. Second, the assumption that computers lead to improved learning outcomes. Rowan argues that computers do not improve outcomes, but rather change outcomes. Ie changes social relationships and interactions, the type of pedagogy and therefore produces different outcomes e.g. design sensibility rather than improved scores in numeracy. Finally, there is a high level of unpredictability when computers are factored into learning. In the case study following that explores the notion of cultural apprenticeship to encourage boys to become more engaged in learning, the aim was to blur the difference between learners and experts as teachers and students were both learners and experts when it came to ICT. Rowan concludes that while the previously disengaged boys gained significant new status being computer experts and tutors in classrooms, they both challenged and reproduced traditional hegemonic masculinities of the playground. Boys asserted traditional relations of gender when it came to their relations with girls, and thereby disadvantaged girls. Rowan suggests that strategies cannot address boys or girls alone when integrating ICT, but must deal with the ways in which computers change or reproduce the social relations of gender.

Scanlon, E. 2000, 'How gender influences learners working collaboratively with science simulations', *Learning & Instruction,* Vol. 10, No. 6, pp. 463-481.

This paper presents an overview of several research projects involving groups working with science simulations, in particular with relation to gender effects on science learning. The groups of learners discussed include pairs of adults working together on computer simulations at a distance, or side by side, pairs of 15 year-olds working with computer simulations, and larger groups of younger children working co-operatively on combinations of computer simulations and real science experiments. While collaboration may be in many respects a good thing, there is a growing realisation amongst science educators that particular features of the learning experience are altered by the gender composition of the groups. These features range from the way in which conflict is expressed or the task perceived to the differences in the way that

dialogue is used. These findings need to be considered together with evidence concerning the barriers which girls experience while learning science. This work is reviewed, together with some research projects involving students working collaboratively with computers on science topics.

Schaffer, E. C. et al. 1997*, Impediments to Reform: An Analysis of Destabilizing Issues in Ten Promising Programs*, Office of Educational Research and Improvement (ED), Washington, DC. 29p.

Major school-improvement efforts, despite planning, will constantly encounter a variety of problems. This paper identifies impediments to school reform that were widespread within both elementary and secondary schools with large populations of socioeconomically disadvantaged children. The paper identifies broad, overarching conditions that must be met to replicate successful programs for at-risk students. Data were gathered during the study of *Urban and Suburban/Rural Special Strategies for Educating Disadvantaged Children*, a Congressionally–mandated and funded study of promising school-reform efforts implemented prior to 1990 in schools with a majority population of economically disadvantaged children. The three-year study evaluated and compared the success of ten different programs: Comer Model (School Development Program); Success for All; Paideia Program; Coalition of Essential Schools (Sizer); Schoolwide Projects; Extended Year Schoolwide Projects; Reading Recovery; Computer Assisted Instruction; Extended Time Projects; and Tutoring Programs ("locally adapted"). Methods included visits to 25 program sites (two visits per year at each school), document analysis, observation, and interviews. Ten issues appeared to hinder the successful, full implementation of each reform effort: financing; leadership; commitment; perceptions of the general public, of parents, and of students; program staffing; curriculum; political pressures; racial problems; insufficient facilities; and problems of management and scheduling.

Schott, G. & Selwyn, N. 2000, 'Examining the "male, antisocial" stereotype of high computer users', *Journal of Educational Computing Research*, Vol. 23, No. 3, pp. 291-303.

The popular stereotype of the frequent computer user persists to be one of a male, socially inadequate and isolated individual—a perception which has been found to cause many students to avoid coming into contact with information and communications technology (ICT), both inside and outside of school. This article reports on a study examining the gender and social competency of both frequent and infrequent computer-using students in Year 12 (n = 117). The results suggest that students who are highly oriented toward ICT are just as likely to be female as they are male and are no less sociable, popular, or self-assured than their non-ICT using peers. These data are then contrasted with interview data from the "high" and "low" using students, which suggest that negative stereotyping of the computer-using student persists—although primarily among students not engaging with ICT in school. The article postulates that the vast increases in ICT use in schools over the last ten years has created a more accessible 'computer culture' to which increasing numbers of students are now subscribing; although teachers need to be aware of the persistence of the male, anti-social stereotype within elements of the student body. [JEM]

Schumacher P. & Morahan-Martin J. 2001, 'Gender, Internet and computer attitudes and experiences', *Computers in Human Behavior*, Vol. 17, No. 1, pp. 95-110.

It is widely assumed that participation by females on the Internet is hampered by their attitudes towards computers, which in turn is reflective of their attitudes towards new technology. Research generally supports that females have less overall experience with computers and are more likely than males to have negative attitudes towards computers. Although limited, research on Internet experiences and attitudes has found parallel gender differences, with females reporting lower levels of experience and more negative attitudes. This paper explores whether Internet and computer experiences, skills and attitudes are related, using evidence from two studies of incoming college students, in 1989/90 and 1997. There were significant gender differences in many computer experiences and attitudes of incoming students in 1989/90. Males were more experienced with computers, more likely to have taken high school courses requiring computer use, and reported higher skill levels in applications such as programming, games and graphics than females. By 1997, incoming students were more experienced with using a computer than the earlier students. However, gender differences in computer experience and skill levels had diminished in some areas. The 1997 survey also assessed Internet experiences, skills, competence and comfort. Students had more exposure to computers than to the Internet. Males were more experienced and reported higher skill levels with the Internet than females, with the exception of e-mail. The overall competency and comfort level for students in 1997 was significantly higher for computers than for the Internet; 19% of the students did not feel competent and/or comfortable with the computer compared to 36% with the Internet, with females reporting higher levels of incompetence and discomfort for both. Competence and comfort levels with the Internet and computers were highly correlated, and both predicted Internet skills and experiences.

Sefton-Green, J. (ed.) 1999, *Young People, Creativity and the New Technologies. The Challenges to the Digital Arts,* Routledge, London.

This text provides some excellent examples of how teachers have developed curriculum and pedagogies to integrate the digital arts across the curriculum. It points to how multimedia projects can change what students do, increase teamwork and multidisciplinarity, and provide teachers with new approaches. It also raises issues about how to integrate ICT into national curriculum (in the UK) and also how to assess multimedia projects. Articles on multimedia productions in primary schools and how these were published widely, through to projects working out how young people out of school use and can be attracted to the Internet through cyber cafes are included. The focus of the text of value to issues of inclusive education using ICT is on the capacity of the digital arts to provide alternative ways of producing curriculum, different pedagogies and new kinds of assessment.

Selwyn, N. 2000, 'Researching computers and education—glimpses of the wider picture', *Computers & Education,* Vol. 34, No. 2(Feb), pp. 93-101.

With information and communications technology (ICT) beginning to form the basis of extensive educational reform around the world, this paper considers how research into educational computing can move beyond its 'hobbyist' origins and keep abreast of the burgeoning role of technology in education policy and practice. After discussing the present limitations of educational computing research, the paper goes onto suggest an agenda for advancing and improving inquiry in this area. In particular, the discussion focuses on the need to embrace diverse methods of research and theoretical approaches to examining educational computing, as well as the need to ask 'wider' questions of the social, cultural, political and economic aspects of ICT in educational settings.

Shashaani, L. 1994, Socioeconomic Status, Parents' Sex-Role Stereotypes, and the Gender Gap in Computing, *Journal of Research on Computing in Education,* Vol. 6, No. 4, pp. 433-51.

Describes a study that examined the effect of family socioeconomic status (SES) and parental sex stereotypes and behaviours on high school students' attitudes toward computers. Highlights include gender differences in student attitudes; the effect of parental encouragement; and the effect of SES on parents' beliefs and behaviour.

Smith, G, and Carroll, G. 2000, 'On-Line Tutoring by Pre-service Teachers', Paper presented at the Annual Meeting of the Michigan Association for Computer-Related Technology Users in Learning, March 10, Grand Rapids, Michigan.

This project involved on-line tutoring by pre-service teachers for high-risk students as part of a Technology Literacy Challenge Fund grant from the Michigan Department of Education. The project provided iMac computers and other technology resources in 20 classrooms within four Detroit public schools. Each computer was connected to the school district server for Internet access. The project provided additional technology resources for each school's computer lab or media centre. In these schools, the majority of students was eligible for free or reduced lunches, and their academic achievement was substantially below state averages. Regular instruction for teachers helped them explore ways in which they and their students could use some of the educational applications available through the Internet. Teachers selected five students who could improve their academic achievement through this additional support. Pre-service teachers were trained in how to plan and proceed with tutoring in how to use the software. Students and pre-service teachers used a telephone connection during tutoring sessions for verbal exchanges, while the Internet connection was for displaying games, Web sites, and text. Written transcripts of the online tutoring sessions provide feedback on the program. Data are examined using Vygotsky's Zone of Proximal Development.

Snyder, I. 2001, 'The new communication order', In Beavis, C. and Durrant, C. (eds), *P(ICT)ures of English: Teachers, Learners and Technology,* Wakefield Press, Adelaide.

Snyder argues that literacy needs to be conceived within a broad social order, a 'new communicative order' that takes account of the literacy practices associated with screen-based technologies. This would recognise that print-based reading and writing is now only part of what people have to learn to be literate. She begins by focusing on some of the important characteristics of the new communication order, discussing their implications for English curriculum and pedagogy. She then suggests the directions research might take to further understanding of the new order. She concludes that the notion of 'communication practices' might be more useful for English teachers than 'literacy practices' as it is less tainted by reductive interpretations that reduce all forms of literacy to foundational literacy, and therefore is theoretically more generative and strategic. Snyder suggests that social relations in email, online discussion groups and chat rooms are considerably affected, and points to how debates exist as to the democratising impact of computers. More specifically, class, race and gender relations are affected. For example, it seems that women and members of non-white male middle class groups are more likely to express themselves openly through the protection of the electronic medium. Some argue that computer-mediated communication could offer a chance to reverse traditional power relationships in communication practices. Others argue that there is enough accumulated knowledge

about the social uses of technology to know that time after time people adapt the new technology to meet their needs. Rather than creating radically new patterns of social practice, computer-mediated communication is more likely to reinforce existing patterns. Yet these new structures of communication blur the social practices related to work, education, home and entertainment. This convergence of experience in the same medium is blurring the institutional separation of domains of activity. This poses dilemmas for English teachers and for students in current school settings. To what extent will work, home, school and entertainment all be connected into the same system of symbol processing? To what extent does the particular context determine the perceptions and uses of the medium? For teachers, trained in print-based texts, this creates some issues as students are into multimodal communication. She raises questions as to whether it will lead to radically different teaching and learning practices, or whether there will be a process of 'remediation', that is, a reshaping past practices. The implications for teachers included which aspects of literacy, i.e. reading, writing, and visual should be emphasised. Multimodality raises certain curriculum issues. It is less likely that writing will become increasingly the medium used by and for the power elites of society, and we need to ensure that all students have the opportunity to achieve the highest level of competence in this mode: print and writing must not be side-lined. Further research is needed on the impact of different modalities of literacy longitudinally on student literacy practices; on the differential impact on the 'haves' and 'have nots' in school and home; on how school technology-mediated communication practices in low socio-economic communities; and issues of access to standard linguistic and literacy conventions.

Somekh, B. Mavers, B. 2001, *ICT and Home-School Links* BECTA, DfES, London

This is an evaluation of the National Grid for Learning launched in the UK in 1998 that sought to provide high-quality-on-line and off-line digital content relevant to UK education system, that ensured schools had access, and provided teachers with appropriate training. These were achieved through a 'Virtual Teacher Centre'; the Teacher Resource Exchange with resources and lesson plans and the GridClub for students. The Grid was linked to other strategies such as the Education Action Zones, Technology Colleges and Information management Strategy. The ICT and Home School Links Project sought to identify the types of technologies being used and models of home school initiatives, identify any benefits, investigate the ways in which the benefits may relate to teaching, learning and also school organisation and management, consider the software and web content available at home, consider implications of school governance and finally the benefits of utilising home school links more. Of the 115 schools involved in the evaluation, most were in early stages of developing home school links. A quarter had laptops. Secondary schools saw communication with parents as a greater need than primary schools that had greater face to face contact. Some schools were moving to wireless links within 11 km radius of school, which allowed 24 hour 7 day week access to a password protected website containing curriculum materials etc. Pupils used ICT most for leisure at home, and less for schoolwork. Some used the ICT for homework and revision sites, but school based resources were low. At best the use of ICT for home school links can transform the role of homework into a pattern of integrated learning between home and school. Pupils with laptops had greater flexibility and were able to do this. All schools had websites in early stages of development, more for information and communication than pedagogy. Teachers and students considered ICT extended the school day and enabled pupils to resume, refine, expand and extend their work. Those teachers and students with laptops integrated this more into daily practice and ICT was valuable for students unable to attend on a daily basis. Strong leadership was required to integrate ICT into all aspects of school and this happened most successfully when staff had freedom to

innovate. Twenty-four hour access is demanding financially, in terms of time and technically, and there is an ongoing need for technical advice and financial support. Those schools that had advanced more in integration had greater income. Schools in urban areas where there were broadband infrastructures were advantaged. Website development and ongoing administration required a professional web manager. Teachers required significant in house support. Safety issues were ever present with screening devices required. Parents and teachers feared ICT would damage other school based skills- reading, writing and discussion. The most obvious effect was potential for increased inequalities between the pupils who had access at home and those who did not. This is most likely to have 'knock on' learning effects as ICT is integrated throughout curriculum and pedagogy. As access improves, the issue then becomes the quality of access and family values and choices made about the type of computers. These inequalities are compounded as teachers are reluctant to ask students not to use computers at home, and there is considerable embarrassment that some students with laptops use them in school while others do not have them. Inclusive strategies include an audit of home provision and the development of a Personal Access to ICT Plan that parents agree to re use of ICT at home. The greatest potential lies with mobile phone computers. But this requires plans for use and policies to support it, perhaps the development of inexpensive commercial products for the student market.

Soto, G., Muller, E., Hunt, P. & Goetz, L. 2001, 'Critical issues in the inclusions of students who use augmentative & alternative communication: an educational perspective', *ACC Augmentative & Alternative Communication*, Vol. 17, June.

This investigation used focus group research methodology to identify critical issues regarding the inclusive education of students with alternative communication needs. The focus groups produced a database for thematic analysis using qualitative research methods. The premise was that inclusive education for students with communication needs is possible and desirable, based on the literature that supports the inclusive education for students with disabilities because it produces:

- increased social participation and accessibility to regular curriculum;
- learning and generalisation of new social, sensory, motor and communication behaviours;
- improvement in quality of individualised educational objectives; and
- increased sensitivity for classmates.

The study confirmed previous findings on the outcomes of inclusive schooling and identified the following critical issues for successful inclusive schooling for students with disabilities: ownership by teachers of the students; collaborative teaming; appropriate training; educational supports and instructional assistance; administrative support, both locally and at district level; natural supports from classmates; classroom structures that support participation; philosophical support for inclusive education; parental involvement; support for the development of positive social supports; and friendships and supports for students with challenging behaviours.

The study also identifies the barriers to successful inclusive schooling using augmented communication technologies, which includes, in addition to the inverse of the success indicators: teachers' technophobia; breakdown of equipment; lacking of funding; lack of availability of technology 'on loan' or 'on trial'; and limits of the technology.

There were also findings related to attitudes, with teachers' discomfort with disability, fear of failure, personal insecurity and feeling undervalued being identified.

The study also identified the necessary skills of teachers, attitudinal and practical, and the positive outcomes for inclusive education for the students with disabilities, their families, the teachers and the schools.

Subramanian, K., Greenfield, P., Kraut, R. and Gross, E. 2001, 'The impact of computer use on children's and adolescents' development', *Journal of Applied Developmental Psychology*, Vol. 22, No. 1 Special Issue SI, pp. 7-30.

In recent years, electronic games, home computers, and the Internet have assumed an important place in our lives. This paper presents a review of the research on the impact of home computer use on the development of children and adolescents. Time use data are presented along with a discussion of factors such as age, gender, and ethnicity, which impact the time spent on computers as well as the activities engaged in. Research on the impact of computer use on cognitive skill and academic development, social development and relationships, and perceptions of reality and violent behaviour are reviewed. The special role of the Internet in the lives of adolescents is brought out using data from the HomeNet study. The paper concludes with recommendations for future study in order to understand better the growing impact of computers on our youth.

Sutherland R., Facer, K., Furlong, R. & Furlong, J. 2000, 'A new environment for education? The computer in the home', *Computers & Education*, Vol. 34, No. 3-4, pp. 195-212.

This paper derives from an interdisciplinary research project that is studying the engagement of young people with different aspects of techno-popular culture. The focus is on the young person and the significance of digital technologies in their lives as a whole. Drawing on cultural studies research, the ways in which the contexts for computer use are structured by the different discourses present within the family, and the ways in which these discourses may provide a framing context for children's interactions with digital technology are investigated. Drawing on socio-cultural research, it argues that learning is learning-to–do–something with a cultural or cognitive tool. Our analysis of data from case studies of 16 families shows that the context of home computer use amongst young people is far from a simple and uniform phenomenon and is structured by the different discourses present within the family. What young people learn through interaction with computers is thus as much framed by the context of use as by the affordability of the technology.

Sweetman, D. & Tomlinson, L. 2000, 'Learning technologies in the classroom', *Education in Rural Australia*, Vol. 10, pp. 46-49.

This paper examines some of the ways South Kalgoorlie Primary School has integrated learning technologies into the classroom programs to enhance the learning environment for our students.

Toomey, R., Ekin Smyth, C. & Nicolson, P. 2000, *A Case Study of ICT and School Improvement at Bendigo Senior Secondary College*, Victoria, Australia.

This case study exemplifies how leadership, school staffing, organisation and planning integrating ICT can change attitudes to the use of ICT in teaching and learning.

Bendigo SSC is a single campus senior secondary college of 1787 students enrolled in Years 11 and 12 in eight KLAs and VET courses, and is a provider of accredited programs of CISCO, Microsoft and Aries courses (commercial technology–related courses). They have 113 full time teachers and 46 support staff with an annual budget of $8.6m. Bendigo is Victoria's fourth largest city and regional centre for Central Victoria. The school has a high proportion with Education Maintenance and Youth Allowance and low proportion of NESB, and therefore not considered to be a likely 'high performing school'. BSSC has also sought to be accredited with the European Council of International Schools (ECIS) so as to benchmark itself against international criteria. The school was central to the Navigator School program initiated in the 1994 in Victorian schools. Navigator schools were provided with significant additional funds for computing infrastructure. ICT has been central to the program of the school for seven years, and for its high profile as being innovative.

Underwood, J., Underwood, G. & Wood, D. 2000, 'When does gender matter? Interactions during computer-based problem solving', *Learning & Instruction*, Vol. 10, No. 5, pp. 447-462.

Children worked in pairs or as individuals on a computer-based language problem-solving task, and their keyboard activities were monitored along with their discussions of the task. A total of 60 children worked in either single-gender or mixed-gender pairings, and a further 21 children worked individually. Previous investigations have indicated that suggestions and evaluations by the children are associated with improved task performance, and that the gender composition of the pairs has also been found to influence performance. The boy-girl pairs showed lower levels of verbal interaction and less keyboard co-operation, but few differences in task performance in comparison with single-gender pairs. All children working in pairs out-performed children working individually.

Vollands, S. R., K. J. Topping, et al. 1999, 'Computerized Self-Assessment of Reading Comprehension with the Accelerated Reader', *Action Research Reading and Writing Quarterly: Overcoming Learning Difficulties*, Vol. 15, No. 3, pp. 197-211.

A quasi-experimental action research project evaluated a program for computerised self-assessment of reading comprehension (*The Accelerated Reader*) in two schools in severely socio-economically disadvantaged areas. It finds that the program, even when less than fully implemented, yielded gains in reading achievement superior to gains from regular classroom teaching and an alternative intensive method, as well as significant improvement in girls' reading attitudes. This research utilises highly limited conceptions of 'reading' and is severely qualified and equivocal in its findings. It tested for reading comprehension and reading attitude, and draws comparisons between children using a computer program and children taught by a classroom teacher. Problems identified in describing the findings suggest the research ignored such factors as the quality of the books set, or the purpose of the reading from the children's point of view. No attention is paid to student engagement or interest. '[In both groups] insufficient lower readability AR books were available, and the colour-coding of book point value was not attended to by the children or initially encouraged by the teacher. Some children selected books too hastily and read them too quickly, resulting in low test scores and rapid consumption of AR book stocks.' The study makes the point that information about reading levels generated by the research was only of use if acted upon immediately by the teachers concerned. It also blames a number of factors for the difficulties experienced by the AR classes (who did the computer generated reading

program), for example, 'the very restricted nature of the pilot UK version of the program, the insufficiency of books, the brevity of the initial training received by the teachers, and that the program was not properly implemented'. While the study found that students undertaking the computer based program scored better on tests than did those in the 'alternate (teacher-centred) class, these results show merely that students got better at taking these tests. The research offers a reductive and mechanistic, test-score centred view of reading likely to be harmful rather than productive for students with reading difficulties, and at odds with constructions of literacy taught and valued in Australian schools.

Wenglinsky, H. 1998, *Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics,* Educational Testing Service, Center, Princeton, New Jersey. http://www.ets.org/research/pic

This report presents findings from a national study of the relationship between different uses of educational technology and various educational outcomes. Data were drawn from the 1996 National Assessment of Educational Progress (NAEP) in mathematics, consisting of national samples of 6,227 fourth graders and 7,146 eighth graders. Data include information on the frequency of computer use for mathematics in school, access to computers at home and in school, professional development of mathematics teachers in computer use, and the kinds of instructional uses of computers in the schools. The study finds that the greatest inequities in computer use are not in how often they are used, but in the ways in which they are used. Poor, urban, and rural students are less likely to be exposed to higher–order uses of computers than non-poor and suburban students. For both fourth and eighth grades, teachers of urban and rural students are less likely than are suburban teachers to have had professional development in technology. There were few differences in the frequency of school computer use in either grade, although black fourth graders reported more frequent use than white fourth graders. Yet for both grades, black students were less likely to have a computer at school. In essence, the study found that technology could matter, but that this depended on how it was used. The size of the relationship between the various positive uses of technology and academic achievement was negligible for fourth graders, but substantial for eighth graders. Taken together, findings indicate that computers are neither a cure-all for problems facing the schools nor mere fads without impact on student learning. When used properly, computers may serve as important tools for improving student proficiency in mathematics and the overall learning environment of the school. The aim was to analyse the needs of the teachers and to provide support for them in their work with pupils in classrooms; to assist IT coordinators as they planned to add ICT to the repertoire of strategies for raising literacy and numeracy standards, and to target training providers, policy makers and wider research communities.

With regard to professional development of teachers, the report concluded that policymakers should redouble their efforts to ensure that teachers are properly trained to use computers. Moreover, teachers should focus on using computers to apply higher-order skills learned elsewhere in class. Computers should be a component of a seamless web of instruction that includes non-technological components. Finally, the primary focus of all technology initiatives should be on middle schools rather than elementary schools. The effects of technology appear to be much smaller in the fourth than the eighth grade, and so may not be so cost–effective.

Yates, S.J. 2001, 'Gender, language and CMC for education', *Learning and Instruction*, Vol. 11, pp. 21-34.

This article develops a critical analysis of the democratic claims made for CMC, and argues that contrary to the many hopes that CMC would alleviate gender inequalities in educational interactions, 'it suffers, like all communication media, from the intrusion of existing social relations, including those that are based upon inequalities of access and power' (pp.32-33). There are two main foci for the article, and both address adult learning. One examines gender differences in language and response style among participants on electronic List serves. Contrary to much research praising CMC for eliminating gender bias, the author reported significant gender differences in, for example, the rate of responses to contributions (those authored by males tended to receive more responses than those authored by females) length and style of response (men tended to write longer contributions). Yates reports on a linguistic analysis of contributions and responses which found that conversational patterns emerged in e-lists that were similar to face-face interactions. For example, other research has indicated that men become 'threatened by situations in which women take up more than 30% of the interactions' (p.24). Overall Yates found that the emancipatory possibilities of CMCs were not borne out by close analysis of gender differences in language and net style. The second foci is the use of CMC in distance education: here Yates found that there were some positive gender aspects of CMC use, but that these did not offset the persistence of social inequalities, despite the allure of a technological fix for social problems. In an earlier study of CMC and distance education students, Yates found that at the beginning of a course women were less confident than men in their technological competence and experience, and that the impact of such gender differences in perceived competence and amount of prior experience needs to be acknowledged, particularly when women are starting afresh. But, importantly, Yates found that once adult students started using the CMC 'there were very few differences in attitudes and utilisation' (p.30). Both gender groups, and women in particular, rated favourably the opportunity to interact with other students that CMCs provided. [JEM]

Yekovich, F. R., C. W. Yekovich, et al. 1999, *A Formative Evaluation of the TRALE (Technology-Rich Authentic Learning Environments) Project*, Office of Educational Research and Improvement (ED), Washington, DC, 37p.

The Technology-Rich Authentic Learning Environments (TRALE) project aims to improve young children's literacy skills through the creation of a community of technology– enriched classroom environments. TRALE has been implemented in kindergarten through Grade 3 classrooms in one urban elementary school in the District of Columbia, a school located in an area of high poverty, high crime, and much drug use. The school was identified as one of the city's 20 lowest performing schools. The implementation of the TRALE program, with its emphasis on multimedia computing and an authentic learning environment characterised by a cognitive apprenticeship approach, was studied by determining student achievement, teacher perceptions, and the degree of program implementation by each teacher. TRALE increased student achievement even during its first year of operation. The eight TRALE teachers understood and appreciated the educational potentials of the technology. High-implementing teachers addressed the role of the community and their classroom roles while low-implementing teachers did not. Evaluation results clearly show that TRALE's effectiveness was related to the degree of implementation by the teacher. There was great growth in students' academic progress in highly implemented teachers' classes compared to low-implementing or non-project teachers' classes. These formative results show the promise of TRALE for educational improvement in urban schools.

Yelland, N. 2001, *Teaching and Learning with Information and Communication Technologies (ICT) for Numeracy in the Early Childhood and Primary Years of*

***Schooling*, Research and Evaluation Branch, DETYA, Canberra**
http://www.dest.gov.au/research/fellowship/docs/Nicola_Yelland/Yelland_report.pdf

Yelland reviews the literature pertaining to the impact of ICT on teaching and learning. Despite specific policy initiatives focusing on encouraging the use of ICT, she concludes that 'the use of ICT in educational settings is marginal and often peripheral, acting as an "add on" to regular classroom work in many instances'. While there have been a large number of studies measuring the impact of computers on classrooms and learning, it is apparent that the level of acceptance of the evidence is dependent upon how one measures and defines outcome. Those studies that do show gains tend to be on single standardised test scores in experimental situations or only on drill and practice, but even then the effects are marginal. She suggests that there may be other ways than computers to achieve the same ends given the significant investment required for ICT. 'It is easy to find strong claims for the power of computers to improve student's minds but difficult to find scientifically valid research testing these claims'. Three possible pathways exist— computers used for drill and practice, for structured learning through instructional software or for innovation. She cites researchers' conclusions that if we take the innovative path it will require research–based responses that are reliable enough to use as a basis of policies that may well influence an entire generation of learners. Yelland recommends ICT as a fundamental aspect of learning and funding should be targeted to implement it in schools and teacher education programs. Moreover, there is a need for Australian research on the impact on learning especially with regard to multiliteracies, as well as a need to identify relevant research questions, and any funding should support variety of research methodologies, both qualitative and quantitative. There should also be initiated longitudinal studies of literacy and numeracy effects. The exemplary teaching practices using ICT e.g. Indigenous model of What Works should be made more widely known and adopted to other situations.

ICT and INDIGENOUS ISSUES

Bailey, S. & Chaffey, G. 1998, 'Talent development in Aboriginal students: Two projects in north-west New South Wales', *Talented*, Vol. 16, No. 4 (5 Nov.), p. 1.

This article discusses two projects that eschew a 'deficit' explanation of the under representation of Aboriginal students in programs for the gifted and talented. These projects are exploring ways of identifying and nurturing hidden potential, through raising cultural awareness in the students and their teachers and by using computer technology as a means of ongoing communication and mentoring.

Balsamo, F. (2000), Education Access: National Inquiry into Rural and Remote Education, Human Rights and Equal Opportunity Commission, Australia.
http://www.hreoc.gov.au/pdf/human_rights/rural_remote/Access_final.pdf

This report examines limits on access to education in Australia. Accessibility must be available without discrimination because of physical or economic limitations. Chapters are devoted to nine different types of limited accessibility affecting: children with disabilities, especially in remote areas without alternative local schools; children isolated from public transport or denied access to school buses; students studying by distance education who are dependent on unreliable power sources or inadequate or very expensive telecommunications infrastructure; Indigenous children in Homeland

Centres and remote communities without schools, teachers, or tutors to supervise distance education; Indigenous teenagers with no accessible secondary school curriculum; non-English-speaking children whose curriculum is in English; students in vocational programs who cannot find work experience placements locally and who cannot afford the costs involved in placements away from home; teenagers whose only chance of a secondary education is a boarding school at risk of losing its subsidies; and schools trying to use computers and the Internet where the telecommunications infrastructure is inadequate. The report uses a combination of case studies, evidence submitted to the National Inquiry into Rural and Remote Education, and information about government programs to illustrate the limits presented. It concludes each chapter with recommendations on how to address these limits. A map of each state and territory shows junior and senior secondary school locations and school-aged populations.

Blitner, S, Dobson, V, Gibson, F, Martin, B, Oldfield, N, Oliver, R, Palmer, I, and Riley, R. 2000, *Strong Voices*, Batchelor Institute of Indigenous Tertiary Education, Darwin, Northern Territory.

Strong Voices is a booklet about the differences in pedagogical approaches to teaching by Indigenous educators and looks at the ways in which these differences will lead to successful outcomes by Indigenous students. They document eleven principles to follow to ensure success for Indigenous students in the classroom situation.

Bourke, Rigby and Burden, 2000, *Better Practice in School Attendance: Improving the School Attendance of Indigenous Students*, DETYA, Canberra. http://www.dest.gov.au/schools/publications/2000/Attend_Synth.pdf

This study concentrates on improving the school attendance of Indigenous students, and notes that using computers has been successful in improving literacy performance of Indigenous students and therefore school attendance. The first recommendation of the Report states that 'The problems of transient students and mobility-related irregular attendance associated with cultural and social obligations could, perhaps be addressed through the introduction of computer assisted learning strategies and individual training programmes'. The report cites evidence that strategies that improve literacy performance of Indigenous students include personal praise, use of learning contracts, and ICT. (p. 37-8). ICT was seen to increase student motivation, literacy skills and also school attendance. The conclusion from studies on Indigenous students and computer usage indicates that there are many computer-based learning practices that are compatible with Indigenous students' preferred way of learning. However, this study also suggests that a lot more research has to be done in this area to ascertain the benefits to Indigenous students. The report also suggests that 'computer facilities should be made as accessible as possible to students, for example, through enabling access to computers in schools after hours, as well as in homework centres and libraries' (p. 38).

Cain, K. & Tingay, C. 1998, *Koorie Literacy Using IT, Keys to life: early years of schooling conference. Sharing the journey: conference proceedings*, Sunday 31 May and Monday 1 June 1998, Convention Centre, Department of Education, Melbourne, pp. 30-32.

Outlines the literacy program at Woolum Bellum Koorie Open Door Education School in Morwell. Discusses the context of language at the school and the relationship between culture, communication and technology as well as the provision of alternative whole

school experiences for Koorie children. Preschool experiences are usually based on informal oral storytelling, demonstrated practical learning, a preference for visual stimuli, group work and discussion, spontaneous and intuitive thinking with limited print based experiences that make students more ready for formal literacy and a resistance to risk taking solutions. Woolum Bellum values three forms of language-Koorie English, traditional Ganai language and standard Australian English. In order to build upon past experiences, the teachers have used Hypercard to tell traditional local stories produced within a theme linking art, video, photography and audio. Teachers cited increased enthusiasm and willingness to undertake literacy and IT centred tasks, increased instances of risk taking, willingness to complete literacy processes from draft to final printout, an increased ability to associate words and literacy styles in other contexts and an increase in the ability to distinguish parallels between Koorie English and Standard Australian English Equivalents. Students have developed their own webpage to make email links and global projects. This brings about individualised focus, ownership and showcases children's work. Electronic messages allow for anonymity and improving literacy. The students are involved in the I*EARN Global Art Project which provides feedback to artwork on different cultures around the world. There is a use of software packages e.g. Wiggleworks, that addresses audio, visual, text and computer based learning, varying levels of competency, self pacing, oral and visual presentation of words and sentences, picture clues and extension activities. Others are Kid Pox. Living Books, Typing Tutors, Clarisworks . This is community based, encouraging partnerships with parents.

Crawford, K. 1990, Language and Technology in Classroom Settings for Students from Non-Technological Cultures, *Journal for the Learning of Mathematics--An International Journal of Mathematics Education,* Vol. 10, No.1, pp. 2-6.

Describes the difficulties encountered in a bicultural educational context by Australian Aboriginals. Crawford discusses the way in which language is used to convey meanings in the classroom-particularly in the teaching of Mathematics. Theoretical perspectives on culture and communication are reviewed. The social context for mathematics communication is important, and it is important that in multicultural communities the cultural assumptions underpinning the qualitative aspects of mathematics education need to be explored. e.g. in the Anangu Teacher Education program, both cultural groups become learners as the Aboriginal categories and relationships are discussed. New educational software provides new ways of mathematical learning that advantages Indigenous students by: focussing on collaborative learning and elaborated language forms of other cultures; providing a socially neutral source of information; providing a common experience of dynamic visual representations; and providing goal directed activity. New technologies have increased the use of visual and aural information. But the above is dependent on teachers being prepared to adopt and adapt their teaching to focus on use of ICT creatively and in culturally responsive ways. Computers can offer Aboriginal students visual representations of abstract ideas, and also can foster discussion of ideas at a metacogitive level.

Cumming, J. 1999, Literacy: Computers play their part', *EQ Australia,* No. 2 (Winter), pp. 16–18.

This article reports on a computer-assisted literacy program for Indigenous students and their non-Indigenous classmates.

Darvall, K. 1986, 'Computers and Aboriginal literacy,' *Aboriginal Child at School,* Vol. 14, No. 4 (Aug/Sept) pp. 3–8.

While this article does not have a lot of information on the use of ICT to enhance learning of Aboriginal students, it is useful because it does document a small project with Aboriginal students at Weilmoringle SSP in which the use of computers has assisted the students to increase their spelling ability. The article notes that the use of computers has increased the self-esteem of the students because they more user friendly than a teacher who often chastises the students for being 'wrong'.

Dench, P. 1991, 'Some computer strategies for achieving literacy in Australian languages: the Yintarri project', *Aboriginal Child at School,* Vol. 19, No. 2 (Apr/May) pp. 3–15.

The Yinatarri Project is a program that uses touch–sensitive boards with microcomputers to assist in the development of literacy in both Wangkatja and English. There are three computer strategies using touch–sensitive boards: touch exploring, language–controlled software, and word processing. These are introduced, and then there is a discussion on the use of touch–exploring and word processing at Yintarri.

Donaghy, B. 1999, Indigenous courses go national', *Campus Review,* Vol. 9, No. 43 (10-16 November), p. 13 10.

This article discusses the views of indigenous educator, Flinders University Professor Paul Hughes, on Aboriginal education and his ideas for an indigenous Internet-based suite of postgraduate programs taught by Aboriginal educators across the country.

Dunn, M. 2001, 'Aboriginal Literacy: Reading the Tracks. Cultural and linguistic factors that affect the efficiency of Australian schools helping Aboriginal children to become literate also have international relevance', *Reading Teacher,* Vol. 54 (April), pp. 678–688.

This article highlights the cultural and linguistic factors that affect the efficiency of Australian schools to help Aboriginal children to become literate. It discusses the notion of disadvantage as being 'the inadequate response of educational institutions to such conditions that causes disadvantage', and pedagogy where the article makes a number of suggestions that will help teachers orient themselves on numerous levels with culturally appropriate literacy teaching.

Fleer, M. C. A. 1989, 'A study of the introduction of microcomputers in selected Western Australian government schools with Aboriginal students', Unpublished MEd Thesis, University of New England, Armidale, NSW.

This study collected data on school and community perceptions about the introduction of computer technology into the school, as well as attempting to observe and document the actual process itself in selected Western Australian schools with substantial Aboriginal enrolments. A multi-method research design, framed predominantly within the ethnographic tradition of participant observation, but also utilising a standardised instrument, was employed. The study involved six schools for a total period of 12 months spaced over two school years. A significant number of factors were found to influence the take-up of the technology: the staff's perceptions of computer education; the support structures established within the school to afford its introduction; environmental constraints; the issue of suitable software; and the provision for the

continuity of the established program. The study's findings clearly indicate that Aboriginal students' access to computers in their schools may be haphazard and certainly not guaranteed year after year. A history of staff turnover, new graduates with limited computer expertise and inappropriate software in these schools further reduced the opportunities and thus increased educational disadvantage, for Aboriginal students.

Folds, R. 1986, 'Desirable characteristics of computer courseware in tribal Aboriginal schools', *Aboriginal Child at School,* Vol. 14, No. 3 (June/July), pp. 37–43.

Folds discusses how computer courseware can provide the type of instruction that appeals to Aboriginal children and may tap into their learning styles. Cultural factors are discussed emphasising that courseware should be in line with expressed community views when dealing with traditional culture. It should be highly interactive in order to overcome fear of failure, and exploit Aboriginal learning styles in ways to enhance learning objectives. Program responses should be randomised to allow teacher input to maintain the learning objectives and prevent courseware becoming merely a game. It should be consistent with proven methodologies in Aboriginal Education, and take account of cultural concepts.

Fraser, J. 1993, *Outcome Based Teaching Strategies and Evaluation for Computer Instruction in Keyboarding on an Aboriginal Island Reserve,* Ontario Secondary School Teachers' Federation, Toronto.

Twenty-eight adult students and four adolescent students were interested in completing computer instruction in keyboarding in their own environment in Canada to gain up-to-date ICT skills and knowledge. The students who enrolled in the keyboarding course were assessed by timed writings, production applications, and personal interviews for grade-level placement. Production assignments were given to students assessed at the advanced level; modelling of function keys and alphanumeric keys and drills were given to students with no previous computer experience. One-on-one instruction was the most common mode of delivery, followed by peer tutoring. Students worked at their own pace since the textbook provided step-by-step instruction. Advanced students were also given the opportunity to complete complex, abstract, and theoretical assignments to achieve advanced level. The students worked in informal groupings that they chose themselves. Community support was evident both among the students and by the friends and relatives who visited the classroom. Students felt ownership in the course by having the opportunity to use computers beyond class hours and to circulate the instructor's computer to their homes for extra practice. Weekly progress reports were issued. (YLB)

Fryer, M. 1987, 'Computers and Aboriginal students', *Unicorn,* Vol. 13, No. 1(Feb), pp. 54–55.

Fryer suggests that there is mounting evidence that many of the elements of computer assisted learning are congruent with the preferred Aboriginal style of learning. Computer Assisted Learning can provide a positive alternative to traditional instruction. Students have adopted computers as a medium of expression. They have developed independence and have made significant gains in their basic skills in the Aboriginal Post Primary Education Project.

Gotts, A. & Makray, J. 1993, 'Quality assurance and computer-assisted learning: Making the next project better', *Reaching out with I.T.: Proceedings of the 10th*

***Annual Conference of the Australian Society for Computers in Learning in Tertiary Education*, Centre for Computing and Mathematics, University of New England, Lismore NSW, pp.309-315.**

On completion of a computer–assisted learning project it should be possible to identify and analyse the strengths and weaknesses of the project, and to implement guidelines to improve the quality of new CAL projects. This paper examines a case study, a project for producing literacy materials to meet the English language needs of remote Aborigines and Torres Strait Islanders, and outlines some of the CAL management issues which were identified by the project team, including the development of a prototype, instructional design, and estimation of time. It also develops some guidelines to be implemented for future projects.

Henry, J and Brabham, W. 1994, 'Aboriginal Learning Styles and the Legacy of Biological Determinism in Contemporary Koorie Education. The History of Attempts to Define and Measure the Intellectual Capacities of Aboriginal Australians within Western Scientific Tradition', Deakin University, Geelong.

Henry and Brabham look at the way the theory about Aboriginal Learning Styles has become a popular theory and about how it is in fact based on the old ideas to explain the psychological differences between people of different races. Their paper locates Aboriginal learning styles within the biologically deterministic theories about the intelligence of Indigenous Australians.

Hobson, J. 1997, Strategies for Building an Indigenous Australian Cybercommunity: The Koorinet Project. Paper presented at the 1997 Fullbright Symposium: Indigenous Cultures in an Interconnected World, July 24-27, Darwin.

In this paper, Hobson discusses the Koorinet project to increase the participation of Indigenous Australians online. The Koorinet project is also about fostering community control of intellectual property. The paper documents the progress of the Koorinet project, the growth of its philosophical rationale, and the hopes for the future. The Koorinet project grew out of the desire by the University of Sydney to provide quality computing facilities for the Aboriginal and Torres Strait Island students in a culturally appropriate setting. The early success of the computing facilities confirmed the important facts that given a supportive and identified environment and quality facilities, Indigenous students were as keen to utilise technology as their non-Indigenous counterparts and that computers could be as much as Koori thing as a 'whitefella' thing. In the needs-based, self-directed learning and individualised teaching, Indigenous students could demonstrate as much capacity as anyone else.

One of the warnings that Hobson echoes is that western technology is not culturally neutral and may transfer socio-cultural traditions of Western societies.

HREOC, 2000, Emerging Themes: National Inquiry into Rural and Remote Education, Human Rights and Equal Opportunity Commission, Australia, March, 76p. http://www.hreoc.gov.au/pdf/human_rights/rural_remote/emerging_themes.pdf

Public consultations had revealed that access to education was a significant concern in rural and remote areas of Australia, particularly in relation to ongoing economic decline. In response, the Australian Human Rights and Equal Opportunity Commission initiated the National Inquiry into Rural and Remote Education. The inquiry took evidence at formal public hearings in the capital cities of every state and territory and at less formal meetings with parents, students, educators, and community members in rural and

remote areas of every state and the Northern Territory. The inquiry received 300 written and e-mailed submissions, including one from the government or education department in every state, the Northern Territory, and the Commonwealth. The inquiry also commissioned a survey from the Youth Research Centre at Melbourne University to which 3,128 individuals responded. This report summarises major concerns raised by the public, drawing on selected quotes that are broadly representative. Following an introduction, Chapter 2 describes the numbers, locations, schooling arrangements, and outcomes of rural and remote students. Chapters 3-6 cover the following themes: availability and accessibility of schools; distance education; travel; financial aid; schooling quality (curriculum, staff, facilities, information technology, and other learning opportunities); students with disabilities (numbers, discrimination, barriers to integration, and some special programs); and Indigenous students (numbers, situation, access, barriers to participation and support, outcomes, Indigenous cultural studies, and Indigenous languages). The final chapter presents an overview of the human rights provisions relevant to rural and remote education.

***Indigenous Funding Inquiry*, draft report. Commonwealth Grants Commission, 2000.**

This is a draft report into the Indigenous Funding Inquiry into the distribution of Commonwealth funding programs that affect Aboriginal and Torres Strait Island peoples. This report is a part of a wider process of inquiry and puts forward preliminary views and issues raised in the submissions for discussion by a range of stakeholders. The Inquiry looked at health, housing, infrastructure, education, employment, and training. The chapters that are most useful to the issue of ICT use and learning outcomes are Chapters 9 on Education and 10 on Employment.

Johnston, K, Healy, C, Thorne, J, Sheridan, J, Walsh, T and Bazeley, R. 2001, Deadly Kids, Innovative Technology and Creative Literacy Outcomes. Paper presented to AATE/ALEA Joint National Conference, 12-15 July.

This paper documents the Koorie Links Project and the Middle Years Link Project in Victoria. Both projects use Information Technology, specifically videoconferencing, to explore educational achievements of Aboriginal and Torres Strait Islander students in literacy. The school communities involved in the projects have significant numbers of Indigenous students and represent State, Catholic and Independent schools. The initial aims of the Projects were to build on proven literacy successes and to extend these models to targeted Koorie student groups through the use of learning technologies. The need to improve teacher understandings about Koorie Education issues through Professional Development was also an important part of the project.

As a result of the project, there have been improvements in measurable literacy outcomes for a number of students. As Koorie Educators and teachers have become more comfortable with the new medium, they have become convinced about the potential of videoconferencing in improving the literacy outcomes of Indigenous students. Variables such as attendance, health and mobility issues continue to cause difficulty for many students. Findings indicate that most Koorie students enjoy working with computers and the more personal attention that students receive through working in small groups allows for closer relationship to form. There is no individual or group memory of computer technology being used against Koorie people. The sense of purpose and having a real audience for the work produced leads to greater engagement, and the use of culturally relevant texts leads to increased engagement

and interest in reading. The high expectations of the Koorie Educators, teachers and community members had an influence on student achievement. The active participation in all stakeholders in the students education has led to a positive approach to teaching and learning, and, greater knowledge and respect for Koorie English has enabled many teachers to develop a better understanding and appreciation of students' strengths.

Kapitzke, C., Bogitini, S., Chen, M., MacNeill, G., Mayer, D., Muirhead, B. & Renshaw, P. 'Weaving Words with the Dreamweaver: Literacy, Indigeneity, and Technology' ***Journal of Adolescent and Adult Literacy*** **Vol. 44.,No, 4. pp.336-345.**

This report focuses on the positive links between Universities and Schools Project for Indigenous Australians. Educational Queensland developed with the Aboriginal and Torres Strait Islander Education Unit the Murri Thusi, a Web site providing professional development and resources for teachers of Indigenous Australians. Through constructing their own Web pages, Indigenous Australian students enhanced their literacy and technology skills. The article begins with some background on language and literacy education for Indigenous Australians, arguing against characterisations of Indigenous learning styles, while recognising that there is a broad spectrum of Aboriginal learning styles (e.g .learning through trial and error, observation and imitation, cooperative rather than competitive relationships, and holistic approaches). Aboriginal students also benefit from a reduced emphasis on the printed language. Kapitze et al point to the non Aboriginal content of the web arising from non-indigenous dominance of software and web design. Kapitze e al describes the aims, activities and outcomes of the Positive Links program that is University–school based in Ipswich, Queensland, and around the Bundamba School Cluster. They make comments about the new forms of social identity that emerged through literate practice in this cyber-semiotic environment. The program sought to enhance the literacy and numeracy of 20 ATSIC students through an after school program that trained them to construct and design their own webpage. The second aim was to accustom students and parents to be in a university environment. Students were shown websites, and then expected to develop their won with links through group work. Much of the work was self-directed and it was based upon the cultural apprenticeship model of learning. Students and staff learned from each other and with peer tutors. Data was collected by interviews, observation and also from web pages. The main benefits were increased self-confidence, interest, personal empowerment, that translated into improved attitudes to schooling. There was significant development of online literacy, and changed attitudes to ICT. The main problem was the poor writing skills of many students, but suggestions were to link ICT to writing unit. Another factor constraining outcomes was poor access to computers and internet at school and at home.

Koorie Students Assessment and Reporting Support Materials, **1998, Education Victoria, Department of Education.**

This booklet provides an overview of the issues involved in the assessment of Koorie students. It contains a discussion about Koorie English and the transition from Koorie English to Standard Australian English for Indigenous students. There are strategies for assessing Koorie students learning and how to report their achievements. Ways of implementing the CSF in a Koorie context are also presented.

Logan, L. & Sachs, J. 1994, Using technology to increase access to teacher education for Aborigines and Islanders in remote areas of Australia, ***Building Bridges in Teacher Education: Proceedings of the 12th Annual International***

***Seminar for Teacher Education, 24th to 30th April, 1992* edited by B Driscoll and W Halloway, Dept of Social Science Education, University of New England, Armidale NSW, pp.353-363.**

In this paper the authors argue that the concept of interactivity provides the conceptual ingredient that makes the Remote Area Teacher Education Program (RATEP) different from other distance education programs. To this end, following the elaboration of the concept of interactivity, they outline the design and delivery of the program. Finally, the fit between the theory of RATEP and its practice is discussed.

McKenry, R, 1996. 'Deadly Eh Cuz! Teaching Speakers of Koorie English' , Produced by the Goulburn Valley Aboriginal Education Consultative Group Incorporated.

"Deadly 'Eh Cuz!" is an education kit that is a Professional Development course for teachers of Koorie students. The kit is based on an Action Research Project that was implemented by the Goulburn Valley Aboriginal Education Consultative Group to research and document the impact of Koorie English on the learning of literacy by Koorie students in a variety of schools in the Goulburn Valley. The G.V.A.E.C.G. believed that schools needed to recognise Koorie English as the dialect that was spoken at home by the Koorie students and as a legitimate form of English. Standard Australian English then to be recognised as a second dialect of English for these students. Thirty teachers and eight Koorie Educators took part in the initial Koorie English Literacy Project. The results of this project informed the *Deadly Eh Cuz*! kit.

McLoughlin, C. 1999, 'Culturally responsive technology use: developing an on-line community of learners'*, British Journal of Educational Technology,* Vol. 30 No. 3 (July), pp. 231–243.

Considering both the micro and macro-cultural levels of instructional design is essential if culturally appropriate design is to be achieved in Web-based instruction. One of the limitations that has been recognised in striving towards culturally appropriate design is that current instructional design models do not fully contextualise the learning experience, and are themselves the product of a particular culture. A proposed solution is the adoption of a multiple cultures model of design, which is not culturally exclusive. This paper traces the development of an on- line unit for Indigenous Australian learners, and accounts for the cultural issues that impacted on the design of learning tasks and the associated avenues for communication provided to learners. In this context, culturally responsive design was ensured by the adoption of an epistemology and pedagogy based on Lave's (1991) community of practice model. Adapting the model to on- line delivery required incorporation of culture specific values, styles of learning and cognitive preferences, and tasks that were designed to go beyond surface level comprehension to achieve deep learning. The micro cultural level of the virtual community is considered in relation to participatory structures, task design, goal orientation and development of communicative processes that were intended to support the learning needs of a much wider group of Indigenous Australian students.

McRae, D, Ainsworth, G, Cumming, J, Hughes, P, Mackay, T, Price, K, Rowland, M, Warhurst, J, Woods, D, and Zbar, V. 2000, *What works? Explorations in improving outcomes for Indigenous students The IESIP Strategic Results Project,* Australian Curriculum Studies Association, Canberra.

This is a report prepared for the Commonwealth Department of Education, Training and Youth Affairs by the IESIP SRP National Coordination and Evaluation Team. There are two articles of use to this project. Screening Processes: Using information and communications technologies, a summary of the outcomes of projects using ICT. The actual description of the projects is also useful. The summary of the projects looks at the emergence of research evidence that suggests that, in the right circumstances, the use of ICT's can enhance the quality of teaching and learning for Indigenous students.

Mortimer, M. 2000, 'Australian indigenous communities online', *Information Literacy Around the World: Advances in Programs and Research*, edited by C. Bruce and P. Candy, Centre for Information Studies, Charles Sturt University, Wagga Wagga NSW, pp. 99-107.

This chapter outlines some personal perspectives of issues and concerns associated with bringing new information technology to remote Aboriginal communities.

Neumark, N, 1991. 'Girls, computers and computer culture', *Contributions to the Sixth International GASAT Conference: Volume One, Schooling,* edited by L J Rennie, L H Parker and G M Hildebrand, Key Centre for Teaching and Research in School Science and Mathematics, Perth, Western Australia, pp. 135-143.

This paper describes research undertaken with Year 7 secondary school girls to consider different approaches to involving girls in computer culture. The project involved devising a prototype resource, in the form of a comic, and trialing it. The comic was intended to be a non–didactic, positive intervention into computer culture. It was aimed specifically at non-English speaking background girls (NESB) and Aboriginal girls. This paper outlines the research, production and evaluation stages of the comic. The project confirmed the importance and the possibility of 'girl–friendly' intervention into computer culture.

O'Donoghue, R. R. 1992, 'Why the Aboriginal child succeeds at the computer', *The Aboriginal Child at School*, Vol. 20, No. 4, pp. 48-52.

In this paper, O'Donoghue documents the finding he has made in his work as a Resource Colleague in Aboriginal schools in the East Kimberley over 4 years. He discusses the fact that English is a second language for most Aboriginal children. O'Donoghue highlights the fact that expository texts and numeracy create many problems for Indigenous students. He documents some reasons for success with computers, they are friendly, they offer colourful graphics and quick dynamic action, there are many programs that don't depend on reading skills and the absence of the spoken word removes the difficulty of understanding what the white teachers says. O'Donoghue highlights three principles:

- The most important element in a successful use of computers is the competent, encouraging teacher.
- The proper use of computers will allow students to make mistakes and learn from them.
- Speaking, listening, reading and writing can be practiced at the computer**.**

***Open Learning '94 Proceedings of the 1st International Conference on Open Learning. Queensland Open Learning Network*. 1994, 9th-11th November, - Continuing Education, The University of Queensland, Brisbane, Queensland .**

Open Learning - A Challenge of Vision. Glen M Farrell, pp 1-7.

In this paper, Farrell discusses how educational systems are experiencing pressures to become more "open". A vision for an open learning system is described in terms of objectives, the learners who will be served, the models of delivery and program products. Barriers to achievement are identified and strategies along with strategies for overcoming them. Farrell looks at the social and cultural factors that he identified as drivers of change including: young families, Aboriginal and First Nations people, people with disabilities, clerical and blue collar workers, second change learners and older people.

Open Learning and Student Support-A Changing Relationship. Allan Doring, pp. 67-72.

This paper looks at the fact that student support in the learning process is crucial, not only in terms of teaching staff and resources, but also access. The effect of educational technology developments on students has the capacity to create a new disadvantaged student.

Rural and Remote Education Inquiry Briefing Paper: Indigenous education http://www.hreoc.gov.au/human_rights/rural_education/briefing/indigenous_ed.html

The Commonwealth Government, together with all State and Territory Governments, recognises that Australia's Indigenous people are 'the most educationally disadvantaged group in the community'. Indigenous people participate in and attain significantly less from education than the rest of the Australian population and this impacts adversely on their economic and social well-being.

There is a strong connection between education, language and culture. Thus education is about a sense of Indigenous identity. Unless identity gains prominence alongside other educational issues, we are swamped, and our language and culture will die out. A sense of Indigenous identity must be integrated in the education system.

Education underpins our economic participation and contributes to our equality in mainstream society. It is bound up with how mainstream society understands and recognises us. It is bound up with being prepared to take our position in society on the basis of equity. It prepares us for jobs and therefore for economic development opportunities to lift us out of the poverty cycle and dependence on government assistance.

Once the children know who they are, once they are accepted as equals, we will see Aboriginal doctors and lawyers working with the white community but also keeping their own culture intact (Doomadgee Qld community meeting, 6 October 1999).

Objective and outline: This paper discusses the issues raised in the Inquiry's third term of will investigate 'whether the education available to Indigenous children complies with their paper covers the following topics: History of Indigenous education; Definitions; Indigenous students—a profile; Commonwealth, State and Territory Indigenous education policies and programs; Barriers to participation and success; Success stories; Indigenous children's education rights; Recommendations to the Inquiry raised in the inquiry; and Further reading

Rural and Remote Education Inquiry Briefing Paper: Information Technology Infrastructure

http://www.hreoc.gov.au/human_rights/rural_education/briefing/it_infrastructure.html

More than anybody else isolated kids are ready - because of their independence and responsibility - to take advantage of this technology and they can't. [Public meeting in Bourke NSW, 1 March 1999]

Objective: The national inquiry into rural and remote (school) education raises, among other things, the quality of educational services including technological support services. This paper sets out some information about the available and proposed information technology infrastructure for your information. Our aim is to invite your comments on the adequacy of the proposals and your recommendations for improving provision for rural and remote schools. This paper is a work in progress which will be progressively developed and refined as further information is received by the Inquiry. The paper contains the following sections: 1. The legal framework; 2. Definitions; 3. Federal government policy; 4. What are the appropriate standards for information technology infrastructure in schools?; 5. What is the current IT infrastructure in Australian schools?; 6. Problems and barriers in the provision of information technology infrastructure for rural and remote students.

Sachs, J. 1993, 'Case study: Technology and teacher education: A study of the Remote Area Teacher Education Programme', *Educational and Training Technology International*, Vol. 30, No. 4 (Nov), pp. 327-333.

In this paper we present information on the Remote Area Teacher Education Program (RATEP) project undertaken in Aboriginal and Torres Strait Islander communities in far north Queensland, Australia. The possibilities for information technology (IT) in the delivery of an onsite teacher education program in remote communities are described. We argue that the RATEP project demonstrates the potential of IT as an instrument for teaching and learning. To develop their argument the authors focus on three issues: interactive learning systems, pedagogy and the features of IT and RATEP pedagogy. We conclude that students have quickly become 'technologically literate' and have appeared to benefit from the opportunities to exercise some autonomy over sequence, rate and mode of access to information.

Sachs, J. & Logan, L. 1991, Stand and deliver: technology and teacher education in remote communities, Australian Association for Research in Education Conference, Queensland.

In many respects teacher education programs have not taken up the possibilities for alternative modes of program delivery that information technology (IT) now provides. Where technology is used it is in the form of the development of hands-on computing skills. Using and understanding IT as a powerful resource for storing, retrieving and processing information should be an integral part of both the design and delivery of teacher education programs. In this paper, information derived from a study of the Remote Area Teacher Education Program (RATEP) implemented in four Aboriginal and Torres Strait Islander communities in Cape York Peninsula and Torres Strait is presented. It is argued that IT can be an instrument for teaching as well as a subject for learning. The example of the success of RATEP in what can only be described as very difficult conditions provides the evidence to support this argument.

Scott, W. J. 1990, 'Evaluation: Westcap Macintosh computer reading program', *Aboriginal Child at School*, Vol. 18, No. 2, pp. 44-50.

This article reports on the use of computers in three schools in remote areas, and a program of evaluation. The aim of the program was to: evaluate the use of `user friendly' computers in the area of reading remediation for poor readers; evaluate the impact of teacher/aide supervision on the effectiveness of the program; observe the attendance patterns of the participating students over a period of 10 weeks; gauge the relationships of students working in pairs and their levels of self confidence; and gauge the responses of students and staff in the schools where the computers are installed.

Shewring, B. 1993, 'Delivery of junior secondary education to remote Aboriginal communities in the Northern Territory using communication technologies', paper presented at The Emerging Culture Of Educational Administration: Putting The Heat On Administrators, in *Collected Papers: Australian Council for Educational Administration National Conference,* Darwin, 5-8 July 1992', Volume 4: Education and society —social issues.

The Northern Territory Department of Education is undertaking trials to delivery junior secondary courses, Years 8, 9 and 10 to remote Aboriginals on site in their communities. The communication technologies being trialed have interactivity as a major component. They are videoconferencing, 'Electronic Classroom', computer assisted learning programs incorporating computer managed learning, and the development of CD ROM and CD-I course material packages. All the technologies are supported by electronic mail, bulletin boards, teleconferencing and individual telephone support. The trials will encompass groups of remote students across the Northern Territory, undertaking firstly English and mathematics at Year 8. Expressions of interest were sought from schools wishing to participate in the trials and 120 students were nominated. It will focus on those students capable of commencing Year 8 subjects, and second chance learners who may have previously done some secondary schooling.

The second paper focuses on the question of, and the problems associated with the development, management and administration of Junior Secondary Education for remote Aboriginal students using technology. This is examined using one of the proposed Aboriginal Education Projects for the 1993/95 triennium.

Spiers, H. 1998, 'Culturally appropriate distance education technology for Vocational education and training in Northern Territory Aboriginal communities, Unpublished MDistEd Thesis, University of South Australia, Adelaide.

Much has been written about the ever-expanding field of communication technology and its applicability to the delivery of vocational education and training. It has been assumed that technology has the potential to be of benefit to adult learners in remote areas and regional centres of Australia, particularly the Northern Territory. The question arises that whether the technology and its associated delivery methodology culturally appropriate for Aboriginal learners in these areas and centres. This study examined the recent historical, educational and physical infrastructure contexts of the delivery of vocational education and training on Aboriginal communities in the Northern Territory with associated comparisons with other States. Interviews were conducted with researchers and educators involved in related activities. A questionnaire was prepared for Aboriginal members of three Top End communities. Participants were asked to consider the learning environment in which they were most comfortable, and which was most culturally appropriate. Material demonstrating the various delivery methodologies associated with distance education was then presented to the participants in a small discussion group situation. They were asked to comment on the suitability of the methodologies to meet their identified community training needs. The use of computers to assist in the delivery of training was welcomed by the Aboriginal

people interviewed, many of whom had prior experience using the technology. However it was generally agreed that independent learning was not compatible with the preferred Aboriginal style of learning. Preference was given to learning in small groups with assistance, not necessarily full-time, from a support person, preferably someone with whom they were familiar. The research also investigated what physical infrastructure limitations, if any, existed on Aboriginal communities in the Northern Territory with respect to communications technology. It was found that the poor quality and high costs of existing telephone lines to remote areas has prevented the residents of many communities from making use of specific forms of electronic communication such as electronic mail and Internet access: Future directions of training providers concerning the use of distance education or open learning methodology on remote Aboriginal communities was also ascertained for the purposes of the study. Concerns were raised that there was, to date, no coordinated approach to the development, or the use, of technological infrastructure on Aboriginal communities in the Northern Territory..

Steen, T. 1997, 'What does the literature say about computer literacy and indigenous Australians' language?', *Australian Journal of Indigenous Education*, Vol.25, No. 2, pp.14-22.

Information technologies, especially computers, are used by many indigenous communities as tools for re-learning their own language, or to improve their literacy skills in the official language. The intention of this paper is to inform readers, and especially educators, of the limited availability of literature in this area. An annotated bibliography is provided with reference to the use of computers to assist indigenous Australians in literacy (the ability to read and write) programs in a variety of educational settings. The major issues raised in the literature are summarised at the end of each annotation.)

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