Exploring pedagogies for effective teaching and learning in new multimedia environments: a comparative study of schools in Australia and the US

Olivia Dorothy Clarke

BA (Melb), BEd, MEd Studs

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Faculty of Education, Monash University

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Abstract

In the past two decades global investment in new technologies for schools has run into billions of dollars. Schools world-wide are expected to provide all forms of hardware, software and communicative tools to assist, and hopefully transform, the learning process for their students. As studies repeatedly show, however, reality rarely matches the rhetoric. The most common uses for the new technologies in schools, especially in post elementary schools, are word processing and searching the Internet. Recent major US and Australian survey studies indicate that relatively few secondary level teachers are prepared to integrate the more complex digital tools into their teaching practices in the pursuit of new learning opportunities for their students. This study examines the experiences of teachers and students in each of these countries who do so. The study explores pedagogical practices in grade 7 and 8 classes in the US and Australia in which extensive use was made of multimedia technologies, in addition to the Internet and word processing, for learning tasks. The study investigated the ways in which teachers and students teach and learn with new multimedia tools, and the contextual conditions which assist or constrain them to do so effectively. The research methodology adopted was a comparative, mainly qualitative, study of the experiences and perceptions of 25 staff and 356 students in two US and two Australian schools where multimedia tools were incorporated into the learning process. Classroom observations in all schools, a student on-line questionnaire, and focus group discussions with students and staff at the four schools comprise the major sources of data.

The study demonstrates that the young Australian and American students enjoyed working with peers to construct learning products with multimedia tools, even more so when both the cognitive challenge and interest in the topic were high. However, the study also found that in both countries effective use of these technologies, by teachers for instruction and students for learning, cannot be divorced from the complex interrelationship of contextual factors at play in the educational setting and system. The findings support the notion that successful integration of multimedia tools into classroom learning tasks is very much dependent on quality instructional design and on supportive frameworks - administrative, technical and collegial - for teachers in schools. Sustainable educational use of the digital tools which so engage young people requires that these supportive structures be embedded in the ecology of a school.

The findings suggest that if schools wish to pursue the learning opportunities that use of new, more complex technologies offer their information age students, then schools, and the systems and governments in which they operate, need to address these contextual factors. In particular, schools need to consider how professional communities of practice operate and/or can be fostered in their institutions to support the work of the teacher.

Disclaimer

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university, and to the best of my knowledge, neither does it contain material previously published or written by another person, except where due acknowledgement is made in the text.

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Chapter 1

Introduction

This study is about the ways in which teachers and students teach and learn with new multimedia tools, and the contextual conditions which assist or constrain them to do so effectively. It is also a comparative study: it contrasts two schools located in Victoria, Australia with two in California, US. In each of these schools, the focus is the grade 7 and 8 classes in which teachers require students to construct multimedia learning products with digital tools. On opposite sides of the world, these teachers face similar government and community expectations to incorporate new computer technologies routinely into curriculum practice. Reflective of the global economic reach of the US computer and telecommunications industry, an almost identical range of technologies - computers and software - is now found in these schools. Moreover, teachers in the US and Australia, not only use similar tools in their schools, it is increasingly apparent that they also share a common range of pedagogical and organisational challenges when they do take on new technologies in their individual settings.

Using mainly qualitative research methodology, this study investigates how middle years teachers in each country, design and implement learning tasks with multimedia tools, the pedagogical and organisational challenges they face, their attitudes to the process, and their views about the value of using these technologies for classroom learning tasks. The teachers are not specialist computer teachers. Rather, they follow the standard, common curriculum, integrating the use of a range of technologies into the instructional design of their respective disciplines.

In both countries the experiences and attitudes of the students to the multimedia-infused learning tasks are also examined. Australian and American young people have been surrounded with digital gadgets almost from birth. Many are familiar and comfortable with new forms of sound, vision, and interactive digital tools. They are not averse to risk when experimenting with these tools, and often are more competent in using them than adults. In the classes studied here, teachers required their students to construct and represent meaning with the types of contemporary cultural tools – including multimedia presentation and webpage authoring software incorporating graphics, sound, animation and hyperlinks - more commonly used outside of school or in specialist classes within the school. From an exploration of the teachers' and students' experiences, the study hopes to develop understanding of the characteristics integral to effective pedagogical practice in these complex learning environments.

This introductory chapter sets out the broad context of the study. I outline issues important to understanding the place of educational technologies in schooling in Australia and the US: the pressing demands on schools to take up technology in the education process; the debate about the merits of doing so; the limited ways in which teachers are reported to be using the available technology and the reasons for this. I also outline briefly the major approaches to teaching and learning generally adopted in multimedia environments and present the study's aims and specific research questions. Finally, I discuss the terminology used, make some brief remarks about doing research in a digital environment and conclude by explaining the organisation of the thesis.

1.1 Current imperatives for use of new technologies in schools

Information and communications technologies currently have a central role in the global economic system driven by the US. Indeed, access to new technologies in schools and their use in the education process, is considered highly important both for developed and developing nations alike.[1] Governments, globally, urged by the corporate sector and other community organisations, exhort schools to transform themselves with the affordances of the new tools to more effectively serve the needs of the emergent knowledge-based information economy: young people must be prepared for a digital future. For example, the briefing notes (*Technological Literacy for the 21st Century*, 1996) accompanying President Clinton's State of the Union Address, proclaim:

> Nothing is more critical to preparing our public schools for the 21st century than ensuring they have the modern technology to prepare students for the information age. The President challenges the nation to work together in a major new national effort to help every student become technologically literate for the 21st century.

In similar vein, in 1997, Tony Blair, Prime Minister of Britain, in the Foreword to *Connecting the Learning Society*, a major government technology initiative for education, said:

> By 2002, all schools will be connected to the superhighway, free of charge; half a million teachers will be trained; and our children will be leaving school IT-literate, having been able to exploit the best that technology can offer.

Likewise, in December 1999, European Commissioner Romano Prodi announced the initiative, *eEurope: An Information Society for All.* Prodi said:

> It becomes even more vital in the digital age to ensure life-long-learning and the emergence of new generations of creators, researchers, and entrepreneurs and to empower all citizens to play an active role in the information society. Achieving this starts at school.

[1] See OECD report *Measuring the Information Economy, 2002*. Scores of additional conference themes and papers on the central place of ICTs for the global economy can also be found on the World Economic Forum website.

In Australia, too, Ministers of Education in all states concur with the need to link use of new technologies with current education practice. The 1996 National Goals for Schooling (MYCEETYA, 1999) state:

> All students will leave school as confident, creative and productive users of new technologies, including information and communication technologies, and understand the impact of those technologies on society.

Education authorities and administrators at the state and district level in the US and Australia have taken up these national calls. *Learning Technologies in Victorian Schools 1998 -2001* (Department of Education, Victoria 1998) states that:

> Young people must be equipped with the skills and understandings to be effective members of a digital age.

And in California, *Connect, Compute and Compete,* the Report of the California Educational Technology Task Force 1996, asserts:

> Technology has the power to teach, to motivate, to captivate and to transform an ordinary classroom into a training ground for the next generation of artists, entrepreneurs, and government leaders. Unfortunately, California school children have far less technology than they need to take their rightful place in tomorrow's information society. An estimated 60 per cent of all jobs in the United States by the year 2000 will require a working knowledge of information technologies.

Government initiatives to support the rhetoric abound at federal and state levels in Australia, the US, Britain and Europe. Offices of educational technology have been established within departments of education; substantial funds for purchase of computer hardware, software, cabling and Internet connections have been allocated; large-scale programs for training teachers in the use of technology in their curricula have been established and in some instances, teachers have been issued personal computers to assist familiarity with their use. Comprehensive web sites have been constructed at national, state and local levels to disseminate information on technical and curriculum issues and to provide on-line professional development for teachers.

Business leaders, especially those in US-based technology corporations, also publicly voice the need for preparing young people for the increasingly digital environment found in most workplaces and which underscores so much of modern life. The US CEO Forum on Education and Technology, comprising chief executive officers, and other very senior staff of leading technology organisations, together with representatives of national education organisations, was founded in the fall of 1996 'to help ensure that America's schools effectively prepare all students to be contributing citizens and productive workers in the 21st Century' (*School Technology and Readiness Report (STAR). The power of digital learning: integrating digital content.*, CEO Forum, 2000). The organisation was formed in response to President Clinton's 1996 technology literacy challenge, referred to earlier, in which he urged leaders from across the country to work together to connect all schools to the Internet by the year 2000. Underpinning the work of the CEO Forum is the funding of large research projects and dissemination of their findings.

Many multinational technology companies, either through direct grants, or by channelling grants through foundations, also provide large amounts of money, equipment and support in various forms to promote the use of educational technologies in schools and higher education institutions. Computer companies such as IBM, Microsoft, Apple Computer, Hewlett Packard Corporation, Cisco Systems, Adobe Systems, Intel Corporation, Bell Atlantic, AOL, all have large sections within their organisations and websites focused directly on sales, training and support for technology-based curriculum at all levels of schooling. Several large non-profit foundations in the US have as a focus the funding, support, research and dissemination of research and ideas on the effective use of technology for learning. Some of these include The Milken Family Foundation, the George Lucas Education Foundation, the Benton Foundation and Joint Venture Silicon Valley Networks to name just a few. Thus in recent years there has been considerable partnering of governments, educational bodies, corporations, and not-for-profit organisations in the quest for developing and supporting wide-scale use of new technologies in education. This is deemed essential by them if countries are to meet local, if not global, economic and social imperatives.

Despite exhortations, and expenditure of vast sums on computer hardware and software, however, only a very small proportion of schools deliver programs or foster learning in the transformative ways envisioned by the proponents of the rhetoric. Searching World Wide Web resources for information, and word processing, are the current mainstays of computer technology use in schools worldwide – thus sustaining the research and presentation of work in written form that has characterised student life for centuries. It is in specialist computer and technology classes, usually elective subjects, that students are most likely to experiment and learn with a broader range of digital hardware and software. But these uses, available to only a few within the student body, do not match the wholesale transformation of schools hoped for by governments and corporations.

Despite considerable research efforts into transformative uses of technologies for teaching and learning (for example the 10-year Apple Classrooms of Tomorrow project), which indicate some positive outcomes within the context of well-resourced and well-supported research programs, there is little evidence yet of a comprehensive incorporation into the institutionalised education systems characteristic of Australia and the US. It is now almost 20 years, for instance, since multimedia tools were available in schools in both countries, yet few schools and teachers, as shown by nationwide studies in both countries, use these technologies on any regular basis.

1.2 The contested nature of the value of computer use in school

Alongside the public rhetoric of governments and businesses, and the billions of dollars poured by them into the provision of new technologies in educational settings, there is considerable ongoing debate about their value: debate about the role computers should play in education generally, especially in the early years, and whether or not their use contributes to improved student learning. This debate occurs not only within education and research communities, but frequently in the public arena as well, particularly in the United States. Proponents and antagonists whether they are academics, school educators and administrators, commentators or authors, often gain wide media coverage. In 1997, for example, Ted Oppenheimer, then Associate Editor of *Newsweek Interactive*, received extensive coverage for his strong critique in *The Atlantic Monthly* of computer-based learning in schools. He referred to the large numbers of studies which show equivocal findings about the value of educational technology, and criticised the diversion of government funding away from music, art and physical education programs and field trips (Oppenheimer, 1997).

Similarly, Clifford Stoll, a long time critic of the alleged societal benefits of technology (Stoll, 1995; 1999) but formerly a proponent and enthusiast, turns his attention specifically to schools. His 1999 book *High Tech Heretic: Why Computers Don't Belong in the Classroom and Other Reflections by a Computer Contrarian* encourages education policy makers to rethink the rush to embed technology in schools. Stoll rejects the idea that students need to use computers intensively and at an early age to become computer literate. He argues that the computer skills needed by adults are relatively few and easily learned, and hardly require computers in every classroom from kindergarten through 12th grade. Further, time on the computer inevitably means time taken away from real interaction with teachers and other students and reduces time for children to become proficient in foreign languages and musical instruments, for example. Young people raised in a digital culture need less time in front of a screen and more hands-on learning experiences, he argues.

For nearly two decades, Larry Cuban, Professor of Education, Stanford University, has urged extreme caution on the rush to make computers pervasive in schools. He argues his case on the basis of historical analysis of classroom use of new technologies since the radio, all of which were also supposed to reform classroom learning (Cuban, 1986; Cuban, 1999; Cuban, 2001). Cuban believes that 'there is no substantial body of evidence that computers have transformed teaching or learning' (quoted in Business Week, September 2000).

William Rukeyser, a founder of Learning in the Real World a non-profit organisation located in California, has also been a persistent critic of the use of technology in education, especially before secondary school age. He too argues that there is little evidence to support the enormous amounts of money expended on educational technology and pleads for decisions about computer-based instruction to be based on 'data and analysis, not faith, fear and hype'(Rukeyser, 1998).

Others critics caution about the introduction of computers into the early years of schooling. Jane Healy, whose book, *Failure to Connect: How Computers Affect Our Children's Minds - for Better and Worse*, received considerable publicity in the US and her views are exposed widely on the World Wide Web. She argues that the physical, social and cognitive development of children is placed at considerable risk with early and inappropriate use of computer technologies (Healy, 1998). That computers have no place in the education of young children is also the tenet of the Alliance for Childhood's 2000 report, *Fools' Gold: A Critical Look at Computers in Childhood.* Their report, available in print and on-line, argues:

> Computers pose serious health hazards to children. The risks include repetitive stress injuries, eyestrain, obesity, social isolation, and, for some, long-term physical, emotional, or intellectual developmental damage.

Concerns about the impact of Internet use on young people are also prevalent. The Center for Media Education in a 1996 report, *Web of deception. Threats to children from online marketing*), expressed grave concerns about the invasion of children's privacy through solicitation of personal information and tracking of online computer use and the exploitation of vulnerable, young computer users through new unfair and deceptive forms of advertising. A US survey commissioned by Public Agenda (1999) indicated that vulnerability of children to dangerous strangers and pornography, and access to information about building bombs are major community concerns. Internet pornography and on-line sexual solicitation of children are major concerns, not only for parents but also for educators and school administrators.

Vocal proponents for the place and importance of technology in schools abound as well. These include authors and commentators, Don Tapscott and Douglas Rushkoff, and academics, Decker Walker (like Cuban, a Professor of Education at Stanford) and Roy Pea, Director, Center for Technology in Learning, at the prestigious SRI International. They argue that we have no choice but to adopt the current technological culture in schools, that it can and should be used in the pursuit of improved student learning. Not only are young people comfortable and familiar with all forms of media and communication technology - it is their means of expression - but modern working life and leisure will increasingly be structured around technology. Don Tapscott (1999, p.8) in *Educating the Net Generation*, pronounces:

> Everybody relax. The kids are all right. They are learning, developing, and thriving in the digital world. They need better tools, better access, more services and more freedom to explore, not the opposite. Rather than hostility and mistrust on the part

> of adults, we need a change in thinking and in behaviour on the part of parents, educators, lawmakers, and business leaders alike.

And, Douglas Ruskoff, author and world-wide syndicated columnist on computer-related issues, argues:

> Traditional educational priorities based on linear thought (written text, planning ahead, writing or reading music, cause and effect reasoning) are giving way to holistic flow of living in the moment.

He believes that 'screenagers' are not 'bound by old-fashioned ideas of order but thrive in the state of chaos found on the Internet'(Rushkoff, 1996).

In predicting future scenarios, Decker Walker believes that Americans will expect educated people in the next generation to: use several symbol systems (visual, graphic, charts, tables, equations, computer languages, sound); apply knowledge in life; think strategically; manage information, learn, think, and create as part of a team (Walker, 1999). Pea, Director of SRI's Center for Technology in Learning, is of a similar view. In a public debate with Larry Cuban, Pea was adamant that new technologies are 'essential to education for the future ... that it's the responsibility of educators and allied disciplines to find designs for their effective use or fall drastically out of step with society' (Pea, 1998).

A common thread among the proponents seems to be that we do a disservice to the young if schools ignore the technologies with which they are so familiar, and do not assist them to take advantage of the power and possibilities new technologies have to offer learning. It is essential young people be taught to locate, retrieve, analyse and evaluate information in digital form, as technical and information literacy are essential skills for the 21st century, argue the proponents for new technologies in schools. From this perspective, the question should not be: 'Does the use of educational technologies improve student learning, but rather: 'How can the technologies best be used to support learning?' Walker (1996, p.102) argues that 'success in computers in education will come only as a result of the intelligent, artful orchestration of many details in the classroom'.

1.3 The educator's dilemma

It is in this milieu of hotly contested, often very public debate, and mounting government and societal demands for technologically literate students that teachers, many with little technical training and professional expertise in understanding or exploiting the possibilities of computer-supported learning, are expected to deliver technology-infused curriculum. Teachers, however, especially in post-elementary schools, generally are in no doubt about their reasons for limiting classroom use of computers. Lack of appropriate resources, skills, time, support and training, and unfavourable school organisational arrangements head their concerns. And their reasons often replicate those given for failures in fully integrating earlier forms of promising technologies (radio, film, TV) into pedagogical practice (Cuban, 1986).

Teachers are also faced with equivocal findings from the voluminous research literature about the value of technology for learning. This situation is made even more difficult for teachers when Australian and US Government reports and nation-wide surveys[2] regularly and repeatedly indicate that the transformative hopes for school use of technology have not yet been achieved and that a major reason for this is inadequate teacher preparation and training. A recent Australian report (*Raising the Standards: A proposal for the development of an information and communication (ICT) competency framework for teachers*) seeking to establish ICT standards for teachers with a view to competency improvement states:

> The need to better exploit the teaching and learning potential of ICT is widely accepted and supported. However, to date, this potential has not been realised in any significant way, particularly the potential to transform how, what, where and why students learn what they do.

Provision of hardware, software and Internet connectivity to schools, without equivalent investment in teacher professional development, is increasingly recognised as the major barrier to successful use of new technologies to support student learning. However, current educational research has yet to establish clear guidelines for the classroom professionals in operating in this new, ever-changing milieu, or to provide in-depth understanding of the conditions in which successful use of technologies for learning is likely to occur.

Nonetheless, despite considerable challenges, a small proportion of non-specialist IT teachers do move beyond Internet searching and word processing in their instructional design and attempt to integrate more complex technologies, such as multimedia, into learning tasks for their students. These teachers usually are of the view that their students not only live in a world infused with technologies that absorb and engage them, but that capable use of technology is also important for their charges' future working lives. They hope to exploit young people's attraction to digital multimedia tools for classroom learning purposes. This study investigates such teachers at the grades 7 and 8 levels in Australia and the US. On opposite sides of the world, these teachers face similar government and community demands and expectations, and use similar tools with their students.

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[2]These reports and surveys will be discussed in detail in Chapter 3.

1.4 Choosing a constructivist paradigm

Adaptation of the affordances of computers to long-established, successful curriculum practices is another challenge for teachers and research alike. In seeking to establish effective pedagogical practice for teaching and learning with the new technologies, educators have tended, in the main, to draw upon constructivist learning theories. The work of the cognitive constructivist theorists, represented by John Dewey, Jean Piaget, and of the socially-oriented constructivists led by Lev Vygotsky among others, has had considerable influence on current pedagogical practices. Drawing on constructivist paradigms about the nature of how learning occurs, frameworks and models for teaching and learning designed to guide the work of teachers in technology-mediated classrooms, have also been developed during the last three decades. Teachers have a bewildering array of ideas and approaches from which to choose when developing student-centred instructional tasks: inquiry-based learning; project-based learning; co-operative learning; multiple intelligences and the different learning styles of students; The 'Dimensions of Learning' model (Marzano & Pickering, 1997); the Australian 'Program for Enhancing Effective Learning'(Mitchell, Mitchell, & Loughran, 2001) represent just a few of the published frameworks and models. Some of the proponents of these constructivist teaching frameworks have begun more recently to incorporate ideas on how to adapt the use of new technologies to their particular model or approach. [3]

It is no easy task for the classroom teacher to mine educational theory and current practice in a quest to understand how to create a student-centred learning environment in which focused inquiry, critical thinking, collaboration and authentic tasks and assessment, are core tenets; one in which new information and communication technologies are integral, hoping to produce students well prepared for the digital future. Even where a clear philosophy of teaching and learning guides the work of a teacher, or group of teachers in a school, translating this to environments where new technologies have a significant place is proving difficult for a large proportion of teachers. Use of the range of new technologies for regular, as opposed to specialist Information Technology subjects, is not yet widespread. Internet searching and word processing are the main school uses of technology - hardly the transformative uses sought by the enthusiastic supporters of technology referred to above. Nor do these uses concur with the rhetoric of government and business leaders who are seeking global education and economic reform through the use of new technologies.

[3] For example, Project-based learning with Multimedia - an initiative funded by a US Government Challenge 2000 grant; the book *Multiple Intelligences and Instructional Technology* by Walter McKenzie (2002); the Program for Enhancing Effective Learning (PEEL) 2001 Conference in Melbourne, Australia had as its focus 'applying technology to good learning behaviours'.

1.5 The aims of the study

The aim of the study is to explore how this complex mix of rhetoric, expectation, and practice plays out in four schools in two countries, Australia and the USA. In each country, similar rhetoric (the social and economic imperatives) frames the educational provision of new technologies. In addition, nationwide surveys in each country indicate similar patterns of technology use in schools as well as similar patterns of constraints to widespread technology integration. Use of the more complex multimedia technologies, which are said to hold so much promise for student learning, is not commonplace in regular classrooms in either country. In the light of these understandings, this study considers the experiences and attitudes of teachers and students in grades seven and eight in two schools in Victoria, Australia, and two in California, USA where sophisticated multimedia technologies do have a central place in the curriculum.

Adopting a mainly qualitative research methodology, the study provides a close and extended investigation of teachers and students in these US and Australian schools. Central questions for the study include:

- What are the characteristics of effective teaching and learning in multimedia-supported learning environments at the grade seven and eight level?
- What social and cultural contextual factors support and constrain teachers in achieving successful outcomes when using these technologies?
- What can be learned from a cross-national comparison of practice in schools in which teachers undertake to use these technologies in their curricula?

The focus of the study is the complex interplay between educational technologies and instructional design, and school culture and practices in a cross-national context.

The study also considers:

- national, state and systemic frameworks within which these schools function in the US and Australia
- organisational structures and provision of educational technologies at the school level
- policies and expectations of staff about technology use
- provision of technology, technical and curriculum support, and professional development for teachers
- the nature of the learning tasks integrating multimedia
- staff and student experiences and attitudes to teaching and learning with multimedia technologies

The middle years of schooling were chosen as the focus for two reasons. Firstly, considerable research on the use of educational technology has already been reported from elementary schools. In elementary schools, the combination of timetable and curriculum structures are usually far more flexible, and staffing and physical organisation of the school seem to enable technology take-up more easily and successfully than in middle or high schools. This study will consider the extent to which school organisation and curriculum demands in these middle schools do affect technology integration. Secondly, the middle years of schooling are recognised in both countries as problematic for some students, often reflected in low academic achievement and disengagement with schooling. If, as proponents argue, young people are 'thriving' in the new digital environment, this study will also consider whether this view is affirmed by the experiences of the middle years students in these schools who use digital tools extensively for learning.

The potential significance of the project lies in the ongoing need to understand conditions likely to contribute to effective use of educational technologies in schools, given the vast resources currently expended on them. Greater understanding of effective pedagogical practice, and how to foster and support good practice in schools which use these technologies is necessary so that available student learning time, as well as the investment is not wasted. Since 1996, the Centre for Research in Instruction (CERI), an arm of the OECD, has been developing policies and strategies to meet the needs of member countries for increased understanding of the role of ICTs in education globally. In describing the CERI project Information and Communications Technology and the Quality of Learning, launched in June 1999, Jarl Bengtsson, Head of CERI, stated:

> There are now strong demands world-wide for informed answers to a wide range of questions about the impact of ICT on teaching and learning. As countries invest heavily in this direction, the main evaluation questions are less "is it worth it?" (since the technologies have become permanent aspects of school life in many places), and more "how can ICTs be used most effectively? ... there is an acute demand for a well developed international knowledge base in this field (Bengtsson, 1999).

The present study, undertaken in two countries, aims to contribute to this knowledge base.

1.6 Terminology

New technologies

Given the plethora of new and ever changing technologies available in educational settings, and that collective terms for technology differ in each country, it is necessary to clarify the terminology adopted for this dissertation. Terms such as 'computers' and 'information technology' (IT) are no longer considered sufficient in themselves to convey the sheer diversity of digital technology currently found in schools: computer hardware and peripherals, software applications, multimedia tools, telecommunications technologies and digital projection facilities. Several collective terms for new technologies are currently in use to describe essentially the same phenomena. In the US, 'educational technologies' is by far the most common generic term found in reports, policies and research and used by education, research and business communities alike. Walker (1999) states that the term 'educational technologies' has come to refer to computer-based learning, the use of interactive videodiscs and CD-ROMs, and to learning environments established with computer and communication technologies such as the Internet and the World Wide Web. Or, as Roy Pea explains, 'education technologies' is a phrase commonly used to refer to whatever the most advanced technologies available are for teaching and learning in a particular era (Pea,1998).

'Information and Communication Technologies' (ICTs), reflecting the convergence of the new technologies, is another term used widely, especially in Britain and increasingly in Australia, where there is a growing consensus in favour of this term. 'Learning Technologies' (LT) has been a term popular in some states of Australia, especially by the Education Department of Victoria in relevant publications. However, this term is not applied generally outside of the education community. At the national level in Australia, ICTs is now the most favoured term[4]. Recently, reflecting the need for a more comprehensive description, the professional teacher association in the state of Victoria formerly known as the Computing in Education Group in Victoria changed its name to 'ICT in Education, Victoria'.

For my purposes, I have chosen to use the collective terms 'new technologies', 'educational technologies' and 'ICTs' interchangeably to incorporate and reflect the different patterns of use in Australia and the US, and to provide variety of expression. In doing so, I refer to the distinction made by Cuban (2001) between 'old' and 'new' technologies found in schools. Old technologies are 'textbooks, blackboards, overhead projectors, television and video cassettes' (Cuban, 2001 p.12). 'New technologies', 'educational technologies' and 'ICTs' will be used here to encompass:

- computers (desk top and portable machines)
- software applications
- peripherals (file storage disks, printers, scanners)
- connectivity to the Internet and the World Wide Web
- tools for multimedia input (digital and still cameras, and audio in-put devices)
- digital projection
- multimedia data storage CD-ROMs/DVDs

The term 'multimedia technologies' is a variation of 'new technologies' and will be used extensively here as well. Multimedia technologies are the hardware tools and software which allow

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[4] 'ICTs' is used throughout the 2002 report: *The Enabling Pillars. Learning Technology Community Partnership. A Report on Australian Policies for Information and Communication Technologies in Education and Training.*

for construction and presentation of information using text, still and moving graphics, sound, animation, interactivity and hyperlinking (within a document and to the World Wide Web).

Levels of schooling

To assist the reader, I use the generic term 'grade' when referring to levels of schooling in each country. In Australia levels of schooling are normally labelled by year (eg. year 7) and in the US by grade (e.g. grade 8).

1.7 Research in a digital environment

A former teacher and school administrator, I used the opportunity provided by my doctoral candidature to acquire and develop a range of ICT skills similar to those of the teachers and students I was studying, including multimedia presentation and webpage construction skills. As the study progressed, it also became a personal exploration of the ways it is possible to research and learn through the use of new technologies simultaneously in different countries i.e. through extensive use of the World Wide Web, email, on-line data gathering tools, on-line collaborative learning forums and professional development delivery programs. In addition, I sought out, evaluated, selected, and learned to use, NVIVO a qualitative data analysis software package – (NVIVO, 1999),- to assist in management and analysis of the considerable volume of data obtained in each of the countries. Thus, through immersion in a digital environment (while experiencing intense frustration with, and awe, at the affordances of the tools - often simultaneously), not only was my own learning and research assisted, a heightened understanding and appreciation of the challenges teachers face when they use new technologies in classrooms was also possible.

1.8 The organisation of the study

The dissertation is organised in the following way: Chapters 2-3 provide an overview of the theoretical position and research literature relevant to the ideas and issues explored in the study. Chapter 2 focuses on learning theories and approaches to pedagogy when technology is incorporated into the learning process. Chapter 3 examines three strands of research literature from both Australia and the US which establish the current context for school use of technology. The design and methodology adopted for the study is described in Chapter 4. Chapters 5-9 present a summary, analysis and interpretation of the findings. National, state, systemic and local educational contexts, within which the two US and two Australian schools operate, and which frame their use of ICTs, are described in Chapter 5 and 6. Chapters 7 and 8 explore the experiences and attitudes of teachers and students as they teach and learn with new technologies. Chapter 9 provides a comparative analysis and interpretation of the interrelationship between the school contexts, pedagogy and student learning, presents the conclusions which may be drawn from the study and offers suggestions for further inquiry.

Chapter 2

Teaching and learning with computers – the theoretical basis for the study

In seeking to understand factors contributing to effective pedagogical practice in school environments where educational technologies are used in the learning process, this study draws on and attempts to link several relevant learning theories. These theories include those relating to the process of cognitive development, how educators can best foster student cognition, the ways in which learning can occur in social contexts, and the ways in which learning is mediated using tools of the culture. This review also considers literature relating to teachers as learners and the ways in which teachers learn to teach with technology.

2.1 Behaviourism and constructivism

Debate about the nature of learning and how teachers appropriate theory into classroom practice has in the past few decades focussed on the broad distinction between behaviourism and constructivism. Howard Gardner compares a behaviourist classroom, one in which the focus is on the answers desired, bolstered by schedules of reinforcement, with a constructivist one, a place where students try out ideas and practices for themselves (referred to in Scherer, 1999). In a behaviourist paradigm, learning is transferred from one who is knowledgeable to one who is not through the medium of instruction. By contrast, a constructivist paradigm, views learning as a personal, reflective and transformative process, where ideas, experiences, and points of view are integrated and something new is created: teachers' work is construed as facilitating an individual's ability to construct knowledge (Sandholtz et al, 1996, p.12). As the teachers in this study generally, although not exclusively, assume a constructivist stance in their approach to teaching, a closer examination of the concept is necessary.

Constructivism encompasses a wide range of cognitive and socio-cultural understandings about learning, and as Perkins (1999, p.7) points out, the array of constructivist ideologies and practices can leave even the most experienced and dedicated teacher bewildered. He comments that advocates have sometimes championed it to the point of overkill and that, 'Here and there, mentioning the C word is almost bad manners'. Prawat (1999) believes that although there are varying interpretations of what the term constructivist means, there is wide consensus about two key features:

(a) learning is a process of active construction, and

(b) that process results in a qualitative change in understanding.

Opposed to instructional delivery models, constructivism can be characterised as supporting students to learn by doing. In practice, according to Jonassen (1996a, p.11), constructivism involves,

> the process of how learners construct knowledge. How learners construct knowledge depends on what they already know, which depends on the kinds of experiences they have had, how they have organised those experiences into knowledge structures, and the beliefs they use to interpret objects and events that they encounter in the world.

In addition to spawning an array of ideas and strategies for classroom practice, the constructivist paradigm has also provided a framework for much recent educational research and practice into classroom use of the new educational technologies. For educators of this persuasion, traditional transmission and behaviourist models of instruction are no longer adequate and limit the opportunities for enhanced student learning the new digital milieu might offer. Key proponents (Means, 1994; Duffy & Cunningham, 1996; Dwyer, 1996; Jonassen, 1996a; Tapscott, 1998) argue that computers can be viewed as learning, or constructivist, technologies, as they can assist learners to organise and represent what they know, can allow for seeing and using text in new ways and support multi-level thinking. Further they claim that computer technologies can promote and enhance collaboration, enable more complex exploration of multiple perspectives and allow for more authentic research activities (Duffy & Cunningham, 1996 p.160).

In the following sections I outline the broad parameters of these constructivist theories and indicate how they influence current approaches to teaching and learning in technology mediated classrooms.

2.2 John Dewey's pioneering ideas on active learning

Constructivist theory owes much to American philosopher and psychologist John Dewey. His pioneering work in the late 19th and early 20th centuries has been regularly revisited and reconstructed and still underscores much current pedagogical thinking. In particular, his ideas on active learning have been influential and are reflected in many current teaching and learning practices. In Dewey's view, the fundamental difficulty with traditional means of instruction was the notion of the child as passive receptor of external data. Rather, he argued, the pupil should be looked on as willful, purposive, curious, and active. He believed ideas (intellectual and rational processes) result from action, and that education is a reconstruction of experience. The teacher should be considered a facilitator who helps the pupil to achieve his own purposes. The relationship between teacher and pupil in Dewey's view should be reciprocal - they plan together and learn from each other. Subject matter is completely redefined in terms of these facts, ideas and objects that are helpful in fulfilling the pupil's purposes. The classroom is a total environment where physical and social conditions, as well as abstract intellectual material are essential features affecting the learning process. Teaching is not 'instruction'. Rather, the teacher is a catalytic agent, who by providing materials, clues, information, suggestions, and clarifications – creates a setting conducive to learning. Since there was to be no separation between education and life, the means of instruction is centred on the live, meaningful, relevant and important problems to be grappled with (Dewey, 1897). For Dewey, the emphasis was on process rather than product. Students should be engaged in long term projects of their own choice, with a teacher in the role of facilitator. The teacher's major function is to keep students on a stable course in the process of their own discoveries (Glassman, 2001).

In the ongoing search for better ways to teach and learn, Dewey's advocacy for student-centred learning continues to have appeal for educators. Nevertheless, his ideas have never been fully adopted and formalised on a large scale by school systems. Teaching in the ways Dewey advocated, is complex work, requiring considerable flexibility. Classrooms designed and built for a teacher instruction model do not easily allow for students to be simultaneously learning with multiple resources, engaged in questioning, research and discussion, working on different projects. Inflexible time organisation in schools, especially secondary schools, and the fact that teachers are not necessarily well prepared and supported for implementing student-centred approaches act as further disincentives. Furthermore, schools and school systems whose accountability framework is focused on student performance on standardised tests and examinations, find it difficult to accommodate a more fluid curriculum based on individual student needs. Nevertheless, the broad thrust of Dewey's ideas holds much currency in the modern classroom.

2.3 Piaget and cognitive constructivist theories

Modern constructivist theories and teaching practices have also been considerably influenced by the Swiss psychologist Jean Piaget through his work on child development and cognitive theory in the early decades of the 20th century. The concept of cognitive structure is central to his theory. Cognitive structures, in Piaget's view, are patterns of physical or mental action that underlie specific acts of intelligence and correspond to stages of child development – the sensorimotor, the pre-operational, the concrete and formal operational stages. Cognitive structures change through the process of adaptation: assimilation and accommodation. Assimilation involves the interpretation of events in terms of existing cognitive structure, whereas accommodation refers to changing the cognitive structure to make sense of the environment (Bybee & Sund, 1982). In Piagetan theory, learning is seen to occur when the learner's expectations are not met, and they must resolve the discrepancy between what was expected and what was actually encountered. Thus the learning is in the individual's constructions - 'individuals literally construct themselves and their world by accommodating to experiences' (Duffy, 1996). Within this framework, it is the teacher's role to facilitate learners' movement through development stages by provision of relevant experiences enabling active engagement in the learning process. Examples of Piaget's influence can be seen in classrooms where students experiment with magnets or manipulate Cuisenaire rods to master the concept of fractions (Fogarty, 1999).

Jerome Bruner drew extensively on the work of Piaget in formulating his early view of learning and curriculum. His constructivist theory encompassed a general framework for instruction based upon the study of cognition. Central to Bruner's early thought (Bruner, 1960) was the importance of the teaching process in assisting the learner to grasp the structure of a subject. Mastery of the structure of subject matter is essential to transfer of learning – particularly principles and attitudes. The presentation of fundamental ideas is not sufficient, however. Knowledge is best acquired through the learner's own cognitive efforts – through acts of discovery. Moreover, to understand basic concepts, the child needs to be helped progressively from concrete thinking to the more complex formal stage. Instruction must be concerned with the experiences and contexts that make the student willing and able to learn – the teacher must identify readiness for learning. Bruner used the term 'spiral curriculum' to allow for the introduction and revisiting of important ideas and concepts to children at different stages of development. To Bruner, 'the 'reality' that we impute to the 'worlds' we inhabit is a constructed one' (Bruner, 1960, p.19). Education must be seen then as aiding learners to use the tools of meaning-making and reality construction. Practical application of his theory took the form of a major discovery-learning curriculum program: 'Man: A Course of Study' (Bruner & Dow, undated). This program was widely used in social studies curricula in the 1970s and 1980s, and indeed by this researcher.

Similarly, as with change efforts in active, constructivist learning mentioned earlier, discovery learning failed to make a large-scale impact and to become widely accepted in the pedagogical canon. Because the curriculum content of discovery learning approaches was not clearly defined, it was considered to be tarnished with the same critical brush as open, progressive classrooms and other apparently *laissez-faire* pedagogical practices popular in the 1970's and 80's. Also, teachers often adopted inquiry approaches so students would discover given content, and students were not encouraged to appreciate the inquiry process as a way of understanding complex issues in a subject domain. Nevertheless, inquiry or discovery learning is grounded in constructivist theory and has appeal for educators who explore ways to more actively engage their students in challenging learning processes.

Piaget's cognitive theory has also contributed to more recent theories on metacognition, which in turn have begun to be adopted by educators who seek to engage students more actively in their own learning. Piaget considerably influenced John Flavell who originally coined the term 'metacognition' which he referred to as one's own knowledge about cognitive processes and knowledge that can be used to control cognitive processes (Flavell, 1976). In a review of the work on metacognition, Hacker explains metacognition in terms of awareness of oneself as an actor in one's own environment - an active deliberate storer and retriever of information. Hacker goes on to say there now seems to be general consensus that a definition of metacognition should include at least the following notions: knowledge of one's knowledge, processes, and cognitive and affective states, and the ability to consciously and deliberately monitor and regulate one's knowledge, processes, and cognitive and affective states. Development of individuals' metacognitive abilities is also increasingly recognised as contributing to enhanced learning (Hacker, 1998). Overt teaching of metacognitive strategies are now often included in the repertoire of educators who adopt a constructivist teaching stance.

2.4 Socio-cultural mediation of individual learning

Socially-oriented constructivists take the view that as well as consideration of how the individual constructs knowledge, it is also imperative to understand that knowledge-making occurs in social and cultural contexts. In contrast to the focus on individual constructions, these theories emphasise the socially and culturally situated context of cognition, and its role in the learning process of an individual (Duffy & Cunningham 1996, p 175). According to Salomon and Perkins (1998) socially mediated instruction can be one-to-one (tutor, parent, teacher to learner), one to many (teacher to a group), and many-to-one (a pair, trio or other group of collaborative learners with the learner as a participant).

In seeking to explain the role and importance of social context for learning, the work of Lev Vygotsky, the Russian educational philosopher is often used. Vygotsky's theory of cognitive development is based on a student's ability to learn how to use socially relevant tools (such as money, pencils and computers) and culturally based signs (such as language, writing and number systems) through interactions with other students and adults who socialise the students into their culture (Doolittle, 1997). According to Vygotsky, central to understanding the social context of learning is the notion of a 'zone of proximal development'. In 'Mind and Society', Vygotsky (1978 p.86) defined the zone as 'the distance between the actual development level of a child as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers'. Doolittle (1997), drawing on Moll (1990), suggests that Vygotsky's zone of proximal development has three key implications for teaching: *the use of whole, authentic activities* (activities that involve applying learned knowledge and skills in the completion of a real-world task within a meaningful cultural context); *the need for social interaction* (students internalise the knowledge and skills first experienced during these interactions and eventually use this knowledge and these skills to guide and direct their own behaviour); and in *the process of individual change* (as the student learns and develops, his or her collaborative interactions with another individual lead to the development of culturally relevant behaviour). According to Doolittle, the zone of proximal development provides a sound theoretical basis for cooperative teaching and learning strategies. In their further development of Vygotsky's ideas, Duffy and Cunningham state that success in zones of proximal development (Zo-ped) requires support for learning, and that term is referred to as scaffolding or the affordances of the environment. 'Scaffolding includes the support of other individuals, any artefacts in the environment that afford support, as well as the cultural context and history the individuals bring to the Zo-ped' (Duffy & Cunningham p. 186).

That individual learning rarely occurs without being embedded in a social context. has also been the thrust of Lave and Wenger's research (Lave, 1988; Lave & Wenger, 1991). Through their work with apprentice learners, they highlight the situated, context-dependent nature of learning or cognition. They have developed the idea of distributed cognitions on the grounds that activities are so highly context-bound, and the processes involved in an activity so varied from one social and distributed setting to another, that the distinction between the cognitive toolbox, the context and the activity, becomes untenable. They argue that in typical real-life situations, a person engages in the process of knowing as part of their actual activity in the world, not (just) in the application of pre-existing knowledge and skills. They also assert that participation in a culture of practice can, in the first instance, be observation from the boundary or 'legitimate peripheral participation'. As learning and involvement in the culture increase, the participant moves from the role of observer to fully functioning agent. Legitimate peripheral participation enables the learner to progressively piece together the culture of the group and what it means to be a member: 'To be able to participate in a legitimately peripheral way entails that newcomers have broad access to arenas of mature practice' (Lave & Wenger, 1991, p. 110). Helping learners to move from legitimate peripheral participation to centripetal participation in the actions of a learning community should be the goal of the learning situation they argue.

In their theory of situated learning Brown and his colleagues (Collins, Brown, & Newman, 1988; Brown, Collins, & Duguid, 1989) similarly propose that activity and situations are integral to cognition. They assert that knowledge is the product of an activity, context, and culture in which it is shaped and developed. As a result, learning should be situated in real-world, 'authentic' tasks and activities that would normally involve that knowledge, and learning requires social interaction and collaboration. Social learning theorists suggest that social contexts give students the opportunity to successfully carry out more complex skills than they could on their own. Students learn by not only imitating what others do, but through discussion, make thinking visible (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Situated learning, with its emphasis on authentic learning and cognitive apprenticeship, has been successfully adopted in some new approaches to education and training for specific types of jobs and professions (Herrington & Oliver, 1999). In these cases, learners can be readily placed in relevant contexts and given learning tasks of immediate applicability. This is generally not as possible or practical in the average school, however, given they are often context-bound to an inflexible organisational structure.

In development of his earlier work, Jerome Bruner expands his view of cognition as an individual construct. In 'The Culture of Education' (Bruner, 1996, p.43) argues that 'education is not simply a technical business of well-managed information processing, nor even simply a matter of applying "learning theories" to the classroom ... It is a complex pursuit of fitting a culture to the needs of its members and of fitting its members and their ways of knowing to the needs of the culture'. These socio-cultural constructivist theorists clearly place the onus of the school in preparing young people to make a useful and valuable contribution to the society in which they live.

Although the cognitive and socio-cultural theories of learning gathered under the loose banner of constructivism, and broadly represented by Dewey and Vygotsky respectively, share an emphasis on the importance of everyday activities, the implications of each for classroom practice are quite different (Glassman, 2001). For Dewey, the process of individual discovery, based on interest/motivation for the activity to achieve an aim, despite obstacles and barriers, is fundamental. In such classrooms, the teacher acts as facilitator. The child must recognize themself as viable agent of change for that social organisation. From the Vygotskian perspective, on the other hand, the teacher builds ideas for the learner that will lead to mastery; guiding the thinking of the child through the zone of proximal development, for example with demonstrations, questions, and raising problems related to those in later life. In this case, the teacher acts as guide and mentor. For Vygotsky, the purpose of education is to meld children into the larger social structure so they can become productive members of the community (Glassman, 2001).

2.5 Constructivism and teaching practice

Many current popular approaches to pedagogy: student-centred learning, project-based learning, inquiry/discovery learning, learning by doing, co-operative and collaborative learning, authentic learning and assessment, and popular terms such as 'guide on the side', all can be seen to have their roots in these constructivist cognitive, metacognitive and socio-cultural theories of learning. This is the case both in schools and the tertiary sector in both Australia and the United States. For example, Australian researchers Herrington and Oliver (1999) who based their research in higher education, describe critical elements of a learning environment which embraces these socio-cultural active learning theories. These elements include:

- authentic context: reflects the way the knowledge will be used in real life, that preserves the full context of the situation, that invites exploration and allows for complexity
- complex authentic activities
- expert performances in which situated learning environments provide access to expert performances and the modeling of processes before attempted by students; allows for accumulated narratives and absorption of strategies which employ the social periphery (legitimate peripheral participation)
- opportunities for learners to investigate multiple roles and perspectives
- support for collaborative construction of knowledge
- coaching at critical times and scaffolding of support where the teacher provides the skills, strategies and links until the student can manage independently
- reflection and articulation to enable tacit knowledge to become explicit
- integrated assessment within the learning tasks

American authors Martin and Jacqueline Brooks suggest in *The Case for Constructivist Classrooms* (Brooks & Brooks, 1993) that classroom teachers who teach in a constructivist way

- encourage and accept student autonomy and initiative
- use raw data and primary sources, along with manipulative, interactive, and physical materials
- when framing tasks, use cognitive terminology such as 'classify', 'analyse', 'predict' and 'create'
- allow student responses to drive lessons, shift instructional strategies, and alter content
- inquire about students' understanding of concepts before sharing their own understandings of those concepts
- encourage students to engage in dialogue, both with the teacher and with one another
- encourage student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other
- seek elaboration of students' initial responses
- engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion
- allow wait time after posing questions
- provide time for students to construct relationships and create metaphors
- nurture students' natural curiosity through frequent use of the learning cycle model: discovery, concept introduction, and concept application

According to Sandholtz and colleagues, researchers with the Apple Classrooms of Tomorrow (ACOT) schools, in knowledge construction classrooms teacher-student interactions are less didactic and more collaborative. Students work together. Learning environments can feel more like real workplaces where problems are solved through conversation, inquiry and trial and error. Making sense from facts is a paramount value (Sandholtz, Ringstaff, & Dwyer, 1996).

However, as with the attempts described earlier, teachers, who do move from an instructionist to a constructivist stance, often face considerable challenges applying the theory. According to Windschitl, these teachers need to: deal with the complexity of constructivism as a philosophy; prepare for the subject matter understanding and pedagogical expertise that constructivist instruction demands; re-envision the culture of the classroom; and face political challenges that arise from implementing constructivist instruction in school settings (Windschitl, 1997). With a similar note of caution, Airasian and Walsh (1997) draw attention to the difference between the appealing tenets of constructivism and its practical application in classroom settings. They caution teachers against relying on one teaching method alone, as students construct meaning in many different ways. The task should be to find the right balance between the activities of receiving and constructing knowledge. These writers also raise the issue of the extra time needed: time to learn how to perform in a constructivist classroom and the time needed to respond to individual constructions.

Tom Reeves, an advocate for some of the new paradigms of learning, also cautions against blind adherence to theory, emphasising that constructivism does not mean that telling is always bad; that situated cognition means all learning should be in realistic contexts; that social constructivism means that all students should always work in groups; that distributed intelligence means computers are required for every task (Reeves, 1999). Similarly, Perkins (1999, p.11) argues that even teachers who support flexible, active, social and creative learning will, if necessary, diverge from ideological constructivism when solving problems in teaching and learning. They devise a form of pragmatic constructivism:

> If a particular approach does not solve the problem, try another – more structured, less structured, more discovery oriented, less discovery oriented, whatever works. And when knowledge is not particularly troublesome for the learners … forget about active, social, creative learners. Teaching by telling may serve just fine.

Sandholtz and colleagues (1996, p.14) assert that 'knowledge instruction and knowledge construction are not incompatible … they can be viewed as different complementary positions on a continuum of possible learning strategies'. Based on their research, they believe the most effective teachers are those who can implement a variety of approaches for the benefit of their students and reach a balance of instruction and construction activities'.

Although active learning is a common denominator for the pedagogical approaches examined in each of the classes in the four schools in the current study, none of the approaches could be described as fitting a pure ideological constructivist model. The degree to which teacher instruction and the social dimension adopted varied, the degree of real world authenticity varied, as did the amount of scaffolding or support to individual cognition as students and staff operate in the so-called zone of proximal development. Overall, the teachers' practices examined here fit more comfortably with a more practical, pragmatic approach to teaching. Constructivism represented just one set of strategies in the toolkit available to them and which they drew on in their daily work.

2.6 The place of technology in instruction and construction

Piaget's cognitive theories had considerable influence on Seymour Papert in his pioneering work on the use of computers for learning (Papert, 1980; 1993). Papert's theories are manifested in Logo, the programming language he developed for children. Papert and the group of researchers who worked with him at the Massachusetts Institute of Technology in the 1980s hoped that constructivist technologies would enable students to be architects of their knowledge (Goldman-Segall (1998). In Papert's view (1993 p.168), computers, 'should serve children as instruments to work with, and to think with, as the means to carry out projects, the source of concepts to think new ideas'.

The assertion that information and communication technologies, the ubiquitous modern tools, can, even must, play a vital role in the education of the young, also has a basis in socio-cultural ideas of learning. Vygotsky incorporated the term 'intellectual tool' into his theories on learning, and asserts that humans use these culturally invented intellectual tools to make sense of their environment (Davis et al., 1997). Intellectual tools include language, symbols, and theories, for example; but they also can include mechanical tools such as pen and paper. These tools can empower the user. However, the tool must be learned and practised and its limits explored. In their discussion of Vygotsky's notion of intellectual tool, Davis and colleagues assert that information technology represents an adaptable intellectual tool and can support learning at different levels of abstraction (p.16-17). Jonassen (1996a p.3) similarly believes that 'students cannot work effectively at thinking without access to a set of intellectual tools to help them assemble and construct knowledge'. The computer applications that students are required to use then, he argues, should be selected on their ability to make students think in meaningful ways and to enable then to represent what they know.

Grounded in part on Vygotsky's work, Saloman and colleagues (1993) have further developed the notion that human cognitions are both culturally situated and distributed, which in turn has implications for learning. They postulate that cognition is distributed among individuals, that knowledge is socially constructed through collaborative efforts to achieve shared objectives and that information is processed between individuals and the tools and artefacts provided by the culture. Given an acceptance that knowledge is socially constructed and distributed, these researchers explore how technology might be used to extend and enhance learning. According to Salomon (1993, p. xiv), 'It becomes observable, if not patently evident, that the collaboration of individuals and computers is often characterised by superior performance that cannot easily be accounted for by individual's cognitions alone'. Pea (1993, p.81) further argues that because human cognition aspires to efficiency in distributing intelligence – across individuals, environment, external symbolic representations, tools and artefacts – a principal aim of education ought to be that of teaching for the design of distributed intelligence:

> We should reorient the educational emphasis from individual, tool-free cognition to facilitating individuals' responsive and novel uses of resources for creative and intelligent activity alone and in collaboration.

From this perspective, new technologies should not be just used as intelligent tutors or to deliver packaged software solutions. Rather, computer-mediated instruction should assist the change from instructionist to constructivist learning institutions. Salomon and Perkins state that, whereas computers in schools were originally for drill and practice, they now carry with them a whole educational philosophy of knowledge construction, symbol manipulation, design, exploration and discovery. Today they are seen as promoting restructuring of classroom learning environments, changes in teachers' ways of functioning, redefinition of curricula and new ways of assessment (Salomon & Perkins, 1998).

Strommen and Lincoln (1992) similarly believe that constructivist notions of inquiry and group collaboration offer a sound theoretical basis for learning with technology. Although tutorial and drill and practice computer applications are directed at individual learning, other findings show that social and collaborative learning are facilitated through communications and networked technologies. Roschelle et al (2000, p.80) assert that technology 'can enhance the degree to which classrooms are socially active and productive, and can expand students' understanding of the subject'.

That design and use of technologies for learning should reflect theoretical understanding is also Veneema and Gardner's (1996) assertion. They state that if the mind is neither singular nor revealed in a single language of representation, technologies, which include a variety of media, may well be able to help more students form rich representations of an event and cultivate deeper understandings. However, multimedia authoring has to have the explicit goal of greater access for more students, and include ways to assess what and how they students have learned.

If there is validity in the notion of socially and culturally situated cognition, educators cannot ignore the rapidly changing culture which the current generation of young people experience in the US and Australia. Don Tapscott (1998) has labelled this generation the 'net generation', so called not only because of the ease with which they use computers, but more importantly because of their adoption of the interactive communicative possibilities made possible by the new technologies. Adolescents increasingly use computers for email, on-line chat groups, posting thoughts and feelings on bulletin boards and inviting comment, support and advice, sharing interests, creating personal web pages which express their individuality, building friendships, exchanging homework, seeking information, downloading and sharing music files, playing games etc. Moreover, this interactivity is just as likely to be global as local. As author Jon Katz iterates 'Technology is youth culture ... these kids are building a revolution ... technology is part of their ideology, their language, everything they do' (quoted in Tell, 1999/2000 p.11). From this perspective, instances of school education which continues to rely solely on transmission modes of instruction, using traditional, old technology, tools of education and ignoring the new tools and cultural experiences of their students may become ineffectual.

A more sceptical, perhaps realistic, view of this technical determinism in relation to school use of the new technologies is offered by Bromley and Apple (1998). They argue that assumptions about the use and value of technology in education need to be examined more closely. By over-emphasising the 'tool' metaphor, the technology may come to be seen as a neutral tool whose impact depends wholly on the intent of its user. A more adequate analysis is called for:

> We need to look at the site where a technology artifact is put to use. We need to consider who is using it and why, what goal those people have and how they're likely to utilize the technology in pursuit of their goals ... we need to examine what the technology carries with it into any context. We must ask what predispositions constrain how it may be used ... we need to remain attentive to the way technologies refect and affect the surrounding social conditions (Bromley, 1998 p.4-5).

In calling for an educational theory of technology, de Castell, Bryson, & Jenson (2002) similarly state that it is important that we come to understand how education might use these new tools, by asking what, educationally, they might offer rather than taking their use for granted. They argue that an educational theory of technology:

> would investigate technology from the standpoint of educational values and purposes, and with reference to what can be discerned from a study of 'educational technology' as a socially-situated artifact. Such a theory of technology would offer material grounding to a rethinking of educational epistemology. Accordingly, an educational theory of technology would seek to articulate particular machine capabilities with specific epistemic purposes. In order to learn from our tools, we have also to take seriously the study of them, in the multiple and variable contexts of their intended and actual use

In the light of the theoretical discussion above, this study of US and Australian schools will explore both the technologies with which teachers and students teach and learn, and the social contexts in which the teaching and learning occurs. The final section of this literature review turns to the situated contexts in which teachers operate and examines the theoretical underpinnings and research relating to teachers as learners in organisational contexts.

2.7 Teachers as learners

Although constructivist theory and its offshoots have been the dominant paradigm for recent education research, most teachers would have received their formal pre-service education without the benefit of much of the new pedagogical thinking.[5] Based on relatively recent research, school educators are urged to establish student-centred learning environments in which inquiry, critical thinking, collaboration and authentic tasks and assessment are core tenets. In addition, teachers are also exhorted to integrate new information and communication technologies into their classroom practice, thereby producing students well prepared for the digital future. Teachers are expected to accommodate change to their long-established, and often personally satisfying, teaching frameworks, often without the benefit of formal training or adequate support. In environments where considerable change is expected in teachers' pedagogical practice how do teachers learn and successfully adapt their practice, and what contextual features in their organisation facilitates that learning?

In their exploration of research which describes successful work in practices like teaching, Brown and colleagues (Brown, Greeno, Lambert, Mehan, & Resnick, 1999 p.74) report that findings emphasise flexible, intelligent improvisation. Improvisational work requires integration of skills and knowledge in action and that 'the fundamental characteristic of action and thought in complex practices is that they are not isolated from one another ... practice involves knowledge in action ... Successful work integrates both planning for learning and negotiating learning in the performance of the work'. They argue that teaching in complex situations requires constant on-the-spot analysis and learning in context. The strategic knowledge – the knowing in action – must be grounded in the

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[5] The median age of Australian teachers in 1999 was 42 (Dempster, 2001); in the US in 1996 it was 44. (NCES, 1998).

practice of teaching and should be considered to be a system of actions performed intentionally and coherently.

'Learning in context' differs from the way in-service, on-going professional development of teachers has generally been supported. Exploration of a new teaching idea or learning of a new skill through attendance at an annual conference, one-off workshop or short sessions is common, and usually takes place outside of the school. Whereas aspects of social learning theory may be starting to have some impact in classrooms, this is not necessarily being transferred to provision and support for teacher learning.

Wenger's (1998) notion of 'communities of practice' offers a useful framework for understanding the ways in which teachers can learn and develop their professional practice in their school contexts. In developing his work with Jean Lave, mentioned earlier, Wenger's basic assumption is that engagement in social practice is the fundamental process by which we learn. He argues that all people belong to a range of communities of practice that are integral to our everyday lives. In organisations such as schools, these communities are the social fabric of the learning of organisations. In a community of practice members develop among themselves their own understanding of what their practice is about. The shared learning and interest of its members are what keep it together. Through a process of reification, practitioners negotiate and produce concrete representations of their practice, for example tools, documents, symbols. A community of practice has an identity as a community, which shapes the identities of its members. A community of practice exists because it produces a shared practice as members engage in a collective process of learning.

The centrality of discourse to knowledge creation is also recognised as a major component of learning (Harr & Gillett, 1994). The authors state that knowledge creation occurs in the variety of discourse forms, ranging from hallway conversations and brown-bag lunches to peer-reviewed archival journals that make up the fabric of communication within every discipline. In her study of instructionally effective schools, Little (1982) found that in most successful schools, teachers are more likely to discuss teaching and learning with one another, to critique each other's work, to collaborate on the preparation of materials, and to jointly design lessons. Little concluded that the norms of collegiality and experimentation were essential ingredients of the work culture of an effective school. Further, for teachers of a collaborative, rather than a private orientation to teaching, teaching is viewed as a process of continual, reflective inquiry and exchange of ideas with other professionals which leads to the development of a shared technical language and a shared knowledge base (Little, 1993).

The value of participation and negotiation for shared meaning within a practitioner culture is further highlighted by Darling-Hammond's (1998) work. She identifies the following features of professional development strategies that improve teaching. Such teacher learning is:

- experiential – it engages teachers in concrete tasks of teaching, assessment, and observation that illuminate the process of learning and development
- grounded in participants' questions, inquiry, and experimentation as well as profession-wide research
- collaborative, involving a sharing of knowledge among educators
- connected to and derived from teachers' work with their students, as well as to examinations of subject matter and teaching methods
- sustained and intensive, supported by modelling, coaching and problem-solving around specific problems of practice.

2.8 Learning to teach with technology

Understanding the ways in which teachers learn to use digital tools, and more specifically, how to use them in appropriate ways to support curricular goals, is necessary. Given the discussion in the previous section about principles identified for effective teacher learning, it would be expected that the ways teachers learn to teach with technology should follow a similar direction. Moursund (1992) contends, nevertheless, that current educational systems have done a miserable job empowering teachers to appropriately and effectively use computer-related technology in the classroom. Training of teachers has tended to focus on skill training, learning software, out of context from teachers' daily work.

McKenzie (2001), echoing the research on social learning, says 'informal support systems, partnerships, teams, and collaborative structures might be the most effective elements in a broad-based change effort when teachers learn to integrate technology'. Other critical elements identified to promote successful teacher learning with technology include teachers being able to see a direct link between the technology and the curriculum for which they are responsible (Byrom, 1998). Further, teachers need access to follow-up discussion and collegial activities, as required of professionals in other fields (Lockwood, 1999, cited in Rodriguez (2000); teachers also need time to discuss technology use with other teachers, whether face to face, through e-mail, or by videoconferencing (David, 1996; Yocam, 1996).

In conclusion, the theoretical perspectives on learning, and learning with technology presented here help to frame the context for the present study – the examination of the ways teachers and students teach and learn with multimedia technologies in schools in the US and Australia. Given the underlying premise that the process of learning with technology is highly context bound, in the following chapters I explore aspects of the literature which help to further contextualise the school use of educational technologies in Australia and the United States.

Chapter 3

Reviewing the Literature

This chapter presents an overview of the recent literature on school use of digital technologies in the United States and Australia, pedagogical practices teachers adopt to support and enhance student learning with these technologies and the growing consensus on conditions necessary for successful outcomes. Links to relevant theories addressed in Chapter 2, and to the questions explored in this study are made throughout. Although an essentially qualitative methodology underpins this project, findings from surveys, reports, meta-analytic studies and from long term, well-funded projects establish broad contexts and a reflective lens through which to examine pedagogical practices, and conditions likely to promote success in each of the four schools.

The review begins with comments on the complex nature of doing research in changing times, then

- provides a brief historical overview of the use of educational technology in schools
- outlines key issues of current concern about school use of new technologies
- summarises large-scale survey research in the US and Australia on school use of educational technologies
- presents findings from studies on the effectiveness of technology use for student learning
- explores the different ways in which digital tools are used to support teaching and learning
- makes links to this study.

3.1 Mining the research in changing times

The ways in which educational research is accessed and disseminated has altered in recent years with the dramatic changes brought by the information and communications revolution. Researchers and educators seeking guidance from the published literature relating to the school use of educational technologies to support student learning face a most daunting task. Previously, the vast canon of work, from nearly three decades of research was published in more or less similar scholarly journals and books in print. Access to it proceeded in a generally orderly and predictable manner, albeit with a significant time lag between research, writing, peer review and publication. The ability now to access anywhere, anytime, statistics, research studies, reports, commentary and debate, via the Internet, in databases, on the World Wide Web, on synchronous and a-synchronous discussion forums and email communications compounds the legitimate sources for discovery and examination. Searching, accessing, sifting, sorting, interpreting, analysing and evaluating the abundance of material available in digital form makes the research task a quantitatively and qualitatively different pursuit than in the past.

A much broader range and volume of readily accessible information about educational technologies is available in the public domain than ever before. Accessing the sheer number of multi-faceted Internet websites devoted to this topic alone can prove a particular challenge. For example, the websites of federal, state, local departments of education, faculties of education in universities, research institutions, schools, corporations, non-profit foundations, proponents and opponents of school use of technology, often support a bewildering array of possibly useful data. Full reports or digests of research findings can be found alongside information, commentary, advice, ideas, reports, related web links and even advertising under the one banner, further complicating the task not only for the researcher, but also for the policy maker, educator, parent and journalist - anyone with even a modicum of interest in this field of inquiry.

Researchers have wider choices in which to publish. Long established and respected print journals, are now joined by the new, designed to meet the rapidly changing needs and demands of the growing global research community and the many stakeholders interested in the field. Some of the long-established print journals are now also available on-line[6] and new on-line journals, sometimes with no subscription rates, have also been established in recent years (*Technos*, *Techknowlogia*, *First Monday*). Such publications can disseminate results of research in a timelier manner than reliance on print and post could ever do. Digests of the latest research and reactions and commentary can be delivered regularly, daily if you so choose, by email.

The diverse choices, formats, and sheer volume demand not only fortitude, but also constant and increased vigilance around the issues of accuracy, bias, validity, and reliability on the part of the reader. The thrill of the new, the ease of accessibility and speed of dissemination via the Internet, must not overtake the fundamental requirement for continuous critical evaluation. Accurate citation and retrieval of on-line publications can be problematic because of their possible temporary existence. Web sites and their contents can easily be modified, moved or removed, making rigorous examination of research distributed in these new formats difficult. Thus the nature of the research and access to it has changed considerably in recent years. Issues of selection, quality, bias, and vested interest nonetheless become even more important, albeit more complex. These issues of course are not only problematic for the researcher, but are also a concern for the educator and who seeks guidance from research, or the teacher who requires students to use the online tools for learning. All face similar challenges the moment the Internet and email are switched on.

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[6] AERA maintains a list of all e-journals in education at Electronic Journals in the Field of Education. It links to more than 125 scholarly, peer-reviewed, full text journals from around the world, available at no cost.

3.1.1 US domination of on-line research and literature on educational technology

Not only is published work on the use of instructional technologies available in greater quantity, in a more diverse range of forms and more readily accessible because of new technologies, the bulk of this on-line material is American in origin. This situation may reflect the early, and now pervasive, take-up of ICTs in the US. It may reflect fundamental US principles of freedom of information and open-source access to intellectual property. Also, the level of research funding is proportionately far higher in the US compared to Australia, and the sources of funds for research are also more diverse. Adding to the more traditional ways of production and dissemination of knowledge, in the United States, large not-for-profit education foundations are increasingly becoming generators, funders and disseminators of large-scale research. An example is the Milken Family Foundation. One aspect of their charter has been to support the use of new technologies in schools. Through an extensive network of partnerships, the foundation supports a large number of research projects and surveys, the findings of which are disseminated in print and on-line through the Milken Exchange on Education Technology and through its partnership with the respected journal *Education Week*[7]. A comprehensive website supports the work of the foundation, so its reach and possible influence, is global. Similarly, the George Lucas Education Foundation, another not-for-profit organisation, makes available considerable funds to research, and documents and disseminates best practice in the use of educational technologies in US schools through published print and audio-visual materials and through its website. The Internet allows immediate global access to these types of sources – unprecedented even five years earlier. The researcher does not necessarily even have to seek out the new material – digests of the latest material can be pushed to the desktop for immediate access.

Major multi-national technology companies such as Apple, Compaq, Hewlett-Packard, Microsoft, IBM, and Packard Bell all maintain large education websites in addition to their business sites. These education sites serve not only to promote globally the latest company hardware and software products directed at education, but also to actively disseminate research findings and stories about technological use in schools (particularly use of that company's products and services).

Thus the researcher has a new range of issues to consider. Should large-scale research and digests generated and supported and widely disseminated via multiple web links by multi-national vested interests be ignored? Is research from these sources by default less valid than unfunded, small-scale research from individuals in local research institutions and university departments and published in more traditional formats? Or is it just incumbent on the researcher to vigorously apply the standard

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[7] The two organisations have jointly produced two major reports: (*Technology counts '98. A question of effectiveness*, 1998; *Technology counts '99. Building the digital curriculum.*, 1999).

academic procedures for research and accountability when exploring issues, drawing conclusions and interpretations? For the Australian researcher and policy maker, to what extent should the wealth of American generated research be used to understand the Australian situation? While my analysis demonstrates that many of the issues and challenges facing educators in Australia and the United States are similar, there are many differences too. These differences range from system structures, education funding and accountability to differing cultural practices and expectations, all of which impact in different ways at the classroom level (see Chapters 4 and 5). A review of relevant literature for this comparative study must therefore take account of the imbalance in available research and be mindful of establishing appropriate contexts for comparative analysis.

3.1.2 Research debate in the public arena

Ready access to information allows for issues of particular concern to be debated more quickly in the public arena as well as in the education community. This is certainly true of the issue of technology provision and use in schools. Cross-over to the public arena via the more traditional means of newspapers, magazines, TV and radio occurs frequently with writers and contributors often selectively promoting the latest research that meets their point of view or political stance. Added to these means of debate, is the growth of on-line interactive feedback sites. On media websites, discussion forums and chat rooms established by academic communities, education bodies, and parent interest groups can hotly debate issues and pressure legislators and policy makers with relative ease.

In this milieu of dramatic increase in information on the topic of educational technology alone, informed decision-making, based on critical analysis and evaluation of available data, is becoming increasingly difficult. Difficult, not only for education policy makers and administrators, but also for the educators at the school level as well. They must strive to meet the considerable expectations placed on them to provide the latest hardware, software, and connectivity options in their schools, provide adequate teaching and to demonstrate improved learning outcomes for their students. Given the heavy emphasis, particularly in the US, on accountability measured by student performance on state and national standardised tests, the political and parental demands for increased technology use in schools, vigorously encouraged by the marketing clamour of the computer and telecommunication industry, it is not surprising there is an abundance of research and that the results have become a battleground. If the research question posed by these bodies is directed at discovering whether the use of educational technology improves test scores, the task is complicated further when there is considerable disagreement about the value and significance of published studies and when that debate is carried out in the public arena.

3.2 Broad patterns of technology use and failure in school education

Indentification of recurring patterns of technology use in schools with subsequent little success has dominated the work of Cuban. Much has been promised for instructional technology use in education, but little has been delivered according to Cuban (Cuban, 1986; Cuban, 1999; Cuban, 2001). He defines useful instructional technology as 'any device available to teachers for use in instructing students in a more efficient and stimulating manner than the sole use of the teacher's voice' (1986, p.4). Through an analysis of the introduction and effects of radio, film and TV into classrooms, he concludes there is a consistent pattern. When there are new technological advances, academic studies demonstrate their effectiveness compared with conventional instruction. Findings generally show these new media as being as effective as a teacher. However, soon complaints come from teachers and observers about logistics, technical imperfections, incompatibilities etc. Surveys would indicate little use by teachers. There are criticisms of administrators about the waste of resources; there are criticisms of teachers being reluctant to use learning tools shown to be academically effective. Reformers brand stability in teacher practice contributes to inertia or knee jerk conservatism. Thus, Cuban identifies an exhilaration/scientific credibility/disappointment/teacher-bashing cycle. Cuban also highlights the inherent dilemmas facing educators who must:

- socialise all children; yet nourish each child's individuality
- teach the best the past has to offer, but insure that each child possesses skills marketable in the community
- demand obedience to authority yet encourage children to think and question
- cultivate cooperation but prepare children to compete.

He argues that the pedagogy most teachers have constructed allows them to cope with these contradictions; it has worked. It has provided continuity between generations while presumably laying the foundation for individual change in children. Yet shifting public expectations for what schools should achieve leaves teachers consistently open to attack.

In examining pedagogical practices with new multimedia and communication technologies in the four schools in this study, it was of interest to explore whether this same recurring pattern would be detected. If new technologies are able to support active, engaged, student learning behaviours, and thereby move schools from instructionist to constructivist learning institutions (as canvassed in Chapter 2), what pedagogies and school policies and structures are needed, to support such a change? Are there factors and conditions which allow teachers to adopt innovative practice, successfully, despite the inherent conservatism of the profession and given that technology innovation has had such a dismal record of failure? These questions are central to the present study. It seems that much of Cuban's thesis can readily be demonstrated now about the failure to realise the potential computer technologies have in supporting school learning in both Australia and the United States. However, findings from the 1998 US-wide survey conducted by Henry Becker and colleagues at the Centre for Research on Information Technology and Organizations (CRITO) indicate that teachers' approaches to teaching and learning with technology can change, and that it is becoming clearer what conditions need to be in place to support that change. Exploration of both the CRITO findings and Cuban's contention was undertaken in the context of the four schools in this study.

3.3 Phases of computer-based technology use in school

Penetration of new technologies into school systems, schools and classrooms lags long behind the innovation, development, research, trialling and dissemination of findings about their possibilities. Three broad phases of research and development in the use of computer-based technologies in schools can be identified:

1. Early 1970s – 1980: computer-aided instruction-using drill and practice programs based on behaviourist notions of reinforcement and of stimulus response associations (Jonassen, 1996b; Valdez et al., 2000).
2. 1980 – mid 1990s: introduction of word processing applications and the early exploration of multimedia technologies (Valdez, 2000).
3. Mid 1990s – present: rise of Internet, World Wide Web and communication tools

Different pedagogical issues, different forms of research and evaluation, with different methodological issues tend to characterise each phase.

3.3.1 The beginnings: the late 1960s to early 1980s

During the 1970s and 1980s computer technologies - typically text-based, locally networked or stand alone computer-assisted applications (McMillan Culp, Hawkins, & Honey, 1999) - were gradually introduced into elementary and secondary schools, and tertiary institutions. Early research sought to demonstrate the impact of technologies or software on student learning. Kulik and Kulik's 1994 meta-analysis of more than 500 individual studies of computer-based instructions in the '70s and '80s period drew several positive conclusions: students on average scored higher on achievement tests than those in control conditions without computers; students learn more in less time when they receive computer-based instruction; students like their classes more and develop more positive attitudes (Kulik, 1994). Despite the many problems aligned with trying to draw a direct positive link to use of computers and learning, the need to achieve this link is still of major concern for some and will be discussed further in Section 3.7 below. This same period also marked the beginning of the use of interactive technologies in a constructivist way as seen in the work of Seymour Papert and the MIT Learning Laboratory (Papert, 1993).

Although studies from this first stage did show positive outcomes in situations where the use of computers was closely related to subject matter, they contributed little to understanding of learning with computers in a social context. As McMillan Culp et al (1999) highlight, in order to answer the question: Does technology improve student learning? researchers had to eliminate for consideration everything other than the computer itself and the evidence of student learning. Teacher practices, student experiences, pedagogical contexts were bracketed out so teachers could make powerful, definitive statements about effects – statements unqualified by the complicated details of schooling (McMillan Culp, 1999). Clearly, the complex nature of classroom life makes this almost impossible.

3.3.2 Second wave educational technologies

The late 1980s and throughout the 1990s saw 'the combination of computation, connectivity, visual and multimedia capacities, miniaturization, and speed' in the development of computer hardware and applications (Honey, McMillan, & Carrigg, 1999). Technological changes and the introduction of the new convergent technologies into educational settings dramatically accelerated during this time. Both the large-scale, mainly US-based Apple Classrooms of Tomorrow (ACOT) project, and the Navigator School project established in some schools in Victoria, Australia, highlighted new understandings about the use of these second wave educational computer technologies in schools. At the same time, each project also raised methodological issues about doing quality research in classrooms where new technologies are used, especially when used to support a more constructivist mode of teaching and learning. These projects and related issues are examined in more detail below (see 3.8).

3.3.3 Spread of the Internet and networked communication tools

Since the mid 1990s the World Wide Web has become one of the most frequently used computer technologies in schools (Meredyth, Russell, Blackwood, Thomas, & Wise, 1999). Teachers have adopted this technology and the use of email at far higher rates compared with their take up of other instructional technologies. Access to vast amounts of rich multimedia and interactive resources which can be directly used for teaching and learning, the speed of access and ability to communicate easily both locally and globally are some of the reasons cited for this. The call for new forms of research to assist in evaluating how and under what conditions these new technologies can support learning in the latest digital environments, mirrors that of the second wave identified above, and there is an increasing urgency for this due to the rapid spread of their use.

3.4 The computer technologies teachers and students use

Three US-wide survey studies and one Australia-wide survey undertaken during 1998 and 2000 (the same period during which research data were collected for this study) help to provide a contextual backdrop for the present study. The survey studies establish which educational technologies are used in schools in each country. The studies explore the provision of educational technology in schools, the type of software applications teachers and students use, the skill level of teachers and students, the frequency of technology use, the training and support teachers' receive, and barriers to take-up of technology in classrooms. The survey reports discussed here suggest broad patterns only. Moreover, different sample sizes, methodologies and questions asked in each, obviate a detailed comparative analysis. Nevertheless, some useful conclusions about school computer usage in each country can be drawn. It must be remembered too that these studies are snapshots in time. Given the pace of technological change, the situation may now have changed.

Although the US and Australian survey reports do not explain how teachers actually use the technology in their curricula, or how students make use of the opportunities in pursuit of learning, the patterns and issues raised can act as a lens through which to interpret what is happening at the micro level in individual schools. Close observation of teaching and learning experiences of teachers and students as they use technology in each of the schools (the domain of the qualitative researcher) may or may not reflect the broader patterns and issues revealed in the large-scale surveys. On the other hand, should the individual school experiences reflect national trends, specific, contextualised data may be useful in gaining a deeper understanding of the issues. The question might then be asked what makes their experiences the same or different compared to the broader sample.

In using this extensive survey data to establish a comparative framework for the present study, I summarise the information, amalgamate data into tables, and use graphs (with due attribution) where appropriate.

3.4.1 RealTime: Computers, change and schooling, 1998 - an Australian survey

The first national sample study of the information technology skills of Australian school students was carried out in May 1998. As it is the only Australian survey of its type, it bears some close examination and provides a useful comparison with US survey data, although the questions and samples differ. The RealTime survey (Meredyth et al, 1999) comprised 6213 students, 1258 teachers and 22 principals from 143 government schools, 38 catholic schools and 22 independent schools. The samples were drawn from grades 6 and 7 (the final year of elementary school) and grade 10 (the final year of junior high school). Limited space here does not allow for detailed consideration of the disaggregated findings, however, the report reveals considerable differences across the Australian states and territories and in the different school systems. The RealTime study differs from the US surveys in that students as well as teachers completed the questionnaires.

Findings relevant to this dissertation indicate that at the time of the study:

- 71 per cent of the schools have a student-to-computer ratio of 15:1, with 40 per cent having 10 or fewer students per computer.
- 31 per cent of secondary schools' computers are found in general use classrooms; 37 per cent are in labs, 16 per cent of computers in schools are laptops, 8 per cent are found in libraries
- very few schools have multimedia creation applications
- on average 34 per cent of students spend more than one hour per week on computers; 44 per cent spend less than 40 mins per week
- ICTs were most used in the subjects Studies of Society and Environment, English, and Technology and Enterprise
- students enjoy using computers at school

Skill level of students and teachers

- students express high levels of confidence in their own computer skills, especially in comparison with teachers
- 97 per cent students have more than half of the basic information technology skills. Nearly 67 per cent have all of them. The majority of students who have the basic skills developed them at home. Basic information technology skills were identified as the ability to:
    - use a mouse
    - turn on a computer
    - use a keyboard
    - shut down and turnoff, exit/quit a programme
    - delete files
    - get data from a floppy disk or CDROM
    - save a document
    - print a document
    - start a programme
    - open a saved document
    - create a new document
    - move files
- students' basic skills match those of their teachers
- more than half the students have a sound range of advanced technology skills. On eight of the thirteen advanced skills, students are more likely than their teachers to have that skill (see Table 1).

Table 1 compares the advanced computer skills self-identified by students and teachers. This table is compiled from Tables 5.9 and 6.2 in *Computers, change and schooling* (Meredyth, 1999).

Table 1

Advanced computer skills of students and teachers - Australia

	Students %	Teachers %
Play computer games	94	80
Draw using the mouse	93	77
Creative writing, letters etc	92	85
Use spreadsheets or databases	68	75
Use the World Wide Web	65	71
Search the Web using key words	58	76
Create music or sound using computer	58	26
Send an email message	53	65
Copy games from CD-ROM or Web	53	41
Create a programme e.g. in logo, Pascal	52	45
Use virus detection software	50	52
Create multimedia presentations	48	12
Make a web site/home page	38	24

Students indicate they are more likely to have learned nine of the 13 advanced skills at home. In terms of multimedia creation skills (of particular interest for this study) student skills in use of music and sound, multimedia presentation and web site creation surpasses that of teachers.

Domains of educational information technology activity

In addition to skill level, the Real Time study details what teachers and students use technology for. The RealTime survey categorises these activities into 'four domains of educational activity':

- Creative uses, which include any use across the curriculum for writing stories, poems, scripts, creating pictures, graphics, slide shows or animation and making music or sound
- Informational uses, which include research activities (getting information from a CD-ROM, from the Internet/World Wide Web and/or using computerised library catalogues) and mathematics/science/social science applications (creating graphs or diagrams, and using spreadsheets or databases to store information)
- Communication uses, which include sending or receiving email, taking part in email discussion, Internet relay chat, video-conferencing and communicating with other schools
- Educational programmes and games which include skill-building applications such as learning

(Meredyth, 1999, p.110)

The following table constructed using Tables 5.20, 5.21, 5.22, 5.23, 5.24 and 6.3 (Meredyth, 1999) shows how teachers and students indicate they use ICT at school in the domains of technology activity.

Table 2

Domains of educational activity of teachers and students - Australia

	Students %	Teachers %
Informational uses	62	70
Get information from CD-ROM	66	70
Get information from Internet/Web	43	57
Use computerised library catalogue	56	53
Create graphs or diagrams	41	43
Use spreadsheets and databases	47	37
No response	5	11
Creative uses	56	50
Create own pictures	86	41
Creative writing	85	51
Make music or sound	24	9
No response	4	32
Communication uses of IT	12	10
Send and receive personal email	16	15
Communicate with schools in other countries	11	17
Take part in an email discussion	7	5
Take part in an Internet Relay Chat	7	2
Educational programmes and games	45	43
Use an educational programme or game to help them learn	72	61
Record their level or score when using programmes and games	41	27
No response	20	34

Although these domains of educational activity provide a helpful structure for consideration of the use of computer technologies by Australian students and teachers, the categorisation used here, imposed on the survey response data by the research team, is also a constraint. Overall the survey indicates that informational uses comprise the dominant use for teachers; creative writing and creation of pictures the dominant use for students It could be argued, however, that a clearer understanding of how technology is used by teachers and students might emerge if some of the individual items that form the domains were worded differently. That word processing seems only to have a place in 'Creative Uses' is a limitation. As McCrae (2001) argues when discussing the same RealTime survey data, word processing is not of itself a creative process It would be more helpful to establish the extent, and for what purposes students used word processing (for example. taking notes, writing reports, essay writing, presentation of research findings in words and graphical form). Such tasks may or may not be creative. The data as it stands may give a distorted view of actual use of word processing.

US surveys considered in Section 3.4.2 isolate word processing from creative applications in their search to understand the type and extent of computer use in schools. The US surveys show that word processing applications are high on any list of most used, whereas creative uses are not so prevalent. This distinction is an important one. Are Australian students using word processing applications more creatively than for just routine learning tasks? Or, are they using these applications to explore different and engaging ways of learning - the hope of protagonists for the embedding of technology in schools? McCrae (2001) concludes (from the RealTime survey and other personal research in Australia) that 'by far the most common use of ICTs is for word processing' followed by Internet and email use.

Availability of hardware and software for teachers

A high proportion of Australian teachers (82 per cent) indicate that schools provide them with access to computer hardware and software for teaching and learning purposes, for administrative purposes (80 per cent) and personal use at work (82 per cent). A much lower proportion indicated that their school provides them with software and/or hardware for personal use at home (42 per cent). Given the constant demands on most teachers throughout the school day, it would also be interesting to know how frequently the computers are used for each function.

Technology support services

Most teachers do not accept that 'the availability of maintenance and technical support is adequate to support teaching and learning'. Support services include availability of lending, in-school technician, software installation services, timely repair, on-line technical support via email and a help desk support hotline. Support personnel in a school are mainly limited to a teacher coordinator and 84 per cent of schools provide this. However only 20 per cent of schools have full-time network managers, 45 per cent have part-time managers, 12 per cent have full-time technicians and 23 per cent have part-time technicians. If the degree of support is contingent on successful, school-wide integration of ICTs into the school curriculum, these figures are of concern.

Teacher professional development

Eighty-eight per cent of teachers agreed with the statement that 'it is essential for all teachers to be technologically literate'. By contrast, only 34 per cent agreed that the availability of training is adequate to their needs. However, most teachers had undergone some form of professional development in information technology in the previous two years. Most training provided by schools is for teachers' use of the commonly used applications: word processing, CD-ROM applications, the World Wide Web, classroom/curriculum software, library reference material, email and spreadsheets. Professional development is commonly held after teaching hours on school days. Ninety-one per cent of teachers indicate they would like further professional development or re-skilling in educational applications of computer technology. Only 25 per cent of teachers consider themselves able to keep abreast of new programmes and educational applications

The findings from the 1998 RealTime Australian survey indicate that computer hardware and software applications are to be found widely in Australian schools, that both students and teachers have a good grasp of basic technical skills, and the skills needed to use the most common applications. Nevertheless, only a small proportion of students and teachers use technology on a regular basis for curriculum use and these uses are limited. The findings indicate that educational technologies are not embedded in a consistent cohesive way across school curricula. The extent to which the technologies are used creatively for construction and representation of knowledge, is somewhat unclear, and as will be seen with the US studies below, student use and frequency is dependent on an advantageous student computer ratio.

The following section provides key findings from similar survey and reports in the US.

3.4.2 Teachers and technology: 1998-1999 US surveys and reports

Three US surveys canvassing similar information to those in the Australian study are examined here. All of the data come from teacher or school administrators, but unlike the Australian study, students' views were not sought in any of the surveys.

1. *Teaching, Learning and Computing* This US-wide study undertaken in 1998 under the auspices of CRITO (Centre for Research on Information and Technology on Organizations) by Becker and colleagues, examines teachers' use of computer technology, their pedagogies, and their school contexts. Findings are based on responses from 4,100 teachers, 800 technology coordinators, 859 principals in 1,150 schools. This study produced a large number of reports commencing in 1999 all of which are published on the CRITO website. Here they will commonly be referred to as the Becker (1999) studies.

2. *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology* (Smerdon et al., 2000). This report commissioned by the National Center for Educational Statistics (NCES) incorporates multiple data sources to describe the availability and teachers' use of

educational technology in their classrooms and schools, their training and preparation for its use and the barriers to technology use they encounter. This report will be referred to here as NCES (2000).

3. *Technology Counts 99: Building the Digital Curriculum* – a nationwide survey, sponsored by the Milken Exchange on Technology and the journal *Education Week*. Findings are based on a sample of 1,407 teachers.

The following section synthesises findings relevant to this study from each of the reports. Not only are the findings from these US studies remarkably similar to each other, they also mirror to a large extent (apart from computer:student ratio) the data from Australia reported above.

Technology availability and use by teachers

- Eighty-four per cent of US public school teachers have at least one computer in their classrooms; 36 per cent, one computer; 38 per cent have two to five; and 10 per cent have more than five computers in their classrooms. Many of these have Internet connections (NCES, 2000). The typical school had a computer student ratio 1:6 (Becker, 1999). Eighty-two per cent of teachers reported having a computer at home; 63 per cent had the Internet (NCES, 2000).

- More than 90 per cent of American teachers use computers for professional activities (Becker, 1999; *Technology Counts 99*, NCES, 2000). The most common of these professional activities include making handouts, keeping a record of student grades, and writing lesson plans or notes.

- Despite almost universal use by teachers for some of their professional work, these high levels of personal use are not yet reflected in their teaching practice. While the majority (71 per cent) assign computer work to students at least occasionally, the 'typical' teacher provides students with fewer than ten opportunities to use computers during a school year and only 27 per cent do so frequently (Becker, 1999). The Becker study defines 'frequent basis' as a typical student using computers in class 20 or more times in the course of a 30 week period (i.e. roughly weekly use).

- Becker's study also indicates that despite widespread availability and connectivity to the Internet in classrooms, teacher-directed student use of the World Wide Web on a regular basis is relatively low: 13 per cent used it in more than 10 lessons; 16 per cent used it in 3-

9 lessons; 11 per cent 1-2 lessons; 60 per cent no use at all (Becker 1999). Regular use is highly dependent on access.

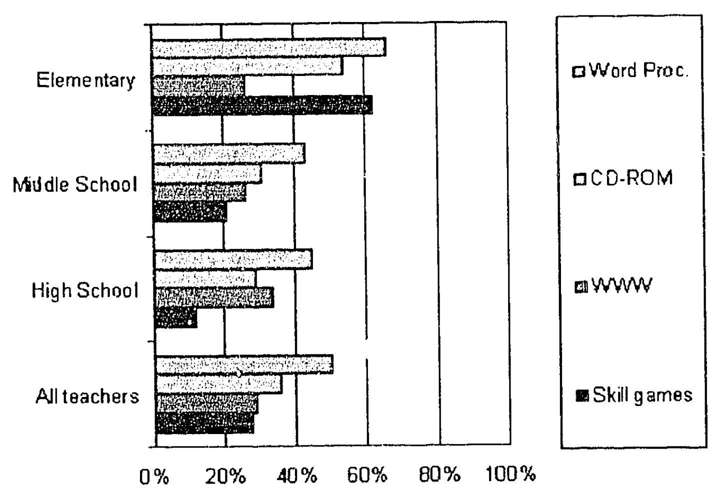
- In contrast to their directed use for students, 68 per cent of teachers used the Internet to find information resources for use in lessons with 28 per cent reporting doing this on a weekly basis (Becker 1999). The *Technology Counts 99* survey found that 61 per cent of teachers reported using the Internet and 53 per cent used specifically designed software for k-12 instruction, but unlike the Becker survey, no indication of frequency of use is given.

In summary, computer technologies are more prevalent in US schools compared to Australia; teachers in both countries use technology for administrative and lesson planning purposes; but use by teachers for instruction is at similar low levels. That teachers seem to use the Internet and other applications for their personal professional use, but not so much for classroom teaching purposes might well be associated with the many barriers to technology take-up teachers cite.

Type of software used by students

Both the Becker *Teaching, Learning and Computing* study and the NCES surveys indicate that word processing comprises the most widely used software in school closely followed by informational uses afforded by the Internet and CD-ROMs. Figure 1 below (Figure 7 in *Teaching, Learning and Computing*, 1999) shows the types of software applications the teachers who do use computers require their students to use. Interestingly, the study indicates greater use of computer applications in the elementary school compared with the other levels of schooling.

Figure 1
Student use of software – US



The NCES report *Teachers' Tools for the 21st Century* presents in more detail the type of learning activities teachers' require students to do with digital tools The following table represents the data in Figure 2.6 of the NCES, 2000 report.

Table 3

Student learning activities with computers – US, 1999

	%
Word processing and spreadsheets	61
Internet research	51
Solve problems/analyze data	50
Drills	50
CD ROM research	48
Multimedia projects	45
Graphical presentations of materials	43
Demonstrations/simulations	39
Correspond with others	23

Thus, the US studies indicate that in-school use of computers follows a consistent pattern. Furthermore, when compared with a similar Australian survey (see 3.4.1), the same patterns of computer use by teachers and students are also to be found.

Access to computers

Regular use of computers with students is highly dependent on access to computers according to each of the US surveys. Teachers are more likely to use the technologies when computers were available in their classrooms as opposed to computer labs and where they are available in greater numbers (NCES, 1999).

Similarly, *Technology Counts 99* shows that 67 per cent of teachers in classrooms with six or more instructional computers use digital content to a very great or moderate extent, compared with 40 per cent of teachers whose classrooms have only one or two instructional computers (*Technology Counts* 1999).

With one classroom computer, teachers may use the technology to prepare for lessons or for demonstrative purposes during classroom instruction, however it may be difficult to have students use computers under these conditions. Interestingly, all teachers who had computers in their classrooms reported that students used computers elsewhere in the school more often than teachers with no classroom computers (NCES, 1999).

Teacher preparation for computer use

Only one-third of teachers feel well-prepared or very well prepared to use computers and the Internet for classroom instruction (NCES, 1999). Training on integrating technology into the curriculum has a greater impact on teachers than basic technology skills (*Technology Counts* 99). However, all three studies show that, on average, teachers receive less curriculum integration than basic skills training.

In the NCES study, teachers cited independent learning most frequently as preparing them for technology use (93 per cent), followed by professional development activities (88 per cent) and by their colleagues (87 per cent). The high level of attribution to colleagues for technology preparation begs the question as to how and under what circumstances this occurs in the school setting. The Becker study shows, moreover, that frequent informal contact with other teachers at their school correlates with higher levels of teacher computer use. Becker states that these teachers talk more frequently with other teachers at their school about how to teach a particular concept to a class, or ideas for group projects, or even about personal matters, and they are more likely to have other teachers observe their own teaching. These finding are particularly interesting in the light of the theoretical discussion about how teachers learn to teach with technology (see 2.8).

Findings from each of the surveys indicate that there is some shift in teachers' pedagogical practices as they incorporate new software applications into their teaching programs. But it is clear that widespread, regular use across all curricula areas, at all grade levels and indeed throughout individual schools is inconsistent and by no means extensive. There is a common and considerable range of reasons given as to why teachers do not, or find it difficult, to incorporate technology into their teaching and learning programs, despite the advantages being touted for its use and the pressures on them to do so.

3.5 Barriers to teacher take-up of technology for instruction

Each of the three US surveys refer to teachers' reasons for not using technology in their instructional programs. In summary:

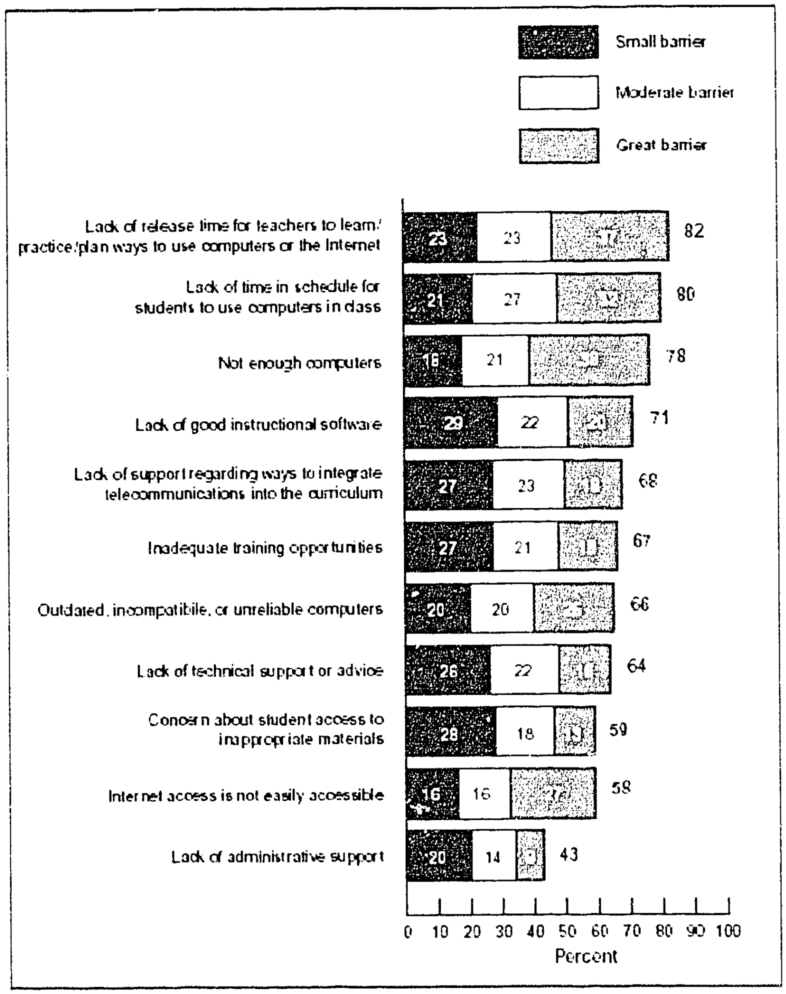
- Seventy-five per cent of teachers cite lack of classroom computers for not using software for instruction (*Technology Counts* 99).
- Sixty-nine per cent of teachers cite lack of net-connected classroom computers for not using the Internet for instruction (*Technology Counts* 99). Becker's study shows that by far

the most important variable in predicting teachers' Internet use is the teacher's level of classroom connectivity (Becker 99).

- Forty-eight per cent of teachers who use the Web to look for instructional materials say it is somewhat or very difficult to find sites to meet their specific classroom needs (*Technology Counts 99*). Similarly the Becker survey finds that five in 10 teachers who use the Web say it was 'somewhat' or 'very difficult' to find educational Web sites (Becker 99).
- Fifty-nine per cent of teachers who use software for instructional materials say it is somewhat or very difficult to find software to meet their specific classroom needs (Technology Counts 99). Teachers in Becker's study found seven in 10 high school teachers who search for software said it was 'somewhat' or 'very' difficult to find products suited to their classroom needs (Becker 99).
- Fifty-four per cent of teachers who use software for instruction say amount of class time necessary is a big or moderate problem in using software and 49 per cent say this about 'amount of preparation time' (Technology Counts 99).
- Inadequate training, especially in how to integrate technology into curriculum, is cited as a problem by more than 50 per cent of teachers in both *Technology Counts 99and* the NCES study.

Figure 2 below (Figure 6.1 in the NCES, 1999 report) indicates both the type and extent of barriers to teachers' use of computers and the Internet.

Figure 2
Barriers to teachers' use of technology – US



These findings on barriers to take-up of technology for classroom instruction are remarkably similar across the studies, and they reflect similar findings from Australia reported both in the RealTime Survey (see 3.4.1) and in a contemporary Victorian Government report *Rethinking Teaching and Learning* (1998).

Moreover, these barriers appear to have changed little from previously reported constraints to teacher use (Dwyer, Ringstaff, & Sandholz, 1990; Zammit, 1992). From the Apple Classrooms of Tomorrow studies Dwyer and colleagues (1990) identified the main barriers to teachers developing improved classroom practice with information technology as:

- teachers' lack of access to appropriate technologies (hardware, software, and connectivity) due to costs, rapid rate of obsolescence, and location decisions

- teachers' lack of time to experiment with technologies and plan lessons using new methods that incorporate technology
- teachers' lack of knowledge or understanding of best curricular uses of technology (what software to use, how to integrate it into the curriculum, and how to organize classroom activities), owing to insufficient training, support and models of best practice
- teachers' lack of knowledge and support for resolving technical and logistical problems in the classroom.

On the basis of the studies cited above, Cuban's contentions are supported and are also reflected in Darling-Hammond and McLaughlin's (1995 p.194) comments:

> It is now clear that most schools and teachers cannot produce the kind of learning demanded by the new reforms, not because they do not want to, but because they do not know how, and the systems they work in do not support their efforts to do so.

3.6 Factors necessary for high-quality frequent teacher use of computers

Becker and colleagues conclude that despite the overall low use of computers in general academic classes, it is possible to identify factors which point to conditions necessary for frequent, high-quality use of computers in becoming a normal part of most teachers' instructional practices. Through a detailed analysis of a range of factors from the *Teaching, Learning and Computing Survey* they conclude that a clear majority of US teachers are regular users of computers in their academic classes where teachers:

- have reasonable technical expertise in using computers
- have clusters of five to eight computers in their own classrooms which enable everyday use by small groups of students or individuals taking turns, and
- believe more strongly in constructivist-oriented pedagogies such as developing student responsibility for selecting and carrying out learning tasks, emphasising group work involving discourse and the use of projects, products and performances for outside audiences. One of the strongest and most widespread findings of the study is that 'teachers who avoid computers are also the ones who seem to be most "traditional" in their teaching philosophy; teachers who believe that their role is to transmit to students an externally mandated curriculum by means of a highly controlled pedagogy' (Becker, 2001 p. 9).

The Becker study indicates also that teachers who are most broadly engaged with their teacher peers in collaborative and leadership roles, substantive conversation and classroom observation are much more likely than the average teacher to have their students use all kinds of software (word processing, researching on the Internet, presentation software, multimedia authoring software, and electronic mail) and were more likely to be active users of computers themselves. Interestingly, the matter of time (to learn and use computers in class), so important in the other two studies, does not emerge as a significant issue in the Becker study.

The following section turns to the research and debate relating to student achievement and educational technologies. Meta-analyses and reviews of literature are used to assist with the volume of material. And, like the survey studies in the previous sections, the effectiveness studies are used here to provide another lens through which to understand pedagogical practice with educational technologies, the focus of the present qualitative study.

3.7 Effectiveness of technology use for student learning

Countless studies are available which explore whether, and to what extent, the use of computer technologies contribute to improved student learning. This is not one of those studies. Nevertheless, the pattern of findings and the issues effectiveness studies raise are important in the context of this study. As canvassed earlier (see 1.2), the public debate about value for the technology dollar and the pressure (particularly in the US) for improved scores on standardised tests is the milieu in which teachers must operate. A brief outline of the current understanding of technology effectiveness is in order then, together with a discussion of some concomitant methodological issues inherent with this type of research.

Consistent findings about the positive contribution of technology to improved learning are not yet established (Roschelle et al., 2000). Nevertheless, both Roschelle and colleagues and other supporters of a pro-technology stance consistently refer to the same studies which do show a positive impact. These studies often are published in both print and digital form and made available on World Wide Web sites, thereby guaranteeing a wide readership among those with an interest in the topic. John Schacter's review of research: *The impact of education technology on student achievement: what the most current research has to say* (Schacter, 1999b) is one such case.[8] He draws on seven key studies to support his conclusion that students, with access to:

- computer assisted instruction, or
- integrated learning systems technology, or
- simulations and software that teach higher order thinking, or
- collaborative networked technologies, or
- design and programming technologies

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[8] In 1999, Schacter's paper was published both in an academic print journal under a different name (Schacter, 1999a) and made available on the World Wide Web by the Milken Exchange on Educational Technology (Schacter, 1999b).

show positive gains in achievement or researcher-constructed tests, standardised tests, and national tests.

The seven groups of studies Schacter refers to are:

a) the early meta-analysis study by Kulik and Kulik (1987)
b) Jay Sivin-Kachala's (1998) *Report on the effectiveness of technology on schools*, 1990-1997
c) the Apple Classrooms of Tomorrow (ACOT) studies (Baker, Herman, & Gearhart, 1994)[9]
d) The study of West Virginia's Basic Skills/Computer Education (BS/CE) Program by Dale Mann and colleagues (Mann, Shakeshaft, Becker, & Kottkanp, 1999).
e) Henry Wenglinsky's (1998) *National Study of Technology's Impact on Mathematics Achievement*
f) the Computer-Supported Intentional Learning Environment (CSILE) studies by Scardamalia and Bereiter (1996)
g) the 1980s research findings from the Learning and Epistemology Group at Massachusetts Institute of Technology led by Papert and colleagues

Key studies included by Schacter in his review are also used by others to support a positive view for the use of technology in schools. Drawing on many of the same studies as Schacter, similar conclusions were endorsed by the Technology Forum held at the Association for the Advancement of International Education, Houston, Texas on February 25, 1999. Advocates for technology (referring to many of the same studies) were of the firm belief that educational technology has demonstrated a significant positive effect on achievement within all major subject areas, in K-16, with both regular students and special needs students.

Similarly, the US National Middle School Association in their 2000 research review: '*What impact does the use of technology have on middle level education, specifically student achievement?*' (NMSA, 2000) drawing on some of the same studies, supports the view that positive cognitive outcomes through the use of technologies can be demonstrated.

The US CEO Forum on Education and Technology, in its fourth, and final School Technology and Readiness (StaR) report (June 2001) unequivocally states that technology can help improve student achievement on standardised tests. In support of their claim, the authors also cite the 10-year longitudinal research results in West Virginia by Dale Mann and colleagues (Mann, 1999) on the

[9] Schacter includes the ACOT studies as showing some positive learning effects, but also notes they have had no conclusive effect on test scores

relationship of the Basic Skills/Computer Education Technology implementation in schools to improved student achievement. The state-wide BS/CE program commenced in 1991-1992 and the evaluators show across the board increases in all basic skill areas, with all students' test scores rising on the Stanford 9 test indicating that 11 per cent of the gains directly correlate with the Basic Skills/Computer Education Technology implementation in West Virginia schools.

The CEO Forum's StAR report also refers to *Does it Compute* by Wenglinsky (1998) which shows that when computers were used to apply higher-order thinking concepts in math, and when teachers received sufficient professional development on computers, eighth graders gained a one-third grade level increase. They conclude that, 'When deployed appropriately, technology can change the way students think and learn, and thus, revolutionize education' (*School technology and readiness report (STAR). The power of digital learning: integrating digital content.*, 2000).

Thus there is a consistency in the studies used to support the notion that educational technologies do contribute to enhanced learning. Not surprisingly, however, there is no comparable group of individuals or organisations which invest the time and money in seeking out and disseminating contrary views in the ways and to the extent which the proponents do. Nevertheless, some studies have been made. Fleming and Raptis (2000) in discussing their *Topographical Analysis of Educational Technology Research 1990-1999* state that what is actually known (in empirical terms) about the effects of educational technology on the cognitive development of students is remarkably small. But there are plenty of assertions based on philosophical or ideological suppositions, or anecdotal evidence, that there are positive effects. Kirkpatrick and Cuban (1998) in *Computers Make Kids Smarter, Right?* sort a large number of studies into 'positive' and 'negative' effects. They conclude that there is some evidence that technology can improve learning, but that an overall lack of agreement about the goals of education, has contributed to a lack of focus and inconclusive results. As with Fleming and Raptis (2000), Kirkpatrick and Cuban (1998) raise methodological issues inherent in the range of studies: small samples, lack of control groups, small effect sizes (i.e. outcomes statistically significant but limited practical application), short duration of studies, no control for teacher effects, lack of details on environment (effects of teacher training and experience, classroom school culture), inappropriate achievement tests which fail to measure accurately what the computers taught, represent some of the issues of concern Due to the inconclusiveness of the effectiveness studies, new approaches are being called for (see 3.9).

3.8 Research in 'lighthouse' schools.

Much of the research which shows some advances in student learning with technologies occurs in targeted or 'lighthouse' schools and projects both in the Australia and the US. These projects often receive considerable resourcing from governments, foundations, corporations or university research institutions to explore aspects of technology use in schools. Studies, where significant resources are employed and implemented by partnerships of schools, educational institutions and sometimes business entities, can be useful in shedding light on what is possible. Where such school-based research is supported through extensive funding, hardware and software, support personnel, researchers and report writers, and the findings widely disseminated through diverse formats, there might be expectations that it is possible to achieve similar outcomes in all schools. However, as major survey studies in both the US and Australia show some of the innovative technologies and pedagogical approaches commenced, explored and embedded in these leading schools as much as a decade or more ago are only now just starting to be accepted and incorporated in varying degrees across schools. Some would argue that it is just not possible to achieve similar results without that intensive support. Even embedding the use of new technologies equitably across one school so that all students can benefit, can be a challenge. The constraints to uptake are many and varied. Some of these relate to the nature of the technologies themselves, school structures, policies and practices, and the beliefs teachers hold about their teaching practice. The identified constraints also resonate with Cuban's assessment of why technology use has been problematic in schools. Two such studies from the US and Australia are examined here.

3.8.1 The ACOT project

The thirteen-year Apple Classrooms of Tomorrow (ACOT) Project which began in 1985 supported and examined through an evolving research agenda outcomes for students and teachers as they used new computer technologies (computers, videodisc players, video cameras, scanners, CD-ROM drives, modems, and on-line communications services). The ACOT studies are of major importance. Important not only for the depth and breadth of the project, and the fact that such a large scale project was undertaken by a corporation in conjunction with funding from National Science Foundation, but also for developing new understandings about teacher and student use of technological tools for learning, underpinned by constructivist theory and pedagogy. Furthermore, the project highlighted the need for new and more encompassing research paradigms if the potential of technology to enhance learning was to be realised. The book *Education and Technology: Reflections on Computing in Classrooms* (Fisher, Dwyer, & Yocam, 1996), contains reflections on the first decade of the ACOT project with contributions from participating teachers, from Apple Computer researchers and from partnering educational institutions. Some of the issues examined or highlighted during the project relate to student learning outcomes, classroom pedagogical practices, teachers' beliefs, teacher professional development and other support needs of teachers, the complexity of educational change and reform through adoption of technology, partnerships between educational bodies, businesses and the research community, as well as methodological issues associated with the nature and implementation of the research program which were integral to the project.

Methodological issues

Despite the vested interest of Apple Computers and other stakeholders in having favorable, empirically sound research findings on improved student learning on traditional measures, researchers involved refer to fruitless efforts to show this (Baker et al., 1994; Baker, Herman, & Gearhart, 1996). Disappointingly for some of the stakeholders, little concrete evidence was found to support the notion that new technologies are a significant factor in improved student learning as measured on standardised tests.

However, importantly, the project did point to ways in which new technologies could assist classroom learning to become more student-centred, constructivist and collaborative. In addition, light was shed on the complexity of educational reform based on the use of computer technologies, and the need for and importance of reconceptualising professional development of teachers if sustained and lasting reform is to occur.

The project also highlighted the complex and problematic nature of doing multi-site, school-based research with the expectation of valid, reliable and replicable results. Researchers found it difficult to implement controlled studies due to the 'messy' nature of classroom learning, especially in those settings where computers were used. Randomised assignment of students to control and experimental groups was not possible; common treatments did not exist because of differences within schools and across sites. Other problems related to the large scale of the project and the difficulty of controlling the plethora of variables operating in the different contexts.

Use of multimedia technologies

Despite disappointing positive effect findings on standardised test scores, the ACOT studies do show consistent findings about the use of multimedia on aspects of classroom learning, some of which are not normally measured. Outcomes for students included more use of higher order thinking skills, high levels of engagement in on-task activities, more positive attitudes to learning, more use of project-based, thematic, problem-solving and research based learning activities. Other trends included shifts 'from a competitive to a cooperative social structure,' 'from all students learning the same things to different students learning different things', and 'from the primacy of verbal thinking to the integration of visual and verbal thinking' (Collins, 1996).

Tierney's (1996) report of work in the ACOT project showed students tend to produce longer, more complicated text compositions and revise their work more often, engage in larger and more cognitively complex tasks and use higher order thinking skills. He argues that learning technologies can contribute to a changed approach to learning and a sustained productive engagement in learning by:

- providing composition environments (writing, drawing, painting, music, architecture, video, animation) which allow learners to design, compose, manipulate, revise and exchange ideas; where students are composing, cognitive engagement is focused and intense; often centred around a product
- enabling the creation, manipulation, transportation, storage and publication of artefacts of learning activities
- using collaborative tasks for elaborating and deepening learning.

The role of the teacher

The ACOT studies also illuminate several significant aspects about the role of teachers in new and innovative technological learning environments. Teachers are central to the process. Given broad administrative support, they are the key to creating student centred learning environments. The project demonstrated that teachers became guides and mentors rather than instructors, they rethought basic beliefs about education, began to redefine teaching and learning and showed increased use of interdisciplinary studies, team teaching and accommodation of different learning styles. According to Dwyer (1996 p.25) 'The ACOT classrooms have become a model for interdisciplinary studies, team teaching and addressing individual learning styles'. The ACOT experience showed that reflective teacher conversation was essential if teachers were to change their practice (Yocam, 1996).

Professional development of teachers

Another significant contribution of the ACOT project has been to highlight the need for and importance of reconceptualising the professional development of teachers if sustained and lasting reform is to occur. The ACOT model of week-long practicums in 'lighthouse' schools and extended Summer Institutes, each grounded in constructivism and hands-on learning, with time for reflection and discussion, sharing of beliefs about teaching and learning with a commitment in turn to share understandings in their schools and institutions has been widely adopted in the US. For example the Challenge 2000 Multimedia Project sponsored by Joint Venture Silicon Valley used this same model of professional development in its large-scale project.

Slow pace of change

More broadly, the ACOT project demonstrated that change involving instructional technologies is slow. It took three to four years for positive outcomes when teachers were no longer struggling with technology (Baker et al., 1994). Similarly, Sandholtz and Ringstaff's (1996) longitudinal qualitative study using data from teachers' experiences in the first six years of the ACOT project, shows that change is slow, even when classrooms are drastically altered and teachers are willingly immersed in the innovation. Commitment will not occur until teachers see a positive impact on their teaching.

Stages of technology integration

The ACOT project helped identify key stages in teacher use and integration of technology for instruction. Sandholz, Ringstaff and Dwyer (1996) found that fives stages: entry, adoption, adaptation, appropriation, and invention characterize take up of technology in schools, although rarely do teachers move beyond the first two or three stages. At the entry phase, teachers use primarily text-based resources within a traditional environment. When teachers do use computer technologies, they typically encounter problems with technical issues, discipline and resource management. In the adoption phase, teachers begin to teach students how to use technology, they begin to anticipate problems and develop strategies to solve them. In the adaptation phase, although lecture, seat work and recitation continue to dominate classroom practice, 30-40 per cent of the school day involves students using technology (word processors, spreadsheets, databases, graphic programs and computer-assisted instruction packages).

Internet use was in its infancy during the ACOT project. If the same phase model was applied to current classrooms, one would expect to see considerable Internet use by teachers and students by now. In the appropriation phase (considered more of a milestone than a phase), teachers understand technology's usefulness and apply it effortlessly. They interact more with students and students work with computers frequently. There is evidence of project-based instruction, collaboration and creative scheduling of instructional time. Finally, in the invention phase, teachers experiment with new technologies and ways of relating to students and other teachers. Interdisciplinary project-based instruction, team-teaching, and individually paced instruction characterise this phase.

The ACOT studies indicate that the use of technology alone will not improve teaching and learning. Teachers in this project used technology to support their existing practice within the constraints of traditional classrooms, schedules, curriculum guideline and assessment.

3.8.2 The Navigator School project , Victoria, Australia

In Australia in 1996 the Victorian Government embarked on a three-year project in seven test bed sites 'to help define the operational parameters for schools as learning institutions in a technology rich world' (*Rethinking teaching and learning: The navigator schools' experience*, 1998 p.21). The project involved four primary and three secondary schools and was allocated significant funding for new technologies and related infrastructure. One primary and one secondary school were also ACOT schools. Partnerships were formed with business and academic institutions for funding and to assist with research. Key findings from the project concerned the need for effective planning, network design and management, the significance of the Internet and the possibilities of a school Intranet, the expanding role of school libraries, and the changing learning environments for teachers and students.

For the purposes of this study, the findings on teaching and learning are of most significance. Many of the outcomes are similar to those reported from like projects in the US and help to build a consensus about what teaching and learning can look like in well-supported, technology rich environments. Table 4 amalgamates the general findings on student learning and teaching practice from both the ACOT projects and the Australian Navigator schools. It indicates the positive changes observed with regard to student learning and teachers' pedagogical practices.

Table 4
Learning in technology-rich environments

Improved student outcomes on standardised tests in certain conditions
Improved student engagement, motivation and time on task
Stimulated student reasoning and problem-solving ability, learning how to learn and creativity
Stimulated more extensive research by students
Improved student writing (longer and more complex tasks)
Increased student representation of understandings in graphical and non-linear forms
Increased student collaboration on projects among students in same class and among students or classes in different schools
Increased more active and independent student learning
Stimulated more integrated and better assimilated learning through simulation, virtual manipulation, merging of a wide variety of data, graphic representation of data
Changed teachers beliefs about teaching; became more reflective on practice
Encouraged a wider range of teaching strategies
Changed teacher's pedagogical practice – from an instructionist to a constructivist model. Teachers were more willing to: • discuss a subject about which they lack expertise and allowing them to be taught by students • orchestrate multiple, simultaneous activities during class time. • define longer and more complex projects • give students greater choice in their tasks and the materials and resources to complete them
Changed relationships between teachers and students through greater interaction: facilitator, mentor, guide rather than instructor
moved towards child-centred rather than didactic and/or text-book centred instruction; toward collaborative rather than individual tasks;
Increased teacher interest in teaching
Increased teacher curriculum planning and collaboration with colleagues
Allowed teachers to better cater for individual needs
Allowed teachers to better prepare their teaching materials in a more professional way
Encouraged teachers to become risk-takers, no longer conforming to perceived traditional roles
Allowed teachers to feel empowered and unburdened by the efficiencies that technology, such as e-mail, networks, the Internet and intranet, delivers to their work

3.8.3 Problems with 'lighthouse' schools

Despite visitations, consultancies, professional development activities, and conferences designed to share and disseminate learnings from lighthouse school models to other schools, this goal has largely been unsuccessful. Anecdotal evidence indicates there is often resentment towards the 'favoured' schools as comparable levels of funding and support are not available to all. The experiences of students and teachers in schools without these advantages are often vastly different. A major challenge for schools and policy makers is how best to transfer positive findings to other schools so that more students benefit. Moreover, it can be demonstrated that often the benefits do not transfer past the classroom in which the new approaches are being trialled. Thus the methods by which mainstream teachers and schools do manage to successfully introduce technology, and adapt pedagogical practices to accommodate its use, bear closer examination.

3.9 The need for new research questions and methodologies

It becomes an increasingly difficult task for decision makers and classroom practitioners to make considered judgments on what direction to take their state, district, school or classroom based either on contentious findings such as those indicated by student achievement alone and/or from the studies strongly criticised for methodological flaws and the production of little more than anecdotal evidence. School educators gain little understanding from research if the contextual realities of the classroom, the interactions between teacher and student, the beliefs and attitudes they hold and the complexities of computer using environments are largely ignored.

In July 1999, new ways of evaluating the effectiveness of technology on student learning was the focus for the US Secretary of Education's Conference on Educational Technology attended by federal, state and local evaluators and practitioners (McNabb, Hawkes, & Rouk, 1999). In his opening address, the US Secretary of Education said: 'We are far along in the technological revolution and its application to learning that it is time for systematic review and analysis of what works best' (McNabb, 1999, p.1).

Critical evaluation issues identified by participants included the need for a broader range of measures and practices to systematically capture, analyse, interpret and communicate evaluation data in its appropriate contexts. Rather than reliance on summative measures, participants called for more emphasis on formative evaluations which seek to ascertain what technology applications work, under what conditions and with which students. The most useful program evaluation, it was argued, is one in which a strong formative element examines the connection between instructional practice, technology uses, and learning outcomes. There is a need for more evaluation of the type which demonstrates the change from what was not in place, or not so apparent before, and now is, through the use of educational technologies, for example: student attitudes towards learning, collaborative learning activities, development of technical and information literacy skills, higher order thinking skills, abilities to design, experiment and model complex phenomena, etc.

Similarly in the introduction to the *Technology Counts 98* report there are calls for new and different research:

> Evidence has consistently shown that drill-and-practice computer activities can help children develop basic skills ... But the picture is murkier for more sophisticated uses of technology in the classroom, especially for the host of applications and methods that support "constructivist" learning, in which students are encouraged to work in rich environments of information and experience, and build their own understandings about them.

The bottom line for teachers is the design and delivery of effective learning opportunities for students. This is teachers' work. McMillan Culp and others (1999) argue persuasively that a good research study of student learning in a technology-rich context needs to focus less on establishing that technology-rich situations are 'better' than non-technological situations; rather that the technology rich situation makes possible something different from what would be possible without technology. In addition, that students can and do succeed in learning the concepts the technology-rich situation is designed to help them learn.

3.10 Use of computers as tools to support constructivist-style teaching

The broad picture of computer use in US and Australian schools outlined in Section 3.4, although providing some idea of the digital tools teachers use with their students, provides little understanding of how teachers utilise the opportunities new technologies afford student learning. The two most commonly used applications, Internet searching and word processing, do not necessarily enhance cognitive understanding other than facilitating access to information and providing a vehicle for production. However, according to writers who argue from a constructivist stance, new technologies can foster and support constructivist learning: by helping learners to better actively construct, organise and represent what they know and by helping learners collaboratively negotiate meaning and by assisting learners' reflective thinking (Davis et al., 1997; Jonassen, Carr, & Yueh, 1998). By contrast, if computers are used primarily as tools for classroom organisation and control, or for another set of routine tasks, they make little impact on student learning Davis et al (1997) assert.

3.10.1 A taxonomy of educational technology

Based on their work in science education, Bruce and Levin (1997) devised a Taxonomy of Educational Technology which categorises available technologies according to the way applications support integrated, inquiry-based learning. These writers are of the view that new media tools support John Dewey's ideas on learning in which the natural impulses for learners are: to inquire or to find out things; to use language and thereby to enter into the social world; to build or make things; and to express one's feelings and ideas. According to Bruce and Levin, computers and other new interactive multimedia technologies which enable inquiry, communication, construction, and expression can be used to support the full range of learning. Their taxonomy (displayed in Table 5 below) provides a useful framework to facilitate analysis and reflection on educational use of computer tools linked to current learning theory.

Table 5
Taxonomy of media tools for learning

A. Media for Inquiry	B. Media for Communication
1. Theory building • Model exploration and simulation toolkits • Visualization software • Virtual reality environments • Data modeling-defining categories, relations, representations • Procedural models • Mathematical models • Knowledge representation: semantic • Network, outline tools, etc. • Knowledge integration	***1. Document preparation*** • Word processing • Outlining • Graphics • Spelling, grammar, usage, and style aids • Symbolic expressions • Desktop publishing • Presentation graphics
2. Data access • Hypertext and hypermedia environments • Library access and ordering • Digital libraries • Databases • Music, voice, images, graphics, video, data tables, graphs, text	***2. Communication*** • Electronic mail Asynchronous computer conferencing • Synchronous computer conferencing (text, audio, video, etc.) • Distributed information servers like the World-Wide Web • Student-created hypertext environments •
3. Data collection • Remote scientific instruments accessible via networks • Microcomputer-based laboratories, with sensors for temperature, motion, heart rate, etc. • Survey makers for student-run surveys and interviews • Video and sound recording	***3. Collaborative Media*** • Collaborative data environments • Group decision support systems • Shared document preparation • Social spreadsheets
4. Data analysis • Exploratory data analysis • Statistical analysis • Environments for inquiry • Image processing • Spreadsheets • Programs to make tables and graphs • Problem-solving programs	***4. Teaching Media*** • Tutoring systems • Instructional simulations • Drill and practice systems • Telementoring

C. Media for Construction	D. Media for Expression
• Control systems--using technology to affect the physical world • Robotics • Control of equipment • Computer-aided design • Construction of graphs and charts	• Music making and accompaniment • Music composing and editing • Interactive video and hypermedia • Animation software • Multimedia composition

Despite the availability of this range of media options for inquiry, communication, construction and expression, as shown in the earlier discussion, few of the applications or tools, and the learning activities they might support, are to be found in regular use in classrooms in either Australia or the US.

3.10.2 The concept of 'mindtools'

Jonassen's term 'mindtools' is a similarly helpful construct for categorisation of educational technologies. According to Jonassen (1996, p.190) mindtools comprise databases, spreadsheets, multimedia and hypermedia, and semantic network software. He argues that mindtools allow students to learn with, not from, computers. They are the digital tools which can efficiently and effectively support deeper-level information processing, engage learners in knowledge construction, and require them to think more. Use of these tools carries the assumption that the learner is predominately an active creator of knowledge. Further, Jonassen argues that when learning tasks require students to use these 'mindtools' for real-world problems and issues, learners often see a worthwhile reason for learning new material, uncovering new resources and producing a creative, engaging product which is of use and interest for others. The extent to which teachers use educational technologies as 'mindtools' is of interest to this study. In addition to the most commonly used software, teachers in this present study also required students to use multimedia and hypermedia construction programs. The following section examines the term mindtools in relation to the commonly used software and the software used by teachers in the present study.

Word processing, graphics and paint programs

Jonassen argues that while word processing, graphics and paint programs have enabled students to become more productive, use of these tools does not significantly restructure and amplify the thinking of the learner, or the capabilities afforded by that thinking. However, it can also be argued that how teachers design, support and assess student learning activities which involve the word processor is the critical factor. Davis et al (1997, p.17) state that use of the word processor can permit the learner to develop ideas and engage in creative and critical processes; it 'speeds the writing process, reduces the demand on memory and enhances creativity'. Moreover, because groups of authors can share a screen more easily than a book, especially when computers are networked, teachers can encourage students to engage in collaborative writing, critical review and metacognitive reflection on the writing process. Nevertheless, despite survey studies indicating widespread use of word processing in classrooms, if, how and to what extent they are being used intentionally to support the development of writing and metacognitive reflection on writing, is not clear.

Internet

The Internet is a powerful tool for locating vast amounts of information presented in a range of engaging multimodal forms and is rapidly becoming the most used application in schools. Jonassen argues, however, that the Internet does not become a mindtool for learning unless it is intentionally used to engage learners in critical thinking about the content they are studying. Students surfing the Internet for research does not necessarily qualify the tool as a valuable adjunct to learning. Increasingly, concerns about its unfettered use are raised (McKenzie, 1998). Issues of concern include the sheer volume of information, the accuracy and reliability of information posted; the prevalence of offensive material; the abuse of copyright and fair use provisions; the increasing use of advertising and marketing targeted at children and invasion of privacy. Students need to learn skills to actively select, discriminate between the good and the bad, evaluate the content, process, reconstruct and reflect on the information if learning is to occur. The instructional design skills of the teacher and the ability to scaffold tasks to fostering such learning with the Internet thus is crucial

Multimedia and hypermedia construction tools

Multimedia and hypermedia construction tools allow students to represent knowledge and understandings and to provide different perspectives in the multi-modal ways reflective of the media which surrounds them in their daily lives outside of school. Jonassen (1996, p.208-209) argues that the following advantages are associated with the use of these tools:

- learners are more mentally engaged by developing materials than by studying materials.
- multimedia permits concrete representations of abstract ideas and enables multiple representations of ideas
- students are actively engaged in creating representations of their own understandings by using their own modes of expression
- students are highly motivated because they have some ownership of the product
- building multimedia and hypermedia orients teachers and students away from the notion that knowledge is information and that the teacher's role is to transmit information
- this form of knowledge design promotes development of critical theories of knowledge (not every design is successful) and critical thinking, such as defining the nature of the problem and executing a problem to solve it

He concludes:

> The combination of creativity and complexity required to author hypermedia in a form that is intrinsically motivating to students (multimedia) makes it probably the most compelling and potentially effective of all Mindtools (Jonassen, p.209).

Davis et al (1997) also refer to the interactive possibilities afforded by this type of software, adding that the degree of interactivity in software applications can also sustain a higher than normal degree of on-task engagement and 'mindfulness'.

Despite these 'mindtool' possibilities, classroom appropriation of multimedia and hypermedia software tools can be a complex, time-consuming and often frustrating experience. In order to integrate graphics, video, audio, animation, text and hypertext into representations of knowledge, sophisticated software and hardware and a diverse range of peripherals are required. A specific skill set is needed and effective use is governed by the level of teacher and student skill, the type and reliability of the technology used and whether or not timely support is available. Thus, these tools, deemed more conducive to constructivist learning, also require a complex set of preconditions for their effective utilisation. It is not surprising then that the in-school use of basic word processing and the Internet far exceeds that of multimedia authoring tools.

3.11 The role of the teacher

Despite the potential of digital 'mindtools' for student learning, widespread realisation of the promise is not apparent. Even where teachers have mastered technology for personal use, such as email, Internet searching and basic document production, regular and sustained classroom use of the more promising tools for learning is not readily in evidence. The barriers to teacher take-up mentioned previously (see 3.5), are considerable. Not the least of these barriers is the need for teachers to adapt their existing pedagogy and beliefs about teaching and learning to a digital environment. The design and implementation of a pedagogy in which digital content and tools are embedded purposefully to support learning requires teachers to adopt new and diverse range of skills - and not only specific technical skills. Adaptation of existing effective teaching practices to new digital learning environments is also necessary for success. Brunner and Tally (1999, p.7) point out that when using the newer media, students must have an awareness of its unique characteristics and the implications of non-linear and interactive nature of hypertext and hypermedia for both authors and readers. Students must be guided to critically evaluate not only what they see and read, but also what they author themselves. Jessel (1997) notes how children using word processors may not engage in discussion of their collaboratively written text without teacher intervention. In discussing the classroom use of databases and information processing tools, Smith (1997) argues that the teacher needs to understand the cognitive demands imposed by the data-handling environment and be sensitive to the need for intervention either at an individual or group level. Thus the need for teachers to scaffold or structure experiences in computer-mediated learning environments is of no less importance than for traditional pedagogy. Scrimshaw (1997) draws on a description of scaffolding by Maybin et al. (1992) which refers to the help given a learner to accomplish and achieve competence in a task. However Scrimshaw believes that successful learning with new technologies also requires teachers to teach the process of learning with software rather than its products. Furthermore, it requires the explicit teaching of how to work collaboratively and learn from others (Scrimshaw, 1997, p.112). The role of the teacher therefore is fundamental to facilitating a classroom climate in which the potential of technology can enhance the learning process (Hamza & Alhalabai, 1999).

3.11.1 Learning to teach with mindtools

Spector (2001) supports the view that the promise of constructivist learning with new and emerging technologies has not been realised at a significant global level. He argues that the role of teaching in technology-intensive settings is more difficult and challenging than ever before and that instructional designers face critical challenges in transforming the enriched view of learning into meaningful learning experiences. Moreover, the organisational issues required to translate advances in learning theory and educational technologies into meaningful practice have yet to be seriously addressed. Davis (1997) points out the need to assist teachers in acquiring both the technical-level skills of using a machine and software, and the higher-level skills of using a tool to support their own learning or the learning of their students. Being able to do the latter is dependent on the former for most teachers. Provision of a supportive environment for teachers to learn and take risks is also necessary. Davis notes that this can often be achieved in the first instance through 'informal discussions and conversations' (p.256). Davis also supports the view of Brown (1994, p.146) that acquisition of teacher skill in IT and classroom applications of IT occurs in phases: Typically novices are concerned in developing their own competence. Concern then switches to the tasks to be undertaken … the final stage can involve a more critical reflection on the use of IT: how it is used to enhance learning rather than just encourage its use *per se*.

3.11.2 Teacher learning in communities of practice

Chapter 2 outlined key social learning theories related to 'communities of practice' and the ways teachers learn and learn to teach with technology (see 2.7 and 2.8). The *Teaching, Learning and Computing* study by Becker and colleagues (1999) lend some support to these theories. Whether or not a practitioner culture is present in a school, seems to be significant in helping teachers move from an instructionist to a more constructivist approach when using technology. Acknowledging their debt to Little (1993) in their discussion, Becker and colleagues (Becker, Ravitz, & Wong, 1999) assert that a professional practitioner culture is a prerequisite for sustained instructional reform and can act as a lever for changing teachers' philosophies and pedagogies. They distinguish between private and collaborative teacher practices. In private practice, teachers' orientation is to their own classroom responsibilities; they find little time for meetings, conferences or other forms of professional engagement; novice teachers learn through practice rather than shared wisdom. Conversely, in collaborative practice there is professional interaction and leadership; teaching is viewed as a process of continual, reflexive inquiry and exchange of ideas with other professionals which leads to the development of a shared technical language and a shared knowledge base. Teachers with a collaborative orientation encourage dialogue about research findings, share ideas from conferences and work collectively to evolve the most effective strategies for reaching consensus about good teaching practices. These teachers moreover are more likely to build a professional identity than those engaged in private practice by publishing papers, offering workshops and presenting at conferences. High frequency of informal contacts with other teachers (about how to teach a particular concept to a class, ideas for group projects; having other teachers observe their own teaching.) also distinguish these teachers.

Riel and Becker (2000, July) have identified that teachers with constructivist compatible beliefs can play a role in the professional growth of their peers. This aspect of the survey found that teachers who had many professional contacts with other teachers at their school (that is, through discussions and classroom observations) were three and a half times as likely to employ a strong 'knowledge construction' approach in their teaching than were teachers who had few such contacts. Conversely, low professional contact teachers were three and a half times as likely to focus on information transmission and skills practice as high contact teachers. In examining work orientation more broadly, they examined three types of professional contacts: discussions with and classroom observations among teachers at their own school; involvement with teachers elsewhere such as by workshop attendance, district committees, and e-mail discussions; and leadership activity, including mentoring another teacher, teaching peers at workshops or conferences, teaching a college class, or publishing articles on education. The more teachers orient themselves in professional activity beyond the classroom, the more constructivist their teaching practice becomes. According to Reil and Becker, 2000 these findings also show that the most professionally engaged teachers are exploiting computers in a constructivist manner:

> Their use of computers with students is not limited to gaining computer competence, but extends to involvement in cognitively challenging tasks where computers are tools used to achieve greater outcomes of students communicating, thinking, producing, and presenting their ideas. This comes as no surprise. Meaningful integration of computers and instruction is a difficult task, one that requires contact, collaboration, and support from professional peers, the school organization, and the educational community as a whole.

The insistent call for a shared collaborative professional dialogue, within the context of the school, is a clear reflection of social learning theory, but in practice rarely seems to occur.

3.12 Links to this study

The review of the literature has attempted to frame a context for considering the ways in which teachers teach and students learn with multimedia technologies in schools in Australia and the US. It has considered the rhetoric and on-going, often very public debate, about the relative merits of using educational technologies for school learning. Teachers in both countries, especially at the post elementary level, although competent and regular personal users of computers, have been slow to integrate technologies in any sustained way into their classroom teaching practice. The dominant software applications for those who do are word processing and Internet searching. Research provides equivocal findings about the effectiveness of technology on standardised test scores, nevertheless other studies indicate that use of the new convergent technologies does contribute positively to other aspects of learning not so easily measured. Digital technologies which enable students to create, present and think about knowledge in new ways, both individually and collectively, so-called mindtools, are considered more desirable for enhancing student learning than those which are used only to deliver information (Internet) or allow for the production and reception of digitised text (word processing). In order for teachers to better exploit the affordances of educational technologies in the learning process, significant, and recurring barriers need to be addressed. Not the least of these is the need to support teachers in a range of ways at the school level. Promising research indicates that a professional collaborative learning culture can assist the change process.

Within this context, this study set out to examine two schools in the US and two in Australia where teachers required their students to use new digital technologies to represent aspects of their learning. The aim was twofold: to examine the experiences and views of both teachers and students as they teach and learn with multimedia tools and to understand conditions at the school level which contribute to effective integration of the technology.

Chapter 4

Description of the study

This chapter describes the design and methodology used for the study and is divided into three main sections:

1. The chapter begins by outlining the design of the study and includes an explanation and justification for adopting qualitative research methodology.
2. The next section is concerned with the data collection process and associated methodological challenges.
3. The final section explains the process of data management through the use of qualitative data analysis software and describes the various ways adopted to represent and convey meaning from the volume of varied data sources.

4.1 Design and methodology

This aim of this study was to investigate pedagogical practices in school environments in the US and Australia in which extensive use of multimedia technologies was incorporated into learning tasks. Adopting a mainly qualitative methodology, grade 7 and 8 classes in two schools in California, and two in Victoria, were examined using a consistent set of data gathering tools. Classroom observations, interviews, focus groups on-line questionnaires and other electronic communications were used at each site to explore the ways teachers teach and students learn with new technologies. Underpinning the decision to adopt a qualitative research methodology was the recognition that close examination of multiple perspectives and factors operating in such complex learning environments is necessary for a richer understanding of the issues than possible through reliance on quantitative measures alone.

Two major strands of inquiry: functionalism and symbolic interactionism, comprise the theoretical framework for much social inquiry. Functionalist theory postulates that the social world exists as a whole unit or system which comprises interrelated, functioning parts. These might include social institutions, organisations, groups and roles. According to Bowers (1989, p.34), 'the focus of functional analysis or theorising is on the system as a whole … the parts have meaning only in their relatedness to the whole'. In a school setting, for example, a requirement for teachers to take on more complex tasks as part of their existing roles, and their subsequent resistance to this, might be seen as a threat to the larger system and therefore dysfunctional. The functionalist theoretical position has been criticised on several grounds: as inherently normative, evaluative and conservative; for its inability to account for rapid social change; that it suggests a much more orderly account of social life than is borne out by empirical observation; for its failure to access the thinking, feeling, acting individual by its focus on explaining behaviour only in terms of role and function; and finally, that it is logically derived rather than empirically derived theory (Bowers, 1987 pp. 35-36).

By contrast, symbolic interactionism is theoretically focused on the acting individual not the social system. Reality is said to be socially constructed. Joint action, or interaction with others in the social world, is accomplished through a continual process of individuals attempting to take the role of the other person(s), determining how other individuals perceive and interpret their actions to predict the responses of others and to reconstruct their own lines of action. At the same time, the individual is receiving cues from the environment which indicate how accurate their assessment has been and whether the selected course of action needs to be realigned or maintained (Berger & Luckman, 1967; Lincoln & Guba, 1985; Bowers, 1989; Brown, 1994).

Differing types of research methodology ensue depending on the epistemological framework chosen. In contrast to a positivist framework which assumes there is an objective reality which can be observed, known and measured, interactionists assume there are multiple realities which need to be interpreted rather than measured (Merriam, 1988). This qualitative paradigm, unlike the quantitative research paradigm,

> is exploratory, inductive, and emphasises processes rather than ends. In this paradigm, there are no predetermined hypotheses, no treatments, and no restrictions on the end product. What one does do is observe, intuit, sense what is occurring in a natural setting (Merriam, 1988 p.19).

This approach does not mean that some measurement of observed phenomena is not possible, however. Strauss and Corbin (1990, p.17) define qualitative research as 'any kind of research that produces findings not arrived at by means of statistical analysis or other means of quantification ... some of the data may be quantified ... but the analysis itself is a qualitative one'. Schensul and colleagues also argue for collection and integration of both qualitative and quantitative data where appropriate, useful, relevant and valid for the research question (Schensul, Schensul, & LeCompte, 1999).

Qualitative research may be largely inductive, meaning it builds abstractions, concepts, hypotheses, or theories, rather than testing existing theory - the deductive approach of the positivist researcher. Analysis of data derived from naturalistic inquiry can be purely descriptive or can be used for theory building or development. A 'grounded theory approach' to theory building requires that theory must emerge from the data (Glaser & Strauss, 1967; Strauss & Corbin, 1990). 'A grounded theory is inductively derived from the study of the phenomenon it represents ... data collection, analysis and theory stand in reciprocal relationship with each other. One does not begin with a theory, then prove it. Rather, one begins with an area of study and what is relevant to that area is allowed to emerge' (Strauss and Corbin, 1990 p.23). Grounded theory research requires a highly systematic set of procedures to be used to inform analysis of data and to aid theorising. These include specified forms of data coding, and sampling with the data collection and analysis deliberately fused. LeCompte and Schensul (1999, p.16) prefer to use the terms 'recursive', 'iterative' or 'interactive' analysis to describe how they see the process of theory building in ethnographic or qualitative case study research. Recursive analysis uses both inductive and deductive processes whereby the researchers engage in bottom up inductive thinking - that is they generalise from concrete data to more abstract principles - by drawing from and experience in the site, while simultaneously thinking deductively from the top down - that is, by applying more general or abstract ideas from theories that are relevant to their work to the concrete data they have collected.

4.1.1 A qualitative case study

Of the two major strands of sociological inquiry, functionalism and symbolic interactionism, it is the latter with its attendant need for mainly qualitative or ethnographic research techniques, which sits most comfortably with the purposes of this study. Consistent with an interactionist theoretical stance, this study adopted case study research methodology and used a range of mainly qualitative techniques to gather and analyse the data. Some quantitative measures were also used where aggregation of responses was considered useful in helping to understand the complex interactions and interrelationships in operation (see 4.3).

Yin (1984) defines case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used. The quintessential characteristic of case studies according to Feagin and colleagues is that they strive towards a holistic understanding of cultural systems of action i.e. interrelated activities engaged in by the actors in a social situation (Feagin, Orum, & Sjoberg, 1991). Case studies can provide multi-perspective analyses whereby the researcher considers not just the voice and perspective of the actors, but also of the relevant groups of actors and the interaction between them (Tellis, 1997, July). Merriam (1988, p.3) argues that for education research, a qualitative case study is a particularly suitable method for understanding critical problems of practice and extending the education knowledge base. She believes that 'research focused on discovery, insight and understanding from the perspectives of those being studied offers the greatest promise of making significant contributions to the knowledge base and practice of education'.

Case studies require an identifiable 'bounded system' as the focus of investigation (Merriam, 1988; Stake 1995; LeCompte and Schensul, 1999). The researcher must have clearly delineated who or what is to be included - it could be a program, event, person, process, concern, institution or social group. This process of defining and establishing the boundaries of a case study especially when the program, issues, concerns are wide ranging and involve many people, can be difficult. Maintaining the focus also becomes complicated when further questions continually arise during the course of the study and the researcher needs to determine if any of the tangents are worth pursuing in greater depth.

'Thick' description of the phenomenon under study is another distinctive characteristic of a qualitative case study. Guba and Lincoln (1981, p.19) use the term to mean not only the complete, literal description of the incident or entity, but also 'interpreting the meaning of demographic and descriptive data in terms of cultural norms and mores, community values, deep-seated attitudes and notions, and the like'. The researcher needs to select incidents, responses, vignettes, and narratives from the mass of data and describe these as powerfully as possible in order to convey the essence of the phenomena under study.

Building on these understandings, this case study aimed to explore, capture, describe and understand from multiple perspectives: what it is to teach and learn in classrooms with multimedia technologies; the problems, difficulties and constraints teachers and learners face; how they perceive success; what factors contribute to success. Drawing on multiple data sources gathered from each site, the study attempts to provide a detailed, contextualised picture of the experiences of the participants in their everyday settings. Further, by use of recursive analysis and interpretation of the data, the aim is to illustrate, support or challenge existing theoretical assumptions and possibly to proffer some contingent generalisations and so contribute to a deeper understanding of the issues. Using Merriam's (1988) framework, this case study combined both descriptive and interpretive characteristics.

4.1.2 A multi-site case study

Writers apply different terms to research which involves collection and analysis of data about the same phenomenon from several cases. Stake (1995) uses 'collective case studies'; Merriam (1988) uses 'cross-case', 'cross-site', 'multi-site'case, or 'multi-case' studies interchangeably; and LeCompte and Schensul (1999) use 'multiple-site' case studies to refer to research of this type. Similarly, there has been some dispute over how many sites are required to enable a study to be labelled 'multi'. Regardless of terminology, according to Stake (1995, p.171) 'collective case studies are instrumental to learning more about the effects of a phenomenon'. An interpretation based on evidence from several cases can be more compelling than one based on a single instance

(Merriam, 1988, p.154). Miles and Huberman (1984, p.151) further argue that 'by comparing sites or cases, one can establish the range of generality of a finding or explanation, and at the same time, pin down the conditions under which that finding will occur'.

A qualitative, inductive multi-case study seeks 'to build a general explanation that fits each of the individual cases, even though the cases will vary in their details' (Yin, 1984, p.108). While there are considerable advantages in undertaking a multi-case study, this course does have its difficulties. Establishing comparability of the phenomena under study in the different settings, and gathering comparable types and amount of data using similar techniques were but two of the major challenges faced in this multi-site case study.

4.1.3 A comparative cross-national study

By examining the same phenomenon in sites in both Australia and the US, it was hoped to gain a broader perspective on the issues than could be obtained from focusing on examples from one country only. American and Australian approaches to organisation of schooling, teachers and teaching are similar, but also different. However, both school systems are facing the same pressures to invest huge resources in educational technologies to prepare students for the 'demands of the 21st century'. Perhaps in this area of education more than any other, global institutional isomorphism is emergent. Often the same computer hardware and software are used in each nation's classrooms, with students accessing similar information sources through the global reach of the World Wide Web. Comparative analysis of cross-national data from the grass-roots level may be useful therefore in providing insight into similarities and differences and how key issues relating to educational technologies are tackled and resolved in each system. According to Hantrais (1996), a study is held to be cross-national and comparative when individuals or teams in two or more countries set out to examine particular issues or phenomena with the expressed intention of comparing their manifestations in different socio-cultural settings, using the same research instruments. The aim may be to seek explanations for similarities and differences or to gain a greater awareness and a deeper understanding of social reality in different national contexts. Both these aims are integral to this study.

Taking advantage of a two and a half year residency in California, USA, with regular opportunities to return to Melbourne, Australia, and making extensive use of digital communications technology, it was feasible to undertake a comparative examination of the use of multimedia technologies in schools in each country. Immersion in two education systems in which high-end information and communication technology use is being encouraged, also provided opportunities to examine and reflect on aspects of the globalisation of education in respect to the use of educational technologies, not necessarily possible in a single site study.

This study examined pedagogical practices in classrooms in which the use of multimedia technologies had a significant place in the curriculum. The cases selected were grade 7 and 8 classes in two schools in California, USA and two schools in Victoria, Australia. Each of the four school sites was chosen based on its relevance to the focus of analysis - pedagogical practice in multimedia learning environments. In each of the schools, I decided to study students and teachers at the grade 7 and 8 level, whose curriculum required the use of multimedia technologies for data gathering and/or research, and re-construction and representation of this knowledge in multimedia format. The research questions, data collection methods, analytical procedures were selected not only to shed light on the specific cases under examination, but also to enable comparisons of and reflections on effective educational practice in multimedia environments in each country.

4.1.4 The sole researcher

Merriam (1988, p.19) points out that 'the importance of the researcher in qualitative case study cannot be overemphasized'. Referring to the work of Guba and Lincoln, (1981), she states:

> the researcher as research instrument is responsive to the context; he or she can adapt techniques to the circumstances; the total context can be considered; what is known about the situation can be expanded through sensitivity to nonverbal aspects; the human instrument can process data immediately, can clarify and summarize as the study evolves, and can explore anomalous responses.

As the sole researcher in this comparative study, I aimed to recognise and avoid if possible the difficulties sometimes associated with multi-site case studies. I aimed to replicate the study design in both countries as consistently as possible. At the same time, I recognised that it was through my eyes, my cultural biases, my view of education, my theoretical perspectives, and my methodological approach to data gathering, data management, coding, analysis and interpretation that the study was undertaken. It was therefore incumbent on me to be aware of and take account of the peculiarly individual features that I as the sole researcher might bring to the different settings. The need to constantly keep an open mind, ask questions, pursue puzzles and check assumptions becomes even more important when relying on interpretations in different cultural settings without the benefit of co-researchers assisting the process. Throughout the study, I was always conscious that being the sole researcher in a multi-site, cross-national case study was a course lined with difficulties. Not the least were the management of the large amounts of data which rapidly accumulated and maintaining focus when so many other interesting lines of inquiry kept emerging in the different sites.

Being the sole researcher in a cross-national study brought with it other significant challenges. Given the different scheduling of the US and Australian school academic years, arranging interviews, observation schedules and focus group discussions from a distance at times proved quite difficult. Nevertheless, I did receive extraordinary cooperation from all participants who seemed happy to accommodate the sometimes tricky logistics I needed to juggle.

4.1.5 The sole researcher in a digital environment

On-line Internet-based communication capability contributed significantly to the research process in several ways. It facilitated data gathering at each school, sometimes simultaneously, through on-line questionnaires and email communication, and allowed on-going dialogue with participants on substantive issues relating to the study regardless of where I was. Furthermore, it enabled regular contact with my PhD supervisor in Australia. In addition, during the study, I explored extensively the features, possibilities and challenges of the Internet as a medium for doing research. I created my own multimedia web space to enable ready access to relevant on-line academic literature, reports, and organisations' websites etc. Establishing familiarity and comfort working in a digital environment and the possibilities it might have for supporting my own learning, were important in helping me become a more knowledgeable and aware researcher. Given the time it took to acquire these skills, achieving the level of capability I now have would have been far more difficult had I still been occupying my previous full-time role as a school-based educator. I am now far more aware of the time needed for busy classroom teachers to reach the same level of skill.

Participation in several on-line networks and forums was also invaluable in helping me develop in the role of researcher, especially as a sole researcher, operating away from my sponsoring institution and without the benefit of regular peer meetings for discussion and reflection. One such online forum was the QSR Forum, a support feature accompanying NVIVO, the qualitative data analysis software used for management and analysis of data. On-line participation enabled me to communicate with a global academic community with interests similar to mine and to experience new ways of learning in a digital environment. I found the contributions and dialogue - technical and academic - and the sense of community which these forums at times engendered extremely helpful. Contributors represent a range of countries, have different levels of academic and professional experience, have different interests and research focusses. Consequently the forums provided a real sense of being part of a global learning community, at times offering much more than a regular tutorial of my same-country peers might have done.

While in the US, I also participated in a recently established on-line professional development for educators – 'Tapped-in'. This service designed by SRI, a major research organisation located in Palo Alto, California and supported financially then by Joint Venture Silicon Valley Networks, provides opportunities for educators to hold on-line, synchronous discussions and forums about common interests and concerns. Not only did this facility help me understand concerns and issues facing the teachers who participated, it was another outlet for professional engagement impossible without the digital and communications technology.

Thus, through exploration of and involvement in these various new communication technologies in one sense I was replicating the learning experiences of the students and teachers I was studying, while at the same time exploring new possibilities for accessing and sharing knowledge globally. The added advantage was relieving negative feelings of solitariness and lack of a shared community, two elements known to contribute to the 'ABD'(all but dissertation) syndrome as described by Nerad and Cerny, and cited in Kerlin (1997).

4.1.6 The research posture

The researcher becomes the 'primary instrument of data collection' in a qualitative study (Schensul, Schensul and LeCompte, 1999). Establishing a research posture i.e. the relationship a researcher wants to have with their subjects, and then making subsequent methodological choices which consistently concur with these choices, is important for the qualitative researcher (Wolcott, 1992). The role adopted for this research was 'observer as participant' (Merriam, 1988 p.93). That is, my research activities were known to the group, but my participation nevertheless was secondary to my role as information gatherer. The challenge in adopting this role is 'to combine participation and observation so as to become capable of understanding the program as an insider while describing the program for outsiders' (Patton, 1980 quoted in Merriam p.94). In discussions with the personnel at each site prior to commencement of the research, participants understood that my research role was not necessarily only to be the interested, informed outsider. I indicated I would be happy if asked to participate in classroom activities in a helping role with the technology, to feedback my findings regularly, and to participate in professional dialogue on a personal and/or collective level. This offer was taken up in varying degrees at all sites. The participants understood that my approach to data gathering (classroom observations, on-line teacher reflections and student questionnaires, one-on-one interviews with teachers, focus-group discussions with teachers, students and administrators and consideration of documentation and student work) was aimed at gaining multiple perspectives on the issues. At all times I consistently aimed through my behaviour to earn and maintain the trust of the participants to allow them to feel comfortable enough to share their most strongly held beliefs and attitudes and not just what they might think I wanted to hear.

Finding the balance between the insider/outsider roles was less challenging in the three schools in which I had no prior relationship. I was mindful of the constant need to be as objective as possible during field work at the school where I had been recently employed and where I had played a significant role in establishing the programs I was now studying in a research capacity. Although I had an immediate understanding of the settings, roles and programs there, I now wanted to be able to dig deeper and analyse and interpret the issues as an outsider might see them. In the schools with which I was initially unfamiliar, I needed to work harder to establish the insider perspective. However, my experience as a professional who had recent experience of implementing technologies into the school curriculum, both as a teacher and as an administrator, was advantageous at all sites, as a framework for understanding pedagogical practice and the culture of schooling was already in place.

Being a cross-national study brought with it additional challenges in maintaining an objective participant observer role. It was important for me to understand contexts and settings and establish relationships of trust very early on at each site in each country, as I was living in the US but making regular visits to Australia. To maintain a participant stance when not on-site, I needed to encourage participants to accept my ongoing role as researcher and communicate with me on-line when I was not present. In this way I hoped to gain a more or less immediate understanding of the progress of the unit of work and the challenges while the participants were experiencing it. These issues were then referred to in interviews, discussions, and observations when I was again on-site. Similarly, at times tape recordings of meetings were forwarded to me and this too enabled ongoing involvement with and understanding of the participants' work and their perspectives which I pursued later in face-to face settings.

4.1.7 Selection of research sites

For this multi-site study I chose to examine four cases where the phenomenon under study could be clearly identified at each site. Goetz and Le Compte (1984) refer to this as 'criterion-based sampling' and Patton (1980) uses the term 'purposeful sampling'. Criterion-based or purposeful sampling requires the researcher to establish the criteria, bases or standards necessary for units to be included in the investigation and then to find a sample or samples which match these criteria (Merriam, 1988).

The criteria established for a suitable site included schools in which:

- teachers required students in grades 7 and/or 8 to use computer technologies in their curriculum for research and multimedia presentation
- technologies available to students included computer hardware with multimedia capabilities; Internet software (browser and email facility); web page creation programs (e.g. Adobe *Page Mill*, Netscape *Composer*) or multimedia presentation programs (e.g. *Hyperstudio* or *Hypercard*); scanners; digital still and video cameras; audio input
- students were engaged in a unit or units of work which took place over an extended period of time
- I could observe the unit of work in progress
- that students and teachers were able to communicate with me on-line

Four sites, two in each country, matching the selection criteria, were eventually located, although not surprisingly, this task was more difficult in the US than in Australia. The schools, using pseudonyms, were:

- Silicon Valley Middle School, California (SVMS, US)
- Redwoods Catholic School, California (RCS, US)
- Outer Melbourne Secondary College, Victoria (OMSC, Aus)
- Eastern Girls' Grammar School, Victoria (EGGS, Aus)

In California I was able to explore possible sites meeting the criteria established for inclusion through involvement with a large non-profit education foundation - Joint Venture Silicon Valley (JVSV) Networks. Not long after my arrival in the US, I made contact with the foundation as I was interested in the programs and approach the foundation had adopted. With teachers and schools in the local county offices and school districts, JVSV, supported by a Federal Government grant, was working to fast track improvements in literacy, mathematics, science and the curriculum use of multimedia. The JVSV Challenge 2000 Multimedia Project accepted my offer of assistance on a voluntary basis, and during a two-year period I worked on a variety of project activities which enabled considerable contact with schools, teachers, students and consultants involved in innovative curriculum projects using multimedia technologies.

Both school sites I eventually selected in California were part of the JVSV Challenge 2000 Multimedia Project. Both schools received grant monies and support from JVSV as they undertook a unit of work requiring a project-based learning approach using multimedia technologies. The first school site, RCS, is a Catholic elementary school whose grade eight Social Studies classes were involved in an extensive unit of work which required research and presentation of findings in multimedia format. This school had a clearly articulated vision for implementing technologies across the curriculum, and the work being done with educational technologies in this grade 8 classes was the culmination of their program. The second US school, SVMS is a large co-educational middle school whose grade 7 and 8 Spanish classes were doing an extended multimedia project. The 1999-2000 school year was the first time the Spanish teacher had attempted to use technology on a large scale with her five classes and her program was not part of a coordinated school-wide program. The principals of the US schools accepted and acknowledged my credentials (including that I had completed an Ethics approval procedure) and my expertise and experience. The range of people approached to participate in the study also seemed happy to have an 'outsider' working alongside them. Thus I was fortunate to be able to locate from many possibilities, two schools which met my criteria for inclusion: use of multimedia technologies for research and presentation at grade 7 and 8 levels. That I was able to immerse myself in the

Californian school system through involvement with various JVSV projects certainly assisted identification of, and access to, sites for study. Regular collaboration with a range of educators, support staff and educational administrators in many different schools under the umbrella of this significant foundation enabled entrée to schools, programs and support organisations unimagined when I left Australia. I was accepted not merely as an interested visiting Australian researcher, but one whose recent professional practice was also 'at the coal face' implementing educational technologies both as a classroom teacher and administrator.

Of the two Australian schools, Outer Melbourne Secondary College is a government co-educational school. This school planned to introduce a new program in 1999 for a selected grade 7 class. Underpinning this new program was a desire to create an integrated curriculum which made extensive use of multimedia technologies for research and presentation. This school was also of interest by way of comparison with the other Australian school, an independent girls' school. Although OMSC had extensive hardware facilities installed throughout the campus, little had been done in a systematic way to introduce the students at this level to the use of educational technologies. The other Australian school selected, Eastern Girls' Grammar, is a large independent school with a well established approach to the use of educational technologies across the curriculum. In particular, this school has placed emphasis on the use of multimedia technologies in its grade 7 and 8 programs. Staff allocated to both the teaching of computer skills and seeking their effective use in the curriculum is a feature of the school's program. Prior to leaving for the US, I had held a leading teacher and administrative position at this school, responsible for curriculum and staff development, a role which included supporting the curriculum use of educational technologies.

While meeting my criteria for selection, these two schools offered opportunities for a comparative analysis in that they were at different stages of development of their grade 7 and 8 level programs. In both instances in Australia, the principals and relevant teaching staff welcomed me as researcher, recognising that not only did I have some expertise and experience in the educational technology field, but that I was also willing to actively participate in classroom activities and professional dialogue if asked.

My success in obtaining four sites meeting my criteria for selection in the two countries also reflected in part that this study was to be a cross-national study and that all participants were very interested in the outcome.

Table 6 indicates the number of classes at the grade 7 and 8 levels included in the study.

Table 6
Number of classes in the study

RCS, US	SVMS, US	OMSC, Aus	EGGS, Aus
2 x grade 8 classes	2 x grade 7 classes 2 x grade 8 classes	1 x grade 7 class	4 x grade 7 classes 2 x grade 8 classes

Stake (1995) argues that the opportunity to learn from the case/s the researcher selects is of primary importance. The cases that formed my multi-site study allowed for this. Apart from all sites meeting my base criteria, these sites offered the opportunity to examine pedagogical practice operating in two countries with different school systems, structures and practices. Of the Californian sites, one was a Catholic school, whose grade 8 classes were involved in a systematic school-wide technology program and was the exit year of the elementary system. The other US school was a state-run middle school whose grade 7 and 8 students were commencing a teacher-initiated program in the use of technology. Both US schools were coeducational and both were receiving support from an outside funding organisation. In Australia, I used an independent girls' school with an established educational technologies program and a state coeducational school, attempting an ambitious program for the first time. Both of these schools' grade seven and eight classes were located in the Victorian secondary school structure. Thus the phenomenon under study in all four sites was constant, but the different structures and settings allowed for further issues and questions to be explored.

4.1.8 Selection of participants

The need for research to consider ordinary experiences and commonsense problems is stressed by Yates (1999). On this basis, it was important to select a range of participants at each school site who collectively could provide voices and perspectives from the classroom to assist understanding of the issues. During the case selection phase, I held preliminary discussions and investigation with teachers, administrators and /or support personnel at each site and progressively formed an idea of who might be key informants. Later, during the course of the study, as I became more familiar with the programs, and how they operated in the unique culture of each school, this preliminary group of possibilities always expanded. Judgments then had to be made progressively about who should be included and who might best contribute to the aims of the study. In the first instance at each school site I sought the participation of classroom teachers engaged in the teaching of a unit of work using educational technologies. I sought permission to observe them and their classes at work, and to interview them. I also encouraged them to communicate with me on-line during the course of the unit of work they were teaching.

Exploration of student perspectives was also central to the study. Given young people's saturation in modern digital culture outside the school, both as consumers and creators, students' experiences and views on their use of computers for school learning tasks was seen as essential. I sought permission for students in the classes selected to respond to an on-line questionnaire following completion of the unit of work and for some of them to join focus groups.

Where there were technical or curriculum personnel providing support to the classroom teacher and students, I sought their inclusion as well. Perspectives of administrators who had key decision-making roles were also seen as important to the study and were included wherever possible. Some of these participants became 'key informants' that is by the nature of their position, expertise or respect they commanded, their perspectives were essential to an overall understanding of what was happening in the schools. Table 7 indicates the total number of participant staff and students in the study at each school. Numbers reflect the different type of program at each school.

Table 7
Number of participants in the study

	RCS, US	SVMS, US	OMSC, Aus	EGGS, Aus
No. staff	5	2	6	12
No. students	70	110	22	156

Considerably more staff and students are participated in the EGGS Aus study than in the three other schools. This is due to the comprehensive, coordinated nature of the ICT program in that school which involves many staff in several different subject departments, who also act in support roles. A study of just one class in one subject at this school would not provide sufficient understanding of the ways in which technology is used and supported in the curriculum. Classroom teachers are supported by an extensive range of other staff in a number of ways not seen in the other schools.

At OMSC, the other Australian school, four subject specialist teachers taught the integrated studies/technology components for the one Grade 7 class, the focus of this study. Of these four teachers, one was also the school's Learning Technology Coordinator. While on a term's long-service leave he was replaced by another teacher. Both this new teacher and. the Curriculum Coordinator, who had overall responsible for the trial Grade 7 learning technologies project are included as participants.

Both US schools chosen for the study were schools involved in the Challenge 2000 Project-Based Learning with Multimedia Project funded by the Joint Venture Silicon Valley Networks. In addition to school-based staff, support staff funded by the Project were included as participants in the study. Thus the range of staff selected included those best placed to contribute to an understanding of the pedagogical practices operating in the various classes.

4.1.9 Issues of validity

Whereas long established procedures and protocols have been devised to determine validity and reliability in research done in the positivist tradition, determining whether qualitative research can be deemed both valid and reliable is a hotly debated issue. Schensul, Schensul and LeCompte (1999 p.272–273) make a case for adapting, modifying and translating positivist rules of validity and reliability to ethnographic practice. Above all, they argue, the researcher should aim for quality. Further, Lincoln and Guba (1985) and Wainwright (1997) argue that valid and reliable procedures applied consistently throughout a study are essential if the qualitative research is to be trusted and accepted as an accurate representation of the phenomena examined. For this qualitative case study, I chose to accept these views and aimed for on-going consistent application of the research process and analysis of data grounded in the chosen methodology, while at the same acknowledging the controversies and being ever alert to the difficulties and threats to validity and reliability that research of this nature might raise.

Internal validity requires that the findings match reality; that they are a valid reflection of how respondents felt and thought about a topic. This could be problematic however, given the interactionist paradigm which argues that reality is a 'multiple set of constructions' (Lincoln & Guba, 1985). These authors argue that the investigator must show that they have 'represented those multiple constructions adequately' (p.168). Similarly, Wainwright (1997) states that qualitative researchers must be concerned with the validity of the data they collect progressively that is, with whether or not the data express the considered and authentic views of the informant, with minimal interference or distortion by the research process. Construct validity requires that the interview guides, questionnaires, focus group discussions etc are appropriate for gleaning the information being sought. Where the research is carried out over a long period, it can be quite some time between the initial data collection and the point at which consistent patterns emerge and make sense. Thus there is a need for regular checking for the validity of the research process throughout the study (Schensul, Schensul and LeCompte, 1999, p.277).

A major means of ensuring internal validity in qualitative case study is triangulation. Triangulation in research terms usually means that researchers use different sets of data, different types of analyses, different researchers, and/or different theoretical perspectives to study one particular phenomenon. Triangulation requires that the same phenomena be viewed from different perspectives and stakeholders to allow for corroboration of information gained from responses, items, events or themes (LeCompte and Schensul, 1999). These different points of view are then studied so as to situate the phenomenon and locate it for the researcher and reader alike (Denzin, 1978). Yin (1984) explains that the need for triangulation arises from the ethical need to confirm the validity of the processes. Stake (1995) adds that triangulation protocols are used to ensure accuracy and alternative explanations. In each of the cases comprising my study, I aimed to triangulate through the use of multiple sources of data (from teachers, students, administrators, classroom settings, meetings, student work), and multiple methods of data collection (participant observation, interviews, focus group discussions, questionnaires) consistently applied at each school site. According to Anfara and colleagues (2002), it is also incumbent upon qualitative researchers to publicly disclose the means they use to 'establish internal validity (triangulation), theme development and the relationship between research questions and data sources'. To this end, detailed description and accompanying tables related to the multiple data sources used is found in Section 4.2. In addition the Appendices contain samples of the various forms of data used.

Another means by which qualitative case study methodology attempts to ensure validity is through prolonged engagement. Prolonged engagement is the investment of sufficient time to achieve the purposes of learning the setting, testing for misinformation, and building trust (Merriam, 1988). Although the length of time I spent on-site at each of the four schools varied, the collection of data was sustained over a considerable period. Data collection commenced at the start of the Australian school year in 1999 and ended at the end of the US school year in June 2000. The flexible means of data collection used during this time - on-site, face-to-face field work at all sites; on-line communications from staff and students, audio tapes of meetings at which I was not present and minutes of meetings contributed to satisfying the criteria for prolonged engagement, and thus to the validity of the study.

Member checks, the taking of data and interpretations back to people from whom they were derived for checking, is another means to promote validity (Guba and Lincoln, 1988; Merriam 1988; Stake 1995). I used this strategy wherever feasible, for example when I had multiple interviews with a participant or where I had an ongoing dialogue either face-to-face when doing the fieldwork or by email, or through the focus group discussions. I decided against returning full transcripts of interviews to the interviewees for checking. Often I found teachers were so busy, that asking them to do over and above the giving of their time for the interviews, seemed an imposition. Also, in one case, when I did return an interview, the interviewee was horrified, as she thought her spoken language was very inelegant and tangential. Normally she prided herself on her grammatically correct written language and wanted to rewrite what she had said. When reassured by me that I wanted to capture her nuances and emphases as they told me so much about was important to her, she was satisfied.

Persistent observation, which requires the researcher to 'identify those characteristics and elements in the setting that are most relevant to the question being pursued and focus on them in detail' (Lincoln & Guba, 1985 p.304), is another of the techniques that can promote credibility and confidence in the findings of the study. Once it was clear to me from the emerging data what were the key issues and concerns of the participants, these were then explored and examined further, especially in open-ended interviews and discussions.

To establish validity in qualitative data analysis, Wainwright (1997) also argues that it is important to synthesise the subjective testimony of informants within a broader historical approach. He argues that issues emerging from participant observation or ethnographic data can be placed in an historical and structural context, and that problems identified in the academic literature can influence the direction of the ethnographic study. By this means,

> the researcher does not set out to test a pre-conceived hypothesis, nor is an entirely open-ended approach adopted. Instead the researcher begins by observing the field of study, both as a participant observer and as a reviewer of academic literature. From the synthesis of these sources a research agenda emerges that can be pursued, again, by a mixture of observation and theoretical work.

Wainwright draws on Hammersley and Atkinson's 1983 definition of reflexivity: the researcher's conscious self-understanding of the research process, or more specifically, to a sceptical approach to the testimony of respondents (i.e. Are they telling me what I want to hear?), and to the development of theoretical schema (i.e. Am I seeing what I want to see?). This reflexive management of the research process in the pursuit of validity applies to each stage of the research process, from establishing relations in the field to writing up the conclusions (Wainwright, 1997). Whereas grounded theorists tend to rely solely on data from the study combined with rigorous analytical procedures to make valid explanations and judgements, reflexive practice does allow for researchers to apply their personal understandings, knowledge of the relevant literature and the research process in the quest for validity.

4.1.10 Issues of reliability

Reliability refers to replicability of research results over time, different sites and populations and with different researchers (Schensul, Schensul and LeCompte, 1999). However, the term, which comes from the positivist research paradigm is particularly problematic for naturalistic, qualitative studies which focuses on never static human behaviour, where the researcher is the instrument of the investigation and where rigid laboratory controls are not applied (Meriam, 1988; Schensul, Schensul & LeCompte, 1999). Delineating clearly all of the steps in conducting an ethnographic study research is essential to ensuring its reliability and can go a long way toward ensuring that other researchers might approximate the research process - although not necessarily the results

(Schensul, Schensul, & LeCompte, 1999 p. 288-289). Similarly, Herschell (1999) uses the term 'process of believability' - the design and implementation of principles and procedures to ensure that the qualitative data, analytical tactics and outcomes are authentic, believable, trustworthy and reliable. Thus a detailed account of the research design, data collection methods and the approach taken to analysis and interpretation is provided with the view of establishing the credibility and reliability of the research.

4.1.11 Generalisability

In the case site selection process, I aimed as far as possible to find sites which would glean comparable data in order to meet the structure and focus criteria which Bennett and George (1997) believe are essential for effective comparative case studies. There was no attempt to look for a representative sample of schools in either country. Rather, I wanted to use schools with teachers and students at the same grade levels doing similar things. Case study methodology purports to describe and explain the phenomena under investigation but will not provide generalisable findings applicable to other cases or systems. Bennett and George argue that through case study methodology, researchers can seek contingent generalisations that apply to similar cases with similar variables. Ideally, these contingent generalisations will form typological theories which address the causal dynamics of many different types of a phenomenon or different causal paths to the outcomes of interest, but each generalisation is by itself still contingent. Case study researchers are more interested in finding out the conditions under which specified outcomes occur than the frequency with which those conditions and their outcomes arise.

Stake (1995) argues for a case-study approach centered on a more intuitive, empirically-grounded generalisation. He terms it 'naturalistic' generalisation. His argument is based on the harmonious relationship between the reader's experiences and the case study itself. He expected that the data generated by case studies would often resonate experientially with a broad cross section of readers, thereby facilitating a greater understanding of the phenomenon.

4.2 Data gathering across time and space

This section explains the methods used for data collection, the methodological challenges faced, and provides details of the data set obtained. Consistent with a study adopting an interactionist framework, multiple sources of data and multiple techniques were used to explore the research questions and to provide ample opportunity for triangulation within the individual schools and across the data set as a whole. Of particular concern was the need to find flexible means of collecting comparable data in both Australia and the US, given I was the sole researcher and that data was to be collected in two countries, in four schools, sometimes simultaneously. Thus on-line sources (student questionnaires, teacher emails and on-line reflections) were adopted alongside face-to-face ones (interviews with staff, informal conversations, classroom observations, student focus groups, attendance at teacher meetings). In addition, meetings I was unable to attend personally in Australia were audio-taped and posted to me, and meeting minutes were forwarded as email attachments or delivered in hard copy. This design was consistently applied at each school site. Although the numbers of teachers and students involved differed, and the framework for curriculum delivery at each school, and in each country also differed, the same research principles applied. In all cases in this study, data were obtained through the voices of individual teachers, the teachers in meetings, the students individually, and collectively in focus groups, and from my observations.

Discussion of each of the methods used follows. Details of the data set are included in tables either in the body of the text or incorporated into the appendices.

4.2.1 Time spent at each school

Well in advance of the formal data collection phase, I spent time at each school, meeting with the Principals, Curriculum and Information Technology Coordinators, classroom teachers and other stakeholders, explaining my purpose, discussing logistics and establishing trust. In all instances this required more than one visit. Schools, on both sides of the Pacific, are very busy places, and teachers' work, especially at peak times such as reporting to parents, can be punishing. Uppermost for me was to reassure stakeholders that my aim was to understand what was happening in their schools and technology-using lessons, to request as little of their time as possible and to assist their work if requested. Time was also needed to obtain the necessary ethical clearances from participants. Table 8 shows the time actually spent at each school in the data collection phase.

Table 8
Time spent at each school

RCS, US	SVMS, US	OMSC, Aus	EGGS, Aus
7 Dec – 14 Dec 99	7 Feb – 30 Mar 00	21 May – 3 June 99	18 May – 2 June 99
11 Jan – 30 Mar 00	18 – 26 May 00	20 October 99	14 – 22 October 99

Several factors determined the amount of face-to-face time spent at each site in the data collection phase and what I was able to achieve at each site. I scheduled my two-week return trips to Australia in the second and fourth terms of the Australian 1999 academic year. EGGS had computer projects scheduled in all their grade 7 and 8 classes throughout the year and classroom observation, meeting attendance, interviews and focus groups were readily achieved during both visits. Exact replication was more problematic at OMSC, the other Australian school. Only one of the OMSC grade 7 classes was involved in the study, and of the three interdisciplinary multimedia projects planned for the year, I was unable to observe the first as it did not coincide with my visit and the school did not proceed with the third project. Nevertheless the second and most extensive project straddled both visits enabling time for similar data collection methods to those used at the other schools. So, despite a similar design, the time actually spent on-site at OMSC was considerably less than at the three other schools.

I was able to spend more time over longer periods in direct contact with the classrooms, students and teachers in the US schools. The teachers involved therefore did not recourse to on-line reflections or email as was the case with the Australian teachers. The fact that the academic years in the US and Australia differ was an advantage as it allowed for staggering the gathering, receipt and management of the large volume of data.

4.2.2 Participant observation

Real-time observations of teachers and students in classes and attendance at meetings where teaching and learning in multimedia environments were either in operation, or the object of discussion, were a major component of the design of this multi-site case study. As noted earlier, I offered to help in classes and participate in meetings if asked and this offer was taken up at all sites to varying degrees. For example, many times in all school sites, I assisted students, and sometimes teachers, with technical difficulties or advice on computer or software issues. In some meetings and in *ad hoc* discussions my contributions and opinions were sometimes sought. In Australia, at EGGS, the school in which I had previously been employed, there was also a sense of staff wanting to share new developments with me and garner reactions to these. Balancing the need for trust and a willingness to participate, while maintaining a sufficient objective outsider stance, was therefore always a consideration and a challenge. In the US schools my presence was considered somewhat of a novelty and I was welcomed as bringing a fresh perspective to critical issues. The perspective of an Australian educator who was able to identify with and relate to many similar problems and issues relating to the use of educational technologies in the US was advantageous to establishing acceptance in the researcher role.

4.2.3 Classroom observation

Computer-mediated learning tasks in the classrooms of the type under examination here are messy to observe and can be even more difficult to represent accurately. In any one instructional period, students can be engaged in several quite different learning activities relating to both content and skill, using different software packages, and solving different technology issues in different ways and with different levels of ability. The vagaries of technology can frequently interfere with the instructional design plan of the teacher. Teachers in these classes can also move between different roles: instructor, facilitator and learner. Moreover, often overt observable intense involvement and engagement of students in computer-mediated activities can mask quite superficial and low-level cognitive tasks. Recording and conveying accurately what is happening is difficult even if there is more than one researcher involved in the task.

Initially I set out to record specific classroom interactions at each school in a very structured way using a classroom observation proforma (see Appendix A). Devising the proforma had allowed me to identify and focus on features and aspects of the class activities that might be of significance: design and structure of lesson, time spent on various activities, role of teacher as instructor/facilitator/discussion leader, pattern of interactions between teachers and students, students and students, student access to and use of technology; problems experienced, how problems were solved. Using the structured format at each site was initially very valuable. However, as I became more familiar and comfortable with the different classroom settings, teachers and students, and as most of the projects observed were undertaken over an extended period of time in the same learning setting, I found the proforma too restrictive. As the participant observer I gained more insight by walking around, watching and talking with students and teachers as they worked. Students and teachers knew I was a knowledgeable adult and often asked me for help or comment as well. Thus I came to prefer to describe each classroom observation session in my notes both during (if appropriate) and/or after an observation session. These notes might include: broad description of the lesson and the teachers' instructional procedures; specific issues faced by the class or by individuals; snippets of conversation; impressions and comments on significant events; items that needed validation from other sources or means, questions for further research etc. The notes were then coded and available to draw on during the analysis and writing phases. An example of my rough field notes is included (see Appendix B).

Although this approach was useful in trying to capture and portray the messiness of the classroom experience, it is acknowledged that one researcher cannot hope to observe record and make sense of all factors at play. Moreover, I was also mindful of subjectivity and personal bias issues in what I chose to focus on in the course of an observation session.

Table 9 (p.93) gives details of the number of classes observed at each site.

4.2.4 Formal meetings and informal discussions

I endeavoured to attend as many relevant meetings as possible. At the two Australian sites, I was invited to attend and participate in formal teacher meetings where matters for discussion included: issues relating to implementation and progress of the particular programs or units of work; pedagogical practice in computer environments; school policy relating to the use of technology across the curriculum. Most of these meetings were successfully audio-taped by me and personally transcribed. Audiotapes of relevant meetings I was unable to attend at EGGS, Aus were forwarded to me in the US. The other Australian school, OMSC, forwarded me minutes of their meetings which I was unable to attend in person. As referred to above, rarely was my role when attending meetings in the Australian schools one of passive observer. In both schools I was often asked to contribute an opinion or suggestions as someone who had considerable experience with the issues under discussion.

In the US, attendance at in-school meetings at the two schools was not appropriate for several reasons. At RCS, the focus of the study was the two grade 8 Social Studies classes taught by the one teacher. No formal meetings were held between her and the Technology Learning Coordinator, the one most directly involved with her work. Planning and discussion were held on an infrequent, *ad hoc* basis. This scenario was repeated at SVMS, US. There were no formal meetings between the grade 7 and 8 Spanish teacher and her sources of support - their discussions and planning sessions were also held (infrequently) when and as required. However, I did attend nine of the monthly meetings of the Challenge 2000 Multimedia Project's Technology Learning Coordinators (TLCs). Members of this group included the TLCs allocated to SVMS and RCS, the two US schools in the study. Through the reporting framework of these meetings, specific information about SVMS and RCS, and the student projects were tabled by their respective TLCs and discussed in the broader context. So although no formal meetings were attended at the two US schools, gathering of pertinent school data was enabled through attendance at this forum. The TLC meetings were designed to update participants and provide opportunities for sharing and reflection on experiences in the Challenge 2000 Project. Participation in these meetings assisted me considerably in understanding the context and framework for innovative technology use in these Californian schools. I was able to explore the policy and practices driving the Challenge 2000 Project and the ways they played out in a large number of northern Californian schools including the two schools in this study. I was able to see at first hand the impact an injection of US Federal funds, expertise and expectations could have. These meetings also provided insight into the operation of the support network for the Technology Learning Coordinators themselves. In contrast to my meeting attendance at the Australian schools, I was much more of a passive observer in these US meetings. I was considered to be the interested, informed outsider allowing me greater freedom for objective reflection. Also in attendance at these meetings were the evaluators and researchers involved with the Challenge 2000 Project. Thus these TLC meetings and the resultant networking with its members provided a rich source of data enabling insight into the particular schools under study as well as the broader issues facing use of educational technology in US schools. Table 9 (p.93) gives details of the number of meetings available for analysis.

Many, many informal discussions and activities with participants and myself occurred at all sites. These occurred prior to and at the end of lessons, over lunch, in the corridor. I noted the gist of these conversations and annotated them as soon as possible after the event as well. I realised, however, that relying on memory to truly capture the meaning and nuances of the dialogue was more difficult than using an audio-taped version.

4.2.5 Teacher on-line reflections and email communications

In addition to face-to face contact with, and observation of, participants at each of the four sites, on-line communication in various forms enabled contact in a timely way, not possible had I relied solely on my physical presence at each site in either country. Through regular email contact with teachers and through an on-line Teacher Reflection proforma (see Appendix C), I was able to keep track of their thoughts regardless of where I happened to be. The on-line reflection format was designed to give teachers the opportunity to put their thoughts down as soon as possible after a lesson or significant set of behaviours. I used the issues and concerns raised in these reflections in several ways: to build a picture of classroom practice even when I was not present, as a basis for further exploration in face-to-face-interviews, as a means of helping shape what I should look for in classroom observations, and for helping to frame the focus group discussions with staff and students. (See Appendix D for a sample teacher reflection).

These forms of communication were particularly valuable in the Australian schools as I spent less time there. I don't think I would have been able to establish the same level of trust and confidence if I had just arrived at the schools several months between visits and be expected to take up where I had left off last time. In this way I felt I had a reasonable understanding of the units of work and teachers' difficulties, challenges and successes. Interview time was thus able to be used for clarification and elaboration, rather than starting from scratch. Familiarity and comfort with the use of email and on-line reflections varied however. At the start of the study, staff at OMSC, Aus had only recently been allocated portable computers with Internet software and some of them had had little training in the use of email. As the study progressed, so did the comfort level. Other factors constraining the successful use of on-line communications were network crashes and teachers finding time in their busy lives to communicate with me. None of the teachers in the study had a computer permanently connected to the Internet available on their workspace desk. This meant teachers who wanted to communicate in this way with me needed to use either an Internet-connected computer in a staff room, connect up their portable computer or wait until they were at home to use a connection there if they had one.

Table 9 (p.93) gives details of the number of on-line teacher communications available for analysis.

4.2.6 Student on-line questionnaires

An on-line Student Questionnaire (see Appendix E) asking for both structured and open-ended responses was designed for completion by students at the end of their unit of work in which the use of the Internet and presentation in multimedia formats were required. The aim was to elicit from students what they perceived were the learning tasks asked of them, the range of computer hardware and software used in doing those tasks, any problems encountered, what support was available for them and to reflect on their learning in a technological environment. The richness of relevant data obtained indicates the questionnaire items were appropriate and met demands for construct validity. Student perspectives gained from the open-ended items were particularly valuable. The questionnaire was available in digital form and students submitted their responses on-line directly to me. This had a number of benefits: it was relatively easy for students to complete, requiring on average 10 minutes; the format mirrored the digital learning environment of the unit of work; it allowed me instant access to responses wherever I was; and because the data were in digital form, it was relatively simple to insert into the NVIVO software for coding and analysis. I am grateful to SRI, Palo Alto, California for their assistance in receiving the questionnaires on their server and scripting the data before redirecting it to my email address. Thus I was able to keep abreast of the students' experiences and attitudes in a timely way. It also gave me the opportunity to digest and reflect on the data prior to pursuing ideas and issues in subsequent focus groups with students and teachers, and in meetings or interviews. This use of technology was able to support the ethnographic research framework, in that I was able to further clarify, explore and probe ideas, which distance, time and logistics might not normally have permitted.

However, not all students in every class completed a questionnaire. Time constraints, competing curricular demands, inaccessibility of computers and some technical difficulties affected the overall number of responses received. Technical difficulties at OMSC in Australia were a particular problem. A network crash while questionnaires were being transmitted accounted for a low response. Moreover, of the four responses that were received from this class, only two were really useful. The other two were obviously not completed with any degree of seriousness and no open-ended questions were completed. Both the technical problems and the way in which some students treated the study, reflected broader issues at this school. These will be elaborated later. Therefore, to understand the experiences of these students, greater reliance on focus-group data, the teachers' comments and my observations was necessary.

Student Questionnaires were also not received from all students at EGGS in Australia, albeit for different reasons. The grade 7 English class lost the period designated for the task and the teacher was unable to reschedule the time. Nevertheless, alternate sources ensured I had access to the range of student perspectives: two students from the English class were involved in the grade7 focus group and I had access to several student self-evaluations about their technology use from this class. The self evaluations were teacher- administered and contained an open-ended question similar to mine (see Appendix F for a sample). Questionnaires were received from students representing all other grade 7 and 8 subjects involved.

Nearly all students in all classes in the two US schools completed the on-line questionnaire. Table 9 (p.93) gives details of the number of student on-line questionnaires received from each site.
The immediacy of the on-line communication from both students and teachers was impressive, especially when Australian responses were received in California and vice versa. Being able to read, manage and analyse the responses soon after completion, despite the differences in time and distance, made for a far more satisfying research experience than might otherwise have been the case had I needed to rely on other means to get the same sort of data. Thus, given the on-line student responses, together with teacher reflections, via the Teacher Reflection template and email communication, the potential difficulties in attempting a cross national study by one researcher were diminished.

4.2.7 Interviews

Audio-taped interviews were conducted with classroom teachers and other staff at each of the school sites. Table 9, p.93 provides details of the number of interview conducted at each site. In the early stages of the study, these interviews were semi-structured, with similar types of questions asked of each interviewee. As the study progressed and I became more familiar with the personnel involved and the issues at each site, I used the available interview time to pursue the identifiable concerns emerging from the growing data pool and items relating to the study with which the interviewee was most concerned. During interviews, where I had previously received email and on-line communications from the participants, these were referred to. Interestingly, at times teachers had forgotten the intense feelings experienced when reflections were written, and by the time of the interview were able to bring a less emotional, more measured view of the behaviours or events that prompted the response. Similarly, where appropriate, references to my classroom observations and items from meetings were also included for exploration in interviews. I found the face-to-face interactive time spent with interviewees very valuable as often their comments were frank, whereas in meetings with their peers some tended to be more circumspect. We were able to explore issues at length and I was able to check and verify comments and impressions in pursuit of and efforts to ensure validity. Keeping the interviews on track in the time set aside was sometimes an issue. Staff mostly relished the opportunity to talk about their work, and some used the time to criticise the institution or culture of their school along paths tangential to the focus of study. To remain encouraging and non-judgmental were further skills I needed to draw on at times. An extract from an interview is included (see Appendix G for an extract from an interview).

In all instances where interviews, focus group discussions or meetings were audio-taped, I transcribed the data myself. Although time-consuming, I found the experience invaluable. Through personal transcription I was able to thoroughly capture the ideas and thoughts of the interactions, to recall the nuances and emphases and to grapple with issues difficult to understand or exchanges that may or may not have been significant. As I was transcribing I was also able to categorise and code the data for later analysis.

There were the occasional problems with the tape recording equipment, both with interviews and in focus groups. Where this occurred in interviews, I took notes during the session, and compiled a summary afterwards. I then submitted my notes to the interviewees for verification. A similar problem occurred with one focus group discussion forcing me to summarise the discussion as best I could but without recourse to checking by the students. Nevertheless the quantity of data obtained from students individually, did serve to counter balance this.

4.2.8 Focus-group discussions

Focus-group discussions with students at all schools and with teachers at the Australian schools were organised to enable the researcher to pursue in more depth the participants' attitudes, beliefs, and experiences emerging during the study, than was possible in observations, interviews and on-line communications. Powell and Single (1996, p.499) define a focus group as 'a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research'. By eliciting multiple perspectives and explanations of behaviour through questions, dialogue and discussion, focus groups can well serve the symbolic interactionist paradigm. Morgan (1988) recognises that focus groups can elicit information in a way which allows the researcher to find out why an issue is salient, as well as what is salient about it. However, Morgan warns that the researcher has less control over the data produced than in one-to-one interviewing. The moderator has to allow participants to talk to each other, ask questions and express doubts and opinions, while having very little control over the interaction other than generally keeping participants focused on the topic. By its nature, focus group research is open-ended and cannot be entirely predetermined.

Another possible limitation of focus groups is it should not be assumed that the individuals in a focus group are expressing their definitive individual view. They are speaking in a specific context, within a specific culture, with the result that sometimes it may be difficult for the researcher to clearly identify an individual message. Gibbs (1997) refers to other possible limitations of the value of focus groups. Focus groups can be difficult to assemble. It may not be easy to get a representative sample and focus groups may discourage certain people from participating, for example those who are not articulate or confident. The method of focus group discussion may also discourage some people from trusting others with sensitive or personal information as the groups are not confidential or anonymous.

Focus-group discussions, involving groups of six to eight students, were held at all sites during the students' lunchtimes. Teachers were asked to invite students with a range of ability and comfort level with computers and who were happy to talk about their experiences to join the discussions. By this time, students in each site were familiar with me and my research role as I had spent time in all of their classes. Also, by the time I met with each of the groups, I had received the on-line student questionnaire responses from the schools giving me an understanding of the collective response of students to the unit of work they had completed and their attitudes to the use of computers for learning. The discussion time with students enabled me to explore in more depth, issues drawn from the aggregated responses, interesting individual responses and impressions gleaned from classroom observations and other data collection methods. Each of the student focus groups was valuable in illuminating more clearly the issues from the participants' perspectives. (See Appendix H for an extract from a focus group discussion).

Where appropriate, I also held focus-group discussions with groups of teachers involved in the programs. Focus groups with teachers were held at both Australian sites but not in the US schools, where only one or two teachers teaching across several classes were involved. This is a reflection of the different school structures in each country. To focus the discussions, teachers were asked to individually complete a Discussion Prompt (see Appendix I). The prompt sought out teachers' feelings and attitudes about teaching and learning in a multimedia environment, its perceived value for their students and what they most needed to continue in this mode. The US teachers were asked to complete the same prompt prior to our interviews. The prompt, which was designed as the issues emerged and crystallised during the course of the study, was successful in tapping into the key experiences, reactions and feelings of the participants. Originally conceived as a discussion starter, the prompt also became a valuable tool to examine teachers' views and experiences more closely. Further, use of the prompt served to expose different interpretations held both on my part and among participating teachers about the meaning of the words 'challenging' and 'challenged'. Without a Focus Group discussion these misconceptions might not have been detected. Section 7.5 examines this issue in more detail.

Table 9 shows the major data collection methods used and the number of items available for analysis.

Table 9
Data items available for analysis

	RCS, US	SVMS, US	OMSC, Aus	EGGS, Aus
No. classroom observations	17	16	6	35
Teacher on-line reflections/email communications	-	-	6	15
No. teacher interviews	5	2	5	10
No. teachers in focus groups	-	-	5	6
Meetings	Challenge 2000 Multimedia Project TLC meetings - 9		observed - 2 minutes - 4	observed - 6 audio-taped - 6
Teacher Discussion Prompts	3	2	4	9
No. student questionnaire responses	60	112	4	80
No. students in focus groups	8	Grade 7–5 Grade 8–6	7	Grade 7–7 Grade 8–6
Student evaluations	-	-	-	9

4.2.9 Documents

Various forms of print and on-line documents from each of the countries were also considered. At the school level, these documents include policies, brochures and journals, reports, and curriculum and syllabus outlines. To contextualise school-based information, extensive use was also made of information from district, state and national education sources chosen to add to the pool of understanding about the approach each school had to the use of computers in the curriculum.

4.2.10 Student multimedia presentations

Throughout the observation phase in the classrooms I watched the development of the students' multimedia presentations and with most of them I was able to see the finished products. Some schools uploaded the student work onto their websites to enable viewing by a wider community than the school. In some instances I sat with teachers as they assessed the presentation and explored with them the quality of the work as they perceived it. There was no systematic attempt to look at all the student work or to make cross-site comparisons: - this was beyond the scope of this study.

4.3 Management, analysis, representation and interpretation of the data

A major concern was how to effectively manage the mass of data from all sources and to compile it into a useful form for analysis and interpretation. The key ethnographic research methodologists, whose approaches I have drawn from when designing this study, tend to refer to the tasks of meaning-making from a large mass of mainly unstructured data in similar ways. In essence, rigorous analysis and interpretation of data, which may also lead to theorising, is fundamental to doing qualitative research. According to Patton (1980), analysis brings order to the data, turns raw data into smaller crunched or summarised data, and permits discovery of patterns and themes. Miles and Huberman (1984, p.21-23) consider analysis to be data reduction, data display, and conclusion drawing and verification. Analysis turns 'raw data' into cooked data and is a critical step leading to interpretations and implications for further research, intervention or action. Interpretation, the second step of the analytic process, requires the researcher to figure out what the crunched data mean, or what they say about the people, the groups, or programs the ethnographer has been studying (LeCompte & Schensul, 1999).

4.3.1 Qualitative data analysis software for data management and analysis

To assist with the storage, management and ongoing analysis of the data I chose to use the qualitative data analysis program NVIVO produced by QSR International. Several factors influenced my choice:

- the program's ability to handle documents which could be edited, annotated, coded and linked, both internally (to other project documents and to my memos) and externally (to multimedia data and Internet URLs)
- the ability to search and retrieve textual data coded and organised in a variety of flexible ways and to constantly refine these searches as new data or ideas were added
- the ability to create attributes for each document (e.g. school, country, role, gender, opinion on a scale) and then to filter and search the attributes.
- the ability to generate frequency tables and matrices from coded data which could then allow the data to be represented in a range of ways, including graphs.

Having chosen the software, I embarked on a steep learning curve on how to use it. Struggle, trial and error characterise this period. As mentioned earlier, one of the ways I coped was recourse to the on-line (email) community of users of the software. Once mastered, I found management, search and retrieval of the data, both efficient and effective. In particular, the search capabilities of the tool made it possible to call up and look at the data in a range of ways which probably I would not have attempted if not using computerised assistance.

4.3.2 Coding

Coding of data is the fundamental means by which order is initially placed around the data set. Codes are used to represent concepts, categories, regularities, patterns or themes around people, ideas, events, and attitudes to support later analysis and interpretation. Coding can be done deductively, established prior to the study or inductively as the study is in progress, drawn directly from the data. According to Goetz and LeCompte (1984 p.191), devising categories is largely an intuitive process, but it is also systematic and informed by the study's purpose, the investigator's orientation and knowledge, and 'the constructs made explicit by the participants of the study'. As categorisation develops, the codes are often arranged hierarchically in trees with sub sub-codes collapsing into sub codes, subsumed into larger codes. Merriam (1988) argues that qualitative research requires on-going analysis throughout the course of a study, otherwise there is risk in developing an unfocused, repetitious and voluminous data set. Further, she states the researcher needs to be more than a recording machine, but rather a critical thinker who constantly reflects on theoretical, methodological and substantive issues throughout the investigation.

4.3.3 Data analysis

Throughout the study, my record of observations, transcriptions of interviews and meetings, email communications, teacher reflections and student questionnaires, and notes from my literature search were entered into the NVIVO program as soon as possible. I was then able to edit, annotate, group, code and link each of the documents - the first stages in analysis described above. Initially in the coding process, I established attributes and sets to represent staff, students, school sites, demographics for example Concurrently, I allocated codes to classroom practices, attitudes, hardware and software used, theories etc. As more data were transformed into digital form and entered into the data base, I was able to detect patterns and themes and sub-themes. In NVIVO these patterns are known as trees with parent and child-trees. (see Appendix J for a sample).

The ability to easily record my thinking-in-progress either by a direct annotation on a document, by a more comprehensive memo in which I was drawing ideas and themes together, making links to relevant literature or data in other documents, enabled constant engagement with the data and broader reflection on its relationship to the research questions. In turn, this on-going reflective process often raised other issues, ideas and questions for further exploration in the field. (See Appendix K for an example of an annotated document and memo).

The ability to make both simple and very comprehensive interrogations of the data quickly using NVIVO was also a considerable advantage in both the analysis and interpretive phases of the study. Text searches allowed for easy access to words or phrases by classes, subject taught, teacher, student, school or country or my observations. Drawing on Miles and Huberman's (1984) and LeCompte and Schensul's (1999) ideas on the value of matrix formation for understanding and interpretation of data, I constructed various matrices, for example, linking data from the coded open-ended responses to other codes and sets of attributes.

A sample of the process in which data were managed and analysed in both qualitative and quantitative means, including the construction of matrices, is included in Appendix L.

4.3.3 Representation of the data

In the construction of this thesis, I present the data and analysis of findings in several different ways. My objective is to extract and convey the key issues facing each school as teachers and students use multimedia technologies for curricular activities. Exploration of a variety of quantitative and qualitative data at the micro (school) level and in the broader systemic and national contexts has enabled exposure of recurring themes and differences. I use diagrams, tables and graphs, objective report format, 'thick description' and 'vignettes' to represent, compare, and illustrate both the situated context of each school and the shared and different issues at work there. A particular form of representation was chosen either because it best suited the nature of the data or because it allowed for a deeper understanding of the school, students, teachers and their educational work with technology.

Thin and thick Description

Thin and thick description (Denzin 1994) are two devices used here to represent the data. For example, in Chapter 5, which describes the broad systemic, state and national, local contexts for each of the schools in the study, I use what calls 'thin' description. Thin description 'simply reports facts, independent of intentions or circumstances'. Supporting the 'thin' description is extensive use of tables and diagrams to display the comparative data in a visual way. In the following chapters I then develop an understanding of the individual schools, and the major contextual factors operating there, through use of 'thick' description. Thick description 'gives the context of an experience, states the intentions and meanings that organized the experience, and reveals the experience as a process. Out of this process arises a text's claim for truth, or its verisimilitude' (Denzin, 1994, p.505).

Vignettes

In Chapters 7 and 8, I explore student and staff experiences and perspectives in close detail and also include a number of vignettes to highlight particular themes and patterns. Le Compte and Schensul (1999, p.181) describe vignettes as 'snapshots or short descriptions of events or people that evoke the overall picture that the ethnographer is trying to paint'. Both the thick descriptions and vignettes are firmly grounded in the data. Each section of a vignette can be triangulated through at least three data sources, even more in most cases. For example, in the Outer Melbourne Secondary College Australia vignette (see 7.3), the sentence: 'PD has almost been non-existent and when is there any time to do it?' was constructed from analysis of frequently recurring incidences from multiple data sources. The need for professional development in technology use and the unrelenting demands on teacher time were referred to by all integrated project staff: individually in interviews, teacher prompts, and email messages and collectively in teachers' meetings. The same issues were also raised separately in interviews and discussions with the Curriculum Coordinator and Learning Technology Coordinator. Support for technology integration is clearly documented in the current OMSC College charter and in the funding arrangements for both the staff laptop program and the grade 7 integrated project. Despite this however, staff felt frustrated and unsupported. Moreover from my observations, it was quite clear the staff had little understanding of the chosen software, were diffident about its use and finding it incredibly difficult to create the extra time needed, either for PD or for planning, in their very busy working days. By condensing the considerable range of data to one sentence: 'PD has almost been non-existent and when is there any time to do it?' it is hoped to convey powerfully that this was a highly significant issue at this school.

Vignettes are also used to highlight similar themes found across the four sites and to draw attention to differences. Further, vignettes also provided opportunities for broader interpretative analysis by linking clearly identified themes in all schools to related relevant and significant findings in other research studies and commentary. For example, studies both in Australia and the US clearly indicate that most teachers need support when they use technology for learning activities. This support might include in-class, or readily available, technical assistance, help in learning how to integrate technology into curriculum activities, or simply more training in using hardware and software. Data from all four sites also deemed this to be a significant issue – either by its presence or absence. Thus, because (for this issue) the data were clearly reflective of findings from other major studies, it was included in each of the school vignettes. Through repetition of the issue in each of the vignettes, and by drawing comparisons between the four sites, the qualitative data here are also used to support and 'flesh out' the quantitative data used in other studies. Thus the comment in the SVMS (US) vignette (see 7.2): 'Also, as at RCS and EGGS in Australia, Carol, the classroom teacher, is not the only adult in the room', not only flags that support is a significant issue, but by continuing to explore its different manifestations in the other vignettes, it is hoped the reader will understand that this is an issue that truly crosses borders.

Selection of items to include in a vignette, given the large volume of data acquired during the research phase, was considerably assisted by the qualitative data analysis software, NVIVO. Following sorting and coding of data into themes, the ability afforded by the software to easily search and retrieve coded nodes, and display them in various report formats and matrices, helped to establish a framework for a first stage analysis. Emergent themes for a school could be readily identified and closely examined, by linking directly back to the original interview transcript, questionnaire, observation notes or other data sources. Examination of a recurring theme or pattern, reflecting on its significance and tracking back to re-read its sources, contributed to a developing confidence in creating a story which validly reflected a particular phenomena.

Verbatim quotes

Direct verbatim quotes by participants are used frequently in the presentation of data. Chosen to best represent the issue under examination, quotes are incorporated into thick description or vignettes where appropriate. The inclusion of quotes by participants from each of the sites on the same issue, both where views converge and where they differ, can serve to highlight and illustrate these issues more powerfully than reliant solely on my interpretative lens. In Chapter 8, in particular, where the focus is on the students' perspectives, at times I include several quotes from students from both the Australian and US schools consecutively in a block. In this way I draw attention to the similarities in the way these young people view and talk about using computers in school.

Quantitative data

Although mainly a qualitative study, quantitative measures were adopted where appropriate. For example, aggregated opinion and attitudes were possible from both Likert scale and open-ended items on the student on-line questionnaire. Aggregation and graphical presentation of the Likert scale items was relatively straightforward. Although coding and pattern analysis of open-ended responses, then their representation in table or graphical format, was far more time intensive, the process was useful in clearly conveying the collective experiences of the students, and the similarities and differences between each of the schools. However, there is no attempt to apply any more sophisticated statistical analysis to the data other than percentage calculation. In all cases where aggregated data is used, it is in conjunction with data from as many other sources as possible. Several forms of tables and graphs are used in Chapters 5-9 to display the data where relevant. Furthermore, in some instances, both quantitative and qualitative treatments of data are used to highlight an emergent theme and to strengthen its case. By relying on quantitative data alone, the outcome may have provided a partial picture only. For example, one item in the Student Questionnaire: 'How satisfied are you with your finished project?' required students to indicate a specific response on a 5-point scale. When aggregated and tabulated, the 257 responses to this question clearly showed a high level of satisfaction among all students with their multimedia products. Such high levels of satisfaction were unexpected, given my observations of their frustrations and with many of the student comments in the various opportunities provided by open-ended items on the Questionnaire. Through further data analysis of other open-ended items and follow-up questioning in focus group sessions, a richer picture of why students enjoy what they were doing and why they found it satisfying, despite the difficulties, is presented.

4.3.4 Interpretation and representation of the data

Various strategies have been devised for analysis and interpretation of raw qualitative data (Glaser and Strauss, 1967; Miles and Huberman, 1984; Woods, 1986; Merriam, 1988; Strauss and Corbin, 1990; Le Compte and Schensul, 1999). Commonly these writers view the process as recursive. Merriam (1988 p. 147) writes: 'Data analysis is a complex process that involves moving back and forth between concrete bits of data and abstract concepts, between inductive and deductive reasoning, between description and interpretation'. Interpretation of the data requires on-going reflection on the phenomena in the different contexts in which it is studied and a return to related and relevant literature to establish its meaning and significance in a broader theoretical sense.

Representation and interpretation of the data commences in Chapters 5 and 6 by placing the schools within their broader contextual framework. The items and issues selected are based on my understandings from the literature and my judgements as to the background knowledge necessary for understanding of the portrayal to come. In Chapters 7 and 8 I choose to focus more on 'telling the stories' of the individuals, revealing experiences, opinions and attitudes of the teachers and students as they teach and learn with multimedia. Chapter 9 examines in closer detail emergent themes and issues from the data presented. It provides some interpretation of the findings and concludes with a discussion of the themes and issues within the broader research and theoretical context.

Chapter 5

National, state and local contexts for the study

Some understanding of the broader contexts in which the comparative study was conducted is necessary. This chapter includes an overview of the systems of education and the frameworks established for the use of educational technologies in the respective education systems in Australia and the United States. The chapter contains two sections. It starts with the macro (national and state contexts), and moves to the micro (local and individual school) policies, structures and practices which impact on why and how educators use ICTs in their curricula. Although not exhaustive, the broad systemic comparison included here should provide enough detail for an understanding of key factors at play at the school level.

5.1 Governance of schooling and provision of educational technology: US and Australia

Similarities between systems are evident: the relative balance of federal and state responsibilities for education, the structural organisation of K-12 schooling, and government and community expectations of schools to provide young people with digital skills. However, significant differences in numbers of schools and students, end point delivery and responsibilities, funding sources, accountability testing, and reward culture are also apparent, and need consideration when comparing the two systems' approach to educational technologies at the school level. In the following sections I outline these significant comparative features and indicate where particular policies or programs have directly impacted on practice in each of the schools in this study. This section thus becomes a point of reference for the detailed comparative analysis of school sites covered later in the dissertation (Chapters 6-8).

No comparison of education between Australia and the US is appropriate without recognition of the size disparity in numbers of students and schools at the national levels and in the states in which the schools in this study are located (see Table 10).

Table 10
Comparative data on public and private schooling in the United States and Australia 1999 -2000

	Australia[10]		United States[11]		Victoria		California[12]	
	n	%	n	%	n	%	n	%
Total no. of public schools	6,961	73	89,599	77	1,629	70	8,563	67
Student enrolment in public schools	2,248,287	69	46,900,000	90	528,189	66	5,951,612	90
Total no. of private schools	2634	27	27,223[13]	23	695	30	4,310[14]	33
Student enrolment in private schools	999,138	31	5,076,119	10	273,506	34	648,564	10

Considering the sheer numbers of schools and students involved, particularly in the US, establishing policy, framing action and ensuring successful adoption practices to meet the rhetoric and expectations of governments and communities for students to become digitally literate for the 21st century is daunting.

5.2 Federal government role in education - US and Australia

The legal structures and organisation of education in the US and Australia are remarkably similar. In both countries, the federal governments do not have direct constitutional responsibility for education. Constitutional and financial responsibility for education lies with the states and territories in Australia, and with the states, and local school districts in the US. Nevertheless, both federal governments do support schools nationwide within their constitutional powers, and both support school provision of educational technologies in a variety of ways.

5.1.1 US federal government role

The role of the federal government in US education has been one of 'broad leadership without undue control' (*Progress of Education in the United States of America: 1990 through 1994*). It has legal responsibility 'to safeguard the right of every citizen to gain equal access to free public institutions and equal opportunity in the pursuit of learning'. Within these boundaries, the US Federal Government attempts to improve the quality of education nationwide through the funding of research, direct aid to students, and the dissemination of knowledge about teaching and learning. This context also frames the work of the Federal Education Department's Office of Educational Technology whose charter is to 'assist the education community with meeting the national goals for

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10 All Australian and Victorian statistics from *National Report on Schooling in Australia*, MYCEETYA, 2000
11 US-wide public school data from U.S. Department of Education, National Center for Education Statistics, Common Core of Data, *Public Elementary/Secondary School Universe Survey 1999-2000.*
12 California public school data from California Basic Educational Data System, 1999.
13 US-wide private school data from the NCES Private School Survey (PSS), 1999-2000
14 California private school data from Counting California (2000).

educational technology' and to implement and oversee special projects (*Office of Educational Technology website*, 2001). Two major Clinton administration initiatives were in effect during the course of this study: the E-rate and the Technology Innovation Challenge Grants. They are illustrative of the way the US Federal Government works within its powers to deliver funding for educational technologies at the school level. The E-rate legislation (enacted in 1997) was designed to enable elementary and secondary schools and public libraries affordable connections to the Internet by providing discounts (e-rates) on approved telecommunications, Internet access, and internal connection costs. The Technology Innovation Challenge Grants (TICG) program 1995-2000 was designed to support partnerships among educators, business and industry, and other community organisations to develop innovative applications of technology and plans for fully integrating technology into schools. Both US schools in this study were participants in one of these federally funded five-year TICG programs operating in California. Under the banner of Joint Venture Silicon Valley, this consortium of interests played a significant role in the approach to technology use in these schools, and are discussed further below.

5.1.2 Australian federal government role

In Australia, as in the US, the federal government has no day-to-day responsibility for schools but does provide Australia-wide funding and co-ordination for schools and systems. It allocates funds to state governments for recurrent, capital and specific programmes to help achieve the nation's priorities for schooling, and undertakes policy development, and research and analysis of nationally significant educational issues. Roles shared by the federal, state and territory, and non-government school authorities include coordination of strategic policy at the national level, negotiation and development of national agreements on shared objectives and interests, national reporting, sharing of information and collaborative use of resources. For example, in relation to ICTs, the commonly agreed National Goals of Schooling for the 21st Century affirmed in 1999 by all federal, state and territory education ministers includes the statement that students should 'be confident, creative and productive users of new technologies, particularly information and communication technologies, and understand the impact of those technologies on society' (MYCEETYA, 1999). One initiative designed to 'promote the benefits of the Internet for learning, education and training in Australia' was the establishment in 1995 of EdNa (Education Network Australia), a company owned and funded by all Ministers of Education and Training (Mason, Dellit, Adcock, & Ip, 1999). EdNA houses and provides links to thousands of on-line resources in Australia and internationally and aims to foster collaboration and communication amongst and between the education sectors through communication links and information.

Thus, where priority is attached to significant national goals, as is the case with ICTs for schooling, each of the federal governments, in conjunction with other governments and partnerships find ways to allocate funds and expertise to help meet perceived need and policy determinants. The extent to which some of these programs affect classroom practice is examined below.

5.2 Role of US and Australian state governments in education

Despite decentralisation of responsibility, and the opportunity this provides for diversity and experimentation in the way schools function, there is a significant degree of uniformity in provision in the states, territories and district levels within Australia and the US. The educational programs available in the 50 US states share very similar characteristics, as the result of such common factors as the social and economic needs of the nation, the frequent transfer of students and teachers from one part of the country to another and the role of national accrediting agencies in shaping educational practice. These are factors also common to the Australian situation. In both Australia and the US, each state has a Department of Education which guides the establishment of policies and requirements for the operation of public schools and regulatory authority of private schools at the local level. In both countries, in line with national and state agendas and expectations, the State Departments of Education have several programs in place designed to support ICT provision in schools.

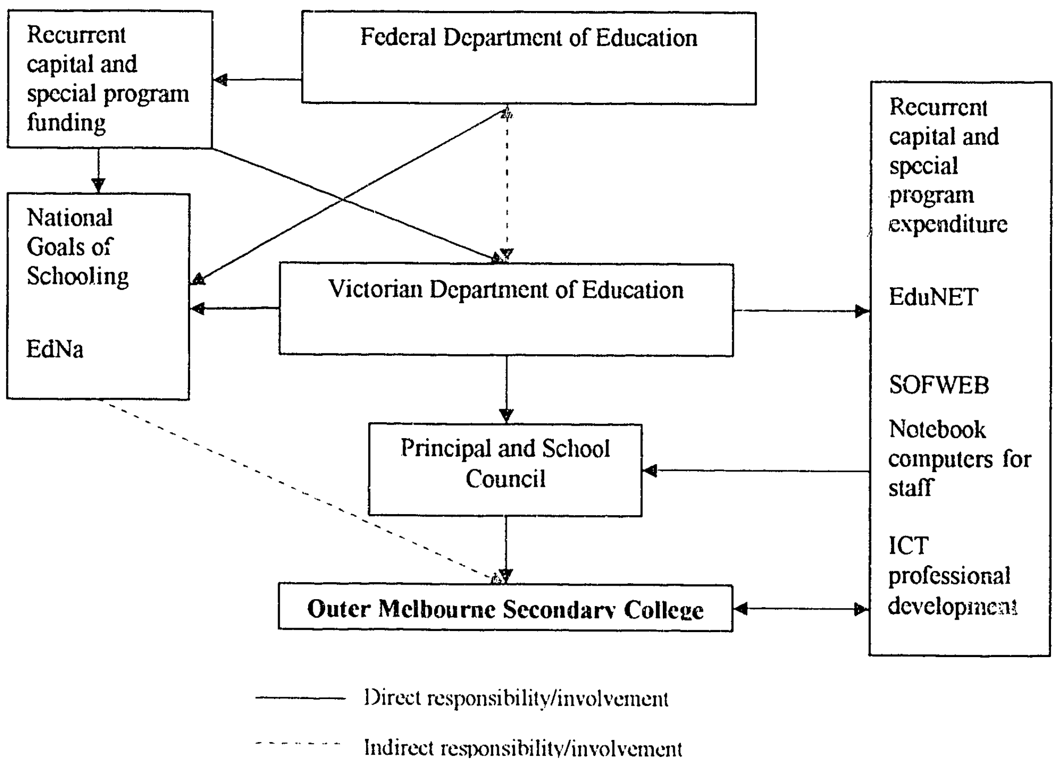
5.2.1 State government role in education – Australia

In Australia, each state and territory Department of Education determines its own policies and practices on such matters as organisation of schooling, curriculum, course accreditation, student assessment and awards and support for non-government schools. They co-ordinate and administer the resources allocated to schools, and administer regional or state-wide programs and projects. In the state of Victoria, nine regions provide administrative services to the schools in their areas, but have no specific authority over them. Considerable responsibility is vested in school principals, in conjunction with their school councils, for decision-making. Each school is required to submit a charter each three years, detailing goals aligned with state policy and are held accountable to the Minister of Education for this. In addition to routine budgetary provision for schools, the Victorian Department of Education, has adopted several approaches to meeting government policy in relation to ICTs: provision of guidelines for school-based technology planning; funding for additional technical support to schools, provision of Internet and email accounts for teachers and students through EdNet, professional development programs for teachers, the establishment of SOFWeb, an Internet portal housing links to all types of relevant information for schools and students; and the phased provision of notebook computers for teachers and principals in state public schools. Teachers at Outer Melbourne Secondary College, (OMSC) the Australian public school involved in this study, are recipients of the staff notebook computer program, have attended some of the associated professional development sessions and are using innovation grant money to help devise and evaluate the grade 7 integrated project, the focus of this study.

Figure 3 indicates how OMSC is situated systemically, and how federal and state governments ICT programs directly and indirectly influence the school.

Figure 3

Educational technology programs influencing Outer Melbourne Secondary College, Victoria, Australia, 1999-2000.



5.2.2 State government role in education – United States

In the US, state Departments of Education distribute funds to local education authorities, interpret and administer state school laws, supervise the certification of teachers, help to improve educational standards through in-service training programs, provide advisory services to local superintendents and school boards and provide limited support to non-government schools. In California, County Offices of Education assist the State Education Department by providing a range of education and business services (including educational technology services) to local districts. To help meet policy objectives in relation to educational technology in schools, the Californian State Education Department has established the California Technology Assistance

Project California (CTAP). CTAP divides the state into 11 regions which provide assistance and coordination based on local needs to public-funded schools and districts in integrating technology into teaching and learning. This assistance includes staff development, technical assistance, information and learning resources, telecommunications infrastructure, coordination and funding. Silicon Valley Middle School, (SVMS) the Californian state school in this project, is attached to a CTAP Region and, through its parent county and district offices, SVMS makes some use of federal, state and CTAP's educational technology services.

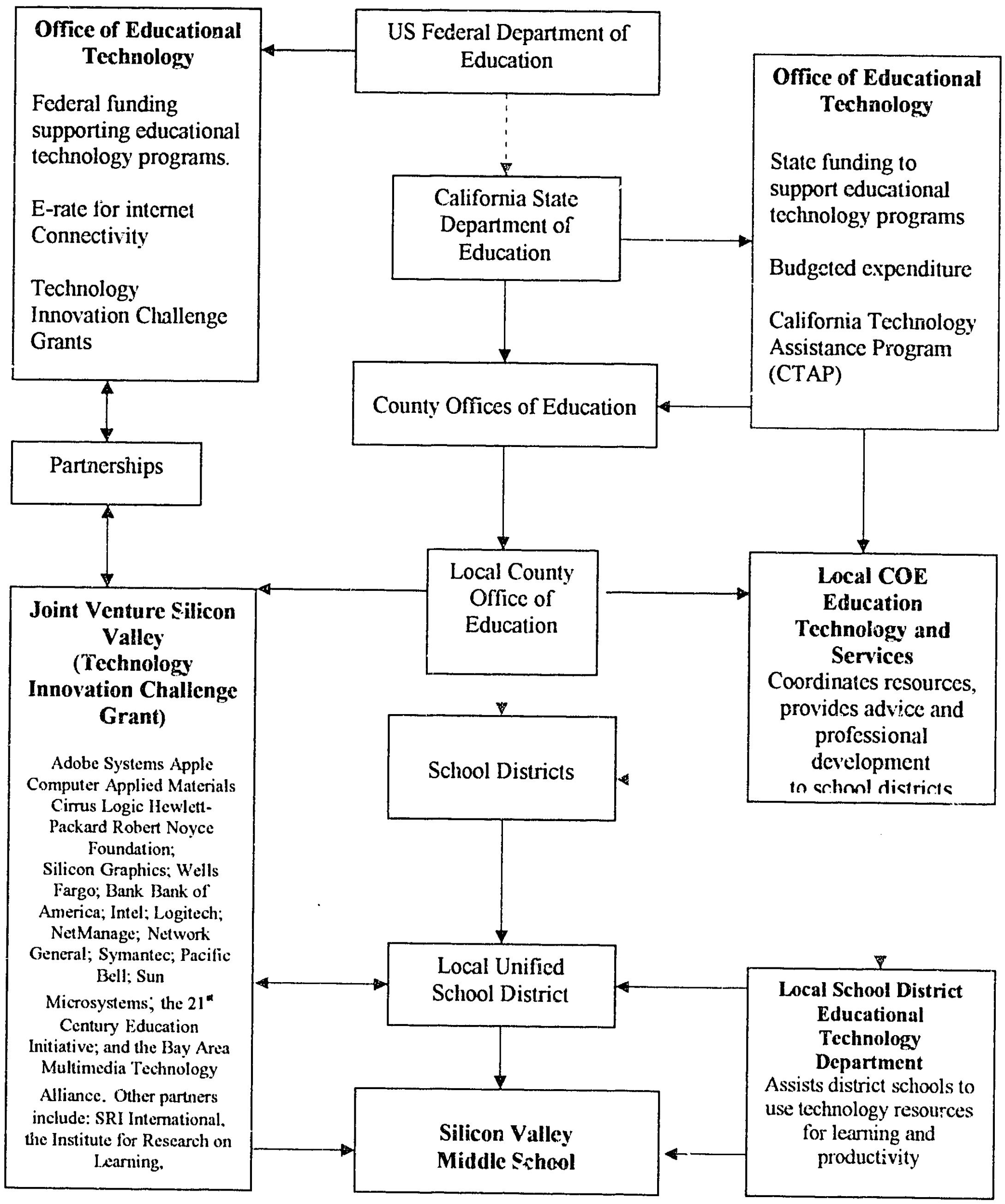
5.3 District responsibility for education in the United States

In contrast to Australia, responsibility for education provision in the US is further devolved to local school districts. Each state is divided into local administrative districts, which have extensive authority and responsibility to establish and regulate public schools, both at the elementary and secondary levels. Generally, local school districts are governed by a Board of Education, either appointed by other governmental officials or elected by citizens who live within the district. Consistent with state law and official policy, the local board operates the public school system through the superintendent and the district staff. Their responsibilities include budget preparation, curriculum decisions, hiring teachers, provision and maintenance of school buildings and purchase of school equipment and supplies. In California, 58 County Offices of Education, in partnership with the Education Department, coordinate and deliver a range of services to 999 local school districts (including those related to ICT provision and use). In addition, each school district has an office or offices providing advice and support for educational technology decision-making. The US state school in this study (SVMS) is beholden to the policies and funding set by its local School District, in conjunction with its parent County Office of Education. It was a joint county and district level decision to involve local schools in the Federal Government funded Technology Innovation Grant.

Figure 4 shows how the various levels of school governance and their educational technology programs directly and indirectly influence Silicon Valley Middle School.

Figure 4

Educational technology programs directly and influencing Silicon Valley Middle School, California, US, 1999-2000.



Direct responsibility/involvement

Indirect responsibility/involvement

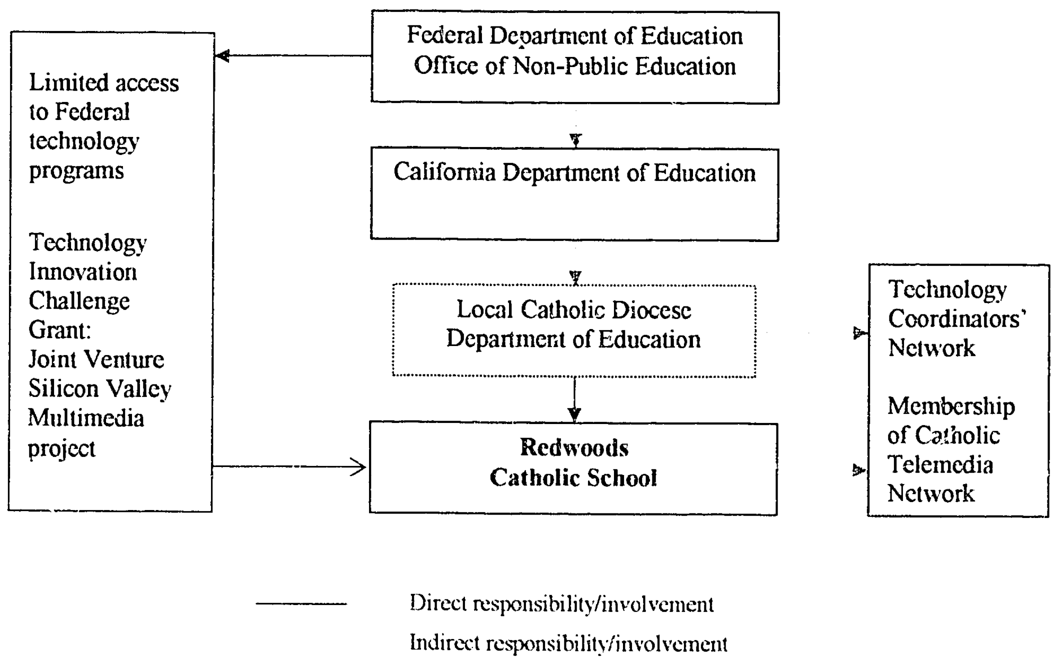
Thus in both Australia and the US, state departments of education, as is their constitutional right, provide a range of direct funding, programs, resources and expertise to support government policies in relation to delivering educational technologies. In addition, as Figure 4 shows, in the US, these types of initiatives are further devolved, even replicated, at the school district and County Office level. California, with its far higher school and student population than Victoria, has a considerably more complex set of issues to manage and considerably more structures in place, and sources of funding, advice, support, available to the practitioners at the school level for implementing government policies and initiatives. Furthermore, as Figure 4 also shows, in California, charitable and corporate foundations form partnerships to also provide finance and expertise in relation to school use of new technologies. To the outsider, there appears to be considerable overlap in these roles and resources. My interest was the extent to which resources from this diverse range of possibilities reach the classroom teacher, and the contribution they might make to supporting effective teaching and learning programs with technology. Moreover it makes for interesting comparison with the Australian situation, whose access to similar resources is not nearly so extensive.

5.4 Private education in US and Australia

Private schools are allowed to operate in both Australia and the US and are subject to state education department's licencing and accrediting regulations. As Table 10 indicates Australia has a far greater percentage of students attending private schools than does the US. In each country Catholic schools comprise the largest proportion of non-government schools. In the US, private schools may receive limited federal aid for specialised purposes, but the great majority are funded by sources other than government. The US Federal Education Department's Office of Non-Public Education works to ensure that non-public school students fully participate in federal programs for which they are eligible. One such program is the Technology Innovation Grant (TIG) designed to assist schools in adopting educational uses of technology in line with national education goals. Redwoods Catholic School, the Californian private school in this study, partnered with the consortia led by Joint Venture Silicon Valley to participate in the TIG program. However, comparatively speaking, direct access to sources of funds and support for ICT is far less than for public schools. The local Catholic Diocesan Education Office and the Catholic Telemedia Network in California does provide some advice and professional development activities, but for Redwoods Catholic School, resources to establish and support the school use of educational technologies mainly comes from parents and their involvement in the TICG project (see Figure 5).

Figure 5

Structure and organisation of education and educational technology programs influencing Redwoods Catholic School, California, US 1999-2000.

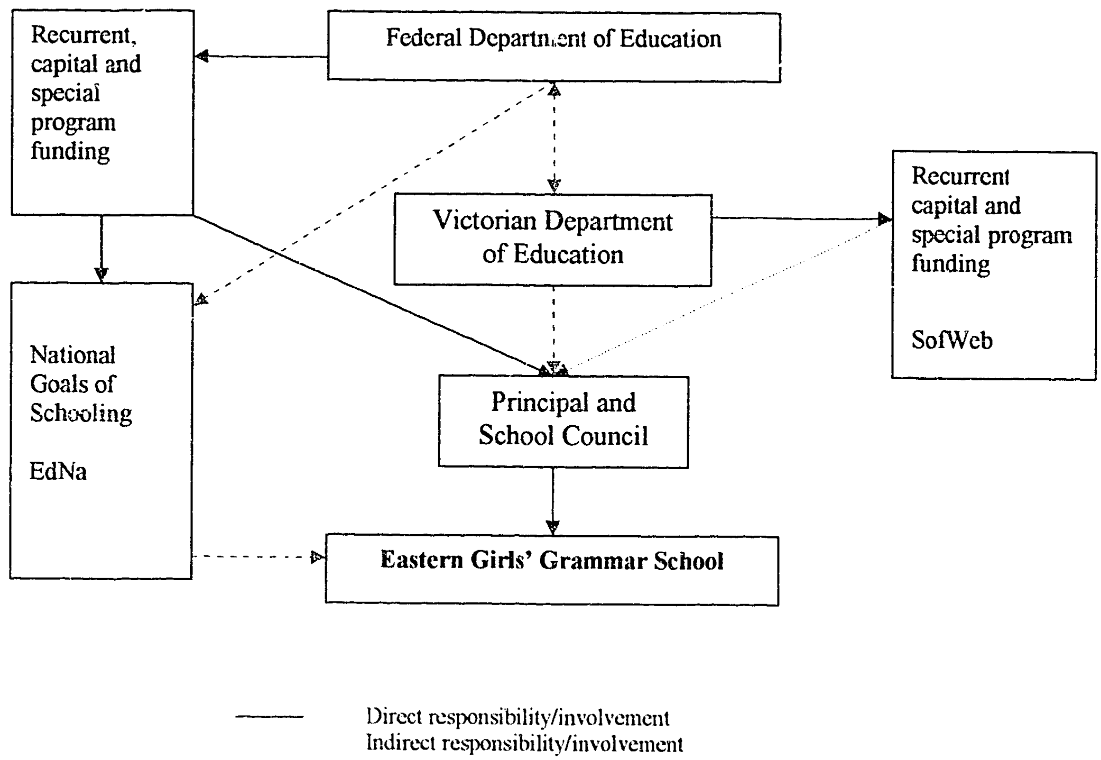


Non-government schools in Australia have broader access to funding from both Federal and State governments than do US private schools. Australian non-government schools receive recurrent capital and special program funding from the Federal Government in line with long-standing bipartisan policies that support the right of parents to choose the educational environment which best suits the needs of their child. At the state level, Victoria also allocates some recurrent, capital and supplementary funding to support the most disadvantaged independent schools and targeted high priority areas. Eastern Girls' Grammar School, the Victorian independent school in this study can access the state SOFWeb and federal EdNa Internet portals, but, because of its financial status, is not entitled to participate in any of the other ICT special government programs. Resourcing ICTs is the college's own responsibility.

Figure 6 shows how the education structures and funding for ICTs influence Eastern Girls' Grammar School.

Figure 6

Structure and organisation of education and educational technology programs influencing Eastern Girls' Grammar School, Victoria, Australia, 1999-2000.



5.5 Role of philanthropy, not-for-profit foundations and partnerships in US education

Unlike Australia, philanthropic involvement in education is a long standing and continuing tradition in the United States. According to Lenkowsky and Spencer (2002): 'From colonial times to the present, donors have sought to shape schools in light of their concerns about the character of American society, the demands of its economy, and the upbringing of its children'. Based on figures cited by these authors, in 2000 alone, US$28 billion was contributed by individual donors and US$25 billion by foundations to education. The scale and *modus operandi* of philanthropic educational foundations in the US has no comparison in Australia.

As noted earlier, large numbers of US computer and telecommunications-related corporations, and non-profit charitable foundations, have established partnerships with research institutions, universities, school districts and schools, also drawing on federal funds, to foster the use of education technologies at the school level. The current high level of involvement is reflective of the economic imperative of the information revolution industry, largely generated in the US, and of the rhetoric from governments, business, other community groups and parents about the need for schools to provide a 21st century education commensurate with the new information age. Both the

Californian schools involved in this study were partners in a not-for-profit consortium managed by Joint Venture Silicon Valley Network which allocated $20 million to 'spark an educational renaissance' in Silicon Valley's classrooms based on a model of venture capital investment in schools.[15]

The Challenge 2000 Multimedia Project (MMP) supported by Joint Venture: Silicon Valley Network was one of the federally funded Technology Innovation Challenge Grants. Beginning in October 1995, nine school districts – comprising 35 public schools, one private school, 1,200 teachers and 23,000 students – received nearly 200 computers, over $100,000 in mini-grants, and on-going training and support from the MMP to support high quality multimedia projects within their classrooms. A key component of the project was the support for educators: partnership with the Institute for Research on Learning researchers, extensive professional development, appointment of Technology Learning Coordinators (TLCs) within schools to support teachers as they introduced multimedia projects, establishment of a support network for TLCs; financial rewards and recognition (awards and accolades) to successful participants.

For the two US schools then there was an additional layer of support for innovative use of technology than that provided by state or district programs, and certainly more than was available to teachers in the Australian schools.

5.6 Assessment-based accountability

Another key point of difference between the two education systems is the greater emphasis on, and public debate about, assessment-based accountability in the United States compared with Australia. Measurement of student performance through a range of national and state norm-referenced, criterion-referenced and standards-based tests is pervasive throughout the US. Results on these tests are often used to determine the effectiveness of a state, a district, a school, or a teacher, and the results can be available in the public domain (Popham, 1999). In California, public school students through grades 2-11 are required to sit the NAEP (National Assessment of Educational Progress) test; the STAR (Standardized Testing and Reporting) program comprising the national norm-referenced achievement Stanford 9 tests and the Stanford Achievement tests which are based on Californian curriculum standards; and the California English Language Development Test. Other than individual student results, all results by state, county, district and school are available for public scrutiny. Strongly held supportive and opposing views about the relative merits of the

[15] Details from the JVSVN extensive website which supports its operations.

testing system abound. These debates often intensify when expanded to include the relationship of educational technologies to test results (see 3.2).

In Australia, no national student achievement testing occurs and it is only relatively recently that states have undertaken testing of students other than curriculum-based tests in the 11 and 12 exit years. The states have determinedly maintained their authority to devise their own performance standards. However, during the 1990s states began to introduce testing, in the main for literacy and numeracy, based on their own state standards. Since the establishing of national benchmarks for literacy and numeracy for grades 3 and 5 by all ministers of education in 1997, state tests are being aligned with these national benchmarks. In 2000 in Victoria, public students in grades 3 and 5 were required to take the Learning Assessment Project tests. Confidential individual reports are now issued to parents and neither school nor state-wide data is available in the public domain. Despite these moves, the issue of testing is not embedded in the national educational discourse to nearly the same extent as it is in the US. Furthermore, the debates about the value of educational technologies tend to focus on issues other than their proven positive (or otherwise) effect on student achievement as measured on standardised tests.

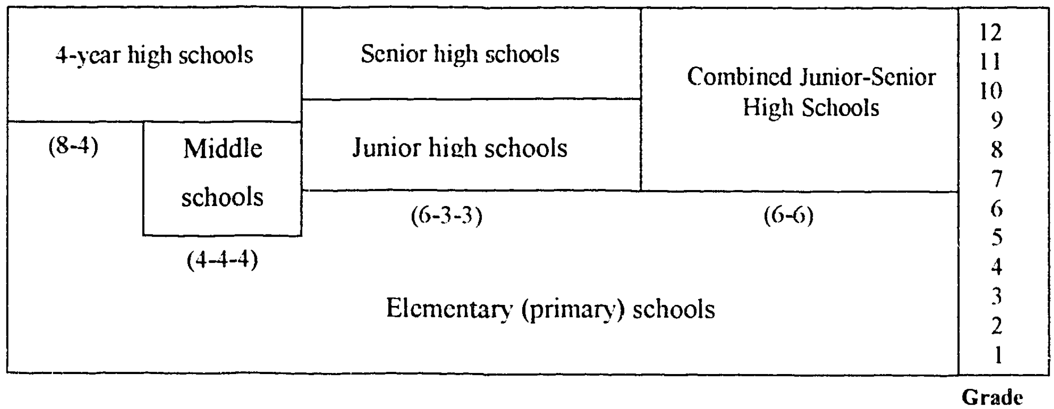
5.7 School organisational structures in the US and Australia

The organisational structure of schools, both within each country and in comparison with each other, exhibit similar broad characteristics: division of student body into same age grade levels; structure of the school day and time allocation to curriculum offerings. Of particular interest here is the organisation of the middle school years, the years in which all of the students in this study are located. In both countries, middle-school years generally refer to the grade levels 5 or 6 to 8.

Australian schools generally are organised into primary (elementary) schools (grades P–6), and secondary schools (grades 7-12). In the US, elementary schools range from first grade through grades 4, 5, or 6, depending on state and district regulations. Students in elementary schools in both countries usually have one generalist teacher and one or two specialist teachers at each grade level, and have specialist subject teachers in secondary school.

In the post elementary years, there are a broader range of school structures available in the US than in Australia. American students can enter the middle years within their elementary school, at a stand-alone middle school (grades 5 or 6–8), then proceed to either a four year High School, a combined six year High School, or first to Junior High (6-9) then to Senior High (10-12). Choice of school is limited however to the structures made available and supported by local school authorities. Figure 7 illustrates patterns of school organisation in the US.

Figure 7
Patterns of school organisation - US



The most common pattern in Australia is the six-year primary, six-year secondary model. However, more recently, as a result of a re-examination of schooling in the middle years, school structures incorporating grade levels 5 or 6 to grade 8 are being established. It is rare to find separate, stand-alone middle schools in Australia. More commonly, middle schools are established within existing secondary school grounds, often with separate organisational structures combining aspects of both traditional elementary and secondary practices.

The grade 7 and 8 students in this study are organised into different middle years configurations in their respective schools: in an elementary structure (RCS, US), in a stand-alone middle school (SVMS, US), in a mini-school structure embedded in the secondary model (OMSC, AUS) and in a standard secondary model (EGGS, AUS).

Apart from EGGS, Aus the schools are coeducational. However, the grade 7 class chosen for the study at OMSC, Australia, is a boys' only class. Prevalent pedagogical practices may differ according to the locus of each of the schools in the elementary, middle, secondary spectrum. Moreover, the ways in which teachers access technology and structure learning activities with it, within these different organisational contexts may also differ, and will be explored in the more detailed analysis of the schools in the following chapter.

In this chapter, I have outlined briefly some of the key contextual factors broadly influencing the four schools and their use of educational technologies. Comparative analysis of classroom pedagogical practice cannot ignore this complex mix of structures, expectation, policies, accountability and cultures which frame teachers' work. The following chapter provides a closer look at each of the schools focusing on the elements that relate directly to teachers' use of educational technologies.

Chapter 6

Introducing the participating schools

In this chapter I describe and locate the four schools in their systemic settings in the US and Australia. Each school is of course unique, but its culture and practices also reflect the particular education system in which it is located. In addition to the broad-brush characterisation of the schools, this section focuses on key ecological factors in each of the schools that have particular relevance for understanding the context in which teachers devise and seek to deliver effective learning experiences for their students with new technologies. As explored in Chapter 3, the type and extent of educational technology provision, available support and staff professional development have each been identified as significant pre-conditions for successful and widespread take-up of ICTs in schools in both US and Australia. Furthermore, as researchers such as Cuban et al. (2002) continue to argue, the fact that so little systematic teacher use of technology for instruction is apparent, despite the vast sums allocated to it, can be understood to some extent by taking account of these factors. Technology provision, support and professional development are now considered at the micro level in each of the four schools that comprise this study. How these factors affect and interrelate with classroom pedagogical practice as teachers and students use ICTs for multimedia curriculum projects is explored further in Chapters 7 and 8.

Full details regarding the ways I have chosen to represent the research data are found in Chapter 4.

6.1 Redwoods Catholic School (RCS), California, US

Redwoods K-8 Catholic School lies nestled in the foothills at the outer limits of Silicon Valley, California. On entering the low slung unassuming building the visitor is in no doubt that this is a school based firmly in the Catholic ethos. Religious statues, icons and biblical quotations have a significant place in the foyer, on corridor walls, and in each of the classrooms. During one of my visits before Easter, the corridor Bulletin Boards could be seen covered in work from all grades exploring the beliefs associated with the Christian tradition at Easter time. However, it is also evident, that this is a learning culture which reflects the current issues and themes of secular America. A November visit saw these same walls and corridors transformed into an election theme. All types of posters and written work representing students' knowledge and understanding of the political process, often accompanied with great flourishes of patriotism, were displayed. Another visit saw grade 8 students formally and vigorously debating the rights and issues associated with homosexuality.

Despite class sizes of 35 in each of the two classes per grade level, classroom work is focused, discipline guidelines are clear, and high expectations are placed on student achievement. The student body averages 625 and reflects the social and cultural diversity created by both the growth in internal US migration to Silicon Valley and that brought by recent overseas arrivals to support and grow the information economy. Few students or their families were born in California. RCS is a parish community school and it is obvious that families from all ethnic backgrounds, and no matter how newly arrived, are welcomed, and needed, to support the work of the school in all manner of ways.

Sister Bernadette, a sister of the Presentation order, has been principal of this school for 22 years. Bernadette is highly regarded by staff, parents and students alike. She has an unswerving commitment to providing the best education she can for her students. In addition to school fees, she elicits extensive support of her parent community for extra fund-raising, time and expertise. 'Vision' is a word used often about Sister Bernadette: 'She's a visionary. I mean she'll look to the future and she'll take risks and she supports people taking risks' (Ruth, the Deputy Principal). Under Bernadette's leadership, this small Catholic school has received considerable recognition for its technology program, both through the provision of hardware and for its technology-infused curriculum.

6.1.1 Approach to technology provision

In the early 1980s, Sister Bernadette together with Ruth, her Deputy Principal, a former nun of the same order, and an RCS teacher since 1976, formed the belief that RCS students would be well served by the utilisation of new technologies in the learning program. Their belief grew from a number of factors: their personal take-up of computers for administration and some teaching tasks, the fact that so many of the school's parents were employed in the booming computer revolution in Silicon Valley, and that they had begun to explore and accept that computer applications may have real benefits for learning. The strategic location of the Diocese in Silicon Valley with a forward thinking Superintendent of Catholic schools, also provided support for Bernadette in her efforts to embed new technologies into all grade levels of the curriculum at Redwoods Catholic School. Ruth was the sole teacher of computers in the early years, using 17 Apple computers housed in a section of the library. During their scheduled classes in the library, younger students used mostly drill and practice software, and the older ones a Math application like Turtle Logo. However, both school leaders believed that all teachers, not just specialists, needed to become comfortable with computer use, and looked for ways as Bernadette says, to 'move them along'. Through strong and directive school leadership, all teachers were encouraged to learn some of the new applications, especially word processing. Early on, Ruth recognised that teachers did not want to know about technical aspects of computers: 'What they needed know is how to work this thing, how to make it work for them'.

Theresa, the grade 8 teacher of the classes which provided the focus for the study at Redwoods Catholic School, and who has been at the school as long as Ruth, recalls the proactive determinedness and unswerving support of the administrative leadership in relation to computer use:

> [Bernadette] said we have to move with this. And I remember us old veterans saying I'm not doing it, I'm not doing it, I'm not doing it. ... We were not all happy with it but, you know, we respected what she said - and she said this is the way of the future and this is what I want, OK?

Eleven years earlier, in 1988, Sister Bernadette recruited and appointed a full-time Computer Resource Coordinator to RCS. This was viewed as a ground-making move for the sector. Normally, teachers within a school who showed some interest in technology would be allocated a little time to do this role. Sharon, the first appointee to the role, was told 'you are to come in here and you are to teach the teachers ... actually what we want you to do is work yourself out of a job'. One of Sharon's first tasks was to coordinate a staff-parent committee to develop and implement a five-year technology plan. The results of this work, and ongoing work since, supported extensively through time, money and labour from the parent body, can be seen throughout the school. Each classroom houses six multimedia, Internet-connected Apple G3 desk-top computers and a printer. In 1999, a computer laboratory was established using classroom space in the centre of the school. The lab holds 36 Apple I-Macs, a digital projector, printers and a scanner. The whole school is connected via an Ethernet network, uses an Intranet, and has file storage space for all students. The glass-walled Learning Technology Coordinator's office, incorporated into the newly constructed lab, contains the network servers, and inevitably the spare cables, old computers and the left-over clutter of computer paraphernalia that can never seem to find a place in schools. To support the work of the Learning Technology Coordinator, whose focus is curriculum support, the school has a part-time technician who divides his time between three other local Catholic schools. Email facilities have been provided for all staff, and provision of school email for students is currently under discussion. In the academic year 2000 – 2001 each classroom was to be allocated an Apple Imac for teacher use only. In any comparison with Californian school statistics on school provision of technology, this small Catholic school on the outskirts of Silicon Valley certainly is a very well resourced school.

Provision of technology alone at Redwoods Catholic School, however, was not the end goal of the administration. Bernadette and Ruth very early on set firm expectations for the use of technology for learning tasks. There has been a clear commitment to the integration of technology into the learning program. A key plank of their strategy requires classroom teachers to incorporate a technology goal into their curriculum plans for each year. In their annual performance review Bernadette will discuss progress towards achievement of that goal with her staff. In the early years of the program, teacher and student use of subject-specific software and word processing to meet the administration's expectations predominated, but this is starting to change. Some teachers now require their students to use the Internet for research, and to represent their learning using multimedia creation software (e.g. *Kidpix*, *Hyperstudio*) and webpage authoring tools. The most adventurous ones, like Theresa and one or two others, have embarked on extended collaborative projects with their students, using a range of multimedia technologies for presentation of their work. Not all staff uniformly and enthusiastically fulfill the Principal's requirement, as Bernadette, Ruth, Sharon and Yvonne, the second appointee to the Learning Technology Coordinator role, all acknowledge. There are one or two stubborn ones who resentfully do the bare minimum. However, the faculty at this school, most of whom have been employed here for a long time, are under no illusions about the expectations and on the whole try to meet them.

6.1.2 Support

The significance of the role of Learning Technology Coordinator and the astute appointments to it, in addition to the unequivocal support from the administration, cannot be underestimated at Redwoods Catholic School. Provision of technical skill training for teachers and students, in-class support and encouragement to try new ideas have been critical to facilitating changed pedagogical practice for all but one or two staff. Sharon, the first appointee, held the position for 11 years and this year, Yvonne, the second appointee, is learning the ropes and carving out her own place. Sharon has moved on to a broader technology coordination role for the Catholic Network of schools which also affords her many opportunities to return to the school and assist with specific projects. She finds it hard to let go. For her, understanding of educational technology and what is possible for students to achieve has been nurtured and realised here. Theresa, the grade 8 teacher, has nothing but praise for both Sharon and Yvonne and the support they provide:

> Sharon ... really, really paved the whole way for everything. She knew far beyond any of us. And she obviously was very, very supportive. In fact I did this project because of all the work that she had done for me, with me. She encouraged me to do all sorts of things that I would never have done. She sat with me and showed me how to use the computer. I mean I didn't even know how to use the stupid mouse! She would constantly come in and teach the kids. Constantly. You know, if the kids had a question she'd constantly show them how to do it. That was what her job was to do. Her job was not to basically teach a class, but she was to teach us so that we could teach the class. ... Yvonne has been wonderful ...Yvonne has been

> phenomenal. She has been with me in my room. She has worked with my kids before school, lunch-time, after school, with me. She would come over to my house to make sure things are working. I mean she's just been very, very wonderful. So between her and Sharon they've been wonderful.

The school is al fortunate that it has a technically knowledgeable parent body, ready and willing to support the part-time technician and the Technology Learning Coordinator. With this parental support there is more time to assist classroom teachers as they grapple with the technology in the classrooms.

As one of the participant schools from the non-government sector in the US Government funded Challenge 2000 Multimedia Project, Redwoods Catholic School has also been able to tap into further sources of support for its technology program, both in funds for new equipment and the support network of expertise that is one of the hallmarks of the program.

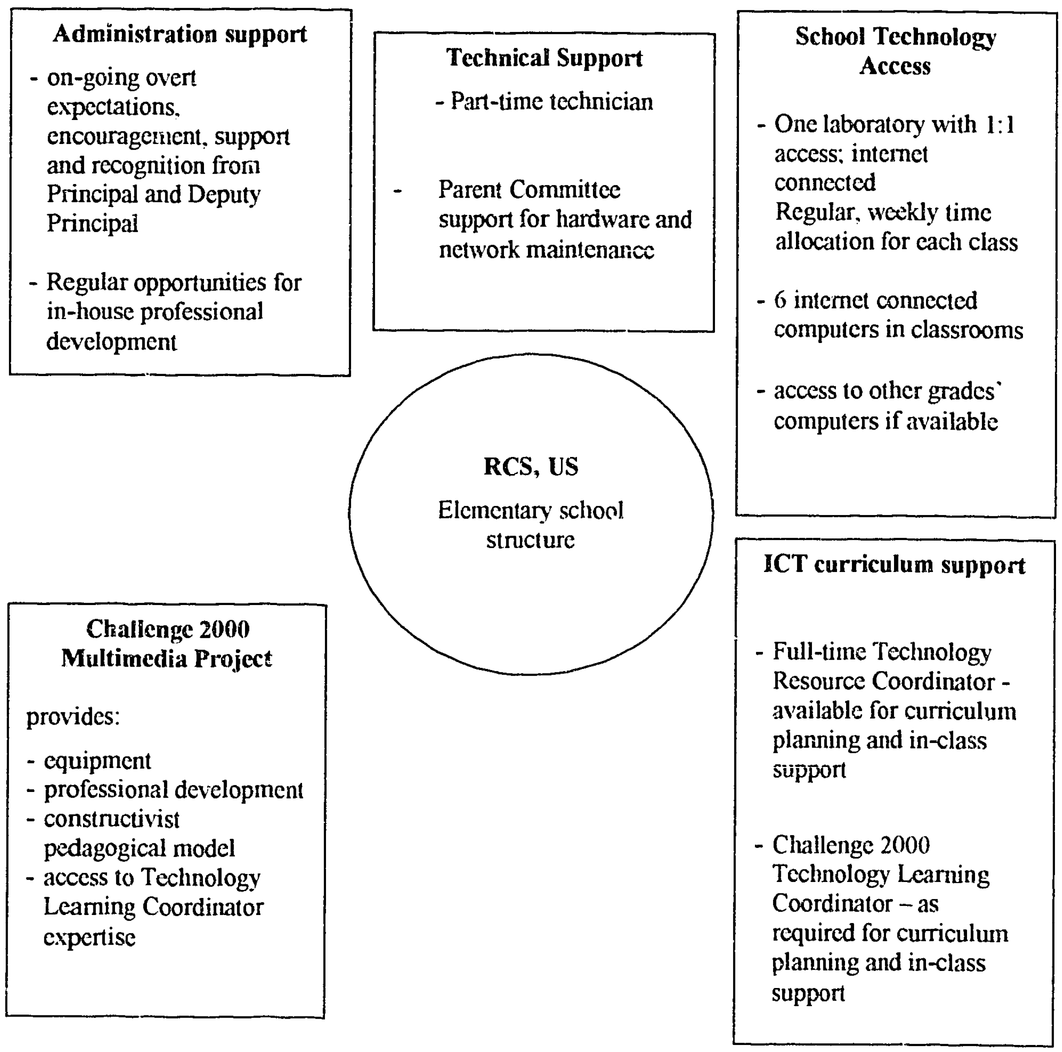
6.1.3 Staff professional development

From very early on, the RCS weekly staff meetings were, and still are, a vehicle for staff awareness and training in technology use. Yvonne continues the model set by Ruth, then Sharon, and takes some of the available time in these meetings to demonstrate a new piece of software, or lead a hands-on session and discussion on its value for student learning. In the role of Technology Learning Coordinator, Sharon and Yvonne regularly attend peer network meetings, and leading edge technology workshops and conferences, in California and elsewhere in the United States, enthusiastically bringing their new skills and ideas back to the school staff. Sharing of successful classroom practice has also been encouraged in the staff forum. The current Technology Learning Coordinator, Yvonne, however complains that there still needs to be more time made available for staff, given the complexity of the new multimedia software that teachers are now being expected to adopt.

Figure 8 summarises key school ecological factors relating to educational technology at Redwoods Catholic School, US.

Figure 8

Key school ecological factors, Redwoods Catholic School, US



6.2 Silicon Valley Middle School (SVMS), California, US

The Silicon Valley Middle School, comprising 1100 grade 6, 7 and 8 students, is located in the heart of the valley and has a proud heritage with a strong academic focus. Many of the SVMS students involved in this project are obviously motivated to perform well to ensure they enter the prestigious feeder high schools which assist the passage to a good college education. Children of academics and Silicon Valley high tech workers abound. Only 4 per cent of the students are eligible for the free or reduced price lunch program. The cultural mix of the student body also reflects the social and cultural diversity which characterises Silicon Valley at the start of the 21st century: students with close ties to India, China, Taiwan, Korea, Vietnam, Japan, Israel, Russia, the Philippines, join longer term Americans who have come from all parts of the country to benefit from the economic dynamism of the area. The staff value and respect the extraordinary diversity of the school population. There is genuine warmth in the student teacher interactions. The schools comprising the SVMS school district, including SVMS, are highly sought after, and noted for academic achievement. The school's API (Academic Performance Index) puts it in the top 10 per cent of similar Californian schools. Despite its location, and the wealth of the area, however, the school buildings are old and uninviting. The bright blue paint on all external walls seems to be trying, not very successfully, to brighten up the drab 1950s buildings.

The middle school structure at SVMS allocates the grades 6, 7 and 8 students into homeroom classes of 30 with one teacher who is responsible for teaching the core subjects. An elective program allows an interesting mix of options for students. Foreign languages (French, German, Spanish and Japanese) are placed in the elective program and the majority of students take one of these as a foreign language is a prerequisite for university entry in California.

6.2.1 Approach to technology provision

Surprisingly, considering that the computer revolution germinated a stone's throw away, educational technology provision, as in most Californian state schools, falls well below that provided in other US states. At SVMS the overall student:computer ratio is about 1:10 and there is considerable pressure for the available resources. Two labs, fashioned from former classrooms, house 30 Apple multimedia Internet-connected computers, two scanners and two colour printers in each, and are generally busy throughout each school day. One lab is dedicated to scheduled computer skill tuition. The other lab is available for booking by subject teachers incorporating technology into their teaching programs. In each of the crowded, cluttered traditional-style classrooms can be found at least one computer and there are some available in the Library. In a room adjoining the staff room, teachers can access eight computers. These are used mainly for administrative purposes such as word processing of instructional materials, and the recording and aggregating of grades. The school's involvement in the federally funded Challenge 2000 project has provided access to a few extra computers, two digital cameras and a scanner and, importantly, professional development and expertise. Consequently some teachers have now started to explore more complex curriculum uses for technology.

Currently all students receive six weeks (two periods per week) of computer tuition in grade 6 and have the option of taking a semester-long web design subject in the elective program. Students regularly submit word-processed assignments mostly done on home computers and a very small number of teachers are starting to require student PowerPoint and other forms of multimedia presentations for assessment purposes. Besides the standard use of word processing, increasingly teachers book the second lab for Internet access, and the small minority of teachers for web-page authoring and multimedia creation purposes. Use of technology in non-IT subjects is left to the interest of the teacher. There are no expectations placed on staff. Carol, the teacher of the classes involved in this study, says a lot of teachers recognise the frustration and the amount of work it takes, and refuse to use computers with their students:

> there are some teachers that you will never see in the computer lab. Never. They would just make it a point to just stay away and assume that the other teachers in time will bring them to the computer lab for technology things ...There are some teachers who probably really don't know how to turn on their computer.

In accordance with school district policy, SVMS has appointed a Lead Technology Teacher and adheres to the district's educational technology guidelines, but there is little overt, pro-active support and encouragement from senior administration according to the teachers most involved in using technology. The Principal is said to be a reluctant technology user and not particularly supportive of the technology changes happening around her. Participation with the other district schools funded by the Challenge 2000 project has, however, been of significance. Participation has enabled purchase of extra computer hardware, software and peripherals, and provision of staff training and on-going support outside of the normal budgetary avenues thus enabling interested staff to move more rapidly than might otherwise have been the case.

Susan, an enthusiastic proponent of technology use, currently holds the role of Technology Learning Coordinator, a position funded by the Challenge 2000 project. Funding has allowed her two periods per week to support staff undertaking multimedia projects. Susan asserts that a small school Technology Advisory Committee, of which she is a member, has been central to the progress the school has made. Membership comprises the Principal (mostly in name only), the Dean of Students, representatives from subject departments, the Lead Technology Teacher and Susan, the Technology Learning Coordinator. At the classroom level, Carol says, 'I don't think the administration has any idea what I'm doing. I don't think they have any clue'. Rather than a strategic move from the top, introduction and support for technology has come from elsewhere according to Carol: 'I think there's a push from teachers, there is a push from parents and there is a push just from the community as a whole that computers and technology is important and so we need to provide space, we need to get money and grants to get newer, better, faster computers'.

6.2.2 Technology support

Despite these sentiments, and the relatively low access to computers, SVMS is well served for technology support with one full-time and one half-time computer technician, both supplied through the local school district office. The full-time technician, Irene, has her desk in the lab used by the non-IT teachers. She is young, has considerable rapport with the students and often shows interest in their projects. Carol and the students value the fact that there is always readily available help in class when problems arise. And there is a lot of call on both technicians. As Carol says:

> They were always here. They were always helping out and physically in the room. And through them, I just gained some confidence in being able to restart the computers myself and work out problems myself'.

The local school district office is currently looking at ways to centralise technical support services to schools, a move not appreciated by the staff, who grapple with technical issues seemingly every time they choose to use computers in their classes.

6.2.3 Staff professional development

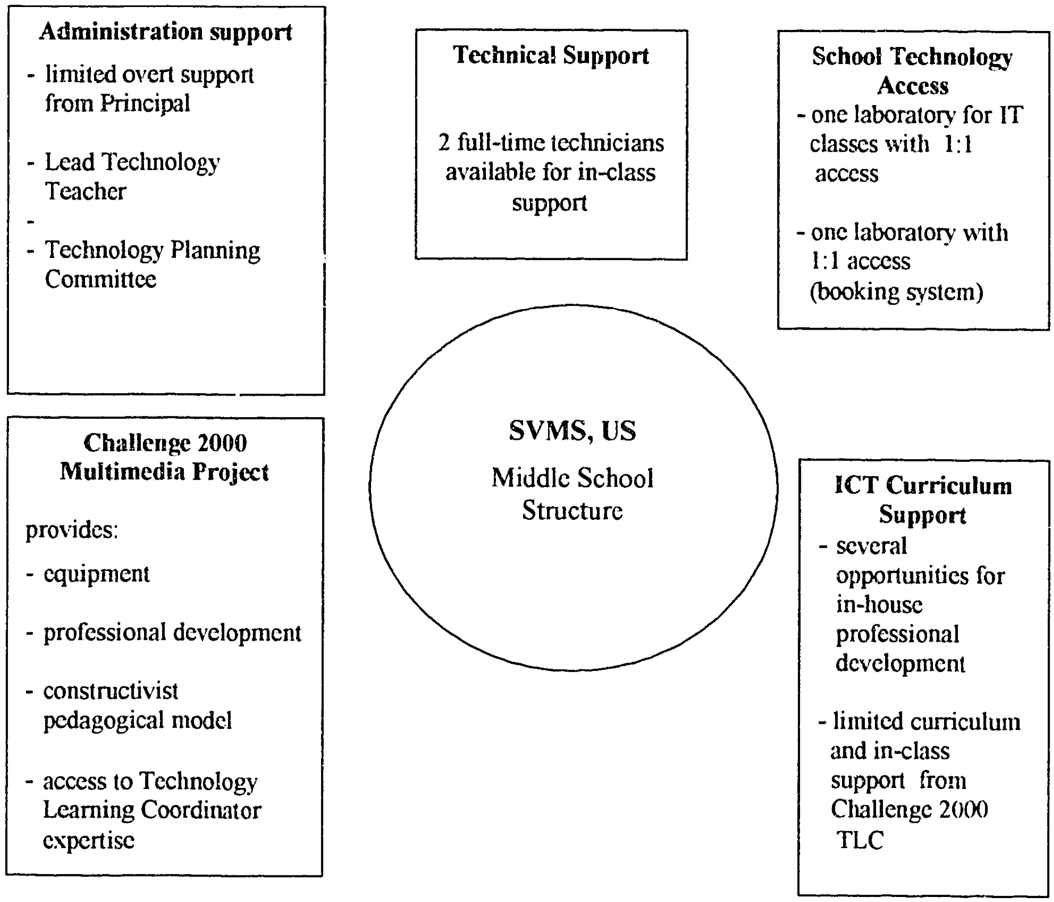
Learning both how to use and how to integrate technology into curriculum, most commonly occurs outside of the school and in teachers' own time. Teachers generally have been either self-taught or learn through attending externally provided courses. The Challenge 2000 project funding arrangements have made it possible for teachers to attend, and be paid for, attending a two week-long summer training institute. As a condition of funding, these teachers are required to undertake a multimedia project with a class and are supposed to share what they have learnt from the process with their peers at the school level. As a Challenge 2000 Technology Learning Coordinator, one of Susan's roles is to facilitate this process. Although no formal structures are in place, Susan uses every chance she can to talk with, help out and support teachers like Carol. Early in the life of Carol's project, Carol and Susan swapped classes so that Susan could teach the basics of the multimedia program *Hyperstudio* to Carol's Spanish classes. However, despite another teacher doing a similar project under the same funding arrangements, Carol says that in reality they have had little time to talk to each other, let alone share the work they do. Collaboration as envisaged by the project rarely happens.

This academic year has seen more in-house learning opportunities for staff. Susan, together with the main IT teacher, have been running 'Share the Wealth', voluntary after-school workshops for interested staff, in which skill development sessions such as using a digital and video cameras, the scanners, and new software programs are offered. With the Challenge 2000 Project about to end, Susan is concerned that the model of professional development established and supported through funding, despite being relatively *ad hoc* in practice, may disappear and is hoping that initiatives from the school district will fill the possible vacuum.

Figure 9 below summarises key school ecological factors relating to educational technology at Silicon Valley Middle School, US.

Figure 9

Key school ecological factors, Silicon Valley Middle School, US



6.3 Outer Melbourne Secondary College (OMSC), Victoria, Australia

Outer Melbourne Secondary College is a 7-12 state government co-educational school of 700 students located in a native Australian bush setting in the outer eastern suburbs of Melbourne. A range of academic and technical courses via flexible pathways is offered to meet the diverse range of student abilities. Formerly a traditional technical school, the school is now required to provide a comprehensive academic program alongside the range of vocational training courses which many staff still believe are more appropriate for the student population they serve. For the past two decades, to better meet the social and emotional needs of this middle to lower socio-economic cohort of students, the school has adopted a mini-school structure. Four mini-schools, with identical curriculum offerings, staffing and organisational structures operate at the Grades 7-10 level. As much as possible, teachers are assigned to one mini-school to maximise their continuous contact with the same students. The classrooms of the four mini-schools, fan out around a central administrative hub. Here can also be found the facilities shared with the senior section of the school:

computer and science laboratories, art, music and drama studios. Provision of effective pastoral care for students from the time they enter the school until they leave is a core value – reflected not only in documentation, but seen in several guises during the course of this project. The Curriculum Coordinator comments that teachers sometimes seem to know more about the emotional needs of their students than their learning needs. Allocation of students to the grade 7 class studied in this project, took account of the fact that a significant number of students were experiencing a range of problems, seriously impacting on their ability to learn, and considered best handled with these students in one class with a special focus.

6.3.1 Approach to technology provision and use

The use of learning technologies has high priority in the current (1998–2000) OMSC College Charter, the formal strategic planning document required by the state government. The extensive provision of computers and school-wide Internet connectivity is a matter of pride for the Principal and other senior administrative staff and a tour of the laboratories is always incorporated into the route of prospective students and their parents. OMSC is well equipped with technology and has a 1:5 computer student ratio. There are three laboratories with 26 Windows multimedia computers in each, a bank of 16 computers in the Library and smaller numbers of computers distributed throughout the mini schools in strategic locations. Dan, the Head of Learning Technologies, who has held the role for the past three years, is keen to raise the number of computers in the mini-schools from 3-5, to at least ten, in each space he has found to house them. The Indonesian teacher has been allocated six computers in her classroom as she is one of the few teachers who regularly incorporates their use in her teaching program. The school's computers are networked internally and connected to the Internet. All students have password-protected file storage space on the school server, but must pay a $15 levy for the privilege of accessing the Internet. Payment of this levy and signing the College Acceptable Use Agreement then allows students access to the Internet facilities. Unequal access to the Internet facilities is an issue of concern for staff and students, particularly for those unable to afford it, or whose parents are unwilling to pay, and seems somewhat at odds with the College Charter. The room between the two labs contains a well ordered operational centre for managing the computers and network facilities led by Dan. An experienced humanities teacher, Dan has developed considerable technical understanding about computers and networks over recent years, and with this position of responsibility seems to relish the opportunity, to establish a well-equipped school, despite the many challenges and frustrations, especially those associated with lack of time. Each of the four mini-school staff rooms holds one computer for staff use only. Use of these four computers has, in the main, been for document preparation in Word and for student reporting requirements. During the intense pressure at reporting time, teachers also use labs and any spare distributed machines to write the reports.

Approximately 25 Outer Melbourne Secondary College teachers this year are participating in the recently introduced state government funded scheme which provides them laptop computers at a nominal lease rate. In return, these staff are expected to attend 10 hours of relevant professional development, to explore the use of technology in some part of their teaching practice and then to share what they have learned with colleagues

Despite the 1:5 computer student ratio, there is a clear gap between availability and actual classroom use for teaching and learning. The current Charter states that the College aims to enhance learning outcomes for all grade 7-10 students by the integration of learning technologies (especially the use and integration of multimedia and Internet applications) into the curriculum in all Key Learning Areas. Apart from in the IT specialist subjects, there is some student use of the computers for general word processing tasks and Internet research, but this tends to be *ad hoc* and more often done, not in scheduled class time, but at other times when the computer rooms are accessible. Current classroom use includes a few Maths teachers who use *Excel* for spreadsheets and graphing, ('others wouldn't even touch it'); the Indonesian language teacher uses a CD-ROM, word processing and PowerPoint presentations in her junior classes, and the grade 7 Textiles teacher this year will require her students to use the *Publisher* program to design a brochure. These teachers are seen as quite progressive by other members of staff.

There is little evidence of progress towards systematically meeting the College Charter's technology integration aims for the grade 7-10 curriculum. Theoretically, Learning Area Coordinators are required to include use of technology in units of work at each grade level. This is not happening. Moreover, there is debate as to whether skill development should occur in specialised classes at the start of the grade 7 year or be embedded in the subjects themselves. Without clear direction, the frequent use of the term *ad hoc* seems appropriate. When asked if students are formally taught skills, Dan, the Head of Learning Technologies, says with considerable passion:

> They're not! They're not! Full stop. They happen *ad hoc*. And the worst part of it in my thinking now, and this has become clearer just in going to an In-service in the last week, the worst aspect of this whole deal, is that certain classes at this school are becoming much more information rich and the others are getting zilch. Why? Because of the teachers they have.

Two years previously, students' skills were matched against a checklist of computer skills students should acquire during their first two years at the school and achievement certificates issued. This skill audit has not been repeated. Dan devised the checklist and organised the student survey in its first year and now bemoans the fact that he does not have the time, and that there is no one else who cares sufficiently, or has the time, to establish a place in the curriculum for technical skill development.

In summary, while some teachers are exploring curriculum use of technology, most are not. Nevertheless great hopes are held for improving student motivation and engagement with the incorporation of the multimedia software *Scala*, into the grade 7 integrated projects, the subject of this study.

6.3.2 Support

Currently Outer Melbourne Secondary College is in the process of upgrading its network system, and many technical issues, believed to be only temporary during the transition phase, dominate Dan's time. Dan is allocated only three 'official' periods for this role as Head of Learning Technologies. In practice he says he can squeeze out four periods. The time needed for solving technical problems leaves him with no time to provide support and more training for staff. A part-time technician, Jerry, spends his time (five days a week at .8) dealing with a host of issues both at the central network hub around the labs, and with the distributed technologies. He works very hard, but the sheer demands for assistance rarely seem to be able to be met satisfactorily. Computer freezes and network crashes are referred to repeatedly. A frustrating situation for everyone, especially true when immediate classroom help is required by teachers in areas far from the central hub. Staff say they have no training in trouble shooting or 'de-bugging'. Even what might seem a minor problem to a technician, can be a major hurdle for the classroom teachers. Teachers who have a whole class waiting unsuccessfully to print out their work, or are booked into the lab for an Internet research lesson and cannot connect, become very disillusioned. It is not surprising then, that staff are reluctant to integrate computers into their professional practice and when they do use computers, administrative tasks, not classroom activities are the preferred option.

Students from all levels make considerable use of the labs before and after school, and at lunchtime. At these times, students mainly complete word processing tasks or use the Internet. They generally help each other to solve hardware, software or connectivity issues whenever possible, but also frequently call on the small group of technically competent senior students from the specialist multimedia class who willingly help and provide support in the labs. Dan and the technician very much appreciate the help of these students. Without such assistance, frustration levels would probably be much higher. Moreover, some of these multimedia students were used by the integrated studies project teachers to provide in-class support to the grade 7 students as they grappled with *Scala*, the multimedia authoring program chosen for presentation of the project. Liz, one of these teachers, who had no prior training in the use of the program, said that this help was invaluable:

> Each second Thursday the Year 12s and Year 7s work together, the ultimate peer tutoring exercise. We are getting some good results ... Some of the year 12 students who I have taught since they were in year 7 have given up free sessions to help. They always pop in to the computer room when I'm in there with the boys. This aspect has restored my enthusiasm & faith!

The .3 time allotment for the Learning Technology role, is supposed to encompass supporting curriculum use of technology in the school. But, as Dan acknowledges, to do this is virtually impossible. He has lots of ideas gained from attending conferences, and would like OMSC to be more innovative, but solving technical problems, with the limited time he has available, is the priority right now. Funding for the grade 7 integrated project allowed for time for the teachers involved to meet fairly regularly to plan, share and discuss progress. They valued this time (not a common school practice with regular teaching programs), but all said they needed more time for professional dialogue with colleagues on an ongoing basis, because of the support for professional practice it provided

6.3.3 Professional development

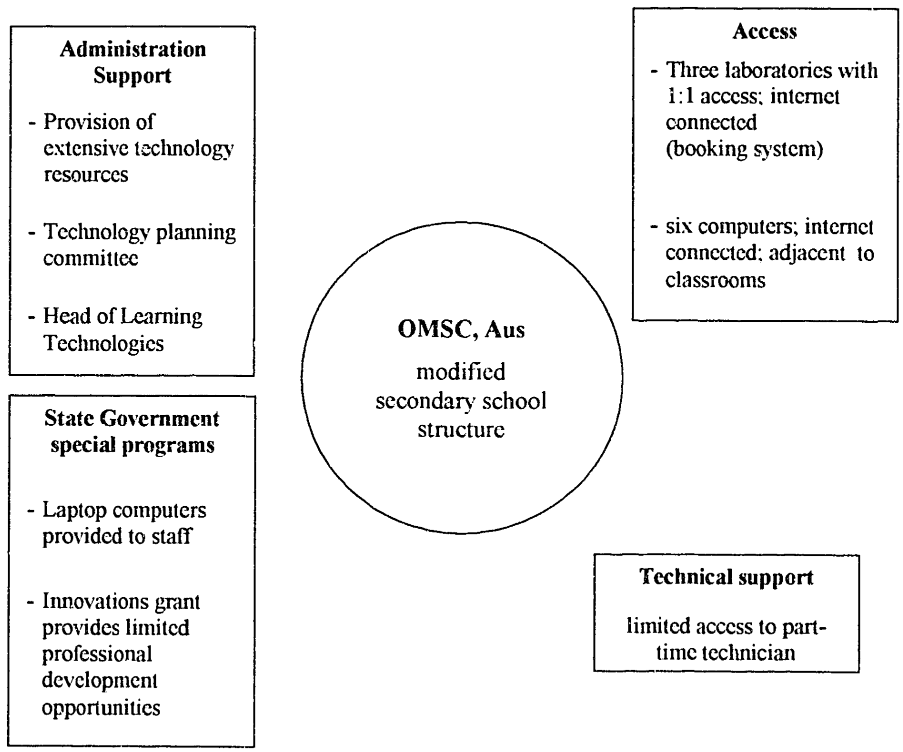
In-house professional development activities, after school and on student-free days, introducing teachers to file management, word processing, Internet and email use, PowerPoint presentations and Excel spreadsheets have been held in an *ad hoc* fashion over recent years. Teachers have attended when it is compulsory to do so, but otherwise participation is sporadic, according to Dan, who alongside his other duties, must also organise staff professional development in learning technologies. Results from a survey conducted in 1998 by the Deputy Principal shows that the vast majority of staff can be categorised as 'low end' computer users, that is basic use of productivity tools such as word processing, email and Internet.

Those teachers participating in the staff laptop computer program are expected to attend 10 hours of relevant professional development. At the end of the first year, 80 per cent of these teachers had completed the required basic training but few teachers had used the allocated laptops at school for other than routine tasks. There is some personal use of the laptops computers for email and the Internet, for word processing of classroom materials, and for administrative tasks such as compiling meeting minutes, but little else. Furthermore, no one at the school has taken on monitoring the staff obligations for professional development or for classroom integration. Dan says he is too busy and that it is a matter of individual personal responsibility.

All of the teachers involved in the grade 7 integrated studies project, have been allocated laptops, but other than Dan and a teacher who joined the team towards the end of the year, none has more than a basic understanding of computers. Thus, for the year 7 integrated project staff who are charged with designing curriculum incorporating a sophisticated multimedia package, with little training or support, the task seems enormous. Figure 10 summarises key school ecological factors relating to educational technology at Outer Melbourne Secondary College, Australia.

Figure 10

Key school ecological factors, Outer Melbourne Secondary College, Australia



6.4 Eastern Girls' Grammar School (EGGS), Victoria, Australia

Eastern Girls' Grammar School - a K-12 independent school of 1100 students, occupies extensive, beautifully maintained grounds in the eastern suburbs of Melbourne, Victoria, Australia. Tuition fees are high. A strong academic tradition, with girls consistently among the top scorers in the state-wide assessment system, which marks the end of secondary schooling in this state, characterises this school. It is very rare for students not to enter some form of tertiary education. The student population represents a diverse ethnic mix from the higher socio-economic demographic of Melbourne. In recent years the school has taken an increasing number of students from non-English speaking backgrounds particularly of Asian origin (Malaysia, Indonesia, Vietnam, Hong Kong, China, Taiwan, Korea, India, Sri Lanka). Some of the students are full-fee paying overseas students on temporary student visas and others are first, second and third generation Australian residents or citizens. The need for English as a Second Language (ESL) tuition and support has grown over the years and is built into all areas of the curriculum and at all year levels. Senior School comprises grades 7 to 12. Grade 7, is the first year of secondary schooling for students from the EGGS Junior School and for students from other feeder primary schools.

6.4.1 Approach to technology provision and use

Using funding mainly from school fees, the past ten years have seen EGGS develop extensive computer technologies to support its teaching program. As an independent school for girls, in a very competitive sector, the school has sought to position itself as a leading edge educational provider and user of educational technology for learning. The school is well equipped with four computer laboratories (with a minimum of 28 multimedia machines, a flatbed scanner and a printer in each) and a set of 40 laptop computers available for distributed use in classrooms and for home borrowing by staff and senior students. Lining the corridors near the laboratories are extra computers and printers for students to use when these rooms are occupied. The Library also has 13 multimedia, Internet-connected computers available for student use. Students can access any of the machines before and after school, and during recesses and lunchtimes. It is rare not to see large numbers of students using the available computers for a range of purposes at any of these times. Student computer ratio (1 computer to 3-4 students) is more favourable at EGGS than the Australian average. When individual classes use the labs or laptop library machines, there is a 1:1 ratio.

Students can save their digital work either to a floppy zip drive to enable further work on home computers, or save to their file space on the school network. Although some independent schools in Victoria have introduced the requirement for all students to own a laptop computer for learning purposes at school and at home, this is not the case at EGGS. 'Laptop schools' have received much publicity, and given the highly competitive independent school market in the state of Victoria, not following this course could be seen as a disincentive for prospective parents. However, EGGS has taken the view that flexible provision of educational technologies is the most appropriate position for the school and in an information brochure defends its position strongly as 'the most equitable and cost-effective way of providing up-to-date technology for students and staff'. Although no desk-top computers are found in classrooms, the ready access to class sets of mobile lap computers enables not only wide school access to computers, but also allows teachers the choice of using standard classrooms, or a lab, for the learning activities with technology. Planning for wireless networking in classrooms is underway and this will allow ubiquitous Internet access across the school. The labs, portable laptop library and computers located in the library are heavily booked for class use. Despite this level of provision, teacher frustration when unable to access the technology for teaching when and where required is not uncommon and seems to be on the increase.

Eight computers and two printers are located in the staff room and are in constant use by staff for a range of purposes. Preparation of instructional materials or administrative documents using Word, and using the database software essential for report writing, predominates. More recently, there has been increasing use by staff of the Internet and the school-provided email facilities. It was a deliberate ploy to position high-end computers in the staff room to facilitate access and familiarity, and establish a collaborative support base between the experienced, capable users and the novice. Some subject departments also have a few machines in their dedicated preparation areas. At the time of the study, teachers were not provided with personal computers, but they were able to borrow from the laptop library after school hours. There is considerable staff demand on these computers at report-writing time, as the report system used is now digitally based. The school administration is currently discussing providing all teachers with laptop computers in line with the increasing trend to do so – both in the private and public school sectors.

From the outset of its technology program, EGGS has used Apple computers, and the vast majority of computers in the school are various models of the Apple product. The Apple Company, as part of its marketing strategy, has recognized EGGS as part of its Apple Distinguished School program. In the last two years, however, the school has begun to introduce a small number of Windows machines for use by students in senior Information Technology classes. The school has high-speed broadband cable connectivity to the Internet, and the laboratories, library and staff rooms are all networked to this.

Apart from the obvious curriculum use of computers in specific subjects such as Information Technology and Multimedia courses, there is a concerted effort at this school to teach specific technical skills and embed their practical application in support of learning aims, across many subjects in a systematic and well supported manner, particularly at the grade 7 and 8 levels. School literature and staff repeatedly say computers are used for learning at this school. Considerable time and staff commitment is expended exploring how this can be done with ongoing evaluation and reflection on outcomes. The programs and projects operating here are examined more closely in Chapter 7.

6.4.2 Support

Lack of technical and curriculum support for technology, cited as major reasons for lack of teacher take-up for classroom use, are not significant barriers at EGGS. Technical failures and frustrations occur regularly, but the support structures seem to be sufficient to sustain teachers' efforts. Moreover, the mutual support and collaborative nature of curriculum decision-making by staff for the various technology-based curriculum initiatives under examination in the present study -- indicates that it is this aspect, which might largely account for success.

One full-time technician, Sascha, is available to assist staff and students with technical problems associated with hardware and software. Her office and work space are centrally located opposite the computer laboratories and next to Room 20 which together form a recognisable hub of support for teachers and students. Sascha, despite lacking fluent English skills, can be seen throughout the day competently dealing with a myriad of issues, large and small, either in her office or working alongside teachers and students in laboratories when required. Louise is another friendly, reassuring staff member who occupies Room 20. As part of her role, she has the responsibility for battery maintenance and the issuing of the laptop computers to classes, to individual students, and to the after-school borrowers, both students and staff. Louise sympathises with anguished students and teachers whose work may have been lost or corrupted by the vagaries of a computer or system crash. Moreover, as a technology mentor she has a good understanding of the curriculum goals the teacher with whom she works is hoping to achieve. Room 20 also houses in an open plan layout, the Head of Information Technology and another senior IT teacher. Three computers available for senior students to work at if necessary are lined along the wall next to the servers. Lively meetings where those involved in the various technology programs are regularly held around a large table in this room. Rage and frustration with technology, strong and divergent views on what constitutes good pedagogy with computer use, sharing of practical solutions and continual evaluation and reflection on practice characterise these meetings. The collegial support for exploration of creative use of new technologies these meetings provide is obvious.

The main staff room is another locus of support. A small time allotment has been given to a classroom teacher, Bob, a competent computer-user, to handle staff queries here. The main staff room is the primary work space for teachers and the place where the eight staff computers receive heavy use, so support here is timely. In this role, Bob answers questions, particularly at report writing times, explains the vagaries of the file servers and the printing process, and troubleshoots all types of minor and major problems. When all else fails he calls on the full-time technical support or Head of Computing.

Thus targeted support is available in different guises and in different places. Several staff indicate that without this level of mostly anywhere, anytime technical support, they may have given up long ago. Another often repeated strategy is to promote a climate where students help each other in recognition of the considerable expertise some already have in solving technical issues.

Two key people at EGGS are responsible for technology provision and curriculum use of computers. The Head of Computing has overall responsibility for the provision of hardware, software and networking for academic and administrative purposes throughout the junior and senior schools. The Head of Information Technology, who also holds the title of Coordinator of Learning Technologies, teaches some Information Technology subjects alongside the coordination, promotion and support of the use of technology in the learning program. In addition, the Curriculum Coordinator is also required to encourage and support innovation in the use of technologies across the school, working with the Heads and Coordinators of subject departments who have considerable autonomy for curriculum content and practice. Together with the Head of Library, these four comprise the school's Computer Steering Group who meet regularly to plan, deal with issues and make recommendations on technology use. The overlap of some aspects of their roles, combined with quite different personalities and different personal agendas, has given rise to some ongoing tension and conflict. This situation was reported individually by all of them to me, observed in practice, and often commented on by the teaching staff involved in the study.

Notwithstanding these tensions, at the grade 7 and 8 levels where the most innovative use of computers occurs, cooperative and constructive dialogue between the staff involved is obvious. Flexible technical assistance is complemented by a mix of formal and informal structures and opportunities, which support a shared approach to innovation. These mechanisms include the pairing of IT specialist teachers directly with classroom teachers, and the creative use of subject mentors, all of whom share in devising, implanting and evaluating programs and who participate in class activities at least once in the teaching cycle.

As the Head of History, Michele, says:

> [support is] terribly significant. That is a huge thing … the constant support and availability. It's so easy to come up to this room and talk to people about technological problems, about ideas. I've used Frank so many times to bounce ideas off. Staff members have felt more confident with somebody else in there - whether it's a technological assistant or just more support. Because it is like you are running around the room and some people have found that sort of teaching more difficult than others.

Other committees and working groups related to the use of technologies in the school i.e. the interdepartmental representative group which meets once or twice a term, and the smaller subject or grade level focused meetings, more often than not provide constructive, dynamic forums for lively discussions. Subjects these meetings might address include the value of technology for learning, new software, technical issues, pedagogy in technology using classrooms, professional development needs, etc. Moreover, the voice of the sceptic has a place here. Issues such as the increased time using new technologies requires and the consequential impact on meeting curriculum content goals are vigorously debated in this forum.

In part, the on-going pedagogical dialogue reflects the long tradition at this school for exploring innovative teaching and learning practices in a collaborative manner, through strong leadership at the subject level, and also through the involvement of many teachers in the Program for Enhancing Effective Learning (PEEL). For 12 years a core group of approximately 20 teachers have voluntarily met to share, research and reflect on classroom practices that would stimulate and support more informed, purposeful, intellectually active and independent student learning. EGGS thus is a well resourced school, with an impressive multi-faceted support network, backed by a strong culture of collaborative approach to pedagogy.

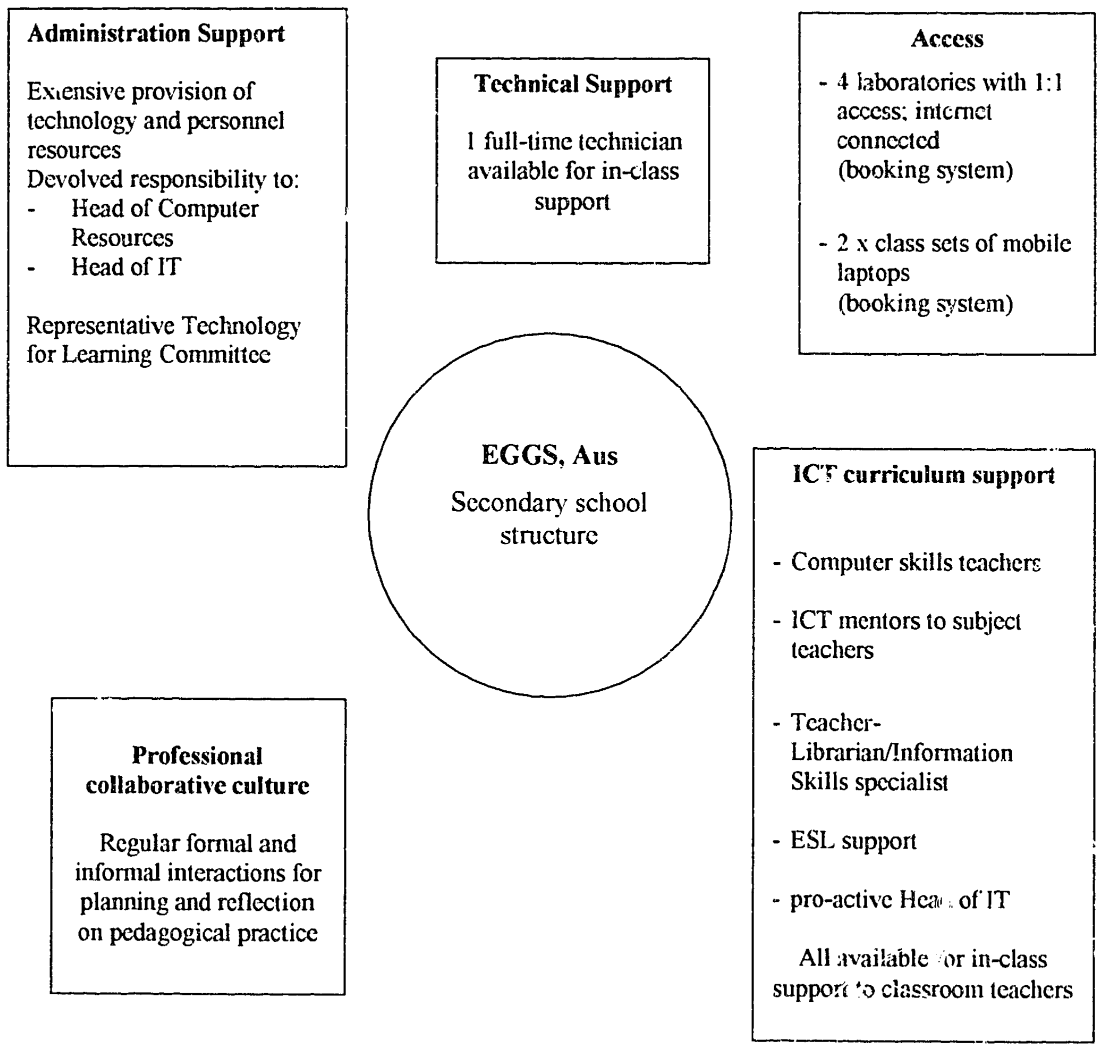
6.4.3 Staff professional development

The most successful forms of staff training for computer use at this school are undoubtedly those conducted in-house, and targeted at specific needs and projects. Training in basic skills such as understanding the features of the Apple Mac environment, word processing, Internet searching, report writing using the data base program, use of email, etc are held on a regular basis in after-school sessions provided by a range of competent school staff, and organised by Frank, the Head of IT. Although there is no formal requirement to attend, most of the staff have acquired basic skills in these sessions. Exploration of how to use technology for teaching and learning is also successfully handled in-house. Jennifer, a teacher librarian, with excellent technology skills, but more importantly a passion for exploring how technology might contribute to student learning, plays a lead role in the many forms of professional development Her enthusiasm and skills, and the respect she earns for her work, are an important contributing factor in the shaping of a positive environment for innovation The various support structures and processes outlined above have also allowed teachers to learn, share and experiment in the classroom in a collaborative manner and is examined more closely in Chapter 7.

Figure 11 below summarises key school ecological factors relating to educational technology at Eastern Girls' Grammar School, Australia.

Figure 11

Key school ecological factors, Eastern Girls' Grammar School Ausralia



6.5 Provision, access and support

As the previous sections have demonstrated, in each of the schools there is a complex array of systemic and organisational factors in operation as teachers and administrators strive to meet policy objectives and expectations relating to educational technology. Each set of ecological factors serves to reinforce the uniqueness of each school setting and underscores the difficulty of making generalisations about effective use of educational technologies for student learning. Each of the schools included here reflects typical school organisational structures - none would be seen to be too far away from a 'normal' school of its type. What does make these schools different from the norm is the preparedness of some of the classroom teachers to include multimedia applications in their teaching programs. As the national surveys indicate, the vast majority of teachers (other than

IT teachers), who actually do incorporate computers into their teaching and learning programs, mainly use routine productivity and research applications. By contrast, the projects examined in this study are those in which teachers require students to use the more complex multimedia applications which allow for the inclusion of graphics, sound, animation, and hyper-linking, in addition to printed text.

Despite the innovative use of some technology applications, these schools are not radically different 'technology schools' making wholesale attempts at completely new ways of doing things. Rather they are institutions seeking to meet expectations within the traditional organisational contexts and constraints. Because of the complexity of multimedia applications, in terms of both the increased skill required and the technical specifications of the hardware and networks needed to run them efficiently, understanding of the interplay and relative significance of contextual factors is of importance. This is particularly so if the uses of these types of applications are shown to be of real value in improving student learning outcomes and thus seen to be worth the resources expended.

Some recurring patterns in the four schools relating to levels of technology provision and access, and the availability of technical and curriculum support, are apparent, and in many ways these patterns reflect the major issues for schools and teachers identified in the large-scale national studies cited in Chapter 3. Regardless of country or educational system, similar issues, seem to play some part in how and with what success schools and teachers incorporate technologies into their teaching and learning programs.

6.5.1 Access

The Technology, Learning and Computing studies (Becker 1999) concluded that access to technology, especially in-class access, to a significant number of computers is a key indicator of teacher take-up. Becker's finding is partially supported in these schools. Of the four schools, only one school (Redwoods Catholic School) has permanent access to in-class computers. Three of the four schools examined in this study have a low student:computer ratio. Silicon Valley Middle School (US) with 1:10, stands out as being the most under-resourced school. Nevertheless, at SVMS, there are other factors at play which have enabled innovative technology use despite access difficulties. At OMSC (Aus) with a low student-computer ratio, there is little consistent school-wide take-up of the extensive facilities.

In each of the schools, the location and configuration of the hardware differs. RCS (US) has six multimedia computers in each of the classes, and regular and easy access to a lab with a 1:1 provision; EGGS (Aus) classes mainly use the various labs but also have access to a portable bank of laptops which allows for 1:1 in-class use, but they too must be pre-booked; OMSC (Aus) classes have lab access with intermittent access to six computers in adjacent classrooms; and SVMS (US) classes use only lab facilities for their projects. Booking of labs is an issue. Because demands for lab resources are high, pre-booking, or using a regular, scheduled time is essential in each of the schools. Gaining access to a lab and using the time fruitfully requires careful lesson planning and a reliable booking system. Some teachers in this study, reliant solely on lab access, expressed frustration that availability of the labs, or lack of it, determines the pace and sequence of instructional activities. Referring to access issues, Liz (OMSC, Aus) comments:

> its just too much of a hassle. It's easier to go and get a class set of books. At least you know you can time it right and you can have them there. I mean it's just sad.

Similarly, Carol (SVMS, US) bemoans the fact that she cannot structure her teaching plan in her own way:

> [the lab] is used just about every period, every single day. Everyday of the year. There is really no day that its empty all day and you see teachers fighting over the sign-up sheet.

In all of the schools, computers are accessible to students before school, at lunchtimes and after school and teachers in all schools comment on the willingness of students to use out-of-class time for working computer projects. Without this out-of-class access, one wonders to what extent the various projects would reach completion.

School organisational structure also affects computer access. Redwoods Catholic School, US, is an elementary school with a traditional structure, i.e. one teacher responsible for most of the learning program for any one grade. Compared with the teachers in the other schools studied, the grade 8 teacher at RCS is much freer to extend time spent on a project, both on any one day and over the course of a project, when needed. With her ready access to in-class computers this situation is enhanced. The other schools, whether in a middle-school structure as SVMS, the mini-school structure of OMSC or the high-school structure of EGGS are far more governed by instructional period time constraints and demands from competing subjects. If a project is dependent on lab access, the constraints are compounded. If provision and access is the fundamental issue, student-owned laptop computers enabling ubiquitous use throughout the school day in any subject, in theory, should solve many of the access issues. Although not the focus of this study, however, recent Australian research shows that high rates of in-class student use does not necessarily follow with the introduction of the personal computer (Newhouse, 1998).

6.5.2 Technical support for teachers

In concert with the large-scale surveys, subject teachers in each of these schools emphasise the need for timely in-class technical support to deal with problems as they occur. All schools in the study have allocated resources for technical support to some extent as shown above, but the support varies in its success at the classroom level. All schools during the course of the study experienced problems to a greater or lesser extent with Internet connectivity, hardware and software. With large numbers of machines in constant use, issues of technical reliability were of concern at all sites. Teachers were to.) used to having their lesson plans thwarted by problems outside of their control and not being equipped, and in most cases not wanting to be equipped, with the skills to resolve these themselves. As Francis (EGGS, Aus) says,

> 'There is a need to have a technology person very much on tap. Now, we do have one, but if you have the four computer rooms all running at the same time and you have that level of difficulty in every one, it becomes a real issue because you don't have enough technical support to keep every child running in class.

When technical problems were solved quickly, teachers and students were more inclined to persevere and talk about their work positively. Those teachers with access to readily available in-class technical support, as do EGGS (Aus) and both US schools, value highly the assistance they receive. They commonly indicate that without it, they would not be so prepared to incorporate computers into their programs.

> I just couldn't have done this course without Louise, the way it's been designed with the use of technology. (Anne, EGGS Aus)

> Yvonne is in my room all the time ... she is always here when ever I need her'. (Theresa, RCS US)

> They were always here. They were always helping out and physically in the room. And through them, I just gained some confidence in being able to restart the computers myself and cope around and work for problems myself'. (Carol, SVMS US)

By contrast, at OMSC, Aus, the limited technical support is focused more on trouble-shooting the many technical issues involved with maintaining hardware and network reliability for the extensive resources spread throughout the school. Not only are teachers (and students) frustrated with the unreliability of the technology, frustration levels are compounded when immediate assistance in-class is not forthcoming. As Annette (OMSC) says, my classes have been 'dominated by technical hassles' and she wishes for 'a fulltime computer technician with all software skills'. As indicated earlier, Liz acknowledged that only help from senior students salvaged the grade 7 project and echoes Annette's comments:

> You need a full-time person, virtually, I think, in the room. A computer technician who knows the program and preferably a teacher. Preferably someone who's got all the knowledge and the ability to relate that to what you need. I mean and you'd do planning together then, I would imagine.

The scenario that Liz (OMSC, Aus) paints for combined technical and curriculum support appears to be a successful one and is the model adopted, and highly valued, at both RCS (US) and EGGS (Aus). At RCS, the full-time role of Technology Coordinator stipulates an experienced teacher with good technical skills and this role is supported by dedicated specialist part-time technical help. Yvonne, the Technology Coordinator at RCS assists grade teachers with curriculum design and technology integration for projects and is available in class during the implementation phase when needed. Furthermore the Challenge 2000 project provided RCS the part-time services of another curriculum/technology specialist, Sharon, who complemented the work of Yvonne.

In addition to readily available in-class technical support, EGGS (Aus) has made a concerted effort to help teachers learn about and solve the more routine technical glitches that occur, while at the same time ensuring that the curriculum is the main focus. Teachers with excellent technical skills are allocated to support and mentor other teachers in-class at the Grade 7 level, and all teachers involved meet regularly. At these meetings curriculum and technical issues are raised, discussed and solutions suggested and shared.

At SVMS, (US) in-class technical support is excellent, but assistance for integrating pedagogy and technology limited, with only two periods allocated from the Challenge 2000 grant for a Technology Learning Consultant.

6.5.3 Professional development and skill training

As with technical support, all the study schools have some programs in place to assist teachers learn to use educational technologies. However, the nature and extent of formal training available for staff in the more complex multimedia hardware and software technologies, the focus for this study, varies considerably. For the teachers in the two US schools, where using multimedia technologies is integral to the Challenge 2000 project, these teachers not only had free access to relevant training at specially provided summer Institutes, they were also paid to do the training, albeit with accountability caveats. At EGGS in Australia, all teachers involved with the grade 7 and 8 classes were taught the relevant skills in-house by knowledgeable others, when and as needed. At the other Australian school, OMSC, three of the four participating grade 7 teachers, expressed dismay that their skill level with the *Scala* multimedia software was so limited - they had received only minimal instruction (two class periods) in its use - and did not feel they had mastered its intricacies in any way. Dan the Head of IT was the one who led the session and he too acknowledged this was insufficient for their needs.

Opportunities for developing teachers' technical understanding were also made possible where in-class or readily accessible technical support structures were in place at the schools. At SVMS, US, Carol frequently discussed problems and how to solve them with the two technicians and the Challenge 2000 Technology Learning Consultant when available. By the end of the year she acknowledged how much both her skill and confidence to successfully trouble-shoot was helped by the availability of this expertise and support. The levels of support available to Theresa at RCS, US, on the other hand actually relieved her of the need to develop more than the minimum level of competence she had gained through the Challenge 2000 Institute of the previous year. She was more than happy to leave teaching the technical matters (e.g. the various software packages, how to use the scanner, importing and manipulating images and sound, file management etc) to Yvonne, Sharon and several technically competent students wherever possible. As she sees it, this then leaves her more time and energy to develop her curriculum content.

At EGGS in Australia many of the teachers used the opportunities afforded by the in-class support to discuss and enhance their personal skill set. Furthermore, at many of their meetings technical issues were often raised and possible solutions discussed. It was a deliberate strategy of the Head of IT at EGGS to facilitate ways for all participating teachers to at least reach a minimal level of technical confidence with the range of hardware and software technologies adopted for their curriculum projects. He is of the view that teachers need to reach a certain level of competence to autonomously handle some problems. With more competent and confident classroom teachers, the schools support resources can then be redeployed to work with other teachers within the school.

Without appropriate training and with only minimal technical in-class support, the teachers at OMSC in Australia were clearly the most disadvantaged both in terms of their personal technical competence and in the means of improving it during the course of their project.

Finding the time for relevant professional development: time to learn and practise new technology skills; time to develop curriculum content integrating their use; and time simply to keep up with the pace of technical change is also a clear concern for all, regardless of the school or country. It was clearly identified by teachers in the national surveys as a barrier to take-up and referred to in some way by all teachers in this study.

> [I wish for] more time for preparation. (Annette, OMSC Aus)
>
> [I wish for] time to develop my teaching material and adapt it to IT'. (Liz, OMSC Aus)

Even at EGGS, well-served with professional development opportunities, the issue of more time still features strongly:

> I do not feel confident using pagemill as I have insufficient time to practise using it, so I never feel as though I am in control. (Barbara, EGGS Aus)
>
> [I wish for] more time to become personally proficient in technology. (Francis, EGGS Aus)
>
> [I wish for] time to develop my skill levels in some software applications and computer skills etc for example html, photoshop, excel; planning and reflection time with others I am working with; time to explore the connections between learning theories/research/experience etc. (Jennifer, EGGS Aus).

Furthermore, even where schools do provide time and targeted professional development opportunities to enable teachers to develop technical skills, this does not necessarily ensure that they will then design curriculum projects which effectively integrate their use. The US and Australian survey studies clearly demonstrate this. The Becker (1999) study also indicates that the professional beliefs and pedagogical orientation of teachers may be a determinant as to whether or not teachers use computers more often, use a more complex array of software and for different types of learning activities. In the following chapters, in closer examination of this proposition, I consider the types of ICT-supported multimedia projects, pedagogical practices and the patterns of professional dialogue adopted by the teachers in the study.

In this chapter I have outlined various national, regional and local factors which impact on the schools and teachers in this study as they seek to use new educational technologies in their curriculum. These include: political and community expectations, school organisation, provision of and accessibility to technology, and the various forms of technical and professional supports available at the school level. All these factors interact affecting the work of the teacher and how students experience using educational technology for learning.

In addressing the central research questions:

- What are the characteristics of effective teaching and learning in multimedia-supported learning environments?
- What social and cultural contextual factors support, or constrain, teachers in achieving successful outcomes when using these technologies?
- What can be learned from a cross-national comparison of practice in schools in which teachers undertake to use these technologies in their curricula?

the next two chapters present data exploring the experiences, views and perspectives of the teachers and students involved in the study. These chapters are designed to 'tell the stories' of the teachers, students and the multimedia projects.

Chapter 7

Teaching in multimedia environments – the teachers' perspectives

In the previous chapter, I outlined various national, regional and local factors which impact on the schools and teachers in this study as they seek to use new educational technologies in their curriculum. In this chapter, for each of the schools, I present an analysis of the learning tasks, pedagogical practices and teachers' views and experiences of integrating multimedia technologies into teaching and learning. Use of the Internet and multimedia applications for student projects at the grade seven or eight levels was the basis for inclusion of each of the four schools in this study. The students in the four schools were required to incorporate a range of advanced technologies into their learning activities and projects: use of Internet for information gathering (text, images, sound, video clips); multimedia presentation and web-page authoring software, use of digital still and movie cameras, scanners and digital imaging software; drawing and animation software. In addition to these complex processes, students also used the more common applications: word processing and graph construction. Although the technologies used across the four schools are similar, the types of learning activities students experienced differed. Tasks included collaborative project-based learning with multimedia (as stipulated by the Challenge 2000 Multimedia project in the US schools), units of work based on exploration of primary sources and fieldwork, and the more conventional research report (albeit with multimedia as the vehicle for presentation). To some extent, each of these learning activities could be labelled 'constructivist'. None involved direct transmission of knowledge by the teacher, other than the teaching of specific skills needed for the various applications. However, depending on the task, the cognitive demands in terms of higher-order thinking differed. Students' attitudes and perceptions differed too according to the type of task (see Chapter 8).

As the large-scale survey studies in the US and Australia indicate, relatively few teachers incorporate the more advanced ICT skills and applications into their teaching and learning strategies. When compared to nationwide surveys, therefore, the teachers involved in this study could be seen to be in the vanguard of innovation. Moreover, these survey studies show that teachers who do use multimedia applications seem to be those who have a more constructivist approach to teaching and have a more professional, collaborative orientation in dealing with colleagues. None of the projects required of students in this study could be described as fitting the teacher information transmission mode. All projects required students to be actively engaged in seeking information from a variety of sources and to represent their findings using multimedia tools. Such characteristics are more typical of constructivist pedagogy. However, the projects considered here vary considerably in terms of the cognitive demands required of the students: some asked students to manipulate, critique, transform and represent information in new ways in the multimedia format, whereas other projects demanded relatively simple research tasks, resulting in a learning product comprising illustrated facts with the added interest and attractiveness multimedia tools can provide.

This chapter is also concerned with representing the interplay between technology access, school structures and support for subject teachers as they designed technology-mediated curriculum and learning strategies and activities for students. It became increasingly difficult during the course of the study to focus on what constitutes pedagogical practice for effective learning with educational technologies (especially with the more complex multimedia tools), without consideration of the diversity of contextual factors impacting on their classroom use. Despite the fact that that for each of the projects at the four schools, teachers and students used essentially the same types of technologies, underpinned by a broadly similar pedagogical approach, the different student learning experiences and teacher satisfaction with the process, can largely be attributed to the different contexts. Indeed, a close examination of the interplay between the players, the learning tasks, the technology and the context in which they were used, reveals recurring patterns of key factors, validated through data triangulation, within schools and across the two countries. The ways in which schools managed and addressed these issues was of critical importance.

This chapter then focuses on the multimedia learning tasks and the teachers' pedagogical practices and experiences. The following chapter focuses on the students and their experiences and perspectives on learning with multimedia. As detailed in Chapter 4, data relating to teachers' experiences were obtained from interviews, classroom observations, focus groups and on-line communications. Given the volume and complexity of the mainly qualitative data, I have devised a number of reporting strategies to convey the complexity, but also to provide insight into what the data might mean. Chapter 4 (see 4.2) contains a detailed discussion on sources used and the ways in which I have chosen to represent the data: 'thin' and 'thick' description, vignettes, tables, graphs and diagrams. Although the iterative process of data exploration, reflection on themes, patterns and omissions, referring back to the literature and back to the data, was fundamental in preparing this section, a more comprehensive interpretive discussion is reserved for Chapter 9.

To provide a common structure of analysis, for each of the four schools, teachers' pedagogical practices and views are organised in the following way:

- the project/s
- computer skill acquisition

- structuring, monitoring and assessment of multimedia tasks
- classroom management in technology environments
- use of the Internet
- time needed for multimedia projects
- teachers' perspectives

7.1 Redwoods Catholic School (RCS), California, US

At Redwoods Catholic School, Theresa Leckie teaches Social Studies to both the grade eight classes. She is also the class teacher for one of them. She has a passion for her subject, and constantly seeks ways to enthuse, engage and excite her students. For Theresa, requiring her students to use the new technologies helps her do this: 'I mean this is Silicon Valley. They all have computers!' And this is despite the fact, as she freely admits, that her own skills, although adequate, generally don't match those of most of her students. Each year she requires the grade eight students to undertake an extended project. This year, as in the previous year, involvement with the Challenge 2000 Multimedia Project grant is shaping the design and implementation of the class project. The C2 funding has provided her classroom with two extra multimedia computers, a digital still and video camera, access to the expertise of a Technology Learning Coordinator and has required her to design a project according to the criteria expected by the grant i.e. project-based learning with multimedia. The project specifies student groups working collaboratively to research, design, plan and produce a multimedia product on a California standards-based topic with real-world application and which fosters higher-order thinking skills. Theresa is fully supported by the school administration (the Principal and the Deputy-Principal) in her work. Well-structured, engaging, student-centred learning activities, clear expectations, nearly anytime access to reliable technology, in-class support for student skill acquisition, for dealing with technical glitches and for more routine ongoing assistance, characterise this extended project. The fact that these grade eight classes at RCS are situated in an elementary school structure, and not so beholden to competing timetable and subject demands, as is the case with the other three schools, is significant. Significant too is the overt, ongoing support of the school leadership for innovative use of educational technology. What follows is a vignette designed to portray her classroom more vividly:

> In this middle-school computer laboratory, students, in groups of two or three, are clustered around colourful IMAC computers. The students in one group are discussing vigorously what background and sound effects to add to the webpage they are constructing for their Social Studies project. Black, with neon coloured text running along the bottom of the screen under the waving flag of Taiwan, is a popular option. At another computer, the student who has charge of the mouse, clicks rapidly through Internet sites in search of information and pictures that might prove suitable for the group's topic on Mexico. Interesting images attract the group's attention but little time is spent digesting the text. 'Get that, get that. It's

good. Remember she said we also have to put in where we got it from. Go back and get the URL'.

Yet another group is at the back of the room with the Technology Resource Coordinator. She is teaching these students how to scan and digitise the family photos each has brought from home. They watch intently and then begin themselves to scan, crop, resize and convert their pictures into jpeg form to load onto the web site they are constructing together. These girls and boys chat excitedly when they see their families' precious images appear in digital form. The wedding photo taken in pre-war Vietnam is especially intriguing for these students. 'Wow that is so cool!'

Meanwhile Mrs. Leckie, the Social Studies teacher is questioning another group about the historical chronology they are preparing on Japanese immigration using the PowerPoint software. Concerned about obvious inaccuracies, she asks the students to check the information. How to change the colour of the bullet points, however, was the main concern of one of the students.

Another student, Vikki, working on her own, is intent on copying onto her web page all the information she gained from the interview with her French grandmother last night. She is engrossed with the task and often stops to read and then revise what she has already typed in. She proudly shows Mrs Leckie who passes by. Mrs Leckie spends most of her time walking around, checking on the various groups, giving advice and answering questions. She is worrying about how long this project is taking. Nevertheless she is seeking a great outcome and urges her students on. Last year her grade eight class won the California-wide multimedia competition for their extended project and all involved enjoyed the considerable accolades which accompanied the win.

Kirtina meanwhile has her hand up seeking help. She needs help in nearly every computer class. 'I just don't get it' she complains to Andy, one of the students, designated to help with problems, when he reluctantly wanders over. He can't fathom why Kirtina has so much trouble understanding which drive and which folder to put her work in. He's shown her three times already. Mrs Leckie, the teacher can't explain it to her either. Andy thinks his teacher doesn't really understand how to do it herself.

An anguished cry in unison comes from the Italian group. The computer has just frozen. 'We hadn't saved it! We are going to have to do it all again! It was so good too! It must have been the sound file'. This class period is only one of two scheduled weekly in the laboratory. However, the Italian group know they have lots of options to restore and continue working on their project: they can use the computers in their own classroom when other subject work is complete or before school and at lunchtime. The also know teachers in lower grades will allow them, as 'techy Leckie's' kids, to use spare computers in their classrooms if appropriate.

Just before leaving class two other boys look furtively around the room to see where the two teachers are, then with a click of the mouse one of them logs on to his Hot Mail account. While sniggering, a quick response is made to one of the messages, the computer is shut down and innocently they walk out of the room. Another two in conversation as they leave: 'This is such an ace project. Can you come over to my house after school? We can look for more information and pictures. My computer is like so much better than these ones.'

7.1.1 The project

Understanding the history of immigration to America through the eyes of the students' families was the topic negotiated between Theresa and her students for their grade 8 extended Social Studies project. Groups were formed on the basis of students' ethnic roots (Irish, Mexican, Italian, African American, Iranian, French, Vietnamese, Polish, Filipino, Japanese, Taiwanese, Chinese, Portuguese, Scottish, German, and Romanian). Groups were also able to be formed across the two grade 8 classes that Theresa teaches. Each student and each group had a number of tasks to complete and were left in no doubt about what was expected of them, when tasks were to be completed and how they would be graded. The tasks included individual research on their families' journeys to the United States, and presentation of their individual and collective stories using a variety of formats: written tasks, oral reports to the class, a group web site authored in Netscape *Composer*, containing linked pages, a timeline and narrative of events constructed using *PowerPoint*, scanned images of family memorabilia and short videos where possible. Each group's web pages were to be linked into a whole class site for loading onto the school website to allow for viewing by the wider community. This project bears all the hallmarks of a constructivist student-centred pedagogy and more than met the Challenge 2000 Multimedia project guidelines and expectations.

7.1.2 Computer skill acquisition

Most of the Grade 8 students already had some of the computer skills required for this project - acquired either from instruction in previous years, or learnt outside of school. However, the skills needed for making multi-page web sites incorporating multimedia elements were unfamiliar for most, certainly for Theresa. She was more than happy to leave the formal instruction of the more advanced technical skills to Yvonne, (Redwood's fulltime Technology Resource Coordinator) and Sharon, (the C2 Technology Learning Coordinator who regularly attended the school to assist with this project). These two alternated in teaching the specific skills required, and supported and nurtured the students throughout the course of the project. The two have quite different teaching styles and sometimes would explain processes differently, which for some students and for Theresa was, at times, a source of frustration. Nevertheless, without Yvonne and Sharon's presence for teaching, advice and support, an ambitious project such as this would not have been possible. Regardless of the way a teacher teaches, Yvonne is convinced that:

> with technology I think learning by doing is probably the one thing you do. You need somebody there with you but learning by doing is how you learn it.

Theresa also acknowledged the importance of the students' role both in teaching the skills to each other and in the process of successfully compiling the final product. Theresa believed the weaker students who still had difficulties (especially with the more complex skills of linking multiple pages and managing the graphic, audio and video files), despite the formal instruction sessions provided by teachers

> actually learned it from the kids themselves I would say. ... I think it's been more of peer teaching.

The more technically able students were also allocated by Theresa to various tasks to share their skills:

> I pulled the kids that were the most competent and they are putting it all together. I have one girl who is the webmaster who has put everything together. And I have another committee that has done all the video, so there is about 6 kids that do the video. So that's another group. I also have about 5 or 6 kids that go around and help the other kids.

In addition, Theresa also acknowledged the students' role in her own computer skill learning, unperturbed that she does not know how to do everything they do. As she sees it, her major role is to engage students in learning:

> The kids are far better than I am. And I learn from the kids. And it's not a concern to me and I don't have to know how to do it. I just need to generate them to do it and to get them excited about doing it. That's basically what my job is. I don't have to be the one who knows how to do it all.

Notwithstanding the school administration's expectations for all teachers at all levels across the school, Theresa and Yvonne are still disappointed with the differing levels of ability students have brought to the grade 8 exit year.

7.1.3 Structuring, monitoring and assessment of learning tasks

Careful structuring and regular monitoring of learning tasks embedded in the extended project to facilitate students remaining on task and learning time management were key concerns for Theresa. Prior to the beginning of the multimedia component students were required to plan, or storyboard, their web pages:

> We had decided that as a group they would have to storyboard the whole project out. And again this is nothing new to them because they are used to doing that anyway. They don't just get up and start typing things.

However, despite meeting the requirement to prepare a storyboard, there was little evidence of students referring to their storyboards during the course of the project. Students for the RCS project are left in no doubt about the expectations required of them: what they are expected to achieve and when, and how their work will be graded. Even when the technology components ran overtime, due dates were negotiated and renegotiated with students. As Theresa says, keeping kids on task, for the parts and the whole of these types of projects, is always an issue:

> There has to be a checklist and there has to be some kind of timeline. I always give my kids dates when things are due. And they have to be due that day ... You have to have weekly checks, sometimes even daily checks. Some kids I had to do a daily

check. What have you done to-day? What have you done? ... and everybody's got to be accountable ... And everybody got an individual grade sheet at the end. And they all had to do all of the things, if they didn't they got marked down.

Monitoring the progress of individuals as well as the various groups, checking for errors and assisting and advising students characterised Theresa's time in the laboratory. Skill acquisition and handling technical problems were left to others: specialists and students.

7.1.4 Classroom management in technology environments

Clear guidelines for students when using computers have been set by the school and sanctions are enforced if the rules are violated. The presence of more than one adult in the computer laboratory – the classroom teacher and the Technology Resource Coordinator - generally assists this process, although not always. Two students had their computer privileges temporarily revoked during the course of the observation period for inappropriate use of the Internet. Theresa believes 'teachers really have to monitor what the kids are doing ... they need a whole lot of good management'.

Theresa is sanguine about the technical difficulties that occur when technology is used in the classroom and believes that students on the whole are too: 'That's just life. The kids know. I mean their own printers break down. Their own technology breaks down, so they were used to that'. However, she also says teachers must plan for the inevitable:

> Now you've also got to be a little flexible because technology sometimes breaks down. We had a lot of trouble for example with technology breaking down, and you can't go do anything if that's happening. But, you also have to have an alternative, so that if all of your technology goes down, you still can rely on your encyclopaedias and your textbooks and stuff like that. And you need to make sure you emphasise that with the kids. They need to always have that there just in case this happens.

Yvonne, the Technology Resource Coordinator agrees that flexibility is critical:

> And the thing about technology you have to be flexible in one form or another because it will go belly-up on you and you have to be flexible enough to know what I have to do when this doesn't work. ...You have to have flexibility built in.

Anytime access to the six computers in her normal classroom and in other classrooms, if available, makes technical failures in the lab not such a problem for Theresa as it is in other schools. Yvonne, the ever-present Technology Resource Coordinator, and Theresa, towards the end of any computer lab session, remind and reinforce with the students the need to save and manage their work files. Too many problems have arisen when this is not done. Theresa repeats, almost like a mantra:

> Did you save it? Do you have a hard copy? Do you have it on your disk? Is your disk labelled?

7.1.5 Use of the Internet

Encouraged by the Principal and Deputy Principal, Theresa has been an enthusiastic advocate of student use of the Internet for information gathering for the last few years, believing it allows them access to a far wider range of sources than has been traditionally available. Nevertheless, she also firmly insists, as a History and Social Studies teacher, that students use a range of other sources in the research process. Furthermore, Theresa stresses that when students use the Internet in class, she selects sites and also monitors the sites they visit.

> You can't just say go out and do it. I had all the web sites. Either I would give them to the kids or the kids would find on their own and I would monitor them.

Despite this, some students still looked for opportunities to access web-based email and irrelevant sites - some were caught and dealt with, others were not.

Yvonne indicated that there is no formal teaching to students about effective use of the Internet:

> There is a difficulty with that in this school in that that's the teacher's responsibility and I don't think any of them wants to do that.

The common practice is for teachers and students to share what they have discovered with each other.

7.1.6 Time needed for multimedia projects

Despite scaffolding the tasks and regular monitoring of student progress, the project which started in November was not finalised until May. Whereas the research tasks were completed in the first month, many issues related to the technology component served to extend the process considerably: the differential skill ability of students in using the array of hardware and software; the conflicting ways the technical specialists asked students to use the web-page authoring program (Netscape *Composer*), combined with the fact that some students used different software at home to make personal web pages, problems with Internet crashes, and inappropriate saving resulting in lost work. Due to the flexibility afforded by the elementary school structure, however, Theresa was able to dedicate extra time for project work. Each Monday, for example, was set aside for students to work on on-going tasks. Furthermore, in-class access to the six computers for students when they had no other commitments and access to them before school, lunch-time and after school, was also advantageous. For Theresa, however, her project design incorporated a research component and written and oral tasks generally stipulated to be completed prior to embarking on the multimedia presentation component, so the time overrun was not of great concern.

It was of more concern nonetheless for Sharon, the Challenge 2000 Technology Learning Coordinator, who was anxious that the students meet the deadlines established by the C2 Project. The length of time the projects consumed was also a concern for Ruth, the Deputy Principal of RCS, despite her generally supportive stance to the use of technology. However, Ruth also acknowledged that learning how to teach in this type of environment is new and different:

> It's messy right now ... There's a lot of things that shouldn't be happening. A lot of wasting of time. A lot of things like only a few kids getting really good at stuff and its too much of a pyramid at this point. It should be levelled out a little bit more and everybody should be learning. And I think that's just messy because people don't know the extent of the technology. I was just talking to Theresa at lunch and she was saying things like well you know we have 17 film bits to put onto the thing. And my response was well if you do it again, because it takes too long, an inordinate amount of time, you need to teach better than that. You need to say OK how can we best get this point across. Do we need 17 clips? In other words its messy and its just my personality. I have to relax. It's a process, it's a process, it's a process for everybody.

On the other hand, Yvonne, Redwood's Technology Resource Coordinator, believes teachers need to understand that although they take time, when doing these projects, there are a range of other learning benefits for students:

> They do take an enormous amount of time and that's what every teacher who gets involved with these projects always say. What they fail to realise is that there's a whole bunch of learning that's going on that's not what they conceive of as learning. I mean they're learning to interact with each other and to cooperate. They're learning to use the technology which is time consuming when you're learning it.

7.1.7 Teacher perspectives on teaching and learning with multimedia

Theresa is a very enthusiastic, committed and experienced teacher of Social Studies who, in all instructional units of work, not just this large-scale project involving the two grade 8 classes, has required her students either individually or in groups to extend a topic through research and class presentation. In recent years, presentation of this extra component has tended to be word-processed, but increasingly she has encouraged students to use multimedia formats: *PowerPoint* and *Hyperstudio* presentations, simple web pages and digital video. Theresa agrees that using technology is worthwhile for student learning, however, is quite clear how she sees her role:

> I am a History teacher not a technology teacher ... I am a History teacher and when they use the technology, that's the fluff. That just makes it look better. But they all do research. I also encourage them not to just to use the Internet to find resources. They still have to use a bibliography, they have to use books, they have to use other references besides that. I think that's really important. I think technology is one tool nothing more. I don't want them to forget how to read.

Before any topic's extension and presentation phase commences, Theresa requires common class work (constructed in a range of ways including delivery in lecture mode or note-taking exercises from text books and other sources) to be completed and assessed.

Theresa emphatically asserts that even though her students can do three-dimensional display boards which are just as impressive, technology does enhance the process for the students:

> Oh yes of course it has enhanced it ... Because the presentation is better. ... Because it is a tool, its fun. They get to play around with it. They like to find new things. They like to go to different sites and find new backgrounds. They like to find music. Its fun. I mean they were raised with computers so to them its part of what they do.

Both Theresa and Yvonne are convinced that students enjoy and are engaged with the new technologies and moreover their use can assist learning:

> this media turns the kids on, excites them and engages them. And I think that that's the most important thing ...They get some knowledge in them a different way. They get it in the back door. They think they're doing *Hyperstudio* or something creative and they are learning Math! They think they're doing webpages and making movies, but they are learning about their families, their history. (Yvonne)

> I think they are very engaged. They're very good. They love to do this. (Theresa)

When I asked: 'Do you see their fun equals learning? Theresa replies 'Sure. You can have fun learning'. From her position as Deputy Principal, Ruth also argues that these types of projects have value:

> These are the advantages I can see. One is that it encourages teachers to take risks and it is good for the educator and the student, because they see that it is a good thing to take risks. The second reason I think they are good is because it empowers the students. Because often in these projects, the teachers don't know how to do everything and that's a good message for kids to get that you don't have to know, you can try this and this. And that teachers are not the sage on the stage, teachers are the guide on the side ...The third reason I think they're good is that the kids are in many of the cases working together as groups. There is a couple of things happening. They are working not in isolation, which is a skill I think they really need to learn which is to work cooperatively. And they're finding lots of different resources.

Theresa does have misgivings, however, about participation in large-scale projects which has involved both classes totalling 70 students, as she has done in the Challenge 2000 project for the past two years. She would rather her students continue to do a variety of smaller multimedia projects that could be completed in a shorter time frame throughout the year.

Theresa enjoys being the standout user of technology in the school. Her students have won awards for their projects and she has received praise and recognition herself from the Principal, the

Challenge 2000 project and in state-wide competitions. Sharing her pedagogical practices with colleagues, however, is not common for her – she is so focused on her own work. As both Ruth and Yvonne indicate, some of Theresa's colleagues don't really want to hear anyway, even if there was time. The task of encouraging, motivating and assisting other staff to explore creative uses of technology falls to the Technology Resource Coordinator, and for the duration of the funding, the visiting Challenge 2000 Technology Learning Consultant.

7.2 Silicon Valley Middle School (SVMS), California, US

Extended multimedia projects about Spanish-speaking countries undertaken by the grade 7 and 8 Spanish students taught by Carol were the focus for the study at SVMS. Carol elected to do these multimedia projects with her classes – there was no compulsion to do so, no fulfilling of school-wide expectations from the administration. The only formal component of ICT skills at SVMS comes in grade 6, the entry point for this middle school. All the grade 6 students take a six-week course in basic computer skills taught by specialist IT teachers, the content of which is not directly related to the mainstream curriculum. It is optional for subject teachers to integrate computers into their curriculum as Carol has chosen to do with her Spanish classes. The opportunity presented by the Challenge 2000 Multimedia Project (for training, assistance and a stipend), was the stimulus for her to try something new. She learnt to use *Hyperstudio*, the software package chosen for the Spanish projects at the C2 summer institute and designed the unit of work for her Spanish classes during this period. The following vignette provides a picture of her class in action:

> On entering the SVMS computer laboratory where Carol's grade 7 and 8 Spanish classes are held, the physical similarities to the RCS (US) and EGGS (Aus) labs are striking. Each are similarly equipped with multi-hued Apple Imacs lined up in rows, whiteboard at the front, with a few scanners and printers around the perimeter. First impressions would indicate that the labs are all located in the same school, in the same country, until the students' accents are heard, that is.
>
> Today, students in one of Carol's grade 8 classes are in the lab working on their multimedia projects about Spanish-speaking countries. Some groups of two or three students are working together around one computer per group; other students are working side-by-side on individual components of the group task. Some students are on the Internet searching for information and pictures about their group's country, or listening to and recording national anthems; others are discussing design features of the slide they are making with the Hyperstudio multimedia software: where to place images, what backgrounds and font size and colours to use, what transitions to use to move from slide to slide. Some are scanning maps of their countries to include in their presentation. The Paraguay group expresses surprise that their country's flag is different on each side, and spends the rest of the period working out ways to show this effect using Hyperstudio.

'Alta Vista' is the best place to get pictures', says Mike. Sharing search tools and tips is commonplace among the groups. No formal instruction on information skills is built into the school's instructional program however. This is a worry for Carol as she sees the students roaming the Internet, often unfocussed, and violating all copyright laws. She is relieved she decided not to ask the students to make web pages which might be accessed publicly. She plans to re-jig her approach for next year.

Writing their information in Spanish to put into their presentation is causing problems for some of these grade 8 students. Their Spanish is not very sophisticated in this their second year of studying the language. Recourse to the dictionary – hardcover and on-line – is necessary for many. Carol spends a lot of class time checking the correctness of the students' Spanish text. That is of course when she is not dealing with the technical issues that have plagued these projects over the several months they have taken. Carol's Spanish classes have been working on their multimedia projects about Spanish speaking countries since November and it is now May. It is only recently that the school technicians and Susan, the Technology Learning Coordinator, have solved what Carol calls 'head-banging' problems associated with using the multimedia-authoring software *Hyperstudio*. There have been endless problems with this version of the program and its incompatibility with the school's hardware and network. Upgrading to a newer version of the program has been the answer. But finding the answer had taken so much time. Much to Carol's relief, problems with students losing work are starting to diminish.

Crashes and lost work seems to have been experienced by nearly all of the groups, but most students take these problems in their stride. They have computers at home (generally not Macs). Problems happen. They are used to persevering to make things work. As Becca says: 'I had a lot of problems with my computer. It was hard figuring everything out and lots of my work got erased and I ended up starting all over again. On the other hand using computers was useful and easier'. Not so accepting is Grace who says: 'This is not the first time that *Hyperstudio* has made my life frustrating and horrible. I wish I will never-ever have to use that program again'.

Carol does not let the technical problems detract from her goal. She now knows enough about Hyperstudio - why the problems are occurring and how to troubleshoot - to manage her classroom. She is reassuring and patient with the students and is willing to decrease the task requirements or extend the time to allow students to feel some sort of success.

Also, as at RCS, US and EGGS in Australia, Carol, the classroom teacher, is not the only adult in the room. Carol is grateful, as are the students, for the ever present, pro-active technical assistance of young Iwalani who is now joined by Zena, a second recently appointed technician. Carol is also grateful for the times when she and Susan, the Technology Learning Coordinator, funded by the JVSV Challenge 2000 program, swapped classes, in order for Susan to give specific instruction to the students on how to use *Hyperstudio*. Carol is not sure she could have managed without these forms of support.

Next year Carol vows to book the only computer lab available to her in uninterrupted blocks of time over two or three weeks so as to complete this component of her Spanish curriculum more quickly. Lack of flexible access to the computers when needed dismays her, together with the fact that the 50 minute time periods seem to be over before they've begun.

Despite the difficulties, she is satisfied. She sees her students challenged and engaged in their work, and is in awe of their 'almost unlimited creativity'.

7.2.1 The projects

The task for each of Carol's two grade 7 and two grade 8 Spanish classes was for students, in groups, to research information on Spanish-speaking countries around the world (Geography, History, Flag, Anthem, Culture) using books, magazines and the Internet, and to present their findings in multimedia format using *Hyperstudio* software. The project had to include a scanned map of the country researched. This research project has been a part of Carol's Spanish program at the grade 7 level for the past six years, but the required end product was traditionally in the form of a poster. This year, Carol has required the grade 8 students to repeat the research component done last year in grade 7 (but with a different country), write the text in Spanish, and like this year's grade 7 classes, present their work in multimedia format. Cognitive demands relating to content are not high. Carol's basic aim is for her language students to gain some understanding of the influence of Spain across the globe. She is still unsure about the value to the grade 8 students of them doing the project in Spanish.

Students were given clear guidelines for the component tasks of the project. However, due to the time required to create in multimedia, combined with the severe technical problems, what was considered acceptable in a final product changed for many students and the submission dates were constantly pushed back.

7.2.2 Computer skill acquisition

The specific skills needed for using the software package *Hyperstudio* were taught by Susan, a grade 6 teacher, who also acted in a part-time capacity as the Technology Learning Coordinator funded by the Challenge 2000 Project. Susan had been the instructor at the Institute Carol had attended in the summer, so was well aware of what Carol was trying to achieve. Organisational constraints required Carol to cover Susan's classes in exchange for Susan teaching each of the Spanish classes the basics of *Hyperstudio*: 'how to create buttons, how to move cards, different fonts, colours, that kind of stuff'. Additional skills in using the scanner, downloading images and sound files and learning to save work in the appropriate folders on the school network and then incorporation into *Hyperstudio* were generally taught by Carol as required, and as she grew in confidence:

I think the hardest thing, the thing that I had to help the kids with the most, was getting something from the Internet, like a picture or graphic image and get it onto their *Hyperstudio* stack. And that is something that they just haven't had a lot of practice with before. They are used to using icons and clip art which is really easy for them. They just click on it and there it is. But they needed to save it, if they need to turn it into a gif file or a jpeg, how to do that. So its many steps involved. And they just forgot, or it was so beyond the bounds that they just needed help along the way.

As with the RCS students, much informal, peer-to-peer teaching was also a regular occurrence. To her surprise Carol saw students who were almost 'invisible' in the regular Spanish classroom 'shine' in the computer laboratory:

some kids that I would never have expected, are kids that can fix any problem and really are confident with helping their peers and teaching their peers. Whereas in the classroom, if I said could you explain that to so and so, they would be kind of like "er"? But here, it's like "I know this computer, let me show you. I can do it". So it's really giving kids a chance to express themselves in a different way.

Further assistance in helping students master the skills and troubleshoot problems was also available from at least one of the technical support people always present in the lab.

For Carol, personally, the risks she took in using this technology with her students and what she learned during the year, were powerful experiences. Despite the Summer Institute, at the start of the year she felt little confidence in being able to lead the project:

I think I know a million times more pieces of information: using technology, problem-solving, navigating, short falls, all of that kind of stuff ... when working with the kids at the beginning, I didn't even feel comfortable teaching *Hyperstudio* ... and just in solving their problems and answering their questions, was able to just with simple little key strokes or checks or OK exactly what's wrong with your computer? Oh I can do this!

7.2.3 Structuring, monitoring and assessment of learning tasks

The simple design of the learning tasks caused no difficulty for students either at the grade 7 or grade 8 levels. They all knew what was expected of them and most used their class time effectively to try to construct the multimedia elements in *Hyperstudio* as required. However, because of the problems experienced with the software, Carol was forced to alter her expectations for completion of the project and for its assessment:

Well I have to admit I started off with really high expectations; it was going to be worth a huge part of their grade. But because of all the technical difficulties we've had - if the students have anything, they've passed this part of it. With just C- at the bare minimum if they have anything to show for it ... If they did everything required of them, A+, if they had 9 out of the 10 things, 8 of the 10 things, I just sort of went down the line and just said there you go. And I'm giving kids feedback and right now they have their feedback, and I am giving them an opportunity to fix anything and add and make it better, and I will re-grade it for them. And so I think I was pretty soft on grading just because we have had a lot of problems. Kids losing stacks, losing cards, computers just quitting on them kind of thing, so I was pretty easy on their grading.

7.2.4 Classroom management in technology environments

Over the course of the project, in order to maximise the available instructional time, Carol set clear procedures for students entering and leaving the computer lab, and established seating plans. She acknowledged that some students will always 'goof off' and kept a close eye on some students (boys) who were suspected of having vandalised some equipment. When the case was proven these students were dealt with promptly by the school's disciplinary procedures.

Carol approached technical question or problems which arose (and early on in the project there were many of these) calmly. She worked through a procedure or solution with the students, by asking questions with the aim of getting students to work it out or troubleshoot for themselves. When neither she nor the students could manage, there was always technical assistance available in the room.

7.2.5 Use of the Internet

Research on the Internet was the major source of information for the students for their projects. At SVMS, teaching students to research on the Internet was left to individual subject teachers on a class-by-class, project-by-project basis. At the start of their projects Carol spent time pointing out relevant and useful sites to each of her Spanish classes:

> When we first started I spent a day with the kids showing them where they could find pictures, where they could find video clips, where they could find music clips, showing them sites like Alta Vista, there's some really good sites there … Putting sites up on the board that were good places to start and telling them to be very careful of the difference between dot com and dot org and dot gov. Giving them sites that you really didn't want anything to do with. And then telling them to be really careful about what they used and start with a reputable place like Yahoo and Alta Vista or something like that. And using the search engines Ask Jeeves which has helped a lot of kids because they couldn't put what they wanted to know in one or two words, but they could make the question. And so that was helpful for a lot of kids.

Most students made considerable use of the Internet, but at times Carol had serious misgivings about the way in which they used it and recognised that she needed to impose more structure on its use for another such project:

when the kids were looking up cultural tourism when there is not such hard facts and end up with such different pieces of information than what they might find in a book or a magazine or some other source that they were not sure what to use. And I find that kids who researched the same country have completely different pieces of information. And I also think the kids just find so much stuff that they don't know how to weed it out.

So I think that next year I might do some legwork ahead of time and suggest that they start with a set of Internet sites which I will already have set up. What I would like to do next year is have my own web page that kids can go to and from there, whether its each country, they could click on their country and there will be web sites for them, or this is a good place for flags, this is a good place for general information, contact your country consulate and so have those web sites. And so have it all set so they can just click from there to give them a place to go because kids will … come back with thirty three thousand Internet sites.

7.2.6 Time needed for multimedia projects

As with the RCS multimedia project, Carol's Spanish projects consumed considerable amounts of time, more than the same projects done in the previous year without the multimedia component:

> It's taken about seven or eight times as long. When you do it on the hard copy we would do it in about a month or six weeks from assigning the project. The presentations completed and everything. This year I think we assigned it at the very end of October or the very beginning of November and its May 18th and we are just really finishing it now.

Limited access to the computer lab was one of the constraints she faced in fitting in the project work around her normal Spanish language teaching:

> So we come sporadically to the computer lab. Sometimes we come once a week. Sometimes we'd skip a month. Sometimes we'd come every day for a week. So it was really sort of sporadic. Most of the school year we have been here.

Carol acknowledged that disorganised students, in particular, faced difficulties with the intermittent sessions devoted to the project, and planned to manage the time and access issues differently should she do it again:

> If I were to do this or some other project next year, I think I would take a month out of school and do it all in a month. And spend maybe three or four days with research for the kids in one week and then starting the next week be in the computer lab for three or four days a week. To have one day in the classroom where we will be practising some grammar, that kind of stuff. So we can be able to just get away from the computer lab for a day, reflect on what we've done, what the next step is, have the kids to be able to talk to their partners. Get it all done and I think I would see a better overall project from beginning to end in a short period of time.

7.2.7 Teacher perspectives on teaching and learning with multimedia

Students in the SVMS Spanish classes, in addition to discovering facts about the global influence of Spain, became more familiar with using the Internet, gained a greater understanding of file structure on the school network and became more adept at using and troubleshooting the *Hyperstudio* software. However, the poster presentations of previous years took a fraction of the time consumed by these multimedia presentations. From Carol's perspective, student engagement with the task, combined with the real world computer and investigative skills they acquired and practiced made it worthwhile - technical difficulties and limited access to computers notwithstanding. She strongly believes that using technology is worthwhile for student learning:

> I think you know just where we are in the world right now, just being able to navigate the Internet as a skill and understand how simple it is, but also how complex it can be, is great for the kids to know. I think that this kind of presentation, whether it be *Hyperstudio* or *PowerPoint* or creating a website are skills that the kids really need to know next year, five years from now, ten years from now.

In contrast to the grade 8 classes at RCS (structured on an elementary model with more flexible time and resourcing arrangements), competing demands for access to the one available laboratory, plus a tighter adherence to a subject-based timetable placed significant time constraints on the SVMS Spanish projects. Nevertheless, Carol was not put off by the experience of this year - she believes it was the right decision.

Her feelings of success, however, were not altogether shared by the Challenge 2000 Multimedia Project evaluator. Although the student presentations demonstrated capable use of technology, the task itself was considered limited, with little evidence of higher-order thinking: students simply presented information about Spanish-speaking countries in multimedia format without any analysis or interpretation.

Like Carol, Susan, the C2 Technology Learning Coordinator who has been supporting Carol through the project, agrees that it is worthwhile for students to use technology as 'it allows several ways for students to learn'; ... it demands practice and application (useful work skills)' ... 'it demands/encourages creative/critical thinking'.

Carol does not fit entirely with Becker's model of a constructivist technology-using teacher – she is not a frequent presenter at conferences nor does she regularly collaborate and share ideas with colleagues. She is too busy with the routine demands of teaching and not particularly interested in wider school issues. Her chats with Susan, are more to do with specifics about the Challenge 2000 funding than about pedagogy. Further, the two hours she takes to get to and from work each day leaves little time for extra commitment, even if she did want to. Whereas the C2 Technology Learning Coordinator role was designed to assist project-funded teachers to design good learning activities for use with multimedia technologies, in this case, assistance focused more on teaching the software skills and troubleshooting in the limited time available. Apart from the opportunity provided by the Summer Institute, time was not made or was not available for in-school substantive discussion about the overall approach to learning in a digital environment.

7.3 Outer Melbourne Secondary College (OMSC) Victoria, Australia

Apart from specialist Information Technology and Multimedia subjects available from the grade 10 level, there has been little coordinated use of the computer facilities at Outer Melbourne Secondary College in other curriculum areas. The grade 7 integrated projects with their embedded use of computers, constitute this Australian secondary school's major effort to meet its charter goals for use of learning technologies. Under the auspices of a State Government Innovations Grant, OMSC linked curriculum design and delivery of integrated units, to the use of ICTs in this selected grade 7 trial class. Dissemination to other grade 7 classes was to follow the trial if the project was deemed successful.

School planning in the previous year had identified four teachers from the English, SOSE (Studies of Society and Environment) Maths and Science faculties willing to design and deliver three instructional units, integrating their subject disciplines with ICTs over the course of the year.

For the duration of each project, approximately six weeks each, instructional time allocated to these four subjects was given to the interdisciplinary unit. Two of the teachers, Liz (Science) and Annette (English), had had some previous experience in the design of cross-disciplinary instructional units, but, for the other teachers Norma (Maths) and Dan (SOSE and the IT Coordinator), the approach was new. All of them, as well as Chris, the Curriculum Coordinator with overall responsibility for the grant, were realistic about the difficulties often associated with delivering interdisciplinary instructional units within a secondary school model whose organisational structure and timetable is geared to discrete subject disciplines.

At the start of the year, of the four project teachers, only Dan, the Head of IT, who was also the SOSE teacher, had any substantial understanding of, and experience in, using computer technologies. Liz and Annette's computer experience entailed word processing worksheets, and compiling student reports; and both encouraged their students to use word processors when appropriate for submission of work. Both Liz and Norma had started to use graph construction tools in some classes, and Liz is a keen explorer of the Internet for possible teaching resources and was becoming an avid user of email. For these three teachers, the state-provided laptop computers have accelerated their use of computers. However, they admit they have no real understanding or experience with the complexities of constructing documents in multimedia format, or how to deal with the constraints multimedia can place on school network capacity. Further, they had very limited training on the *Scala* multimedia software selected for constructing the multimedia presentations and little to no prior experience in using computers with whole classes of students in a laboratory environment, let alone where technical assistance was hard to come by.

The State Government Innovations grant provided funds for teacher release to allow time for planning. The four teachers used this opportunity on three occasions during the year. However, generally they were reluctant to leave their scheduled classes for others, or deal with the extra work substitution entails, and eventually decided to meet after school in their own time for regular weekly meetings to plan and discuss progress.

Thus these OMSC teachers faced considerable hurdles: the requirement to devise and deliver a new integrated curriculum incorporating complex technologies with which they were mostly unfamiliar; the fact that there was limited support available in an environment where a range of technical problems was prevalent; that although some time to meet and plan was in-built, this was limited and insufficient for their needs. The following vignette presents a picture of the project in action at OMSC:

> It is half way through the year. The 22 boys in the 7B trial class are in groups of two or three working on their second integrated project, the Solar System. The team of four teachers (representing Maths, English, Science and SOSE) responsible for the trial integrated projects, and the boys, are hopeful this unit will be more successful and interesting than the last - the Local Environment. Today's lesson is in a computer lab with their English teacher, Annette. The boys are pleased to be in 7B because as part of the trial, they at least get to use computers during class time, even if most don't particularly like what the teachers ask them to do there. This pilot class regularly uses computers for classwork; far more than other grade seven students. Far more than most classes in the school actually, except in the specialist IT subjects. Even so, the boys and Annette ask themselves the usual questions: Will the Internet be up today? Will the computers freeze when using the *Scala* multimedia software to make their planet presentations? Will *Scala* actually be on all computers or will it have been removed from some, as discovered yesterday? Annette also wonders who will help her and the students should, more likely if, these problems happen. Jerry, the only technician (part-time), will probably be attending to other infrastructure problems somewhere else in the school. There is a lot of technology to maintain in this school. Dan, the ICT Coordinator and the one who unilaterally decided *Scala* would be used for the integrated project, is the key person with the necessary skills to teach it to the boys and this term he is on leave. Maybe the students remember enough from last term's *Scala* project to get them through. Jerry can't help. He is not familiar with *Scala*. Glen, Dan's replacement, would prefer the students use web-page making software than *Scala* to present their work. Annette and two of the other teachers, Liz (Science) and Norma (Maths), who team with Annette for the integrated project,

feel frustrated with their lack of skill and confidence in the intricacies of the program. PD has almost been non-existent and when is there any time to do it? Liz has arranged for senior multimedia students to come and help out during the integrated project classtime and at lunchtime, so there might be some chance the boys can finish their projects. To make things more difficult Dan is away this term and none of them, boys or teachers, have yet to even view all the multimedia projects from the last project. Liz, Annette and Norma can see a repeat of this unsatisfactory situation.

Losing time from regular classroom learning for the sake of using technology particularly bothers Annette and Norma. For Annette, not being able to closely monitor the boys' literacy development is a concern. *Scala* does not allow for text to be printed to enable her to check the boys' writing, correct errors and give immediate feedback. I feel 'a total failure there as an English teacher' she says. Norma too is very anxious about the time spent working on the project at the expense of Maths: 'My Maths suffered. The boys are weak generally anyway ... and I know I haven't done them justice when I compare it to my other Maths class'. She also finds it difficult when in the lab to deal with the boys who are not on task and who use every opportunity to seek out irrelevant and inappropriate sites. Even Liz, who is ever keen to try new ways to engage students in learning Science, and believes ICTs might be able to do this, is frustrated with the technology component and that it has been a distraction from Science learning. 'What are we on about here?' she asks. It's not surprising then that these three can't wait to resume teaching their regular curriculum.

On the other hand Glen, who is new to the school as Dan's temporary replacement on the team, is experienced at using technology to support teaching and learning in his History and Geography classes and is convinced of its value both for engaging students and to improve the learning experience. Regardless of their pedagogical stance, however, all four teachers acknowledge that they see the boys empowered and engaged using technology; they recognise students like to manipulate colour, images and sound and like the interactivity. Their students enjoy the challenges the computers provide.

Lunchtime in lab V3. Some of the boys from 7B are gathered around one computer and are working on their multimedia presentation, animatedly discussing how to manipulate the images, text, animation, sound and video to best effect. They work out how to do it together. It is difficult to believe that these are the same boys who often are bored, disengaged and disruptive in their regular Maths, English and Science classes. Despite problems with *Scala*, these boys like what they can do with it – it is 'cool' and 'fun'. Many of them freely admit they waste time in class and would prefer to be doing projects on other things, like learning about motorbikes. 'We did the solar system in primary school'. They also say the current project, and using the Internet, are not really helping them learn much. Some students can't access the Internet because the required fee has not been paid and the school filtering system blocks lots of sites they would really like to visit (like porn sites). However, life without computers at school would be 'nowhere near as good'; 'boredom central' in fact, according to Sean.

7.3.1 The project

The broad theme of 'the Solar System' was used to integrate English, Maths, SOSE and Science in the unit under examination here. The Solar System was the second of three integrated projects using technologies for this trial class. In addition to learning activities involving related social, mathematical and astronomy concepts and creative writing, teachers allocated students to groups of two or three to research and construct a presentation using the multimedia features of the *Scala* software on one of the planets. Students could do the research from the Internet and books. The goal was to link the individual planet presentations to an overall presentation on the Solar System and demonstrate the student work at a parent evening. Focus questions for the research component in the main required students to gather factual data (e.g. location of the planet in the solar system; origin of its name; the history of the planet's discovery and exploration; the nature of its environment and physical features). The staff believed the project would be inherently interesting to the boys. Dan, the Head of IT:

> I feel very confident that the term 2 one on the Solar System is just going to be a ripper. Because the materials are so plentiful, both on the Internet, in CDs, videos.

Information was to be presented in a creative way using graphics, sound, video and animation. For most boys the bases for these elements, in addition to text, were captured from the Internet and recreated on their series of presentation slides. According to Liz, when she outlined plans for the unit to the boys, 'they are absolutely rapt to the last ... there's only one kid that isn't interested'. A pre-test administered to students at the start of the unit indicated that about half the students already had considerable prior knowledge about the solar system.

Technical difficulties with the school network, the *Scala* software and some tampering of programs on the computers were a constant source of staff frustration during the time allocated to the research and presentation phase. This was particularly true for the three teachers with little computer experience.

7.3.2 Computer skill acquisition

Dan, the Head of IT and the SOSE teacher for the 7B team class, taught the components of *Scala* to the boys during the first integrated project in Term 1. By the time they came to do this second project on the Solar System, the students had little trouble understanding how to incorporate the various multimedia elements into their presentations. More difficult for them were the problems associated with file size, appropriate saving, network crashes and limited access to computers with the software loaded and, for some, their lack of access to the Internet. Although Dan was on leave during this second project, his replacement, Glen, an experienced and enthusiastic user of technology for curriculum purposes, was able to assist boys where necessary despite his misgivings with the software chosen before his arrival.

The other three teachers, Liz, Norma and Annette, felt inadequately prepared to help the students with *Scala* and acknowledged that the students were more capable than themselves in this regard:

> I still don't know a lot about it because the kids actually moved forward faster than I could. (Annette)
>
> They moved forward and I didn't. (Liz)

The teachers all recognised that the students learned from each other:

> And when they had problems I'd say go and ask Tim or ask someone ... They were assisting each other. (Annette)
>
> I did that quite a few times too if I didn't know. (Norma)

Liz commented on the difference in student behaviour in the laboratory compared to her normal science classroom:

> I did like the way that they shared ... I like it that the kids felt empowered down there ... I think they feel when they go in there to the computer room, as long as you've told them what to do, they know exactly what to do and how to go about it.

Glen stressed that peer teaching and sharing are the ways that most students learn to use technology:

> you have to accept that most of the kids are going to know more than what you do. Therefore if you don't know how to do something you say to someone "who knows how to do this?" Can you come up and explain it to the class. That's a huge hurdle for a lot of teachers to get over actually. But it's the most effective way of doing it.

There was also the acknowledgement by Annette that being a technical 'expert' can place unwanted demands on a student:

> I'd say ask him, ask him. And they were finding out. But that was a bit of a strain on kids like Tim who is quite sensitive and didn't want to really be bullied into doing something or going and helping someone he didn't want to help. But he felt he had to.

Linking of experienced older students from the grade 12 Media specialist class with grade 7 groups towards the end of the Solar System project not only helped develop the younger boys' skills, but contributed considerably in moving the project towards completion.

7.3.3 Structuring, monitoring and assessment of learning tasks

Given the many problems faced in the first integrated project done earlier in the year, better management of the second integrated project was a major concern for all the staff involved. As Dan said, they were 'stumbling along' for the first project. At planning meetings, staff devised ways of helping the boys to become more organised and focused: through provision of special folders for each group containing colour coded direction sheets for each learning task and requiring a journal to be written up at the end of each project lesson. In practice, this method lasted only a short time. This was attributed to an on-going problem of student absence affecting continuity across the groups. Teachers also kept a class chart for showing progressive submission of work by individuals and groups. Failure to hand in work resulted in lunchtime detentions.

Assessment of the multimedia component was problematic for Norma, Annette and Liz. They were concerned that because of the length of time taken to complete the multimedia project they were not able to give students adequate feedback or assessment of their progress. An extract from the focus group:

> Annette: ... the control over the individual's work is less, because it's stretched out rather than in shorter bursts, if you know what I mean. So the product isn't there to see ... But you didn't see a lot of this stuff for ages, so that meant there wasn't a lot of feedback. And I'd say ... we could give more feedback in an ordinary class, and if good learning is based on feedback, then I didn't give a lot of feedback in the learning technologies thing.
>
> Norma: I would agree with that.
>
> Liz: The feedback, the only feedback they've had is their pre-test; when they got to a stage with their alien and their holiday brochure, we got them to print them out. I marked one lot and you marked another lot. We actually assessed that. And I got Annette to check it quickly as she's passing. Quick, quick, quick look at this. There was a briefing one day, you did something there. That was the only feedback they got.
>
> Researcher: Are you saying that your normal practice is to give a lot more feedback than what the structure of this program and the software that you were using, allowed you to do?
>
> Annette: I think that must be it. I don't know whether we can point again at the program, but it was certainly the nature of the whole project, that it was more difficult to give feedback.

7.3.4 Classroom management in technology environments

Classroom management of this group of OMSC students, either in the regular classroom or in the computer laboratories, was more problematic than in the other three schools. Time wasting and inappropriate use of the computer and Internet facilities by the students was a far more frequent occurrence. Norma, in particular, the youngest teacher with the least experience, expressed concerns about this:

> I found also some of the students sidetracked by other materials ... I found they were often emailing each other ... And I just found a problem with the boys who weren't interested in the project looking up motor bike pictures and all these other things. This wasted a lot of your time when you could be helping students who want to work on the project.

Norma did not know about the rules Liz and Glen had established to assist with some boys' inappropriate behaviour and was most interested when Liz explained:

> we just put our foot down. And we had four rules at the beginning of each class. No messages. Stay focused on the project. ... No messages was number one.

Despite the rules, some boys would still attempt to use messaging and access sites irrelevant to the project or those considered unsuitable. Temporary loss of computer privileges and doing written work instead was the sanction if caught. The school's Internet content filtering software did block unsuitable sites. So, not being able to pursue their own interests was a source of frustration for those students and their behaviour also frequently diverted them from the tasks at hand.

Dealing with the variety of technical problems in the laboratories was the other major issue, even for Glen, the most technically experienced teacher:

> Because we could go into room and all *Scala* would be taken off and there'd be only three programs left in the room. We would find that the Internet wasn't on that day. None of them could get it up ... The boys were told to save their work and put it onto a different drive and they'd forgotten, because they were cleaning up something and they'd forget to, so they lost it. So they had to start again. It was a nightmare. (Liz)
>
> And the computers keep crashing, because they're running Windows NT. And running a program that needs 32 meg on its own and you haven't got 32 meg of RAM, so the computers crash. NT needs 32 meg. (Glen)

7.3.5 Use of the Internet

Students made considerable use of the Internet for information gathering, more so than any other source. Of the three non-specialist teachers, Liz was the most proficient in using the Internet: she knew how to bookmark sites and had thought through ways of helping students use it. In one computer lab session, she required students to explore sites, select one good one and justify why it was good. Many of the sites selected by the boys were then added to hers to make a class collection of useful and relevant sites. Other than this, students tended to roam free, gathering information, images and sounds and were not required to cite the sources they used.

7.3.6 Time needed for multimedia projects

As with the extended multimedia projects undertaken at the American schools, the OMSC project consumed a considerable amount of time, far more than was planned by the teachers. As Annette says:

> Because of the nature of the project and perhaps the way we organised it or perhaps the problems we had, I don't know, it tended to go over time. And that meant, because it was over time, we kept wanting to finish it, obviously we didn't want to leave it incomplete.

Dan also believed subject demands (especially from Maths), the constraints of the timetable, interruptions for special events combined with the whole issue of 'emerging technologies' impacted on the time available to complete the project. Even after allowing for extra time, and the boys using lunchtimes to work on their projects, this was not sufficient. By the time of the last observation/interview period at OMSC, neither the students nor the staff had viewed the finished product – a compilation of all student work into one presentation – for either the first or second project.

7.3.7 Teacher perspectives on teaching and learning with multimedia

Use of multimedia technologies for this project at OMSC was dominated by problems with the *Scala* software, problems of access and connectivity, lack of technical support and limited planning time. For the three teachers inexperienced in using technology, these issues contributed to a mostly negative view of the value of its use for their students. Glen, the most experienced and confident teacher, however, is convinced that technology is worthwhile in the classroom. He believes its use 'speeds up menial tasks such as drawing graphs', it 'increases the students' self value because they can create something of high quality' and it 'provides a new dimension for student work by allowing a student to become a cyber-author'. The other three teachers all commented that using technology was worthwhile in that students developed technical skills. They also saw value in the boys' cooperative behaviour in technology environments. In addition, Norma believed the approach held some value for weaker students:

> I think it was good for some of the weak, in terms of Maths. Like Matt Smith doesn't really star in Maths and he's got a modified program, but he worked really well on the project.

Nevertheless, these teachers also expressed misgivings. They resented the amount of time drained away from other learning activities while students endeavoured to make progress with their multimedia presentations.

> When we are doing it on the computers I can't do any Maths because they are working in the computer room. And sometimes it would be a whole week pretty much when they're trying to finish the project off. They've been in the computer room for the majority of the lesson. (Norma)

> I felt like I was just like a computer teacher. We were just in there the whole time. (Liz)

Annette, the English teacher, expressed her concerns about the emphasis on the product rather than the learning process:

> I'm not that impressed with it. I'm impressed with the possibilities it's got in terms of graphics and colour and sound on so on … what are they learning? It's a bit like just putting a cut and paste together … If you're going to have this learning technologies focus, of course that's what you will focus on. But that's the product. But in fact if the process is the most important part, we are just not looking at the product. Then how do they learn about the solar system and how do they understand that one planet turns this way and another turns the other way?

Like Annette, Liz grappled with understanding whether or not the project contributed to sound learning outcomes for the Grade 7 students and drew a comparison with some work done in her Grade 11 Home Economics class:

> I think being the clever country, you've got to be clever with using the IT. You have to find what's going to be best for your curriculum. Like drawing graphs and things like that. We've been using them in Home Ec to do graphs of who eats breakfast and who doesn't out of all the survey sheets. And we surveyed over 300 people. So that's been really valuable in that way, right? And I couldn't have imagined doing it any other way. And so the kids have seen that and said when are we going to do that stuff again? It's really hooked them in. So they love cooking and they love the computers so that's a good combination. What do the [Grade 7] boys love? They like doing the games on the computers. They like finding good sites and telling each other about them. But what are they learning? How can we get that and make it a valuable learning experience? I don't know. I really don't know.

Liz, although acknowledging there were some useful outcomes for the students, believed this had little to do with learning science in ICT environments:

> I don't think the strengths of what came out for Science were anything related to the learning technology. I think it was related to the fact of the way the kids worked together on a particular topic and contributed to a joint project. I think they had most of those skills beforehand and they just kept going and developing on that.

For the OMSC staff the second project for the year was considered a little more successful than the first. However, they would argue that this was more to do with a greater degree of focused team planning and more carefully structured activities and expectations than the use of multimedia technologies.

7.4 Eastern Girls' Grammar School (EGGS), Victoria, Australia

This is the second year a team approach to integrating technology has been in place at EGGS for the grade 7 English, History and Geography classes. It is the first year of the computer skills mentor program for grade 7 English and grade 8 Religious Education teachers. The school's approach to the use of new technologies is that all students (not just those in classes taught by interested teachers) should be introduced to computer skills in a systematic way. Moreover, these skills should be an integral part of the established curriculum, not taught in isolation. In devising its approach, the ability to access a broader range of support staff was clearly advantageous compared with all other schools.

Through negotiation with the English, Geography and History faculties (necessary in this secondary school where the faculty structure dominates curriculum delivery), a structured program of computer skills (file management, creative use of MS Word features, webpage authoring, use of the digital camera, scanning, spreadsheets and graphing with Excel, and effective and critical use of the Internet) are embedded into various units of work in these subjects throughout the year. The specified skills, none of which are covered in isolation from a curriculum context, are taught by the Computer Skills for Learning (CSL) teachers. In addition, for the first time, each of the grade 7 English and grade 8 RE classes had been allocated a mentor. The mentor role is to help teachers align relevant computer skills to the English and RE curricula, and to provide in-class IT support. It is envisaged that given such support English and RE teachers will be able to manage on their own in subsequent years.

Both the CSL teacher and mentor roles are allocated one period per teaching cycle. None of the grade 7 CSL and English mentors are specialist IT teachers, but over the years each has developed an interest in using ICTs in their regular curriculum areas. For example, Megan teaches History to two Grade 7 classes and is also their CSL teacher; Jennifer, a teacher-librarian, is the 7A CSL teacher, the English mentor as well as the school's highly regarded Information Research Coordinator. Thus EGGS has allocated significant human resources, in addition to infrastructure, to meet the 'Computers for Learning' claim of the school's promotional literature. The following vignette conveys aspects of this school's approach:

> 7A Computer Skills for Learning (CSL) class of 24 students is underway in one of the four EGGS labs. The adults in the room include Jennifer, 7A's CSL teacher, and Sue, another of the CSL teachers. Sue has come to watch (and support) how Jennifer teaches students the organisational structure and skills for making linked web pages which the students will use to present their Geography field work. Before the lesson, Sascha, the technician, has checked that all computers are operational and have the relevant software loaded. However she does need to return twice during the period to help with a technical issue that no-one else could solve. During the lesson, Frank, the Head of IT, also pops in from time to time to look at what's going on and help out if necessary. In this 50-minute lesson the students are beginning to construct the personal websites which will display the results of their recent fieldwork. Before the girls open up and start work on the program, Jennifer requires that they make a checklist showing the tasks needed to successfully make a website. She insists they refer to it and check items off as they

progress through the tasks: file structure, making new pages, entering text; inclusion of images in appropriate file format from the scanner, digital camera and the Internet; linking of pages to an Index page; saving appropriately on their zip disk and the school server. Ownership of the tasks has clearly been given over to the students. Even during the course of the lesson, when some students have difficulty conceptually understanding the file structure, or how to convert graphics, each of the teachers in their help role requires the students to problem-solve for themselves first. Students are referred to the 'how-to' sheets stored in their folders. Some students choose to spend their one 'help' token per class by putting their hand up to seek assistance. This strategy devised at a recent CSL teachers' meeting encourages the students to first tackle an issue by themselves, then to ask their neighbours and as a last resort, ask a teacher. All the teachers agree that this approach has seen more effective lab management, as it allows for targeting of students most in need of guidance. Further, they are pleased to see the increasing adaptability most students are showing as they successfully de-bug problems. Girls are clearly focused and engaged with today's tasks. Some are excited when they make their first hyperlinked page and proudly show it to others around them. Before the lesson ends, Jennifer reminds students to fill in their checklist and to hand in their zip disks. She wants to check how the students are managing. 7A's Geography teacher too will want to know what progress has been made. Jennifer is looking forward to tomorrow's regular meeting with the other CSL teachers, the grade 7 Geography teachers and Frank to share and reflect on what she has learned from today's lesson.

In an adjoining lab, 8H's Religious Education class is underway. Barbara, the RE teacher, Frank her mentor, and Daina the ESL specialist, are all assisting when necessary. Due to both her ESL and IT expertise, which she has developed over the years she has been here, Daina often uses her time supporting the many ESL students as they use computers for their regular classes. Barbara is more than grateful for Daina's presence. 'It would be virtually impossible for me to help these students without Daina', says Barbara. In the first five minutes of the class Frank explains the technical aspects of today's task, and then Barbara takes over. The task is to search for and annotate a number of Internet sites about the beliefs, life, and work of the Apostle Paul. Students are to use a variety of search engines and ways of searching, and tabulate the results onto a worksheet provided. Relevant and useful sites are then to be hyperlinked and annotated with evaluative comments onto their individual RE web page. Effective use of the Internet has been drummed into them since grade 7. Jennifer in her other role as Information Literacy Coordinator has seen to that. In a later lesson students will select, illustrate and add one of Luther's hymns, lyrics and music (if possible) to their page. Barbara is generally pleased with how they tackle the tasks.

Despite initial concerns by her and her fellow grade 8 RE teachers about their subject being used as a vehicle for embedding computer skills, Barbara believes the various activities done this year have enhanced the students' conceptual understanding and raised the level of exchange of ideas significantly. However, she is glad only one of her classes per cycle is in the lab as she believes this is no place to hold a successful discussion. Time limits are a frustration for all of the RE teachers, as is the tardiness of students in submitting the required work. Nevertheless, at the regular meeting of the RE teachers with their mentors, Marie still says 'I think the standard of the work for me on the computer has been so much better, so I have been very happy with that. I have seen a great leap forward. And once they got mastery they were most successful and every girl did hand it in and it was very well done. So that was a great success of my class'.

7.4.1 The projects

A range of small tasks and larger-scale projects incorporating the use of the Internet and multimedia technologies are systematically integrated into the English, History and Geography curriculum at the grade 7 level and in the RE classes at grade 8. The prevailing assumption is that all students, not just those with interested teachers, should have similar opportunities to learn with technology. In most cases, the uses for technology included here have been adapted to long-standing curriculum topics that have 'worked' with students; those that teachers believe are pedagogically sound and that contribute to effective student learning in the particular subject.

I have chosen to provide more detail here than for the other schools' learning tasks and projects. Firstly, more projects and classes were examined at EGGS due to the comprehensive, overall approach to the use of ICTs adopted by the school at these grade levels. Secondly, the tasks demonstrate the ways in which technical, curriculum and support staff collaborated to design, integrate and deliver curriculum in which ICTs have a significant place. The major tasks and projects are outlined here:

(a) Grade 7 History unit

Aspects of EGGS history presented in webpage format. Students working in groups of two or three research an aspect of the school's history using mainly primary sources: the school archive collection, memorabilia around the school buildings and grounds, contact with former students and books written about the school. Students are required to tabulate data, formulate hypotheses and draw conclusions from their research. Before compiling text and graphics into a single individual webpage, using the web authoring software Adobe *Page Mill*, they must manually storyboard their design in their project books. The CSL teachers support the classroom teachers by teaching skills for the digital camera, scanning, image manipulation and webpage authoring. Presentation of this topic was formerly done by hand and more recently using word processing.

(b*) Grade 7 Geography unit*

This unit requires students to construct a multi-page web site reporting findings from fieldwork at the Melbourne Cemetery and Victoria Market. Students explore the patterns of immigration, and the nationalities, languages, religions, and cultures found in Melbourne. The aim of this fieldwork is to teach skills of observation, data gathering in a range of ways, report writing, graphing, analysis and the drawing of conclusions. The geography teachers are dedicated to structuring a learning experience that replicates the work of geographers as much as possible.

This year students are to compile their Geography fieldwork report in webpage format. In the past two years, the requirement was a wordprocessed report and in the years prior to that, it was done by hand. Each student's individual web site must include five hyperlinked pages: an Introduction, Data Page (explaining how information was collected), a Cemetery Page, Market Page, and Conclusion and Evaluation Page. The pages are to include a table with data, two graphs, two digital photos, and analysis of data and conclusions. Students decide how to format each of the pages. Adding sound to the page is an optional extension activity. During the lead-up to, and following the field work, the CLS teachers teach or revise Microsoft *Excel* for graphing; scanning and converting digital images; hyperlinking web pages and the necessary saving and appropriate file structure.

(c) Grade 7 English units

The unit on advertising and the media is one of the components of the English curriculum considered for this study. Prior to the multimedia task, students analysed advertising in various forms of media. Students were then required to invent and design a gadget and promote their invention in the form of an animated multimedia advertisement. Finally, they had to write an evaluation on the success of their promotion. For the multimedia task, students were to use the features of Microsoft *Word* including moveable text boxes, the drawing tools, colour, Word Art, and to use *Graphic Converter* to construct the animation and to add sound if they chose. The CSL staff teach all necessary skills and English mentors assist in the classroom during their allocated period.

(d) Grade 8 Religious Education Unit

In these units students construct their own webpage and include links to a selection of web sites about the life of the Apostle Paul. In a separate word processed document, students describe, summarise and evaluate webpages visited, and answer questions. The RE Mentors show, or remind, students how to construct a webpage, and to search and incorporate external links onto their page. Another task required students to construct a webpage on behalf of Martin Luther at the time of the Reformation, components to include: his views on three of his 95 theses and what inspired him etc; an image of him; the lyrics and an explanation of one of his hymns.

7.4.2 Computer skill acquisition

Under the leadership of the Head of IT, Frank, the four grade 7 Computer Skills for Learning teachers meet regularly. They meet as a team and with the subject teachers and the Heads of Subjects in Geography, History and English when an instructional unit is planned, implemented and evaluated. They determine together what computer skills are appropriate for, and how they can be integrated into, the subject areas. A scope and sequence framework for computer skills has been established, and the staff jointly determine where these skills should be formally taught and assessed, how students will self evaluate their skill level, and how achievement will be reported to parents. It is this comprehensive approach to embedding ICT skill acquisition into regular curriculum areas which makes EGGS different from the four other schools in this study.

The four grade 7 classes are each allocated one period per teaching cycle in which the skills needed for the computer-related part of a topic or project are formally taught by their CSL teacher. In addition, each grade 7 English teacher and each grade 8 RE teacher have been allocated an RE mentor for in-class support for one period per teaching cycle. Mentors are also used to teach and/or reinforce specific skills.

Sue, the CSL teacher for 7D, describes one of her computer classes in which she was in the process of teaching computer skills allocated for History, Geography and English:

> The students have been working on webpage construction which includes an Index Home page, a Camp page, a History page and a Geography page of Desert Bookmarks (from previous Internet research work). During the previous lesson the students had worked on finishing off this 'web project' and they had arrived at differing levels of completion. In this lesson, I aimed to have all students to complete the task, and check their work through Navigator thereby doing a self-evaluation.
>
> Nearly all students completed the task and checked their work. We started with a diagram on the board which outlined the 'structure' of the task, how the folders and pages were labelled and how they could and would be linked together. It was emphasised that the graphics had to be inside each folder where they were to be placed on that particular page. The students were handed out a slip of paper. On one side it had a checklist and evaluation and on the back (blank) side the students wrote down what yet had to be completed for each part of the task. As they did these steps they ticked them off. I explained to the girls that they needed to open Netscape, go to File and open their web folder from the desktop in order to do a final check that all their work, particularly links and graphics were indeed working. They knew I was collecting their disks at the end of the lesson for loading on to the school Intranet and nearly all students handed them in. Students who finished early in the lesson handed in their work, including their evaluation and walked around the room to assist students who were not as advanced in what had been completed. Seventeen out of 22 disks were collected for loading on to the Intranet. It WAS a good lesson.

Teachers here, as in the other three schools, spoke about the ways students helped each other, and often the teachers themselves, to acquire skills:

> Students worked collaboratively helping each other with the digital camera and the scanner. They were working in pairs. When they weren't sure they asked a peer not just me to help. I was brought in for the bigger problems, such as graphics not working, problematic links, computers not reading disks etc. (Megan)
>
> We really try to encourage this 'cooperative' learning environment where we can learn from one another in the room - not only the teacher. (Sue)

> The highlight is the flexibility being shown by grade 7 students in using *Excel*. WE are learning to colour code columns, sort in descending order and make a legend independent of chart wizard. (Nola)

Nola also commented that for her, success was seeing the independent learning behaviour of students:

> The main success for me was to see the transformation to student guided work. I was virtually redundant and went out to get some marking to do because they were working so well. The most interesting aspect is that if this was a written report the girls would not have been working on it when I entered the class. However on arrival they were all so obviously on task, it was quite amazing.

CSL teachers expressed awareness of the students as learners and the need to progress carefully:

> Looking back over the lessons this term I feel that often we go too fast and expect all students to 'pick up' the concepts and processes straight away. Some in each group certainly catch on quickly but for many we need to allow time to understand what they are doing and they will consolidate skills along the way. (Sue)

> Some students still haven't got the file management idea. I spent some time with two students who had files all over the place. One student was away when we corrected a poorly organised web folder but some students still don't have the concept. This is a gradual process for some students and one mustn't have this expectation that all will grab the ideas immediately or even half way through the year. (Megan)

Teaching each other new computer skills also regularly occurred among the CSL teachers e.g. learning how to add frames to a web page, and how to create jpeg files with *Graphic Converter*.

7.4.3 Structuring, monitoring and assessment of learning tasks

Through on-going collaboration in planning meetings and in other less formal ways, CSL teachers develop a shared understanding of and adopt a common approach to structuring, monitoring and assessment of computer-related tasks for all students. The same is true for the English and RE mentors. Jennifer explained her role:

> the reason that I think I've been able to have an impact is, as a mentor, I know what they are doing in English; as a Computer for Learning Studies teacher, I know what they have been learning; as a teacher-librarian, I know they do this research in Geography, and at this time of year they do this History and they do this in Science. And you are able to say well if that's so, we can use this or we can use that, and so you are able to seed it through those different areas.

Further, considerable negotiation occurs between the computer staff and the subject teachers to structure learning tasks that meet the curriculum aims and time constraints of both. Where the CSL teacher was also a subject teacher, as was the case with Megan, who taught two grade 7 History classes, this job was easier. The issue of ownership of the tasks - the subject teacher or the CSL teacher - was also a frequent point of discussion at meetings, and not always easily resolved.

Extension activities for students who had completed the base-line computer tasks were built into all of the projects considered here; for example, adding sound to the grade 7 Geography Field report; and seeking out Martin Luther hymn sound files on the Internet for inclusion on the grade 8 RE webpage. As Frank asserted: 'You've got to have multiple tasks, because kids can handle it'.

The need to assess and provide feedback to students was a recurrent theme. The CSL teachers worked together to devise a certificate of achievement for students designed to give progressive feedback on skill development. In addition students were required to self-evaluate their progress and an end-of-year report was to be issued to parents. Some of the CSL teachers also worked side-by-side with the subject teachers as they graded the subject component of the learning task.

7.4.4 Classroom management in technology environments

EGGS was not free of difficulties that affected curriculum delivery using technology. Mention was made of computers freezing due to RAM variations on different computers, students forgetting their disks, work being erased and difficulties accessing laboratories, especially when extra bookings were required. The on-going collaboration, and in-class technical and curriculum support, however, had a significant effect in helping subject teachers deal with many of these problems.

Although teachers at this school acknowledged the cooperative nature of student behaviour when using technology, teachers also expressed concern that all students need the opportunity to acquire and demonstrate effective use of the skills deemed important. Collectively, the support teachers devised a range of strategies to deal with these issues:

> students tend to put up hands and demand help too readily - this makes the teacher feel pressured and how can you possibly get around in order to assist all these students at once. If they have a reference point - like a diagram on the board or a sheet in their folder or beside their computer it seems the pressure on the teacher is reduced and the students can keep working. (Sue)

> sometimes working in the computer lab where you are encouraging them to work with others, is totally opposite to your desire to get them to think for themselves. Because in the computer room they can turn to Susie who can fix it and Susie will just lean over and take the mouse and fix it. And they have never really had to grapple with how do I solve this problem or what do I do that caused the problem ... and if it happens again, and it will likely happen again, they really haven't solved the issue. They've solved the instance but not the issue. (Jennifer)

A common strategy - spending help tokens - to deal with this issue was devised and refined during shared meeting time. Jennifer explained how it worked in practice:

> at the start of the class, we would go over what was going to be done and I would demonstrate. And then, if they needed help they could spend their help token. We had a strategy. If you have a problem, what do you do? You read the sheets, you go back and read and see if you can understand. If you still have a problem you could ask the person on your left and if that doesn't work you could ask the person on your right, and if that doesn't work you could put your hand up and ask the teacher. That was the strategy. Putting your hand up spends the token. So once they had spent that token, there wasn't another response from the teacher. So they had to save it for the big question. Now, they had the strategy and they had the sheets, so I didn't feel bad about taking the token. But what it meant was, and I said to them, if I come to you and say, is there a problem, or what's happening - it wasn't the equivalent of spending a token. And it meant that I could get around to the girls that need help and help them solve the problem. Also if they put their hand up, and the problem was really a technical one that they couldn't solve - the computer freezes or something strange, then that didn't take their token. The token was taken only when they couldn't solve the problem themselves. It works like a charm.

7.4.5 Use of the Internet

Led pro-actively by the teacher-librarian, Jennifer, who also has the role of Information Research Coordinator, a structured and comprehensive approach to effective student use of the Internet is an important component of the grade 7 and 8 technology program at EGGS. Embedded in each of the subjects and regularly reinforced with students were: understanding the nature of different Internet search engines and directories; selection and use of relevant keywords; searching with Boolean terms; book-marking of useful and interesting sites; website evaluation; hyper-linking of well-chosen sites onto their own websites.

7.4.6 Time needed for multimedia projects

At EGGS although teachers did not require extended multimedia projects on the scale of those of the other schools, issues of time needed in a digital environment still persisted:

> Time is against me. I originally scheduled this to be the last but one lesson; however that timeframe will not work with this group. The graphs are the problem ... The next hold-up which is appearing with this group is the queue for downloading the digital images. Other computer rooms were busy and only one computer has the images on it. (Nola)

Megan raised another time-related issue:

> So you need time and you need time for thinking on the computer ... if I had the time I would like to put up a messy web page and ask them to correct it for me ... ask them well what's the differences here? If this is the right way and that's the wrong way? What have you done wrong here? And that seems to put them right. That helps a lot.

For the CSL teachers, the process of using computers, rather than the products which students construct, was the overriding focus.

7.4.7 Teacher perspectives on teaching and learning with multimedia

A systematic approach to embedding the use of technology skills across the curriculum, and for all students, characterises the EGGS program at grades 7 and 8. Further, the range of support structures which foster collaboration among staff in different subjects and with different skill sets is markedly different from those in the three other schools. Also different is the way in which the approach and supportive structures foster a far greater degree of on-going pedagogical discourse and reflection on student learning, and technology-mediated learning. Becker's (1999) identification of constructivist teachers and technology (see 3.7) has a clear fit with most of the teachers involved in this program. The notion of a 'community of practice' (see 2.7) could also comfortably apply here. Those teachers who experienced on-going collaborative support as they integrated multimedia technologies into their subject areas in grades 7 and 8 programs are generally positive about their experiences and the value of using technology. The purpose and value of requiring students to use these types of technology for their curriculum is a central concern in their thinking about technology in their teaching practice.

Barbara, a very experienced RE teacher, commenting on the students' Internet search for Martin Luther's hymns, said:

> I thought that was the most incredible piece of work they did trying to choose a hymn that they could understand and try to understand it from Luther's writing. I was amazed at the effort they went to in the class to try to get it.

The complexity of balancing the demands of the curriculum with the push to integrate technology is well expressed by Nola, the Coordinator of grade 7 Geography:

> For this year I have sat down and thought well really what is the value of this [computer] report geographically? Does it have any benefits for us? And the two main benefits I see, number one being able to present data, visual data particularly. That is photographs, moving images and audio sound as another form of data collection which you cannot incorporate in a written report. So I thought well that's a real advantage. We collect sounds. The second advantage I think I see is that these girls will publish in an electronic medium in the future and therefore ... I guess it's slightly less geographical, but they might be presenting something geographical in an electronic form. So I thought that has real benefits... So now I can justify the project in my own mind as to why I am doing it. And how do I now meet the geographical needs with the technology needs. And so I thought well I am going to keep the structure of a standard Field Report the aims, data collection, findings, conclusions, evaluations and I link that closely with what they do in Science.

Francis, the Head of English and a grade 7 teacher, reflected on the benefits of linking aspects of the English curriculum with web publishing:

> As I'm circulating I'm looking for the English aspects. So I'm reading what they are putting into the frames and I'm looking at the elements of design for an advertising poster and that sort of thing. So I suppose I'm not really thinking about that technical aspect. Di is picking up the technical aspects. And that's fine. But I think it will be a terrific skill for them to have for future tasks. ... I think, they take greater care with what they are producing ... because they see immediately that it's going to look quite a professional, finished piece. Whereas if they're doing it in their own hand and drawing their own pictures, it doesn't look as good. So I think that they do take greater care and the impetus for that is given by the fact they see potential in it.

Similarly, Megan, Coordinator of Grade 7 History, a CSL teacher and English Mentor, explains the value of digital communication:

> Because I see it as future communication and empowering them to be able to publish and have that level of control. So they are not only just consumers of information via the Internet, they can also publish and contribute. So I suppose it's empowering them. I see it as a relevant form of putting information together. Why do a poster? I see that as a redundant form of presentation in the classroom to be honest. And with the visuals become so much more important. So I'm getting them to become much more critical in the use of graphics. And that's what I am emphasising a lot more ... Not that they can just physically do it, because I know that most of them will be able to physically do it; but the thinking behind what they are going to do with the graphics - the critical, visual literacy.

However, not all staff involved with the ICT delivery at EGGS were quite so effusive. Michael, a Science teacher on the IT curriculum committee asserted:

> But sometimes I feel we are being driven by the IT world, companies. They're promoting change because it promotes growth and we are being pushed along. We are not walking we are being pushed .. a lot of people intuitively feel that there is not necessarily anything inherently good about using technology and of course there isn't. It's only good if it provides something new that you couldn't do before and that it is imperative.

7.5 An overview of teachers' beliefs about teaching with multimedia

As outlined in Section 4.2.8, teachers were asked to respond in writing to a Prompt (a range of statements and questions) prior to interviews or focus groups in each of the schools in the US and Australia. The prompt (see Appendix I) was originally designed to focus teachers' thoughts prior to a discussion. It was successful in doing this, but it also proved to be an effective vehicle enabling aggregation and comparison of teachers' opinions about their work using ICTs in their teaching practice and to allow for construction of a useful comparative table (Table 11 below).

Teachers were asked to circle three words from three lists which characterised

(a) their technology-using lessons

(b) their students in technology-using lessons, and

(c) themselves in technology-using lessons

The lists of words were compiled by the researcher and contained both positive and negative terms. Teachers could add others if they chose. The comments by teachers are aggregated in Tables 11, 12 and 13. Although 'cooperative' and 'collaborative' were included separately among the words on the first prompt item (Table 11), I have chosen to aggregate the references to these two words. Some teachers indicated to me that they had trouble making the fine distinction between these two words when referring to their class. Further, I had assumed the words 'challenging' and 'challenged' would be interpreted as having more negative connotations. In practice, however, these words appear to have been interpreted differently depending on the teachers' experience with teaching with technology. Where the use of technology was problematic, as in the case of three of the four OMSC teachers, 'challenging' and 'challenged' were interpreted as pejorative. However, the reverse seems to be true for those whose experience was positive. For this group, 'challenged' and 'challenging', either for students or themselves, was interpreted as positive. Altogether, the prompts did provide the opportunity for an equal number of positive and negative responses.

Table 11
Words teachers use to characterise their technology-mediated lessons

	RCS (US) N=2		**SVMS (US)** N=2		**OMSC (Aus)** N=4		**EGGS (Aus)** N=8	
	N	%	N	%	N	%	N	%
Co-operative/ collaborative	2	100	2	100	4	100	8	100
Problem-solving	1	50	2	100	1	25	4	50
Rewarding	1	50			1	25	3	38
Challenging			1	50			3	38
Learner-centred	1	50					3	38
Flexible			1	50	1	25	2	25
Dominated by technical hassles					2	50	1	13
Frustrating	1	50						
Unstructured								
Time-wasting								
Tense								

As Table 11 shows, in each of the schools, teachers indicate that collaboration and problem-solving are features of their classrooms when technology is used. Furthermore, the teachers in this study generally refer to their classes in positive terms. Even the OMSC, Aus, teachers (who of the four schools seemed to face the most problems with the technology focus), apart from referring to the technical difficulties, still perceive) their classrooms in positive terms.

Table 12
Words teachers use to describe students in their technology-mediated lessons

	RCS (US) N=2		**SVMS (US)** N=2		**OMSC (Aus)** N=4		**EGGS (Aus)** N=8	
	N	%	N	%	N	%	N	%
Engaged	2	100	1	50	2	50	6	75
Empowered	2	100			2	50	3	38
Adaptable			1	50	1	25	5	63
Co-operative					3	75	4	50
Challenged			2	100	1	25	3	38
Supported			1	50			2	25
Focused	1	50					2	25
Confident	1	50						
Disorganised					2	50		
Unsure			1	50				
Confused					1	25		
Bored								
Nervous								
In-control								
Organised								

'Engaged' is how most teachers involved in the study in each of the schools chose to describe their students when using technology. Moreover these teachers also generally see their students' behaviour in terms which indicate they are flexible, autonomous and cooperative learners in classes where technology is used. The few negative comments (disorganised and confused) came from OMSC, Aus.

Table 13
Words teachers use to describe themselves in technology-mediated lessons

	RCS (US) N=2		SVMS (US) N=2		OMSC (Aus) N=4		EGGS (Aus) N=8	
	N	%	N	%	N	%	N	%
Challenged	2	100	1	50	3	75	8	100
Adaptable	1	50	2	100	4	100	6	75
Excited	2	100	2	100			4	50
Supported	1	50					3	50
Well-prepared			1	50			3	38
Satisfied							2	25
Confident					1	25	1	13
Frustrated	1	50			2	50		
Anxious					1	25		
Dissatisfied								
Disappointed								
Tense								
Other: co-learner					1	25		

Teachers in all schools describe themselves as being challenged and adaptable when using technology for curriculum purposes. All other descriptors teachers use about themselves, apart from some from OMSC, are of a positive nature.

The data in the tables above indicate that these US and Australian teachers who use the more advanced forms of multimedia technologies in aspects of their curriculum generally refer to their classrooms, their students and themselves in similar, positive terms. Where support structures and procedures are not so prevalent in a school setting, as is the case with OMSC in Australia, the teachers use more negative descriptors.

7.5.1 An overview of teachers' beliefs: value of computers for learning

In addition to the above items, the prompt also asked teachers to rate their beliefs about the value of using technology for learning purposes, using the following statement as a guide: 'My experiences in using technology for aspects of my curriculum indicate it has been worthwhile in terms of student learning'. Teachers responses are aggregated in Table 14.

Table 14
Teachers' beliefs on value of computers for learning

	RCS (US) N=2		SVMS (US) N=2		OMSC (Aus) N=4		EGGS (Aus) N=8	
	N	%	N	%	N	%	N	%
agree strongly	1	50	2	100	1	25	6	75
somewhat agree	1	50			2	50	2	25
agree					1	25		
somewhat disagree								
disagree								
disagree strongly								

All teachers in the study agree that their use of technology had value for student learning in their subject and most of them strongly agree with the proposition. However, the Science, English and Maths teachers at OMSC, Australia were relatively ambivalent. Although they agreed there may be some value in using these types of technologies in terms of student engagement, cooperative learning behaviour and ability to present understandings in new ways (see 7.3.7), the problems experienced and lack of control they felt over their pedagogical domain was of greater importance in shaping their overall attitudes. Their attempts at using complex technologies with little say in what technology was to be used, with minimal competence in the chosen multimedia software, with insufficient time to explore and evaluate new teaching and learning approaches, without ongoing means of technical support in an environment where Internet connectivity and software access were unreliable, were of greater importance for these teachers. Some of these same problems were also experienced by teachers in the three other schools, but it seems there were sufficient support structures in place (although different in each school) to allow the teachers to experience success and to reflect more positively on the overall value of using multimedia in their curricula.

The following chapter turns to the students and considers their experiences in learning with multimedia.

Chapter 8

Learning in multimedia environments – the students' perspective

The previous chapter has drawn mainly on teachers' views and experiences in each of the four schools as the study seeks to understand pedagogies for effective teaching and learning in new technology-mediated learning environments. This chapter is concerned with the students. It presents the Australian and American students' experiences, perceptions and attitudes towards school-provided learning tasks with multimedia. Intrinsic to this study is the understanding that comparison is a valuable research practice. As discussed earlier, examination of classroom behaviour is a complex, often messy undertaking - even more so in the types of classrooms where students are simultaneously (sometimes individually, sometimes in groups) undertaking different tasks, and using a range of complex tools. Further, as also elaborated earlier, understanding of pedagogical practice in these types of educational programs in which computers are used extensively is made even more problematic given the many different school and system contextual factors which impact on instructional design and delivery. During the course of this study and during the analysis phase, nevertheless, several themes, grounded in the data and relating to the research focus, emerged. These themes, which clearly indicate student experience and attitudes about learning with new technologies, include:

- the learning tasks: subject content, use of the Internet, construction with multimedia
- difficulties with technology
- sources of instruction and assistance
- working in groups on technology projects
- enjoyment with using multimedia
- time issues related to multimedia projects
- satisfaction with multimedia products
- generic/workplace skills obtained
- learning with multimedia.

8.1 Data collection and presentation

These identified themes provide a framework both for shaping and interpreting the data, and assist in a comparative analysis of the students' experiences in the two countries. Through consideration of the students' experiences and perceptions alongside those of their teachers' (examined in the previous chapter), it is hoped to develop understanding about effective pedagogical practices in which multimedia is used in the learning process.

Data from students at the four schools in each of the countries were obtained in a range of ways: from my own observations in classrooms, an on-line questionnaire, which allowed for structured and open-ended responses, focus groups, and student self-evaluation forms required by some classroom teachers. With this mix of data sources, a more complex picture emerges than if reliant solely on a single source. A detailed explanation and discussion about each of the sources and instruments used, and the procedures adopted for the analysis of both the qualitative and quantitative data, is found in Chapter 4 (see 4.3).

Data from the on-line questionnaire, completed by 252 students from the four schools, helped to develop the comparative analysis of students' views begun in classroom observations. Technical difficulties limited the number of questionnaire responses received from OMSC Aus to only four. Greater reliance on the other data sources for this school was therefore necessary to construct a comprehensive comparative analysis of students' experiences. Questionnaires were generally received prior to focus group sessions at each of the schools. Therefore, as with issues arising from classroom observations, questionnaire responses also helped frame questions for exploration in the focus groups. With its mix of structured items and free response options, the questionnaire allowed for data treatments in both quantitative and qualitative modes which serve to deepen and enrich the understandings derived from this study. Aggregated responses from the scaled items provide clear indications of student preference and opinion about the identified themes. Recurring pattern counts from free response items similarly allow for tabular and graphical representation. And verbatim data from open-ended items provide detail about student understandings, perceptions and attitudes towards learning in these types of multimedia projects, not possible if dependent on quantitative data alone. Not all data available from the questionnaire are used in this section; for example, specific details about the hardware, software, computer peripherals and the sources of information students use, have been incorporated earlier (see Chapters 6 and 7). The focus here is on exploring students' experiences and views.

The free response items on the questionnaire used here asked for:

- a brief description of the project
- any difficulties experienced
- who the students asked for help if needed
- a list of three significant or interesting things learned
- what students liked or disliked about the project
- what advice they would give to students and teachers for a similar project next year.

The rating scale items were:

- How confident did you feel using the different types of technology?
- How well do you think you now understand the topic you studied for this project?
- How satisfied are you with your finished project?
- If you worked in a group, how effectively did you work together?

As in the previous chapter presenting the teachers' views, I have devised a number of ways to represent the student data from the range of sources: thick description, verbatim quotes, tables and graphs each of which assist in representation of the students' views and experiences. In previous chapters, data were presented country by country, school by school, to establish the considerable contextual differences between the schools. In this section, the key themes referred to earlier provide the organising framework. Despite differential on-site contextual factors and some variation in the nature of the learning tasks, students in this study were at the same grade levels, using essentially the same types of technology for the same purposes: construction and representation of learning in multimedia format. Therefore, I have chosen to merge and cluster data about their experiences thematically from the range of sources available.

Verbatim quotes are drawn from all sources, but where verbatim quotes are used from the on-line questionnaire, all emphasis remains intact as entered by the students, including upper case, exclamation marks, and repetition. Not only the emphasis remains as entered by a student, but all spelling, punctuation and grammar errors as well. Students are identified, where relevant, by pseudonym, subject, grade level, school and country. To assist the reader, student data from each of the schools are also consistently grouped in the same order as used for the teacher data in the previous chapter, i.e. with the US schools first: RCS US and SVMS, US, followed by OMSC, Aus; EGGS, Aus. As in the earlier chapters, the method chosen to present and summarise the data facilitates comparative analysis.

The aim of the chapter is to tell the students' stories. Exploration of the issues raised by their experience follows in the final chapter.

8.2 The learning tasks: subject content

Each of these middle school level projects required students, mostly in pairs or small groups, to undertake investigative activities based on current curriculum content using a variety of sources and methods. Then, using a range of technologies, students were to present their knowledge and understandings in multimedia formats. That integration of technology with subject content was the goal was clearly understood by the students:

RCS, US

In our project, we were to basically to track down and write about the immigration of our ancestors, what it was like for them to immigrate, and also to write about the Philippine culture. We made a timeline about the immigration on powerpoint, wrote several essays on topics about immigration and culture, and also made videos. After that we had to learn to put all these things on the Internet and save it to the RCS server. (Angela-Marie, 8 RCS US)

SVMS, US

In my project, I chose five topics related to El Salvador and I searched for information on the topic made pages for each of those topics. I then made these pages interesting by adding pictures, sounds, music, movies, and color. (Emily, 7 SVMS US)

For my Spanish project, i was assigned to research and make a hyperstudio presentation on Chile. I had to research culture, general information, music and art, history, tourism, geographical info, a map of chile, and Chile's flag. We had to include all of this into a final hyperstudio project that we can present. Everything that we wrote had to be in Spanish. This helped teach us the language and south american culture. We did this project in partners which helped even out the work to make it managable. (Stephanie, 8 SVMS US)

OMSC, Aus

The aim of this project is to find out information about the solar system and present it on a program called Scala. (Mark, 7 OMSC Aus)

EGGS, Aus

We were to make a web page to put on the intranet. To gather the infomation we went to look at the archives and we were handed a box to our subject that was chosen. Then we were to make our page with writing a hypothesis and conculsion and scan a picture and placing a digitally taken photo on our page. Then we were to test the page which we made in PageMill on the internet. (Anna, 7 History EGGS Aus)

In this project we aimed to report what we had done on our fieldtrip to the cemetery and to the market. We had to set out this information on 5 web pages. Graphs and tables were to be included in these web pages. (Crystal, 7 Geography EGGS Aus)

We had to make a webpage on behalf of martin luther at the time of the reformation including his views on his 95 theses and what inspired him etc. also his potrait, hymns and views on the church. (Catherine, 8 Religious Education EGGS Aus)

Sources students used for the research - the acquiring information component - included books, magazines, CD ROM encyclopaedias, and internet sites. In addition, some of the projects required students to conduct interviews, do specific data-gathering tasks during fieldwork, or handle and consider family memorabilia or school archival objects. The latter activities, requiring more active involvement and personal interaction with the research situation, received favourable comments from some students at RCS, US and EGGS, Aus:

Personal interveiws were useful too. It's really cool to learn another person's outlook on experiences. (Alex, RCS US)

I liked doing something about my country, and that motivated me to do the project (kinda). (Travis, RCS US)

My grandma gave me her story to America, and also gave me how to make gnocchi. (Brendan, RCS US)

I mainly learned that almost everything the Filipino people did to immigrate here was very hard, some people never even made it here no matter how hard they tried. So I am thankful that I was born here and right away became an American citizen. (Candice, RCS US)

The Field Trip was very useful because we got to go and see the Cemetery and Market and not just see it in a Magazine or something. (Amelia, 7 Geography EGGS Aus)

Australia is a multicultural country, I know that. But I when I went to the cemetery and the market, I didn't know that just Melbourne itself had so many different people from so many different parts of the world. (Malavika, 7 Geography EGGS Aus)

The useful items were the ones in the archive, because we could visualise and touch the actual materials used and the uniform that was worn. I liked looking at the achival materials and seeing the actual material used. (Belinda, 7 History EGGS Aus.

I liked looking at the items and thinking of where they could have come from and what they were used for. (Jasmin, 7 History EGGS Aus)

To find out by looking at badges and mottos of the school, how they have changed over the years. (Ashleigh, 7 History EGGS Aus)

The projects which did not have such an active or affective component in the subject matter or task, and were more the conventional research and report style (as was the case at SVMS US and OMSC Aus) elicited some negative comment, especially from boys:

The research and writing we had to do was quite boring. (Brian, 7 SVMS US)

The topic for this project was extremely boring. (Adam, 8 SVMS US)

I thought the work was tedious and time consuming. (Noah, 8 SVMS US)

'[This project] is the most boring thing I've done' Colin, OMSC, Aus told his teacher. This opinion was repeated several times by different boys in the OMSC Focus Group session as well: 'It was boring. It was boring as sin'.

Few girls commented negatively on the content of their projects. Two comments from grade 8 students, EGGS Aus:

I, personally did not like it because it was a bit boring. (Tharuka)

It was okay, there wasn't much to do and nothing was new or very interesting. (Leona)

Only one student from RCS, US chose to comment unfavourably about the content of the project:

The project bored me at many times. (Jocelyn)

The other aspect of project subject matter that drew strong negative comment from seven of the grade 8 SVMS US students was the requirement to present their project research in Spanish. Typical comments:

I think it made the projects longer and harder to translate them into Spanish from English. (Lindsay)

I didn't like that we had to write in Spanish because it's hard to express yourself well. (Paul)

I thought that this project would have been better if it were done in English. I ended up having to look up almost every single word in a dictionary. I don't quite see how that can help me learn Spanish. I remember things for a little while, but they don't stick. (Caitlyn)

Where students in each of the schools used the questionnaire item 'three things I learned /found interesting' to comment on subject matter, some students referred to either specific or more general knowledge acquired:

I learned more about how Mexico got like it is today (Amanda, RCS US)

Why my great grandparents immigrated (Danielle, RCS US)

Information on Paraguay (Alex, SVMS 7);

Good spots to tour in venezuela (Harry, 8 SVMS US)

I learned that the traditional music of Ecuador is based on a pentatonic scale (Shiara, 7 SVMS US).

That Mercury's gravity is only 1% of Earth's (Tim, OMSC Aus)

I found out about Martin Luther (Catherine, 8 RE EGGS Aus)

Some grade 8 SVMS, US students, even Caitlyn, also recognised the cognitive challenge in presenting the work in Spanish:

I learned more Spanish vocabulary through this project. (Maya)

Use of a more wider range in the spanish language. (Elizabeth)

I learned how to write better in Spanish. (Caitlyn)

Some of the grade 7 EGGS Aus student comments on their learning, reflect recognition that the tasks involved more than reporting a collection of facts in digital format, and that fundamentals of research were also an integral part of the process:

I learned how to observe things more carefully. (Crystal)

We had to analyse various items and find conclusions. (Reshika)

How to take notes from evidence more efficiently. (Anna)

the difference between primary and secondary sources. (Arsha)

How to improve my observation skills. (Hui Chi)

I learnt how to write up a hypothesis. A good project for thinking. (Jasmin)

To handle historical items very carefully. Making accurate conclusions. (Maria)

I liked finding out the relevance of each of the objects depending on how much information each of them gave. (Rebecca)

The right approach to interviewing people. (Lee-Anne)

It helped me build up my confidence and knowledge. Finding out how to figure out where people came from by their skin colour, religion and surname. It taught us a lot about Australia's history of migrants. It really taught me a lot. (Natasha)

These EGGS grade 7 student comments reflect that in their History and Geography classes, explicit teaching of research skills in authentic, real-world situations is embedded in the learning process. Moreover student metacognitive reflection on learning, as evidenced here in the Questionnaire responses, is a strategy commonly used in these grade 7 and 8 EGGS classes, both to assist student learning and to assist teachers make sound pedagogical decisions. Reflection on the learning tasks in this manner and extent was not as prevalent in the other schools.

8.3 The learning tasks: use of the Internet

Students in each of the schools were required to use the Internet for information gathering in addition to other more conventional sources for their various projects. Student comments and reflections about their Internet experiences focused on a common range of issues. Students generally like the ease of access to the vast array of up-to-date information and particularly appreciate the access to photos, graphics, clip art; music and video clips which are easily transferable to enhance their own multimedia presentations or web pages.

I felt that the internet was useful because it allowed us to get many different views on the same subject. (Jordan, RCS US)

The internet was very useful because it was easy to get the information. All I had to do was typed in "Puerto Rico" and I would get hundreds of sites. (Anna, SVMS US)

The internet was SUPER useful because it was just there, and so I didn't have to check out books or carry anything extra around in my backpack. The internet was also really helpful for getting loads of pictures witch i could just directly copy down in to our stack. The internet was also a good source of video and audio clips. (Chelsea, SVMS US)

I think the Internet is the most resourceful thing in the world at the moment because if you type in something 20 things come up. (Mark, OMSC Aus)

For the internet, I found it very useful because it had a wide variety of information. It was also easy to use. (Leona, EGGS Aus)

However, students also refer to the time needed to search effectively; their difficulties in finding relevant information and their concerns about validity:

> Internet - it came up with lots of information but 25% was not usefull. (Kevin, RCS US)
>
> The internet is too hard to tell if the information is true. Also it is hard to sort through all the sites and find the kind of information I want. (Jocelyn, RCS US)
>
> The internet was very useful because we could get pictures, music etc. The only bad thing about the internet was that all the info might not be completly true. But all the things that we got from the internet gave our cards a nice look. (Melanie, SVMS US)
>
> I didn't like roaming the internet for pictures. (Robert, SVMS US)
>
> Don't bet your life on anything that's posted on the internet. (Noah, SVMS US)
>
> The Internet's got more information but its harder to find than in a book. (Tim, OMSC AUS)

Of the four schools, EGGS Aus was the only school with specific classroom time allocated to direct instruction about effective use of the Internet. Using classroom materials developed by the teacher librarian in conjunction with classroom teachers, English mentors and CSL teachers, students at this school covered topics such as targeted Internet searching; the ways different search engines function and web site evaluation (design, content and validity).

Notwithstanding the more formal approach taken at EGGS Aus, sharing useful website addresses and search engines - teacher to students, students to teacher, students to students - was a common practice in all classes, albeit in a more ad hoc fashion in the other three schools.

One of the teachers at OMSC Aus required the boys during classtime to show her the sites being used:

> We just have to tell her why it's a good site. We have to prove to her that's it a good site and not a bad one …… We just show her. Click through it and show her some of the stuff that's there. (Tim)

Some student comments reflect a deeper awareness of the Internet and its functions as a result of their learning tasks:

> I also learned how to use the internet more wisely. (Janessa, RCS US)
>
> Altavista as a great sound and picture finder. (Andrew, SVMS US)
>
> [I learned] how to more efficently use search engines w/ the use of quotes, pluses, etc. (Noah, SVMS US)

Put them in the Bookmarks. (Mark, OMSC Aus)

If you search using the best keywords there will always be plenty of great interesting sites available. (Catherine, EGGS Aus)

[I learned to] use internet effectively. (Sian, EGGS Aus)

Bookmarking which allowed me to get to sites fast. (Leona, EGGS Aus)

Each of the schools to some degree required students to cite the sources they used to construct their projects. Issues of copyright were a particular concern for the two US schools involved in the Challenge 2000 Project, as one of the Project's aims was to widely disseminate student work. Thus the teachers were reminded that use of visuals (photos, clip art, maps, graphs, video clips) and music files downloaded from the Internet needed appropriate acknowledgement. Despite reminders, students in all schools found the process of recording sources and compiling bibliographies tedious. With more interest and engagement in the construction process than acknowledging where information was acquired, students mostly left these tasks to last, requiring considerable backtracking to find the relevant details prior to submission. At JSV US the call was definitely 'no sources cited, no grade'. Here students were also required to seek permission by email from the content originators if appropriate. EGGS Aus had citing requirements built into their student checklists and evaluation procedures.

The ways students used the Internet for the various projects depended very much on the nature of the learning task set. Where the multimedia component was a presentation with little cognitive demand, other than gleaning and presenting pertinent facts (as was the case with the Spanish projects at SVMS US and the Solar System project at OMSC Aus, the dominant student Internet use was for locating information of immediate relevance (e.g. details or visuals of a tourist destination, flag or planet; lyrics and sound file of a national anthem), and copying text, visuals and sound for re-use. Where students presented information from original research in *Powerpoint* or webpage format (the RCS US Immigration projects and the grade 7 EGGS, Aus projects), their Internet use revolved more around collecting backgrounds, banners, buttons and other web features to decorate their work.

8.4 The learning tasks: construction with multimedia

Each of the learning tasks in the four schools required students to use an extensive array of some of the more advanced information and communication technologies to represent knowledge and understandings. Whereas school use of technology is most commonly used for word processing and internet searching, students in these projects, in addition, used a far more diverse range of software applications and peripherals for their projects:

RCS US: Internet for research; basic word processing using Microsoft *Word*; Microsoft *PowerPoint* (multimedia presentation software). Netscape *Composer* (web authoring software), digital still and movie camera; scanner; Adobe *Photoshop* (image manipulation software)

SVMS US: Internet for research; *Hyperstudio* (multimedia presentation software); scanner for digital input; Adobe *Photoshop* (image manipulation software)

OMSC Aus: Internet for research, basic word processing using Microsoft *Word*; Microsoft *Excel* for graphing; *Scala* (multimedia presentation software)

EGGS Aus: Internet for research, basic word processing; advanced use of Microsoft *Word* (tables, textboxes, frames; drawing tools); Microsoft *Excel* (spreadsheets and graphing); Adobe *Page Mill* (web authoring software) digital still camera; scanner; *Brushstrokes* (drawing tool) Adobe *Photoshop* (image manipulation software); *Graphic Converter* (animation software)

Most students in the study have computers at home, many with more than one. Many have Internet access as well.[16] At home, many of them already use the same digital technologies but often in very different ways to their teachers, whose main usage is word processing, email and internet searching. Apart from word processing, Internet searching and email, students in this study commonly referred to playing interactive games; downloading and sharing of music files and graphics; participating in instant messaging and chat rooms, and some had started to establish their own Internet space with free sites and tools, outside of school time. Nevertheless, students at all schools acknowledged that they had learned a variety of new technology skills, or enhanced what they already knew, in the course of their school projects.

Students freely spoke about the technology skills they acquired from doing their respective projects. Typical technology related responses on the 'I learned/found interesting' questionnaire item included here show the range of technologies, applications and skills students learned at each of the schools:

Multimedia presentation and web pages

> I learned how to do things on the computer that I've never known before. Like how to make a webpage. (Candice, RCS US)
>
> I learned how to use powerpoint and netscape communicator. (Honore, RCS US)

[16] Information about home computers, Internet access and what students used computers for was gained from teachers, talking to students in class and from Focus Group discussions

I was able to learn how to link different web pages together. (Titi, RCS US)

I learned how to make a webpage. I never really knew how to before so that was cool. (Angela-Marie, RCS US)

Backrounds make a web page look good. (Irving, RCS US)

I got an oppertunity to use my creativity in designing a hyperstudio card. (Elizabeth, SVMS US

I learned how to transfer information and pictures I needed from the internet to the hyperstudio stack. (Lyndsay, SVMS US)

I know how to use programs, such as hyperstudio, a lot better. (Alice, SVMS US)

I learned how to make buttons on Hyperstudio. (Andy, SVMS US)

How good I was with Hyperstudio. (Ricardo, SVMS US)

[I learned] pages have to be in the same folder to link. (Christine, EGGS Aus)

Webpages look better when you don't have to scroll down heaps. (Kalpana, EGGS Aus)

I learnt how to put bookmarks on to my web page. (Jacqueline, EGGS Aus)

[I learned] how to load a graph onto a web page (Emily, EGGS Aus)

I now know how to confidently use a web page program. (Alison, EGGS Aus)

[I learned] how to make a table on a web page. (Emily, EGGS Aus)

It was like the hardest thing we've ever done because it included scans, downloads, text, typing and lots and lots of links. (Bronwyn, EGGS US)

Scanner

[I learned] how to scan pictures into the computer (Miljean, RCS US)

I found out how to use a scanner so I can use it now with more ease (and Adobe Photoshop too). (Maya, SVMS US)

I learned to use a scanner - before this project I hadn't ever used one. *(Arrin, SVMS US)*

I had trouble with the scanner at first, but as I learnt how to crop, trim, and change the size of the pictures, I became confident and now I can help others who are having trouble. (Jie-Yu, EGGS Aus)

[I learned] how to convert your scan onto your page (Yasemin, EGGS Aus)

Digital Still Camera

[I learned] how to take photos with a digital camera. (Alana, EGGS Aus)

[I learned] how to load on photos from the digital camera. (Elise, EGGS Aus)

Sound

[I learned] that you can talk or record yourself onto the webpage. (Casy, RCS US)

How to import and integrate a music file under mp3 format. (Noah, SVMS US)

I learned how to search for sound clips on internet. (Rob, SVMS US)

To put sound on the web page. (Yi Ling, EGGS Aus)

Digital Video

I learned how to import videos on to the computer. (Patrick, RCS US)

[I learned] downloading and importing movies from the net. (Steven, SVMS US)

Image manipulation and compression

Photoshop is good at changing picture formats. (Andrew, SVMS US)

I learned how to use adobe photoshop, very well. (David, SVMS US)

That I must compress my scanned picture before I can use it. (Anna, EGGS Aus)

I know how to convert a scanned photo into a j-peg using Graphic Converter. (Jie Yu, EGGS Aus)

File management

DONT FORGET TO SAVE! (Rythym, SVMS US)

Save everything before its too late (Stephanie, SVMS US)

Save every two seconds. (Erin, SVMS US)

I learnt better saving techniques. (Andrea, EGGS Aus)

Animation

[I learned] more about how to animate on hyper studio. (Danny, SVMS US)

We have learned lot with animation and animation has been the best thing. (Laura, EGGS Aus)

The only students from any of the schools to comment that they hadn't learned any new skills were three Grade 8 EGGS girls:

I used skills i already had. (Jacqueline)

I didn't learn anything. (Leona)

I didn't learn any new computing skills. (Catherine)

Students relied on both formal and informal sources of instruction to learn the necessary technical skills for multimedia construction. For students in these four schools, formal instruction on technical skills was not usually provided by their regular subject teachers. Specialist staff were available to some extent to teach skills in each of these schools and EGGS Aus and RCS US provided both in-class instruction and support for students and staff throughout the duration of the projects. Formal instruction was most needed where the software applications were entirely new to students; where equipment was used that was not often available at home (digital and video cameras, scanners and the associated digital imaging software); and where students used different computer platforms at home. In three of the schools, Apple machines predominated, but at home most families in all schools used variations of Windows-based products. Other issues requiring direct assistance for students related to understanding: the school network structures; the allocated space for file management and storage; file type and size specifications for graphics, animations, video and sound, and the file structure necessary for web authoring. Although the extent of formal instruction and extra adult assistance available to students differed in each of the schools, students, either individually or through their group expertise, acquired sufficient skill to construct (if not entirely complete) their multimedia products.

Students also drew extensively on their peers to assist with skill acquisition (discussed in more detail in 8.5 below). Very few students admitted that they lacked confidence in using the technology or were unable to master the basics of what was needed, even when they did experience considerable difficulties. For most students, practice was the key to mastery. This SVMS student explains that when understood, the problems were not so great:

> I hadn't really had a whole lot of experience with Hyperstudio before this project, but it was easy to follow and I learned it quickly. Now, I'm very confident in using the Hyperstudio program. (Arrin, SVMS US)

OMSC Aus students indicated in the focus group that unlike their teachers, they did not have many problems using the *Scala* multimedia presentation program, once taught the basics. As Matt said: 'Once you learn how to use it, its really easy'. These comments mirroring those of Anabelle, RCS US: 'technology can be easy once it's practiced over and over again'.

8.5 Student difficulties with technology

A wide range of technical difficulties relating to computer hardware and peripherals, software applications, and Internet access and use were experienced by students at all schools as they researched and compiled information, and represented it in multimedia format. Many of the students who mentioned difficulties reported experiencing multiple problems during the course of their project or unit of work. A sample of some of these difficulties:

> My video wouldn't work, links wouldn't work, etc. I found out that I had made stupid mistakes in the programing a couple times. The computer froze almost every second though. (Kristen, RCS US)

> After putting the video i made with my group on the computer, i did not know how to link it onto the webpage so other people could see it. I couldn't find it and when i did it wouldn't work. (Titi, RCS US)

> The Macs often times failed and could not do what my home PC could. We tried many times to compile a PowerPoint, yet it didn't work on MANY different Macs. When I took it home, it worked correctly the FIRST time on my PC. (Jordan, RCS US)

> I had some difficulty using a scanner and the Adobe Photoshop because I am not that familiar with them. (Alexa, RCS US)
>
> Well some times the scanner wouldn't work or the macs would crash or someone would delete my folder or someone would delete my document many of these things happened to me. (Raquel, RCS US)
>
> Hyper Studio has a lot of bugs so a few small things went wrong. Many people lost their stacks and cards. Also it can only take certain types of picture files (not jpeg) so we had to convert every picture we got on the internet to low quality. (Andrew, SVMS US)
>
> Hyperstudio is very unreliable because it often freezes and you might not have things saved so you have to start all over again. Most things worked ok but i still absolutely despise this program. (Stephanie, SVMS US)
>
> When we where half way through our project our whole project got deleted and we had to start over again. This was very frustrating and effected our quality of our work because we had to rush through. (Vincent, SVMS US)
>
> It was hard to make the video clip and scan in pictures and put it in the hyperstudio stack. (Denise, SVMS US)
>
> The sound mic on the Mac didn't work properly, so it recorded our voices and then it erased them. (Aadith, SVMS US)
>
> It was hard to figure out how to save something in one program then open it in another. adobe photoshop also was a little confuzing because i didtn know what all of the titles of the things meant so i had to ask for help a lot. (Erin, SVMS US)
>
> Sometimes the programs got a bit confusing and sometimes the program wouldn't do my commands. Then the computer would shut down or do something dumb just before I was going to save. (Andrea, EGGS Aus)
>
> I had trouble understanding what I was doing with the digital camera and I still have trouble working the printer. (Bronwen, EGGS Aus)
>
> Also, majority of the computers did not have enough memory to open Adobe Pagemill and Navigator together, and this was hard because we had to close one program and open another. (Frances, EGGS Aus)
>
> The computer froze about a million times and then it wouldn't let me save for some strange reason. (Alison, EGGS Aus)
>
> The program kept crashing or freezing. I had to do my Geogrephy page completely over again three or four times. (Caitlyn, EGGS Aus)

OMSC Aus students in their focus group indicated that computer failure and accessibility - to the *Scala* software and to the Internet - were the main difficulties they experienced:

> I was in the Library just before and tried logging into three computers and each one froze. (Brad)
>
> Half of the computers didn't have Scala in the computer room and the ones that did, the computers kept crashing. (Sean)

The content filtering system used by the school was another major source of frustration to those students who had paid the required levy: '99% of the sites are blocked!' (Brad)

Of the 252 students who responded to the Questionnaire, 169 (67.1%) students indicated in the free response item they had experienced technical difficulties. Table 15 shows the percentage of students in each school who had technical difficulties.

Table 15
Students' experience of technical difficulties

RCS US N=60	**SVMS US** N=107	**OMSC Aus** N=4	**EGGS Aus** N=81
81.7%	76.8%	0.0%	46.9%

This table shows a greater proportion of students in the two US schools experienced difficulties than in the other schools. Interestingly, a larger percentage at both these schools experienced difficulties than did students at EGGS in Australia. None of the four OMSC students whose on-line questionnaire was received indicated they had difficulties or needed help. The more favourable EGGS situation is probably associated with the fact that skilled teachers taught the technology components, many problems were anticipated and dealt with through collaborative staff planning sessions among the subject teachers and the technical specialists, and that the range of accessible support was greater. Further, when the EGGS figure is disaggregated to reflect the different grade levels (Table 16), it indicates that the grade 8 students, who had learnt some of the necessary skills in the previous year, found fewer difficulties than did the grade 7 students, for whom the skill acquisition was mostly new.

Table 16
Students' experience of technical difficulties - EGGS, Aus

EGGS, Aus - grade 7 N=55	**EGGS, Aus -grade 8 RE** N=26
50.9%	38.5%

8.6 Sources of instruction and assistance with technology

As indicated previously, students were taught the necessary skills formally and had access to help with technical difficulties, to a varying extent, in all schools. Some direct instruction by the classroom or subject teacher occurred, but more usually an IT specialist or support teacher assisted the process. In addition, considerable informal peer tutoring and problem-solving occurred in the process of student skill acquisition.

Those students who experienced difficulties indicated they called on a range of assistance (often from more than one source), when needing help with software or hardware issues. These sources included the subject teacher, the technical support person, an IT skills specialist, a subject mentor, other support staff, and in the case of OMSC Australia, senior students were also used. Characteristic of these multimedia environments was the trouble-shooting of technical and software problems through the collaborative efforts of students and by student 'experts':

> If I had computer problems, I'd ask our computer teacher. If it was about programing I'd ask a classmate. But I'd didn't need to ask for help a lot because I am very good with computers and I know a lot about them. (Kristin, RCS US)
>
> I asked my friends who had figured my problems before. (Brendan, RCS US)
>
> At first I really didn't understand how to use any of the programs we were supposed to be using. It took a long time for me to understand completely what I was doing. Everyone I asked could barely help me so I figured it out with the help of a few friends. (Honore, RCS US)
>
> I asked people who had already scanned pictures using the scanner, my teacher, my partner, and the people who work in the computer lab. (Alice, SVMS US)
>
> The computer lab lady or our teacher or a smart kid in the class. (Andrew, SVMS US)
>
> Sally and me worked together and figured it out. (Bhavisha, EGGS Aus)
>
> I checked it myself then I asked the person to my right then to my left then my teacher. (Edwina, EGGS Aus)

Being a 'web master' for the RCS classes suited Victoria:

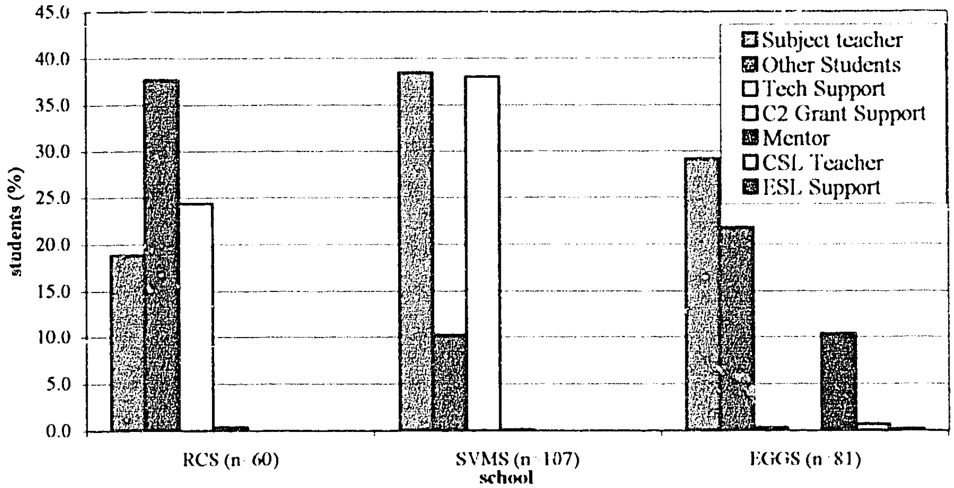
> I liked being in charge of how the web pages would look, act, and perform. (Victoria, RCS US)

For this student, avoiding the issue was the strategy adopted:

> With any of the difficulties that i had using the technologies and programs, I asked someone else to do it for me. (Anabelle, RCS US)

Figure 12 below shows the sources of help students in the two US schools and EGGS, Australia indicated they called on when faced with difficulties. None of the four OMSC students who completed the questionnaire indicated they had difficulties or needed help.

Figure 12
Sources of help sought by students



As the figure shows, at RCS US the subject teacher was the least mentioned source of support, other than the visiting Challenge 2000 Technology Learning Consultant. Theresa, the class teacher, and her students recognised that they knew more about the complexities of the technology than she did: 'Don't ask Mrs. Leckie for help because she gets confused herself' (Vivian). Further, the design of the RCS project which required students to work closely in their cultural groupings, using the complex array of technology over an extended period, and who spent their days together in the one elementary model class with computers accessible in their classroom, make it not surprising that peer support was so high. Interestingly, the percentage of peer support used was close to that of their Technology Resource Coordinator.

At SVMS US where students faced considerable technical problems with the *Hyperstudio* software, students asked for most help from their technically competent Spanish teacher, Carol, and either of the two technicians who were available. They did not mention relying so much on each other. Unlike at RCS, the Challenge 2000 Technology Learning Consultant had no support role in the classroom other than the initial teaching of *Hyperstudio* to the students.

Figure 12 also shows that the EGGS students who experienced difficulties used the opportunity to call on the wide range of help sources available. Despite being encouraged to problem-solve for themselves, then to ask other students before calling on adult assistance, their subject teachers were still the focus for most requests over other students. The CSL teachers, the mentors, ESL specialist and the technician, were all also used to varying degrees, combining to form the widest network of support available to students at any of the schools.

Unlike the other schools, the students at OMSC in Australia had few readily accessible adult resources from whom to request help of a technical nature. These students indicated in their focus group that although their non-specialist subject teachers could help a little, for specialist help and support with technical issues, the OMSC students referred to Dan, the Head of IT, and an integrated project teacher, prior to his leave, then to Glen, his replacement. When available, Jerry the part-time technician was also used, but he was usually hard to find. Considerable collaboration amongst themselves was apparent and necessary, as was the help obtained from senior students.

Thus, for students in each of the schools, technical difficulties were a routine experience when working with multimedia applications, with many students needing help to sort a myriad of issues Help was generally available in various forms for these students, if not from the adults, then from their fellow students. And as Christine, EGGS Aus advised 'ask anyone you can find if you have no idea what to do. You learn better that way'.

8.7 Student collaboration

Students working in groups was a key design feature of these multimedia projects, although the degree of collaboration expected of students did vary. Collaborative group work over an extended period was a fundamental expectation of the US projects funded by Challenge 2000. The RCS and SVMS projects required students to work together in groups during both the research and multimedia creation stages. OMSC Aus, required the students to do some individual work, some group work and to contribute to their group's multimedia presentation during the course of the integrated project. At the other Australian school, EGGS, the grade 7 projects generally required students to do the research phase in groups, but to create individual multimedia presentations and web sites, the aim at this school being to ensure that all students acquire the relevant technical skills. Due to time limitations, the grade 8 RE EGGS projects considered here were all done individually. Group formation varied: by topic (RCS); self selected (EGGS, SVMS); and teacher selected (OMSC).

Apart from the formal expectations of teachers for students to work in groups for research and for the construction of group learning products, informal support and collaboration among students especially during the multimedia construction phase in all projects was not only frequent, but fundamental to success. In all schools on any given observation period where computers were used for multimedia projects, it was extremely rare to see students working totally on their own without reference to others. If not working in clusters around one computer or perhaps a scanner in their specified groups, students in all classes used the people on either side or around them as sources of information, support and validation. Students in these classes were seen to confer, discuss, ask questions, seek out experts (sometimes other students, rather than teachers), compare their work with others, share tips and tricks to deal with technology problems, share interesting websites pointing to relevant (and sometimes irrelevant) sources of information.

A large proportion of students in the US schools used several of the free response Questionnaire items to comment on group dynamics and outcomes. Matters relating to working in groups were the third most common issue referred to by students in the free response questionnaire items – likes/dislikes. Many of these comments referred positively to aspects of working in groups. The comments indicate that working together helped students to learn and contributed to their enjoyment of the extended project. For students whose group experience was positive, typical comments were:

> I liked working with other people to form a web page to share about our history and how we immigrated. (Brian, RCS US)

> I liked working as a group, and learning things about building a webpage and basic computer tricks and things I wouldn't have learned in my own or if we hadn't done the project. (Miljean, RCS US)

> I liked working in a group and also making a webpage. (Marcus, RCS US)

> I like how we got to work in a group and that our teacher just didn't give us a country, she let us do the project on the country we came from. (Kimberley, RCS US)

> I liked how they put us in groups because it made us more of a team and we all depended on each other but we got through it and had a very sucessful project. (Vanessa, RCS US)

> I like the fact that I had a useful part in our group at the end. (Raymond, RCS US)

> I enjoyed working in a group because i had more people to work with and it was easier because we had more ideas and opinons how to do stuff. (Kellie, SVMS US)

> I liked being able to work with a partner that i got to choose. (Shantelle, SVMS US)

> Dividing the work with partners makes it fun and helps a lot. (Stacy, SVMS US)

> I liked getting to work with other people. (Elliott, SVMS US)

> Well i liked that we got to use a lot of technology with the computers and multimedia.and work in groups that we chose so we could have fun with it. (Andrew, SVMS, US)

Not all comments about working in groups for projects were positive however:

> It was hard to get some people to do their part of the project. (Mark, RCS US)

> What I didn't like was that some people in the same group as me were doing somethings that were my part and I din't like that. The group I was in didn't communicate that well with each other. (Alexa, RCS US)

I would have liked to work in a bigger group. (Brian, RCS US)

The big group made it harder for us to work and had fights about the stupidest stuff. (Janessa, RCS US)

I liked the over all idea, but I think it was a TON of work, and my partners didn't always seem like they wanted to do all the work involved!! (Chelsea, SVMS US)

The students in the OMSC Aus focus group indicated they had mixed opinions about their group experience depending on whether they got to choose their own partner or whether their partner did an equitable share of the work. One boy was particularly incensed:

I had to do the entire project. And every time he said he helped I kicked him in the shins so hard. (William, OMSC Aus)

Another OMSC boy would have preferred to work alone.

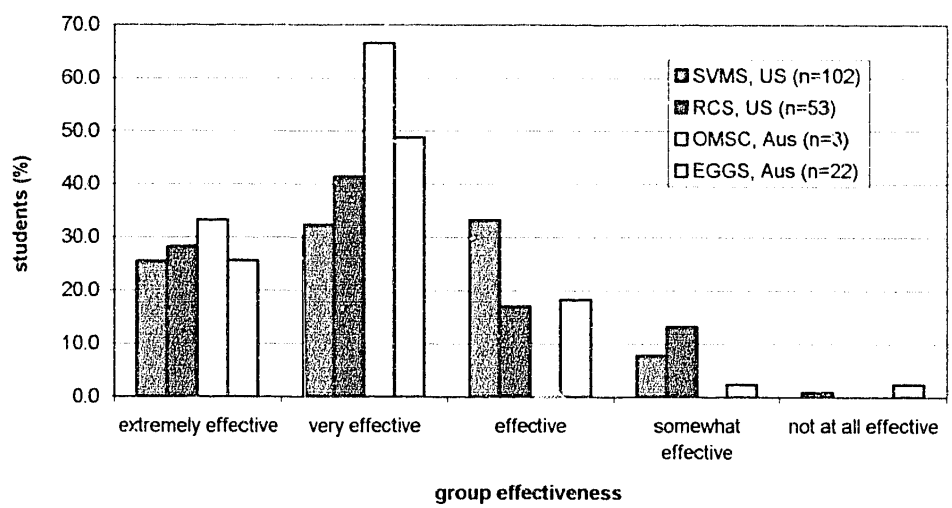
Very few free response comments, evenly divided, about working in groups came from EGGS:

I liked researching in a group. (Bronwyn)

What I didn't like was the way my group and I worked together. (Malavika)

Of the 252 students who completed the questionnaire, 180 rated the effectiveness of their group (see Figure 13).

Figure 13
Group effectiveness



Clearly, for most students who worked in groups for their multimedia projects, the experience was a positive one. At RCS US where the groups were formed on the basis of the students' cultural backgrounds and where they enjoyed the challenge of creatively presenting their family stories, the group effectiveness rating was particularly high. Only 22 of the 72 EGGS grade 7 students rated the effectiveness of their groups, as did three of the four OMSC boys who completed the questionnaire. For the Australian students who did rate their group effectiveness, as with the American students, it was generally a positive experience.

The student experiences confirm their teachers' views about the cooperative and collaborative nature of student learning during the projects. Students in this study relied extensively on each other to learn and problem-solve with multimedia technologies. Moreover, where the instructional design required students to collaborate intensively, despite some misgivings, the students generally believed they did so effectively.

8.8 Time issues

Issues of time relating to multimedia projects concerned many students in all schools, as it did their teachers. Students often mentioned that projects consumed too much time. However, other students in the same schools also complained that they were given too little time to complete projects to their own satisfaction. Time problems caused by technical or software difficulties, the extra time needed for adding multimedia elements, the lack of access to school facilities to assist in more speedily completing their work, characterise their concerns. Even though time issues were problematic, some students still indicated that this was not a barrier to their enjoyment of the project.

> I did not like that we had to do alot of things to finish the project and how long it took. (Jonathon, RCS US)
>
> I didn't like it because it took a long time. (Monica, RCS US)
>
> [I did not like] how long it took to finish but, when it was all done I was happy with the finished product. (John, RCS US)
>
> I didn't like that this project took so long to do. (Shawna, SVMS US)
>
> I takes a long time to get everything together, to make all the finishing touches, and to learn how to get through a program step by step. (Kate, RCS US)
>
> It was neat to do Hyperstudio, but it made the project much harder because it took a lot of time to set up the cards and type up the information, and the only way we could access our report was at school. Even with lunchtimes and after school time to get into the computer lab, it was still hard to get the information into the stack. (Arrin, SVMS US)
>
> We had about one week of lessons every month and that was it. I haven't finished it yet. (Brad, OMSC Aus)
>
> I din't like how long it was. (Elise, EGGS Aus)
>
> It was really drawn out. It took a long time to do because there was lots of thing to do on each page (Bronwyn, EGGS Aus)

The shorter EGGS Religious Education projects did not elicit complaints about time as did those in grade 7: 'It was quite good because it didn't drag on' (Amy).

Some students also commented on how they would have liked even more time to complete their projects:

> Give the students time to do the project and figure it out. And I mean lots of time. (Brendan, RCS US)
>
> I don't think that we had enough time on the class compters to put everything together to our maximum. (Lindsey, SVMS US)
>
> I didn't think we got enough time to perfect our project with more pictures and the music and video clips. (Lucia, SVMS US)
>
> I reckon I didn't have enough time to finish it so I didn't reckon it was that good. (Sam, OMSC Aus)
>
> I would have like more time to work on the pages because i found that near the end, we were in a mad rush to finish everything. (Crystal, EGGS Aus)

This same student also clearly recognised the challenges teachers face on this matter of time for extended projects:

> I would advise that we had more time but i also think that if we were given more time, then everybody would have been slacker and the same thing would have happened. (Crystal, EGGS Aus)

Another student commenting on whether computers might be a waste of time remarked:

> And I wouldn't say that computers are a waste of time. They might take a while to do a certain project but usually the longer you do stuff the more interesting it gets and for the kids its pretty fun. Its fun to explore and stuff like that. (Kelena, SVMS US)

8.9 Student enjoyment using multimedia

Students, in both the two schools in the US and the two in Australia, indicated in a range of ways (in the various free-response items on the questionnaire and in focus groups) that they enjoyed the opportunity and challenge of doing schoolwork with multimedia technologies. Students liked the opportunity to create their own products using images, graphics, colour, animation, Internet links, interactivity, sound and video:

> [I liked] learning things about building a webpage and basic computer tricks and things I wouldn't have learned in my own or if we hadn't done the project. (Miljean, RCS US)
>
> I liked experimenting with differnt backgrounds or colors and dislaying images before I decided on the final copy. (Kate, RCS US)
>
> I liked using the computer to display information. I liked using the computer. (Rob, SVMS US)
>
> I enjoyed making the stacks (scanning, writing, making buttons, getting picures etc. (Melanie SVMS, US)

> I liked making the designs on the project with the computer and getting pictures. (Lucia, SVMS US)
>
> I liked creating fun and interactive activities in my stack for people to do. (Thomas, SVMS US)
>
> I liked the computer part of the project, which was mainly everything. All the multimedia parts were cool. *Damien, SVMS US*
>
> I like using Hyperstudio to make the project interactive. *Andrew, SVMS US*
>
> I liked the videos and the sound. (Kojo, SVMS US)
>
> I liked using the internet and producing my information on my own web page. (Jennifer, EGGS Aus)
>
> I also liked putting little animations from clipart on to my page. (Natalie, EGGS Aus)
>
> I liked making up the web page and using some of my creative abilities. (Jocelin, EGGS Aus)
>
> I liked setting up the photos and the links. (Christine, EGGS Aus)

However, some students in the US did not appreciate the requirement to include video in their multimedia projects:

> I didn't like the part when we had to make the video all though all the other exponents of the project were interesting and fun. (Patrick, RCS US)
>
> Teachers, do not make the kids include movie and video clips! It is too hard to save and bring onto the stack. (Maya, SVMS US)
>
> I liked making the designs on the project with the computer and getting pictures. I didn't like not being able to get a video or music clip. (Lucia, SVMS US)

Many students also expressed ambivalence about working with multimedia:

> I liked working in a group and also making a webpage. I didn't like the technology always messing up. (Marcus, RCS US)
>
> Most of the time it was really easy to make the webpage, but it was frustrating sometimes, but rarely. (Angela Marie, RCS US)
>
> I liked creating cards and designing them. I liked looking on the internet for pictures and information too. But I didn't like the problems that they entailed. Once my partner and I put our work together, which took us a considerable amount of time, it errased our work. I hated doing it all over again. (Heather, SVMS US)
>
> I didnt really like using the computer because somethings were really difficult, but going on the computer made things more interesting and challenging. (Becca, SVMS US)
>
> I liked making the links and finding them active. I did not like the computer turning against me. (Maria, EGGS Aus)

With just as much vehemence (although a decided minority), Alison, EGGS Aus said: 'I hate using computers', and Timothy, RCS US commented:'[I] didn't like the fact that we had so much stuff to do on this project, like the whole technology hype'.

A close analysis of the free response item - like/dislike - on the student questionnaire indicates different patterns of responses at the schools about the students' enjoyment of using technology for learning tasks (see Table 17).

Table 17
Patterns of student enjoyment about technology use

	RCS, US N=60	**SVMS, US** N=108		**EGGS, Aus** N=80	
		SVMS 7 N=41	SVMS 8 N=67	EGGS 7 N=54	EGGS 8 N=26
Technology - like	18.3%	41.5%	55.2%	27.7%	26.9%
Technology - dislike	20.0%	36.6%	31.3%	7.4%	7.7%

Table 17 shows that of the two US schools, RCS students used this free-response item, to comment less on technology issues, either positively or negatively, than did the SVMS students. RCS students were in fact far more interested in using this item to comment on the nature of the project, rather than technology matters (see 8.10). By contrast, a much larger proportion of SVMS students used the like/dislike item to talk about matters relating to technology, with half of the students choosing to talk about their experience in a positive way. Moreover, for many of the students at both schools, their comments encapsulated the ambivalence to technology illustrated earlier. Very few students at either US school (or in Australia) were totally opposed to using technology. Their negative comments tended to be directed at the type of computer or software used by the school, not the use of technology *per se*.

> I do not like macintosh computers so I had difficulty because they are harder to use and less efficient. The progam we used to make the webpage (composer) was also not a good choice. (Katie, RCS US)

> I liked how we got to work with technology but i did not like the technology we were offered. I thought it was quite ancient and difficult to use. Although I seem to be complaining only about how BAD this was, I was happy that we got to use Hyperstudio. (Grace, SVMS US)

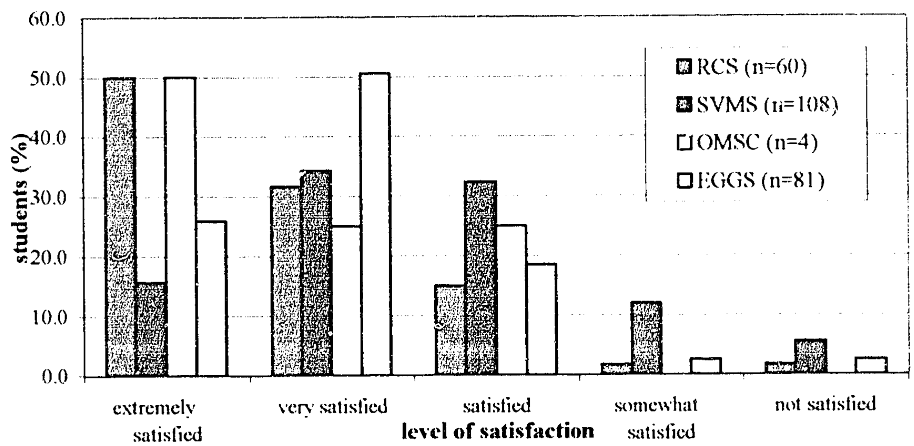
Just over a quarter of the EGGS Aus students in both grade levels, used the opportunity to comment positively about their use of technology, considerably more than those expressing negative views.

The grade 7 OMSC students in Australia indicated in their focus group that they enjoyed using the computers and the Internet. 'I liked using the internet and computers' (Mohit). They also enjoyed downloading images and decorating their presentations using *Scala*, but as some also said, they wished it didn't have to be done for school-related tasks. The ambivalence about technology was also mentioned by Brad: 'In some ways the computers are good and in other ways they are not so good. Because of the Internet. The only bad thing is they always crash'.

8.10 Student satisfaction and enjoyment of the learning tasks and projects

Despite often expressing frustration (with the technology, the time the projects took, the sometimes difficult group dynamics and with the project content), at least 80 per cent of students in all schools were satisfied with the outcome of their multimedia projects as indicated on the questionnaire item 'How satisfied are you with your finished project?' (Figure 14)

Figure 14
Student satisfaction with their multimedia projects



In free-response items on the questionnaire some students chose to express pleasure, even pride, in the outcome of their work:

> I liked the fact what I started the webpage out to be, and what it turned out to be in the end after putting everyone's idea's, talents, and information into the computer. (Amanda, RCS US)

> I like my finished project and the gratitude it gave me. (Honore, RCS US)

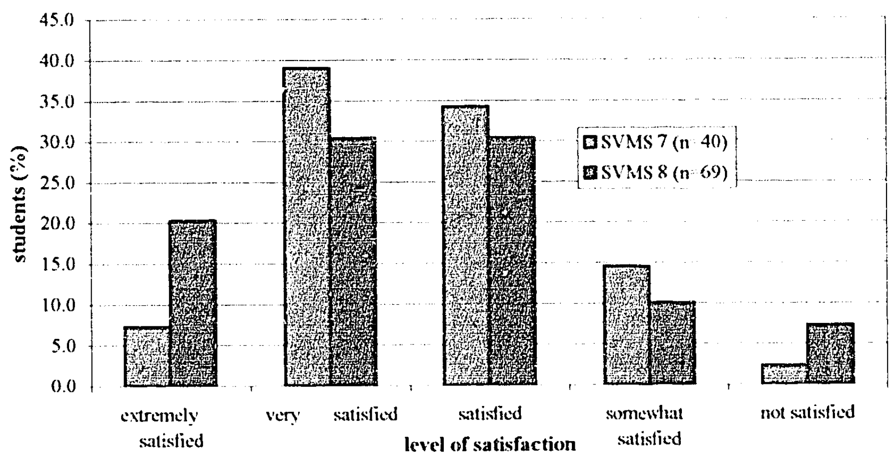
> I feel good knowing that the finished project includes all the required information. (Alice, SVMS US)

> I liked working in a group for the research and I liked the finished product. (Malithi, EGGS AUS)

> I hope if you ever get a chance that you may be able to look at my web page, i hope you like it. (Shereen, EGGS Aus)

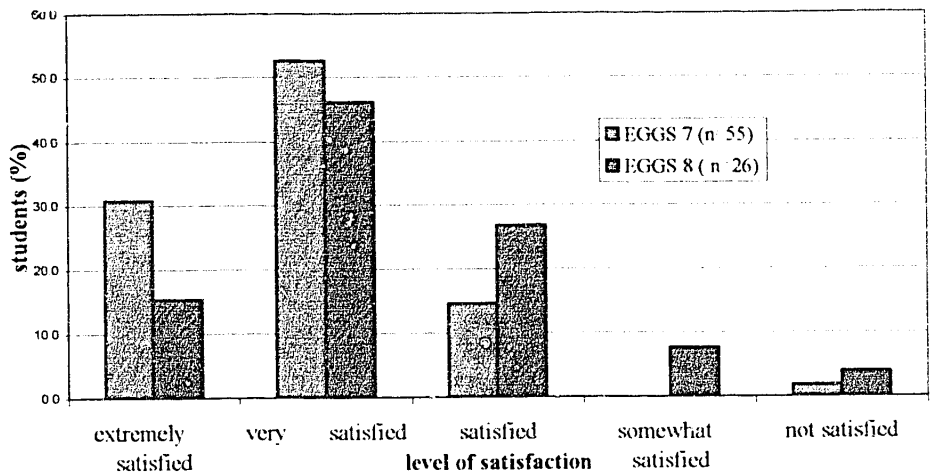
As Figure.14 shows, the students at RCS US, with their extended group investigations of family immigration to the US, expressed the most intense satisfaction with their work, closely followed by the EGGS students in Australia. The four OMSC Aus students who responded were also clearly satisfied with their work. However, when levels of satisfaction are disaggregated for the different grade levels involved at both SVMS in the US (Figure 15) and at EGGS in Australia (Figure16), there are some interesting trends.

Figure 15
Satisfaction with projects – SVMS, US students



As Figure.15 indicates, the grade 7 and 8 students at SVMS US had broadly similar patterns of satisfaction with their multimedia product. Despite this being the second year students had done this type of project, very few grade 8 SVMS students were dissatisfied with their finished work. Some of the grade 8 students expressed concerns about the Spanish language component of the project both in the free response comments and in focus groups, however, no negative comments were made about the repetition of the project design. It could be assumed that the requirement to present their work with multimedia component played some part in their high satisfaction levels.

Figure 16
Satisfaction with projects – EGGS, Aus



Grade 7 EGGS History, Geography and English students were generally more satisfied with their multimedia products than were the Grade 8 RE students. For these students, whose projects were required to be in web page format, this was their second year of webpage construction for presentation of their work. This repetition might explain the lower levels of satisfaction at Grade 8. As one girl indicated: 'I enjoyed making the webpage though the process is becoming somewhat tedious' (Kaylyn). Further, for some, the subject content of the task was not of interest (see 8.2).

In addition to many students using the opportunity provided by the free response item - like/dislike on the questionnaire to comment about technology issues (see 8.9), many students also used the opportunity to comment on the overall nature of the learning tasks or project. A close analysis of these responses indicates different patterns of responses from each school and at different grade levels about their enjoyment of the project.

Table 18
Student enjoyment of projects

	RCS, US N = 60	**SVMS, US** N =108		**EGGS, Aus** N = 80	
		SVMS 7 n=41	SVMS 8 n=67	EGGS 7 n=54	EGGS 8 n=26
Project - like	50.0%	26.8%	14.9%	38.8%	3.8%
Project - dislike	3.3%	7.3%	3.0%	1.8%	11.5%

Table 18 shows that fifty per cent of the RCS US students chose to use this free response item to comment on their appreciation of the project – providing far more positive comments on learning tasks or projects than by students at any of the other schools. This pattern of favourable free response aggregations from the RCS students about their project, mirrors to a large extent that obtained from the scaled item on Project Satisfaction discussed above (Figure 8.3). For the students at RCS, the overall project, with its focus on their families, plus the use of technology, drew the most favourable comment:

> I liked this project because it helped me to learn about my family stuff I may have never known, and it also helped me to know how to make a webpage. I really didn't like the project in anyway except that it had to end. *Courtney, RCS US*

As Table 18 also shows, far fewer SVMS US students chose to comment favourably about the project, and the grade 8 students were far less disposed to do so than grade 7 students. The use of technology elicited more favourable comment than did the content of the project (see Table 8.4 above) especially for the grade 8 students who were essentially repeating the concept, but using multimedia technology. Four comments illustrate this:

> I liked using computers and working with a partner. I disliked working on the project. (Andy, 8 SVMS US)
>
> What I like about this project was using computers. (Steven, 8 SVMS US)
>
> I did not like the research but it was fun putting together the info in Hyperstudio and adding special effects. (Maya, 8 SVMS US)
>
> I liked going on the internet but did not like writing it up. (Marcus, 8 SVMS US)

Further, as one student advised:

> Get the research done fast so you can play around with hyperstudio for a while. (David, 8 SVMS US)

In probing this same issue of enjoyment with the grade 7 OMSC students in Australia, a similar pattern emerged. Whereas their teachers thought the boys would enjoy the Solar System topic, this generally proved not to be the case. Several of the boys indicated in their focus group that they had covered aspects of the topic at their elementary schools in previous years and their research elicited familiar information. Asked why he found the topic boring Sam said 'Because you've just to look up things and half of what you find, you've already seen before'. For these boys using technology was what interested them.

The grade 7 EGGS students who chose to comment on their projects did so in a positive manner (38.8 % as compared with 1.8 %). Their comments often focused on specific aspects of projects and incorporated comments about technology, for example:

> [I] liked learning about the history of the school's sports proggramme, and the different sorts of things they did back then. I also like scanning pictures on to my page. (Natalie, EGGS Aus)

However there is a different scenario at Grade 8 at EGGS. Only one student (3.8%) chose to comment in a positive way: 'It was a good way to present our information. I understand what

Luther was thinking at the time of the reformation' (Catherine, 8 EGGS Aus). Three students (11.5%) commented in a more negative way about their projects. As Leona said: 'It was okay, there wasn't much to do and nothing was new or very interesting'. For the grade 8 students at EGGS who did choose to comment on the learning tasks, similarly to those at SVMS in the US, their comments are directed more to the technology than the content (see Table 18) above).

For the students at each of these schools, satisfaction with, and enjoyment of their learning tasks and projects is related to their perceptions about the instructional content and design of the learning tasks and projects. It can be concluded that students enjoy working with multimedia, even more so when the learning tasks have cognitive challenge and are of real interest to students.

8.11 The 'fun' factor

More than any other descriptor, the word most commonly used by students about the projects was 'fun'. Repetition of the word 'fun', when these Australian and American grade seven and grade eight students (in their middle years of schooling) refer to using multimedia for learning, is striking. Fun was the most commonly used descriptive word students adopted when referring to enjoyment of learning with multimedia. It was used, unsolicited, by some students in all schools in each of the free response items on the Student Questionnaire. It was also used by students in the Focus Groups as I probed issues further. Table 19 shows the proportion of instances in which 'fun' was used by students at each of the schools.

Table 19
Student use of the word 'fun'

RCS, US N = 60	**SVMS, US** N = 108	**OMSC, Aus** N = 8	**EGGS, Aus** N = 81
16.6%	27.7%	25%	18.3%

What follows is a small sample of the ways these American and Australian students incorporated 'fun' into their comments:

> It was really fun and I would like the next 8th graders to do it and see how much fun we had while doing this project. (Danielle, RCS US)
>
> To the students, have fun and do your best! Have fun! (Krystal, RCS US)
>
> It was a very fun and exciting experience. We got to design a web page for the prodject and that was really cool. Working in groups made the prodject so much easier to work on. Yeah and it was cool. (Travis, RCS US)
>
> Well i liked that we got to use a lot of technology with the computers and multimedia and work in groups that we chose so we could have fun with it. (Andrew, SVMS, US)

It was fun and you got to work with a computer and you got to learn alot of interesting facts about your country that you did not know before and on how to use hiper studio and it was really fun .(Elizabeth, SVMS US)

It was a fun project and i learned lot. (Mark, SVMS US)

It was fun to learn how to use the technology and to work with my partner on a country I knew nothing about. (Luke, SVMS US)

You have to have fun. (Kimberley, SVMS US)

[I liked] making fun things. (Mohit, OMSC Aus)

Have fun and learn lots!! (Tim, OMSC Aus)

Teachers: I highly recommend this way [of web-paging] rather than a hand-written report. It's more accessible and more FUN! (Frances, EGGS Aus)

Have fun!!!! (Alwynne, EGGS Aus)

Its so much better than all the other stuff I've ever done before. All we did in grade 6 was play games and type up. Now we are discovering things and making new stuff. Its really fun. (Yasemin, EGGS Aus)

Thus, there was a commonality of expression (including emphasis) by the Australian and American students about their use of multimedia for learning tasks.

8.12 Generic skills/skills for the workplace

Many students also chose to comment on a range of useful generic skills that they had acquired in the course of their projects. Students used the opportunity afforded by three of the free response items – like/dislike, learning, and advice – to indicate that they understood that project management skills were both useful and essential elements for these types of learning tasks and projects. In addition to the many references to working in groups noted earlier (see 8.6), students also mentioned that they learned how to problem solve, how to manage their time better and the importance of being adaptable in a computer environment. Moreover, advice on project management was by far the most prevalent form of advice offered by the students. Here is a sample of their comments:

Learn to budget time and work together!! That is so very important when you do this. (Angela Marie, RCS US)

[I liked] how I had to work hard together in a group to form one project. (Judy, RCS US)

[I learned] how to organize a group better. (Mark, RCS US)

You also need to have patience because this project takes a while to create. Also, you need to include everyone's idea's in order to make your project huge and fantastic! (Amanda, RCS US)

[I learned to] manage my time on projects (Alex, SVMS US)

Plan well, keep information easily available, make sure to plan for computer error. (Chris, SVMS US)

Team work is very important (Elizabeth, SVMS US)

For students - don't procrastinate! It will catch up with you later, trust me. (Arrin, SVMS US)

PLAN AHEAD!!!!!!!!! If you ever procrastinate about this project, "Thee shall feel the wrath of last minute panic in full blown force!!" (Grace, SVMS US)

DO NOT waste time. (Reshika, EGGS Aus)

Beliefs that learning computer skills at school would be helpful, even important for their future working lives, were also canvassed in some of the focus groups:

Michael: No I don't think it's a waste of time because it teaches kids how to use technology. And like if everyone used technology it might give them ideas for like when they get bigger, older or smarter. They might make up like better inventions or whatever.
Maya: I think it is important to use it because you never know when you're going to need um like that kind of knowledge again. And you might never use *Hyperstudio* again but like you might need to do something sort of like it. Because technology is really important.
(8 Focus Group SVMS US)

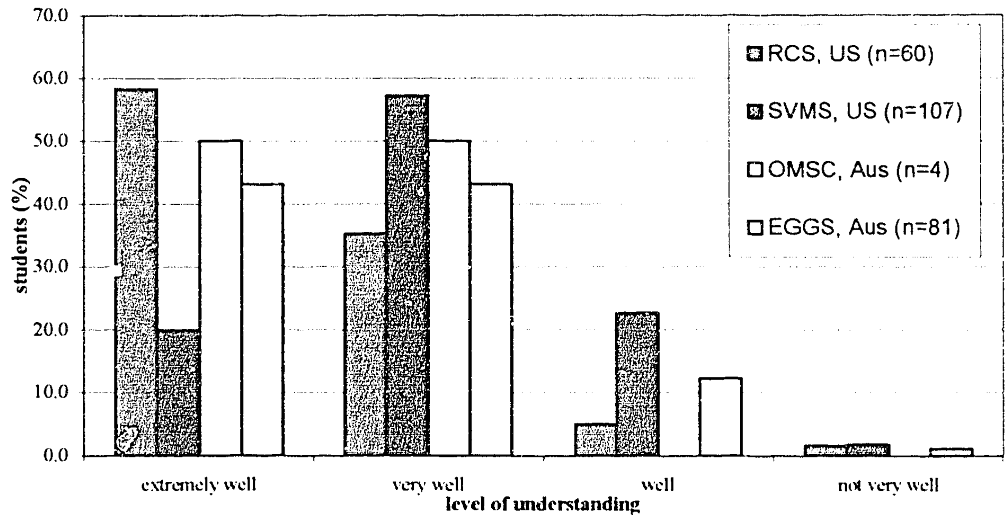
If you look at a lot of businesses these days, most of them have computers, sending faxes, and just the technology on computers has just grown so much that if we didn't use them and just came back in three years we probably wouldn't understand.(Laura, 8 Focus Group, EGGS Aus)

8.13 Student views on learning with multimedia

Student views on learning in multimedia environments emerged in a range of ways, both through structured and less structured means. Several dimensions of student views about learning with multimedia have already been presented, all of which have implications for teachers who might choose to introduce student use of multimedia into their curricula. So far, student views have covered the design of, implementation and satisfaction with multimedia projects, technical skills acquired, project management skills either learned or identified while doing multimedia projects and the frustration and enjoyment of working with multimedia.

Students were also asked to indicate their level of understanding about the topics covered in an item on the on-line questionnaire which asked: 'How well do you think you now understand the topic you studied for this project? Figure.17 displays their responses:

Figure 17
Level of understanding



Most students indicated they understood their respective topics very well or extremely well. The SVMS US students did not rate their understanding as highly as did students from the three other schools; nevertheless, most students obviously felt they were in control of the subject content. Even though considerable technological and other difficulties were faced by students, these factors did not seem to interfere with their understanding of the topic. Whether or not student views on understanding of content matched any formal assessment by their teachers was not the focus of this study.

Other issues associated with the role of computers in assisting the learning process emerged during the study - raised by students in free response comments and explored further in focus groups. These issues include the role of the computer as a learning tool, how multimedia elements help student learn, and whether or not computers should be used for presentation-type projects. Although not the subject of as much comment and opinion as issues already covered, they are included here as they provide important pointers and insight into the thinking of some students in relation to their use of educational technologies.

Students from SVMS and OMSC, whose projects I have consistently represented as not as cognitively challenging as the projects in the other schools, recognised that the technologies they were using were only tools in the learning process and had clear views on the matter:

> If the whole point of this project is to learn about a spanish-speaking country then leave computers out of it. The students end up spending all their time trying to figure out why the computer erased their project instead of using the time to research their country. (Laurel, SVMS US)

Other SVMS US students expressed similar, even more pragmatic, sentiments:

> Researcher: But what about doing your project on the computer, does that help you learn more about Guatemala or Uruguay or whatever?
> Michael: No, because when they give us a project to do on the computer, they're not like teaching us about the place ... We want to get a good grade so we just try and get it done and make it like look it good so we can just get a good grade. But like in [the regular] Spanish class, like when we do stuff out of books and stuff, its not like we are going for the good grade, we try to get it done and when we are doing that, we are learning stuff. But for a project you just want to get it done and be over with it.
> Kelena: Yes, and for the Spanish project, they expected us to do the research so that when we did the research, we know what to do on *Hyperstudio*. So we just had to research and put it on there. So the computer did not like teach us about our country, we did.
> (8 Focus Group SVMS US)

An extract from the OMSC Aus Focus Group (most of whom had considerable prior content knowledge) discussing their multimedia project also illustrates the point that for this project, the computer acted only as a conduit for information.

> Researcher: How do you think you are learning from *Scala*?
> William: We are not exactly learning from it, we are putting stuff on there; putting our work on there.
> Researcher: Do you think you are learning about your environment and the solar system from using the computer?
> Tim: A bit.
> Researcher: What do you mean a bit?
> Tim: You have to read it through and make sure you've spelt it alright, but you don't really learn that much that you haven't learnt before on space and that.

However, later, students in the same SVMS Focus Group said that adding multimedia elements (images, sound, video) makes tasks more enjoyable and more interesting, which in turn may assist the learning process:

> Michael: I think like pictures and like clips and sounds help us like learn more because its something we can do and like something we can do by actions.
>
> Melanie: Yes because like when you find the information that you would like to write, you just like go to a site and just take that stuff, put it into your own words, and type it in to your stack. But like I think when you've got pictures and stuff or music or videos, you can like remember oh this is what Mexico looks like or this is what kind of music they have. For me just like looking at writing on a page isn't going to make me learn very much.
>
> Kelena: I agree with Melanie and I also think it also depends on what kind of learner you are. If you're one of those learners that you learn better by hearing it would be better if somebody read the book to you. If you're one of those kinaesthetic learners, it would be best if you used the computer or if you're one of the visual learners it would be better if you used the computers. So it all comes down to like what helps you learn the most.

Michael: Like it's said a picture's worth a thousand words. And when you see a picture it kind of sticks in your mind.

Researcher: But with a pictureboard, you find a picture, you cut it out and stick it on?

Michael: But with the National Anthem ... I can sort of remember what the National Anthem is for my country, because you can just press a button and hear it.

Melanie: Like as he said if I heard the National Anthem of Mexico, I used to like not know it, but now I do.

Asami:. I think computers are better because when you read you make a mental picture of the place, but if you have a computer you can make a description of that place.
(8 Focus Group, SVMS US)

The affordances of the computer for presenting and learning information in new and (for some students), easier ways were appreciated:

> Its a good way to learn the information besides just looking in a book and writing a paper (John, SVMS US)
>
> I think its easier to use a computer because like you can do so many things at once on it and like I just find it easier. (Michael, SVMS US)
>
> i like this a lot better than the posters we did last year! (Monika, SVMS US)
>
> Yes I think it was easier to do it like that than if you hadn't done it on the computer. Because you couldn't have all the pictures and that. (Laura, EGGS Aus)
>
> I found web-paging MUCH more effective than hand-writing it all, as it wasn't all jumbled up and was not endless pages of writing. (Frances, EGGS AUS)
>
> I like how we used computer to represent this project unlike just do it in the textbooks. (Shu Oi, EGGS Aus)

However, as throughout the study, students' views differ:

> I think a poster would be easier because you can work on it on any time. (Zehara, SVMS US)
>
> Well what i think that i would rather do this on paper because think it is easier (Elizabeth, SVMS US)
>
> Don't do this project on the computer there are too many technology problems and the way we did it the 1st year was the best. (Katye, SVMS US)

The autonomy afforded by computer use was stressed by this student

> Well computers sort of equals freedom because in [a normal] class before the teachers come in people just chat, sit around and talk maybe do their homework they haven't done. But in the computer room before the teacher comes in we either get on with our work because what we are doing is fun or we either play or do a puzzle or something or go on the Internet. There is so much more opportunity. (Yasemin, EGGS Aus)

What is clear is that these grade 7 and 8 students in the US and Australia generally like using computers. They like working with their peers on computers, and they enjoy the challenge of working with the various multimedia applications, despite often experiencing intense frustration. Moreover, regardless of conceptual acquisition and understanding of content, students acquire other attributes and skills through involvement in these multimedia learning environments: adaptability, flexibility, perseverance, cooperative and collaborative behaviours, problem-solving, personal and group organisational and time management skills. Capturing the experiences and beliefs of these Australian and American students as they undertook learning tasks with multimedia has been the purpose of this chapter. In conjunction with the previous chapter, which has considered the same issues from their teachers' perspective, it is evident that considerable challenges -- both pedagogical and contextual - face educators if they choose to, or are required to, engage young people in learning using technologies. These issues are examined in Chapter 9.

Chapter 9

Teaching and learning with multimedia - summary and conclusions

The previous two chapters have explored the experiences and attitudes of grade seven and eight teachers and students to teaching and learning with multimedia technologies in regular, non-specialist IT classes in two US and two Australian schools. The purpose of this chapter is to place the data in the broader research and theoretical context. The overall aim of the study, using mainly qualitative research methodology, was to examine pedagogical practices of teachers who incorporate some of the newer, more complex multimedia tools (defined here as use of graphics, sound, video, animation and hyperlinking in conjunction with the multimedia affordances of the Internet and World Wide Web) into their teaching programs, and the factors which contribute to, or constrain their effective use. Through a comparative analysis of schools in both countries, each facing similar contexts of expectation and broadly similar patterns of technology use, it was hoped further insights about learning and school use of ICTs might emerge.

Specifically, the study set out to explore

- the characteristics of effective teaching and learning in multimedia-supported learning environments at the grade seven and eight level
- social and cultural contextual factors which support, and/or constrain, teachers in achieving successful outcomes when using these technologies
- what could be learned from a cross-national comparison of practice in schools in which teachers undertake to use these technologies in their curricula within a similar milieu of expectation and rhetoric.

In this final chapter I draw together key ideas and issues emergent from the data in relation to the focussing questions of the study and the theoretical context which underpin it; discuss implications of the findings and offer some overall reflections on the research.

9.1 A brief overview of the school contexts

As Berliner (2002) reminds us, context is of such importance in educational research because of the interactions that abound within them. Thus a brief broad overview of the key contextual factors which frame each school's approach to educational technology is appropriate. (Chapters 5 and 6 provide the detail). In socio-economic terms, the four schools vary considerably. In Australia: a privileged, academic, all girls' private K-12 school, and a state-provided co-educational outer suburban secondary 7-12 college with much more of a mixed ability student cohort. In the US: a regular state 6-8 middle school with a strong academic focus located in a wealthy area, and a small

Catholic P-8 school, also with a strong learning ethic, but situated on the far outskirts of the same dynamic economic region. Despite obvious socio-economic and cultural differences, each school's organisational structure and educational aims reflect their particular national and state and systemic norms. None would be seen to be radically innovative. Each of them, like most schools in the US and Australia at this time, in accordance with expectations, were grappling with issues associated with provision of new technologies within the budgetary, organisational and educational framework of their own contexts. Each school was generally well equipped with computers, mostly located in laboratory configurations, and all had internet connectivity. Interestingly, of the four schools, the one located in the very heart of the birthplace of the digital revolution, had the lowest computer: student ratio and offered the least flexible access to computers outside of the laboratories.

It is within these broad contexts that teachers' use of innovative technologies is examined. Large-scale survey studies in both Australia and the US indicate that use of computers in regular classrooms tends to be mainly for word processing and Internet searching. Relatively few teachers incorporate the more complex multimedia technologies to any significant extent into their curriculum. Thus, in this respect, the teachers in the study could be considered in the vanguard of innovation. However, despite the innovative use of technology, the experiences examined here were grounded in traditional structures and organisation of schooling.

9.2 Motivations for technology use

Reasons for choosing to incorporate new multimedia technologies into classrooms learning tasks varied. Teachers in both US schools were voluntary participants in a federal government technology grant scheme which provided access to extra equipment, some professional training and in-school support, and a stipend for successful completion. At Redwoods Catholic School, the administration had been proactive for many years encouraging grade teachers to integrate technology into their curriculum. Not widely available for private schools, participation in the Challenge 2000 grant was viewed as a good opportunity to further develop the school's technology focus. Silicon Valley Middle School was one of a cohort of local district schools chosen to participate in the grant. Despite the incentives offered by the grant, the participating teachers in this study were also keen users of technology not only for their personal needs, but also saw value in student use for learning. In both of these schools the classroom teachers and support staff characterised their students as 'digital age kids'. Not only because they happen to live in Silicon Valley, but also because they saw their students 'switched on' by technology and wanted to exploit this interest for learning purposes.

In the Australian schools, reasons for choosing to integrate technology into pedagogical practice were more disparate. At Outer Melbourne Secondary College, the use of multimedia technologies was tied to another curriculum innovation – the development of integrated units at the grade seven level. Taking advantage of a state government innovations grant, which provided some time for professional development and planning, the school administration saw the opportunity to develop their learning technology program, which to date had little impact outside of specialist classes. Participant teachers had been asked to join the team of four, but only one, the Head of IT, played any role in developing the successful grant proposal. In the main this was handled by the school administration. The classroom teachers thus were required to design new interdisciplinary units of work integrating new complex technologies with which all teachers, except one, were unfamiliar. The Australian independent school, Eastern Girls' Grammar School, on the other hand, had an established technology program for their entire grade seven and eight students developed collaboratively with participating teachers over a number of years. For them, incorporating newer technologies into their existing programs, seemed a natural progression. In addition, Australian independent schools, such as this one, face an educated, informed and competitive market, and recognise that provision of educational technologies is often a key factor in parental school choice.

Despite different motivations, all participating teachers' believed to some extent that educational technologies can have value for student learning. Even the three teachers at OMSC in Australia, who had the most unsatisfactory experiences with them in this first year, acknowledged this (see 7.5).

9.3 The constructivist paradigm, multimedia technologies, and pedagogical practices

The umbrella of constructivism was chosen as the lens through which to examine teaching and learning with new technologies in each of the schools. The learning tasks devised by teachers reflect the type of tasks broadly characteristic of a constructivist teaching paradigm (see 2.5). Design of the technology-infused learning tasks were similar: presented with a research task (using a range of sources including the World Wide Web) and/or personal investigation (based on artefacts, fieldwork and personal contacts), students were required to construct representations of their findings in multimedia format. Software students could use included: word processing, presentation software (*PowerPoint*, *Scala*, *Hyperstudio*), and webpage authoring programs, (Netscape *Composer* and Adobe *Page Mill*). In addition, depending on the school and task, students also used scanners, digital and video cameras, image manipulation and animation software, and sound input devices. These tools cover a range of items included in Bruce and Levin's Taxonomy of Educational Media (3.10.1) and all of these tools have the potential to be 'mindtools' as characterised by Jonassen (see 3.10.2). The Internet allowed students to access information in a range of engaging multi-modal forms not possible using more traditional sources. Students actively enjoyed representing information, new understandings, and different perspectives in the multi-modal ways reflective of the media surrounding them in their daily lives outside of school. Some took pride in producing creative, engaging learning products which had the potential to be viewed by a broader audience other than their own class. In addition, use of the tools did facilitate collaborative learning, shared problem-solving and learning of cross-over generic skills such as project planning and time management.

However, as Jonassen argues, and as this study supports, digital tools such as those used here, do not become mindtools, unless intentionally used to support learning. From observing how students used the tools for instructional tasks, examination of student comments and reflections on learning, and discussing their use with students and teachers it is apparent that the extent to which student use of the Internet and multimedia could be described as supporting learning varied across the schools (Chapters 7 and 8). Expensive, time-consuming digitals tools, however engaging, used for merely gathering and presentation of information (without any reconstruction, interpretation, analysis or evaluation) as was the case with the projects at SVMS, US and OMSC, Aus, would not qualify as intentional use to support learning. Indeed, the term 'power pointlessness' (McKenzie, 2001) seems an apt description. The question could also well be asked whether this type of skill acquisition represents the digital literacy for the 21st century student sought by the purveyors of the rhetoric.

Teachers and students were most positive about the outcomes of their efforts when there was a clear alignment between the technology use and significant subject matter and cognitive skill acquisition, and where they were satisfied that the focus of the learning tasks was not compromised by the time given over to technology use or ruined by technical difficulties. These positive outcomes were found at Redwoods Catholic School, US and at Eastern Girls' Grammar School in Australia. Even where adequate technology provision is present and/or few technical problems experienced, without options for more complex thinking embedded alongside the use of the tools in the instructional design of these types of projects, it is fair to question their value. As this study also shows, activities which relate meaningfully to wider, authentic social practices are more likely to contribute to effective learning. A factor also noted by Lankshear & Snyder (2000).

The study thus poses several challenges for teachers and educational providers. All teachers recognised that students at these grade levels were highly motivated to construct learning products with digital tools and acknowledge other positive learning behaviours when students use the tools. Even the teachers at OMSC in Australia who were most dissatisfied with the outcomes, due to a range of factors, acknowledged that they could see benefits for student learning. However, where other well documented barriers to teacher take-up prevail (see 3.5), the exploration of learning benefits, underpinned by quality pedagogy, is extremely difficult. This seems to be especially the case if the innovation is to move outside of the domain of one or two teachers and be available to the broad cohort of students within a school.

Analysis of the experiences and beliefs (both positive and negative) of the Australian and American teachers and students that took part in the study enabled development of some shared understanding about the pedagogy that supports effective teaching and learning with multimedia tools at these grade levels. Teachers' and students' experiences and attitudes presented in the previous chapters, offer the following suggestions about effective pedagogical practice using multimedia tools.

Students in the middle years of schooling

- value learning tasks which are cognitively challenging, interesting, and reflective of 'real world' situations
- benefit from doing research and acquiring information and ideas in a range of ways and using a range of sources
- very much enjoy constructing learning products with multimedia tools
- will put up with considerable technical difficulties in the process of constructing multimedia products
- benefit from flexible classroom arrangements which allow them to share technical expertise, and to problem solve and troubleshoot technical difficulties
- require guidelines, checklists and timelines to scaffold, manage, monitor and evaluate learning tasks

When designing multimedia-infused curriculum teachers should consider

a) Instructional tasks which

- require students to transform information and ideas from the research to the multimedia construction phase, thereby avoiding 'cut and paste' tasks
- require students to draw on, and share, prior knowledge and skills
- scaffold or structure learning tasks, especially where new skills and knowledge are being acquired
- require students to structure their ideas prior to the multimedia construction phase through use of plans and storyboards
- encourage students to refer to and modify their plans during a project as necessary
- require students to monitor their own progress with checklists and timelines
- allow for the considerable benefits for student learning afforded by group work/distributed cognition

- allow for extension activities which cater for different skills and pace at which students work
- recognise that using multimedia tools for extended, shared projects can foster other transferable skills: time and project management, effective team work; problem-solving; flexibility and adaptability
- require students to reflect on what, and how, they have learned using multimedia tools

b) Technology Instruction which

- recognises, accepts and takes advantage of the fact that students will generally be more familiar and comfortable with technology than they are
- encourages sharing of the collective technical expertise of students: use of hardware, software, file management; use of scanners, cameras and sound equipment, etc.
- formally teaches (or arranges for students to be taught) only those technical skills new to the majority
- avoids 'experts' dominating, so all students have the opportunity to master new technology skills
- teaches students effective searching strategies, critical evaluation of sources and appropriate attribution of materials of any text, graphics and sounds downloaded if the World Wide Web is used for information gathering and as the source for images and sound

c) Classroom Management which

- establishes clear guidelines and expectations for student use of school-provided technologies: hardware, software and Internet facilities
- allows for the extra time needed when using multimedia tools, especially in situations where technology is unreliable
- encourages self or shared technical trouble-shooting before requesting assistance from a teacher or available technical support

d) Forms of Assessment which

- allow for on-going monitoring of student learning, including monitoring of plans, storyboards, and progress checklists to help keep students on task
- give timely feedback (informal and formal) to students about their progress and learning outcomes

These teaching and learning approaches reflect a pragmatic mix of instructionist and constructivist strategies and refer to both instructional design and technology integration, and the ways that this can be fostered in the social milieu of the classroom. These suggestions, drawn from the collective experience of teachers and students in the study, provide not only some shared understanding about appropriate pedagogy, but also demonstrate just how complex pedagogical practice can be in these types of multimedia-infused learning environments regardless of country or school setting. Successful integration of multimedia tools and the Internet into learning tasks seems to require that teachers adopt a scaffolded, student-focused pedagogy and a preparedness to be highly flexible and adaptable.

But as this study also clearly shows, the teachers who experienced the most success and satisfaction teaching with multimedia in their regular class or discipline, had a range of supportive structures and contextual features working in their favour. Unlike the teachers at OMSC, Australia, teachers in the three other schools benefited from a convergence of favourable (but not identical) contextual factors as they incorporated digital tools into their pedagogical practice. These factors are analysed and discussed in the next section.

9.4 School-based contextual factors influencing integration of multimedia technologies

Given a significant mix of in-school contextual factors, this study shows that teachers are not only prepared to experiment and persevere with using multimedia in their pedagogical repertoire, they also believe that use of these tools has value for student learning. Further, successful use of technology in a school is also more likely to move out of the realm of an individual classroom and the committed, enthusiastic teacher, and be available for all students in a school, where these factors are embedded in the culture and ecology of the school. Recurring patterns (either by their presence or absence) in each of the schools identified the following factors as significant in judging whether use of multimedia technologies is likely to be successful:

- school leadership and vision: words and action in support of using technology for learning
- flexible school organisational structure; either at the whole school level (e.g. elementary model) or flexible structures at the grade level
- reliable and sufficient provision and access - to computers and the Internet
- provision of technology instruction matched to teachers' needs
- professional support for teachers to integrate content areas with multimedia technologies
- provision of time for staff to develop, design and evaluate instruction materials for multimedia environments
- in - class, anytime access to technical support for staff and students
- ease of use of multimedia software and tools

- sustained professional collegial dialogue amongst teachers who pursue a more constructivist approach to teaching

Table 20 below indicates the extent (high, medium and low) to which these factors were identified in each of the schools in the study:

Table 20
School contextual factors related to effective use of multimedia technologies

	RCS US	SVMS US	OMSC Aus	EGGS Aus
Leadership vision: words and action				
School model and/or flexible structures				
Reliable and sufficient provision and access - to computers and the Internet				
In-class, anytime access to technical support				
Multimedia software and tools - ease of use				
Appropriate technology instruction available for teachers				
Time provision for curriculum design, development and evaluation				
Professional support for teachers to integrate content areas with multimedia technologies				
On-going, in-school professional collegial dialogue				

High Medium Low

Table 20 shows different patterns in the ways in which contextual factors affected teachers' pedagogical practices when using multimedia in each of the schools of the study. Overall, the schools whose students and teachers experienced more success and satisfaction using multimedia for learning tasks were also the schools with higher levels of the important contextual indicators in place.

The two schools considered most successful – RCS, US and EGGS, Aus – although not sharing the same pattern of experience, have more factors in place at a high level. The only lower rating factor for each of them was for time provision for staff planning. RCS, US, with its elementary school organisational structure and overt support and encouragement from the Principal and Deputy Principal for learning with technology, had the most contextual factors that scored highly. It is worth noting those factors on which both of these schools scored highly: reliable and sufficient provision and access to computers and the Internet; in-class anytime accessible technical support; and appropriate technology instruction, and professional support for teachers in integrating multimedia technologies into their content areas. It appears that these factors enabled effective use of technology to penetrate more pervasively into the deep structure of teaching and learning at these schools compared to the other two schools. It could be argued that without considerable attention to these factors by education decision-makers, there is little likelihood of classroom/subject teachers successfully integrating the more complex technologies routinely into school curricula.

At OMSC, Aus, where levels of teacher and student frustration were high and where teachers expressed ambivalence about using technology, few of the important contextual factors were in place to any great extent. Similarly, without the extensive technical support received by the SVMS, US teacher and the technology instruction she received as part of her Challenge 2000 grant – both these factors scored highly – one wonders if she would have been such an enthusiastic proponent of technology use in her Spanish classes.

Even if well served with technology, lack of time was the major issue of concern for teachers in all schools. They report that there is simply insufficient time available in the regular school day for learning and upgrading the necessary hardware and software skills, and for designing and evaluating curriculum which integrates complex technologies. This factor has been repeatedly found in similar studies (see 3.5). Even at OMSC in Australia, where grant money did provide time release for planning, the teachers chose not to use it to its full extent and preferred to meet after school. The extra workload was not deemed worth it. Thus, in all schools, planning took pace at lunchtimes, after school or where teachers' preparation times happened to coincide. None of the schools has resolved the issue of time satisfactorily. Even in the schools with considerable forms of support, teachers bemoaned the lack of time to develop their professional skills.

Barriers to take-up of technology for pedagogical purposes have been repeatedly and consistently reported in studies over the last 20 years (see 3.5 and 3.6). These constraints include: insufficient access to computers; unreliability of technology; inappropriate software; insufficient and inappropriate professional development; lack of time for teachers to learn to use technology and to construct instructional tasks; restrictive school organisational factors, to name just a few. In addition, Larry Cuban (Cuban, 1986, 2001) has persistently argued that use of technology is generally incompatible with the conditions and organisation of schooling: teachers pick and choose among the new technologies which they can adapt most easily to traditional practices, and will continue to resist widespread use of technology in their classrooms when this is not the case.

Similar experiences and attitudes to those referred to by Cuban can be found to varying degrees in each of the schools in this study. Frustration with the vagaries of technology, the problematic software, the lack of available assistance to deal with these problems, were significant in shaping the dissatisfaction experienced by three of the OMSC staff and their view that they would rather be teaching in other ways. These problems were either not such a concern in the other schools, were more satisfactorily resolved, or other counterbalancing supportive contextual factors were in place, thus allowing teachers to feel success and be willing to adapt their teaching practices. The time consumed by multimedia projects and the subsequent pressure this placed on curriculum planning and delivery were mentioned by all schools. However, for RCS US, the elementary model school, this was not such a concern. Compared with the other schools, RCS's more flexible structure and access to classroom, laboratory and computers elsewhere in the school allowed the teacher to readily adapt her teaching style to using computers.

The study shows that successful outcomes for teachers choosing to use multimedia, depends to a large extent on contextual factors operating in each school. Many of these factors are outside the control of the classroom teacher, the one primarily responsible for guiding student learning.

9.5 Teachers' professional orientation and participation in communities of practice

Ways teachers can learn to develop pedagogical practice with multimedia tools are also highlighted in this study. Qualitative data from the schools lends some support both to the Becker (1999) survey findings which describe the professional orientation of teachers who require their students to use more complex technologies, and to Wenger's (1998) notion of 'communities of practice' and the way these operate in organisations. Becker et al (Becker & Reil., 1999; Becker, 2000; Ravitz, Becker, & Wong, 2000) identified the characteristics of teachers who provide opportunities for their students to use a range of software (particularly presentation software, multimedia authoring software, and electronic mail) as those who tend to hold constructivist pedagogical beliefs, and are the most professionally engaged of all teachers. The Becker study characterises professionally engaged teachers as those who have frequent substantive conversation and classroom observation with peers, frequently participate on committees, mentoring and giving workshops (see 3.6). Certainly, the teachers in each of the four schools could all be described as sharing constructivist pedagogical beliefs, as evidenced by their instructional tasks and teaching style. Further, Becker's findings on professional engagement are also supported to some extent. Of the four schools examined in this study, teachers at EGGS, in Australia provided the most striking example of

Becker's contention that teachers who teach with the more advanced technologies are more likely to have a professional orientation towards working with peers.

Similarly, Wenger's notion of 'communities of practice' where shared meaning (in this case about pedagogical practice with technology) is jointly negotiated through participation and reification (see 2.7) is evident in all schools to some extent, but is best illustrated at EGGS in Australia. At this school, frequent and substantial pedagogical conversation occurred among all classroom and support teachers involved in delivering curriculum with multimedia technologies. Through substantive professional dialogue and negotiation covering issues such as how to structure, deliver and evaluate learning tasks that align multimedia affordances to subject disciplines, how to teach technical skills, how to troubleshoot problems, how to develop student autonomy, was commonplace and highly valued. Discussions of this type occurred in scheduled meetings (usually held in lunchtimes or after school), team teaching in classrooms and laboratories, teaching of new technology skills among themselves, mutual classroom observations, and in informal meetings and conversations. This practitioner culture thus fostered both teacher's skill learning and a shared pedagogical understanding of teaching with technology.

At the other Australian school, OMSC, we see evidence of a temporary and fragile community of practice. The nature of the funded grade seven integrated multimedia project allowed for the four teachers (representing different subject areas), to meet to discuss and plan. Cross-faculty meetings of this type, focusing on the overall learning needs of students, were generally considered rare at this school. In this case, both the Curriculum Coordinator and the teachers involved, commented that one of the benefits of the funded innovation was that it made possible shared professional dialogue even though meetings were mainly held after school and deemed insufficient for their needs. Given the considerable contextual difficulties experienced, and that regular shared pedagogical discussion among staff was not a feature of this school's ecology, one wonders to what extent the innovative use of multimedia would be sustained beyond the funding period.

In the US schools, funding facilitated in-school professional discussion and dialogue to some extent. The Challenge 2000 grants to RCS and SVMS provided Technology Learning Coordinator positions to support classroom teachers as they designed and implemented multimedia learning tasks, and certainly the sharing of skills, ideas and practices occurred between those involved. However, even though it was an expectation that funded classroom teachers would in turn share and collaborate with other teachers about their use of technology, little evidence of this was observed at either school. Substantive, ongoing professional dialogue, and joint negotiation and planning by classroom teachers for school-wide technology use were not features of these schools as it was at EGGS in Australia. Technology discussions were more confined to items on scheduled staff meetings or one-on-one discussions between the support staff and the teacher. However, the overt expectations and support for classroom teachers from senior administration and other favourable contextual features at RCS suggest that this school had a much higher chance of pursuing sustained technology integration, than SVMS, when the funding ceased in 2000.

9.6 Reflections on the research

Before presenting the conclusions, I offer some reflections on my personal journey through the research process using the opportunity to discuss the limitations of the study, particular challenges faced and suggestions for further research.

The initial idea for the focus of the study came from two sources: my own efforts, as an early adopter of technology in my own classroom practice and as a school administrator, with responsibility for curriculum, attempting to encourage and support others to do the same. Early on, both in my Indonesian language classes and my History classes, I was encouraged by the opportunities I saw for student learning with computers. For example, in the language class, the ability to draft, edit, and rewrite seemed to improve not only the quality of students' work, but their willingness to persevere. In History classes, access to on-line global materials seemed to have enormous potential, but even in 1996, the issues of overwhelming quantity and verification of authenticity were apparent. In my administrator role I was part of, and sometimes responsible for, committees to consider all manner of issues relating to the school provision and use of technology. When the opportunity to undertake research in both California and Australia presented itself, I had several choices to make among the many epistemological frameworks and methodologies available. The decision I made for a comparative study using qualitative methodology, focusing on the issue of technology use and the contexts which govern effective use, for me, seemed the best way I could make sense of, and reflect on, my own professional experience, and to develop and learn from the ideas and experiences of others. At the same time, I was also very conscious of the fact that one of the participating schools was where I had worked and where my thinking was initially framed. It was always going to be difficult to ensure that my greater knowledge of this environment and personal relationships with staff would not unduly colour the research. Moreover, of the four schools chosen for the study, I was conscious of the fact that EGGS was the most privileged in a socio-economic sense and needs consideration as a variable accounting for difference.

During the course of the study, other avenues of inquiry, just as interesting, suggested themselves, and would have been possible to pursue, given the nature of the data and the schools from which they were collected. With six all girls' classes and one all boys class in Australia and the six co-educational classes in the US, some analysis through a gender lens might have proved interesting.

For example, What strategies do girls and boys adopt when constructing learning products with multimedia tools? How do they each go about solving technical problems relating to software and hardware? How do they collaborate in a digital environment? Do girls who use digital tools routinely in non-specialist classes move more comfortably into specialist classes and then into technology careers, normally a male province? A discourse analysis of the ways young people in these two countries talk about using technology and using technology for learning would also be of interest. The data also suggest an exploration of the issue of global isomorphism in K-12 school provision and the use of educational technologies and the implications this may have for constricting educational diversity and promoting conformity.

However, as interesting as those avenues seemed, I decided to concentrate on the work of the teachers and how they operated in complex new environments. The close involvement with these middle school teachers and their early adolescent students on two continents over the course of the study continually served to deepen my respect for teachers' work. Regardless of country, so much is expected of teachers: from governments, the corporate world, local communities, school administrators, parents, and not the least from those whom they teach. For teachers, keeping pace with rapid technological change is daunting enough, let alone devising challenging, relevant learning tasks for young people whose ease and facility with digital tools is generally far greater than theirs. It is a truism, but deserves repeating, good teachers are the essence of good schools wherever they are. Examining their stories was the core of the project.

An anecdote serves to confirm the research choices I made. During my years as a school-based educator, I learned to value highly the need to share, evaluate and reflect on practice and would use every opportunity to participate in such discourse. In Australia, the Program for Enhancing Effective Learning (PEEL), which fosters and supports teachers in their own school settings to share understandings about effective teaching and learning is one model of a 'community of practice' that has operated successfully in some Victorian schools over the last fifteen years. This model also operated in the school where I had previously taught. While in California, I participated in another such learning community. The Project Director of the Challenge 2000 grant invited me to attend the regular monthly meetings of the Technology Learning Coordinators (TLCs) funded by the project to provide in-school support to teachers. These meetings were held in different interesting locations throughout Silicon Valley. Once the administrative details had been attended to, the focus of these meetings turned to reports from the schools and reports from the research/evaluators. But of particular interest to me, was the substantive conversation amongst the TLCs about teaching and learning with technology. I was constantly impressed by the nature and value of these meetings. However, at the same time, my inclination was always to say (in my notes) that it is just this type of discussion that needs to happen on a regular basis in schools between the teacher practitioners. One of these TLC meetings was held at the Institute for Research on Learning – the same place where Wenger (and Lave) developed their social theory of learning. I didn't make the connection, however, until much later, after I returned home to Australia and read *Communities of Practice*. The parallels between my earlier school experiences and the research I carried out in both countries, resonated loudly.

Despite considerable challenges in attempting a qualitative, cross-national study as the sole researcher, the study was largely successful I suggest, both in the execution of the methodological design and in eliciting sufficient data to draw some valid and reliable conclusions. The symbolic intertactionist stance enabled exploration and representation of the multiple realities experienced by teachers and students in these of classrooms which survey statistics and reports just cannot provide. I was able to establish a level of comparability, with data in consistent format, from two countries and four schools, where students were undertaking similar projects and using similar technologies. Although there was some imbalance in data collection across the schools (see 4.2), the multiple sources of data provided for, did enable me to produce a contextualised narrative and analysis of the situation in each of the schools.

Issues related to data gathering across time and space using on-line tools and the affordances of data management and analysis with software were raised and discussed earlier (see 4.2). Here I make some further comments. The sheer quantity of data amassed, and how to manage it and learn from it efficiently and effectively, was a significant challenge. Use of the NVIVO, qualitative data analysis software assisted that process considerably (see 4.3.1). However, issues of sorting, categorisation and interpretation from the rich collection of open-ended responses, conversations, observations, reflections, still remained. Sorting and coding data in electronic form can be just as messy as a manual process with paper, scissors and folders. Making sense of the complexity was hard, painstaking work; and there were no unequivocal procedural rules for doing it. Initially, it was a matter of trial and error, trying to keep the focusing questions and theoretical perspective clearly to the fore and being flexible and 'adaptive to surprise and discovery' (Richards, 2000). The intensely lonely and desperate feelings of a novice researcher drowning in a sea of digital data, did gradually (and happily) change as I grew in confidence and as I was able to discern consistent patterns and themes. This was helped by regularly returning to read and re-read the data, memos and observation notes (even in their scrawly handwritten form) and consciously stepping aside from the electronic coding process to get the overall perspective.

One of the more interesting outcomes of the methodology chosen was the fact that the qualitative and quantitative data were often complementary, intertwined and informing each other, allowing for a more complex story to emerge. This was evident when qualitative data at the school level provided situated meaning to the large-scale national surveys. Similarly, close analysis of the range of open-ended responses alongside data from scaled items on the Student Questionnaire revealed unexpected nuances, not otherwise so easily detected.

To extend the present study's findings, further research might include school-based research closely examining examples of communities of practice, where the focus is exemplary pedagogical practice with educational technologies. There is a need, I suggest, for more research which captures, analyses and reports in a timely way the reflective dialogue and the pedagogical discourse of teams of teachers as together they design and evaluate learning tasks and strategies using technologies. Teachers are often too busy to take on the full burden of action research themselves, but could well appreciate the informed outsider assisting the process and collaborating in the reflexive process. In support of this view, Howard Gardner (2002) argues that there is a need to recognise that much of the most valuable work in improving education has taken place in schools and systems that engage in reflective practice and urges: 'Take serious steps to encourage such work and, when possible, support it by timely regulations and infusion of funds'.

9.7 Conclusions

This study in four schools in two countries affirms Cuban's (2001) contention that teachers' limited and infrequent use of new technologies is largely explained by different contextual constraints in the ecology of the school. Where there is a favourable set of factors operating in a school, this study shows teachers will take the risk to explore and continue the use of multimedia technologies, especially where they see there are benefits for student learning. Becker and colleagues' (1998) findings about the characteristics of teachers who use new technologies are also supported. The teachers in this study did share a similar student-centred pedagogical orientation. Further, where the school ecology offered appropriate supports, a strong community of practice focused on collaboratively developing effective pedagogical practice for multimedia-supported learning tasks, was evident. The findings suggest that school and education providers should consider ways in which to foster and support communities of practice, drawing on the expertise of those with a professional orientation and who may already be users of more complex technologies. If a school's technology budget and organisational structures continue to ignore the needs for in-school learning of teachers, the promise of new technologies to support new ways of student learning will go unmet

This study demonstrates a remarkable number of similarities across the two continents and among the four participating schools: the strident rhetoric from government and business sources about the need to prepare young people for the 21st century; the types of hardware and software used in classrooms; the ways in which students talk about using technology; the approaches to pedagogy; and the frustrations experienced by teachers as they strive to meet the demands on them. Teachers' work in both countries in these years surrounding the turn of the century has been laced with a technological determinism promoted by governments for ideological and political reasons, and stimulated by large technology companies with a global reach, for commercial reasons. In this milieu, teachers have struggled to adapt their teaching practices with technology in accordance with business, government and community expectations. For the most part, appropriation of new technologies for curriculum use in schools has taken the line of least resistance: to do what is most practical; what will interfere least with the day-to-day business (and busyness) of modern schooling. Reliable, robust, technical infrastructure, high levels of access and timely support to handle technical problems - considered essential for commercial institutions - are hard to find in schools, even the best resourced. More importantly, even where school infrastructure is sound, it is rare to find technology provision aligned with the needs of the school as a learning institution whose students are already equipped with the *savoir faire* of the digital age. School provision for on-going professional learning and discourse about the core business of the school, teaching and learning, is also hard to find, let alone for teaching and learning with new technologies. It is not surprising then that word processing and use of the Internet as an information gathering tool have become the dominant student uses of technology in schools. The use of these technologies for extending cognitive development is rarely evident.

Is this the outcome envisioned by governments and corporations? Is this what educated communities imagined? The practice of using digital tools as 'mindtools' to challenge and transform ways of learning, the vision of the most optimistic educators, is apparent in the repertoire of very few teachers. Even in the schools in this study, where teachers have experimented with more complex and more time-consuming multimedia technologies, technologies which obviously engage their students, the cognitive challenge embedded in the learning tasks could hardly be considered transformative.

So what is the solution? The findings from this study indicate that if schools in Australia and the United States are to extend challenging learning opportunities with technology to all students, not just a few with an enthusiast teacher, they must be committed to far more support for teachers. This support must include recognition that professional teachers, the ones expected to nurture students' learning, need learning time of their own: time to learn new skills and time to explore, design, implement and evaluate together appropriate pedagogical practices with technology. Embedding technology skills in curriculum and standards frameworks and school charters in efforts to meet the demands of the rhetoric, without extensive concomitant appropriate support for the teacher practitioners at the school level, is a course destined for failure.

Appendices

Appendix A

Classroom Observation

School: ______________________ Date of observation: __________

Classroom Teacher ID ____________ Class ____ Subject ___________________

No: of students _____ Type of learning environment ________________________

Computers per student: ______

Support available:

A. Observed activities

Brief narrative description

Activity 1

Activity 2

Activity 3

Observation/Activity

Is this activity part of a long term project?	Yes/No	Yes/No	Yes/No

Activity Structure

	Observation/Activity		
	Activity 1	Activity 2	Activity 3
C1 Teacher led			
C2 Teacher facilitator			
C3 Independent work			
C4 Small group coop			
C5 Small group coll			
C6 Student directed			
C7 Pair coop			
C1 Pair collab			
C8 Competitive			
C9 Rotating stations			

Appendix A

Teacher Role

	Activity 1	Activity 2	Activity 3
Explain/clarify/provide info/demonstrate			
Question (known answer)			
Question (open-ended)			
Assist or help (teacher-initiated)			
Assist or help (student initiated)			
Encourage independent problem-solving			
Manage/monitor organisation of task			

Discourse Structure

	Activity 1	Activity 2	Activity 3
(known answer questions; short response required)			
(known answer questions; long response required)			
Teacher facilitated discussion			
Student facilitated discussion			
Presentation/sequence of teacher monologues			
Presentation/sequence of student monologues			

Student Learning Activities

	Activity 1		Activity 2		Activity 3	
Listen						
Watch						
Copy						
Practice						
Complete worksheets						
Read						
Search						
Select						
Take notes						
Organise information						
Summarize						
Experiment						
Decide topic/structure of project/representation						
Create/construct representations						
Question						
Discuss - class						

Discuss – coop/collab						
Analyse						
Synthesise						
Problem solve						
Think critically						
Evaluate						
Reflect						

Major instructional resources used in this activity

	Observation/Activity		
	Activity 1	Activity 2	Activity 3
Learning/Research Tools			
Worksheets			
Classnotes			
Models			
Visuals			
Newspapers			
TV/Video			
CD ROMs			
Internet			
Email			
Interviews			
Hardware			
Computers			
Zip drive			
CD Rom writers			
Scanner			
Digital still cameras			
Digital video cameras			
Sound recorder			
printers			
Overhead projector			
Data projector			
Software			
Text			
Drawing			
Clip Art			
Photo editing			
Graphing			
Multimedia presentation			
Web Page construction			

Technology issues

	Observation/Activity		
	Activity 1	Activity 2	Activity 3
Hardware			
Software			

Other Comments

11 Jan. 00 8'5 [illegible]

Students came in quickly

1 fs checks hotmail

1 ms checks Excite – for [illegible]

MFB – arrives to teach Ss as a group webpage making.
Holding dev. of web until new aspect is taught.
T wants all Ss to know + herself.
1 S. per computer

MFB
– has loaded media files on to SJV server.
Ss asked to copy to desktop + all Ss do this w. a little help from neighbours if necessary.
Ss asked to go to Netscape Communicator/Composer.
MFB uses accurate description of all terms.
dialogue box; tool bar; icons etc.
No Ss had ever used Composer – all do as asked
Ss asked to explore each icon.
S. asks a Q. – able to answer herself.
MFB – constantly talks through what she is doing.

We will create a 'silly ~~image~~ web page & throw it away – in this way we will all learn'
1 Student models while MFB teaches
1. Insert image. from media files on desktop for Background
2. Insert Banner – and aligns
(T. helps 1 S who is having difficulty) would have been better asking another S.
Reviews procedure orally

Teacher on-line reflection

Teacher Reflection

Please complete this reflection and submit it to Olivia Clarke. Your time is **very** much appreciated

---

First name [ ] **Password** [ ] **Date of lesson** [ ]

School Australia School 1 **Subject** [ ]

Year Level 6 **Class** [ ]

What I aimed to do in this lesson:

[ ]

To what extent did you feel satisfied with the outcomes?

(•) extremely satisfied ( ) very satisfied ( ) satisfied ( ) somewhat satisfied ( ) not satisfied

What successes occurred in this lesson for you and/or your students?

[ ]

What frustrations/constraints/disappointments did you and/or your students experience in this lesson?

[ ]

Submit reflection

Thank-you for your time!

Sample of an On-line Teacher Reflection

Name: Nola
Lesson date: 19.8.99
School: EGGS, Aus
Subject: Geography

Class: 7D

Lesson aim: To work further towards the production of cemetery and market graphs following the excursion to these locations. You will hear a tape recording of F, Jennifer and my conversations about the set up for the making of the 5 web pages. The process has started and I feel much more positive this year than last. There is a very real structure to follow. Help has been provided for F so that his groups will be able to do all that mine should. In addition he is quite supportive of what we are doing. Things will change I know as the group begins to fan out and the lost disk syndrome appears.

Satisfaction: very satisfied

Successes: The highlight is the flexibility being shown by Year 7 students in using Excel. WE are learning to colour code columns, sort in descending order and make a legend independent of chart wizard. The class is well focussed and are producing some good graphs.

Problems: That I learned how to sort in descending order after this lesson. Sue showed me what they did in her other Year 7 class. It could be that the extra time spent in creating these graphs may have repercussions on time down the track. However to be able to manipulate a graphing package is a most useful skill.

Student On-line Questionnaire

Student Questionnaire

Please complete the following form and submit it to Olivia Clarke. Your time is **very** much appreciated

First name ______ **Password** ______ **Date** ______

School Australia School 1 **Year Level** 6 **Subject** ______

Project Title - *write title of your project*

______

Description of the Project - *briefly describe what you aimed to do in your project*

______

For this project I was expected to work

(•) individually ( ) in a group ( ) both individually and in a group

Research

In researching this project, I used: *(tick all that you used)*

[ ] Books [ ] Newspapers [ ] Magazines Journals

[ ] TV Video [ ] CD ROMs [ ] Internet [ ] Email

[ ] Class notes [ ] Personal contacts interviews

[ ] Other *(please list)* ______

Indicate how useful the research items were for your project

Books (•) very useful ( ) useful ( ) not useful ( ) did not use

Newspapers (•) very useful ( ) useful ( ) not useful ( ) did not use

Magazines/Journals (•) very useful ( ) useful ( ) not useful ( ) did not use

TV/Video (•) very useful ( ) useful ( ) not useful ( ) did not use

CD ROMs (•) very useful ( ) useful ( ) not useful ( ) did not use

Internet (•) very useful ( ) useful ( ) not useful ( ) did not use

Email (•) very useful ( ) useful ( ) not useful ( ) did not use

Classnotes (•) very useful ( ) useful ( ) not useful ( ) did not use

Personal contacts/interviews (•) very useful ( ) useful ( ) not useful ( ) did not use

Other ( ) very useful ( ) useful ( ) not useful (•) did not use

For those items you marked **useful** or **very useful**, explain your reasons in a few words

For those items you marked **not useful** explain your reasons in a few words

Use of technology and multimedia tools

For this project I used: *(tick all that you used)*

- PC desk top computer
- Mac desk top computer
- PC laptop computer
- Mac laptop computer
- zip disk
- scanner
- digital still camera
- digital video camera
- sound recorder
- printer
- overhead projector
- data projector
- other *(please list)*

How confident did you feel using the:

PC desk top computer	very confident	confident	not confident	did not use
Mac desk top computer	very confident	confident	not confident	did not use
PC laptop computer	very confident	confident	not confident	did not use
Mac laptop computer	very confident	confident	not confident	did not use
scanner	very confident	confident	not confident	did not use
digital still camera	very confident	confident	not confident	did not use
digital video camera	very confident	confident	not confident	did not use
sound recorder	very confident	confident	not confident	did not use
printer	very confident	confident	not confident	did not use
overhead projector	very confident	confident	not confident	did not use
data projector	very confident	confident	not confident	did not use
other	very confident	confident	not confident	did not use

To make my multimedia project I included: *(tick all that you included)*

- text
- tables
- drawings
- graphs
- photos
- clip art
- sound
- video
- animation
- interactive elements (eg buttons, links)
- frames
- Other

The programs I used to make my multimedia project included: *(tick all that you used)*

- Microsoft Word
- Power Point
- a web page authoring program
- Hypercard
- Hyperstudio
- Macromedia Director
- Adobe Photoshop
- Other

Explain any difficulties you had using the technology and/or the programs

If you did have difficulties, who did you ask for help?

Reflecting on your learning

List 3 important and/or interesting things you learned doing this project

1.

2.

3.

How well do you think you now understand the topic you studied for this project?

- extremely well
- very well
- well
- not very well

How satisfied are you with your finished project?

- extremely satisfied
- very satisfied
- satisfied
- somewhat satisfied
- not satisfied

If you worked in a group, how effectively did you work together?

- extremely effectively
- very effectively
- effectively
- somewhat effectively
- not effectively
- did not work in a group

In a few words explain what you liked, and/or did not like about doing this project.

What advice would you give to students and teachers about this project for next year.

Submit questionnaire

Thank-you very much for your time!Bottom of Form

Student Self-Evaluation, EGGS Aus - sample

Year 7 Evaluation - Laura 7A.
(Students rated themselves on a scale of 1 – 5)

Computer systems. 5

I am very confident in doing these thing I did this in Junior School.

Graphics 3

I was not confident at the start of the year but I learnt a lot but I'm not very sure about everything yet

Word Processing 4

I know how to do most of these things but I am still unclear on some things. Like redrafting and style formatting. But I did the other things in Junior School.

Spreadsheeting 4

I did this at the start of the year for maths, so I know most of it.

Multimedia 4

I am OK with both things because of learning most things in English and Computer.

File Management 4

I am pretty organised, but I don't normally keep back-up on student folder

I really like using computers they are very helpful. I enjoy creating pictures (drawing) and creating web pages. Mostly graphics I need to improve on. I don't like it when my things wont work.

Extract from an interview

Extract from an interview between the researcher and Annette, a teacher OMSC, Australia

R: So reflecting on how you came into the project and how you feel about it now. Did you put your hand up for this or were you suggested or coerced or did you choose to do it?

A: No I was asked to do it. And I agreed to do it. I'm sort of interested in , because of my ESL background and my interest in other areas of the curriculum anyway, it didn't seem to be a big ask. Obviously it was going to be more work.

R And has it?

A: Well its been more work, there's more meetings, there's more paper work, there's more communication having to happen, where perhaps it didn't happen. I mean that's not a bad thing but it still is time consuming and we've just got so little time. And we are working more and more hours at home as a result. So the more things you do in your day at school the more you do at home.

R: So you haven't been given any more time to do this innovation in the curriculum.

A: We've had some time to have meetings that have been covered during the day. So we've had that time release. But we've still had to leave work for classes we leave behind and so on. So it breaks even a bit. There has been some time release but it's not really quite....you can always expect if you take on something like this that you are going to end up doing more.

R: Now that you've done it for one and a half projects are you feeling that there is some value in what you're doing. Are you starting to see it is a worthwhile thing, doing the integrated project?

A: Yes I think there is value in crossing over the curriculum and looking at things at the same time. I am just not sure ... the multimedia focus is fine. But in a way, to me, that's not so important. To me it's more important that the children are actually thinking about these things across areas and they're using that as a springboard for their imagination or for their writing.

R: And do you think that's happening?

A: Well it seems to be happening, yep in this case perhaps. I don't know until we tie in some of the other things that Cathy's trying to achieve at the science level or the maths level. Certainly it's easy in a way for English to tap into anything because it's all language related. There's a huge number of things we can do with language in virtually any topic, which is why I'm open to the integrated curriculum in the first place. For Maths it's a little bit harder I think. But she's going to deal with Maths in lots of interesting ways too.

R: I understand you did the first project on Scala and what do you think about it? You all seem to be unhappy with the content and maybe the topic wasn't quite right but what about he program itself. What do you think about as a way of kids representing their learning?

A: Um, it's a bit limited I think actually. I'm not that impressed with it. I'm impressed with the possibilities its got in terms of graphics and colour and sound on so on. But in a way I didn't really feel, that there was… what are they learning? It's a bit like just putting a cut and paste together. The textual stuff seemed to suffer. There wasn't a sense of a story being told, or a beginning and an ending. There wasn't an end product in mind other than their particular little frames which were slotted into a bigger section at the end. You can't print out on Scala, so there is no ability to review information or correct spelling or look at the language and think of a better way of doing it. And again perhaps the speed in which it was all put together and the newness of it affected that. I think they enjoyed using it. But maybe when they're more familiar with using it again for this project. But I actually think there is more possibility in using a range of multimedia rather than one program. And Power Point supplies you with that option of printing it out or seeing what you're doing, or having notes if you want to present orally with the multimedia, which to me again is much more of a real life skill. And a need of learning is to be able to speak while something is being shown.

Extract from a Focus Group Discussion

Focus group Discussion with 7 SWMS students

R: It seems to me there has been a lot of problems, sometimes caused by the hardware, sometimes caused by the fact that you are on a network and sometimes because you forgot to do things. Does that make you not want to use computers for this sort of thing? Does that make it so frustrating for you that you don't want to do it on a computer? Would you rather do it by hand?

M: I think its easier to use a computer because like you can do so many things at once on it and like I just find it easier.

R: So you are prepared to put up with the hassles sometimes?

A: It makes me not want to use the Mac. I really don't have any problems on my computer.

R: As you don't have a choice at school its Macs, would you then rather then go back to doing it by hand?

A: No.

R: You would put up with the Mac? Why?

A: When you do things by hand sometimes you can lose stuff. I mean you can lose stuff on a PC too but then you know its not really your fault, it's the PC's fault.

R: So what makes it different doing your work on computer better then?

A: You can just put a picture in you don't have to print it out and paste or something like that. Doing it by hand is easy but I'd rather do it by computer.

M: Well like on computers, there's so many more things you can do. Because like if you did it like on a poster board, you couldn't have videos or you couldn't have music or something.

R: And do you think it makes a better piece of work?

M: I think it makes it more interesting because its just reading text so I think that even though computers can be big hassles I think its worth it in the end.

K: I agree with M and I think that once you learn all the basic techniques that you need to get done for your project or whatever you're doing on a Mac or a PC, it becomes pretty easy. Except when it actually is the computer's fault.

R: What about the quality of your work. If you had the choice would you rather be doing a multimedia project than a handwritten one?

K: Yeah I would still do it on a computer. Just because its easier and faster.

R: Does it look better do you think.

K: Yeah.

A: I think it's nice because its like organised a lot. If you write it ... and also ... you can use pictures, you can use sound .... I lost my stack (inaudible)

R: How were you all taught to use Hyperstudio? Who taught you how to do it?

M: My 6th grade teacher.

R: So everyone got taught how to use Hyperstudio in grade 6?

M: Well we all did the wheel in the Computer lab. And that was Hypercard and it was a little bit different. ... but really a bit of that and now is how I learned. But in 6th grade for our projects we didn't use the computer for anything except for typing, so I didn't really learn that. Its just this project has helped me learn.

R: Did you ever have a lesson in your Spanish class where someone taught you how to do Hyperstudio?

K: Mrs B did. Our English teacher

R: Do you think it would help more formal teaching in how to do it? Or did you basically just work it out for yourself?

K: I think the teaching was OK because as Ashwin said you were allowed to explore and they taught you certain stuff that you needed to put on the Hyperstudio project so that it would make it easier and then all your exploring and if you found clip art and stuff like that you could put it on. So it was pretty good the teaching.

R: A lot of you have also said I learned how to do it by messing around. Would that be a fair comment? Just messing around without having been taught how to do it?
(General agreement)

Teacher Discussion Prompt

Circle 3 words which most often characterise your technology-using lessons

collaborative	problem-solving	frustrating
tense	flexible	learner-centred
dominated by technical hassles	challenging	co-operative
rewarding	unstructured	time-wasting

Other

Circle 3 words which most often characterise your students in these lessons

confused	focused	nervous
supported	bored	cooperative
empowered	adaptable	challenged
engaged	confident	organised
unsure	disorganised	in control

Other

And 3 which describe you in these lessons

well-prepared	tense	dissatisfied
challenged	confident	frustrated
satisfied	excited	adaptable
anxious	supported	disappointed

Other

My experiences in using technology for aspects of my curriculum indicates it has been worthwhile in terms of student learning

Agree Strongly	somewhat agree	agree	somewhat disagree	disagree strongly

Because

I. ....

II. ....

III. ....

If I am to develop my teaching practice with learning technologies, my wish list is:

I. ....

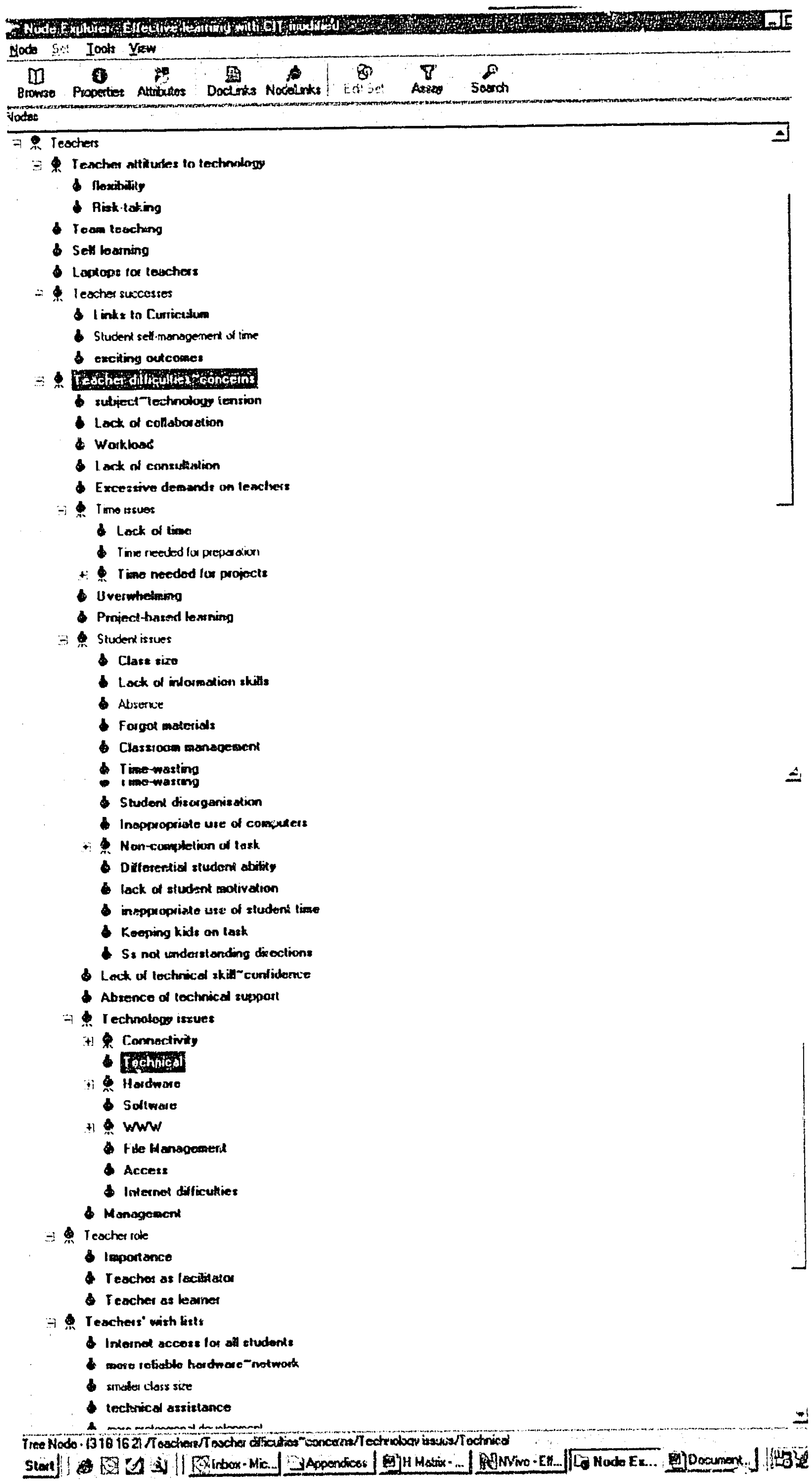
II. ....

III. ....

Name: ....

Tree and sub tree codes - sample

Tree and sub-tree diagram for issues relating to teachers



Notes and comments - annotated sample in NVIVO

* indicates a link to another relevant document: interview, observation, focus group, questionnaire; reflection; prompt etc in NVIVO

Some annotated notes from OMSC, Aus

Monday 24 May 99

Annette * 7B English Teacher and class Home Room teacher in Portable - no decorations, posters, teaching materials in room.
Preparation between two rooms has six computers

Notes from discussion with Curriculum Coordinator

- Ts allocated laptops but have little, no time to use them at school
- Ad hoc use of computers across non-technology subjects; high take-up in elective courses at year 10
- Ts really understand and care about Ss as individuals, a stand-out feature of the staff; do not have same appreciation of them as learners and how to help them.
- Time ripe to again survey staff and capture their skills, what they are doing, problems and how they are feeling about the push for technology

Lunchtime in Laboratory
Group of 7B students who had been relatively disengaged in earlier English class now highly animated working on fixing up the first multimedia presentation. *(need to consider behaviour in and out of the classroom, not only here but at the other schools)*

Wednesday 26 May 99

- Liz's * Science class (not integrated project)
- Clear classroom management procedures and expectations
- Activity based lesson about force; many Ss easily distracted

(How do teachers' manage behaviour in these types of classes?).

Liz asked to join integrated project at start of year by CC. Not sure about use of Scala - believes it distracts from the Science. 'What are we on about here?'

Minutes of Integrated Project meeting 26 July 99

- Norma* identified boys' progress
- Lunchtime detentions for some boys with staff to supervise
- Colin*, Brenton*, Warren*, Brad* and Sean* to catch up (*make sure to observe them in class)*
- V3 (for Scala) fully booked on Wednesday and other times. Bookings made for next week.
- Agreed to seek assistance from able multimedia students to assist with final work combining planets
- Class has not seen completed unit on Local Environment. Dan* put work on a floppy. Find the floppy! *(Dan now on leave).*

Minutes of Integrated Project meeting 2 August 99

- Boys not up to target have detentions at lunchtime in V3 to catch up.
- Scala is missing off 4 computers in V3.
- Jerry* has no knowledge of Scala program
- Multimedia students to work with S7B
- Computer room bookings confirmed
- Decide to use NHS's assessment rubrics for the multimedia presentation.
- 'When will we finish the unit so we can assess the little geeks?'

Minutes of Integrated Project meeting 16 August 99

Peer tutoring by multimedia students are helping in a positive way and Scala section of program is looking better.

Team teaching approach to curriculum issues seen as valuable. Other schools experiencing similar problems eg. time management and computer systems

7B students still very immature and some need to be carefully monitored

Boys have caught up to an acceptable level. Encourage Colin to be more involved

Teachers to follow up Work Requirements owing

Continuing problems with delivery of material and using learning technologies. Check to be made whether student work has been affected by virus

Minutes of Integrated Project meeting 11 October 99

Norma* presented evaluation by students -95%: project 2 better than project 1

Scala seen as the major problem. Lack of knowledge of program and program removed from computers by persons unknown.

Internet most used resource, followed by books. WWW as good as other resources

Tasks were evenly divided amongst groups except for a few notable exceptions

30 - 40% wasted time 60 - 70% allocated classtime on project.

Project can be improved by having more fun! Studying a topic the students like - motor bikes! (Brad and Sean by doing it!)

Report form designed by Annette approved

Sean, Colin, Matt and Shane are students without Internet access. *(This appears to be a real issue here)*

20 October 1999 Focus Group

Focus Group with Brenton, Brad, Mark, Sean, Sam, Tim* and Mark. CC also present.

All have computers at home - three with Internet

Summary of issues:

- unequal access to the Internet at school
- resent filtering; want unfettered use
- technical issues the main frustration
- skills well beyond those of their teachers
- some have own webpage; very enthusuastic about this
- like using computers despite problems and want more next year
- have been taught skills of Scala by Dan
- middle school issues of non-engagement; want to have fun
- don't see that they learn using the Internet
- no clear understanding of what or why

Managing quantitative and qualitative data from the on-line Student Questionnaire in NVIVO

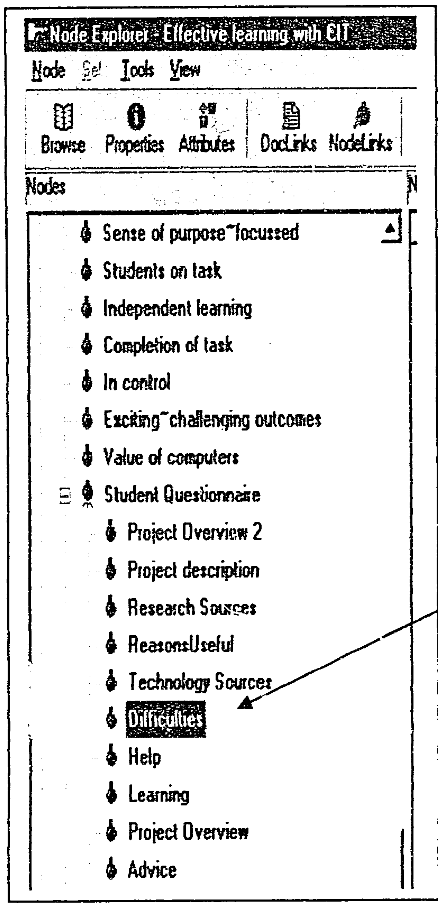
Each questionnaire was treated in a number of ways:

1. A separate document for each student questionnaire received was created in NVIVO
2. Documents were allocated to sets e.g. classes and schools
3. Attributes of each document were identified: (date of data collection, country, school, class, gender, resources used; group type; group effectiveness; understanding of topic; project satisfaction; whether or not difficulties were experienced; who they asked for help; whether or not they indicated positive or negative comments (like/dislike); the type of negative or positive comments. The primary purpose of attribute data is for making comparisons.

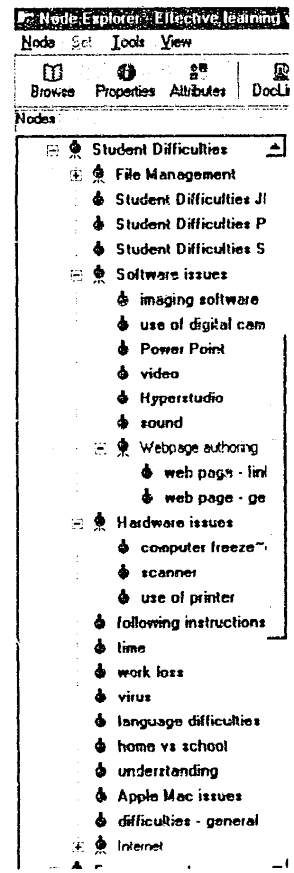
Selected attributes of four students:

	Matthew - RCS	Heather - 7 SVMS	Tim - OMSC	Michelle - 7 EGGS
Class	RCS	SVMS 7	OMSC	7A
Country	USA	USA	Aus	Aus
Data Type	Student Questionnaire	Student Questionnaire	Student Questionnaire	Student Questionnaire
Date of data collection	0/5	0/5	99/8	99/9
Difficulties	yes	yes	-	no
Dislike	-	Technology	-	-
Group effectiveness	very effectively	extremely effectively	very effectively	NA
Group type	individual/group	group	individual/group	individual
Help 1	subject teacher	subject teacher	-	subject teacher
Help 2	Tech Resource Coordinator	subject teacher	-	-
Help 3	-	technical support	-	-
Like	-	Technology	Technology	Project
Project satisfaction	very satisfied	somewhat satisfied	very satisfied	very satisfied
Subject	Social Studies	Spanish	Integrated	Geography
Topic understanding	very well	well	very well	very well

4. Documents were read and codes established. Codes for some data could be established through an autocode function. Other codes were established through text searches. Parent and child trees were developed.



By doing an automatic code by section, I first of all extracted student responses on a particular Questionnaire item (e.g. Difficulties) into a set for enable more focused coding. Through the coding process I established relevant parent nodes and added child nodes according to the comments made.



5. Hyperlinks to other documents were made if relevant, e.g. to teacher comments, my observations and memos, issues raised at meetings etc.
6. Likert scale items were aggregated and graphed (see Figures 13, 14, 15, 16 and 17)
7. Open-ended responses were coded: project description; comments on resources used; difficulties experienced; reflections on learning; what they liked or disliked about the project – project overview; what advice would they give teachers and students. Once coded and patterns established, the patterns could also be tabulated or graphed if relevant (Tables 15, 16, 18, 19 and Figure 12)

Difficulties

I'm not great with computers in general, except for the one my family owns. Thus my understanding and ability to use this computer (iMac) and its programs presented numerous problems. I forgot how to do things and how to go places.

Help

I asked my partner, my teacher, or the person who works at the computer lab.

Learning

Learning1: I learned to use hyperstudiodc, somewhat better.
Learning2: I can use hypercard better.
Learning3: I've learned about the topic I researched, Cuba.

Understanding: well
Satisfaction: somewhat satisfied
Group work: extremely effectively

Project Overview

I liked creating cards and designing them. I liked looking on the internet for pictures and information too. But I didn't like the problems that they entailed. Once my partner and I put our work together, which took us a considerable amount of time, it erased our work. I hated doing it all over again.

Advice

: I have no idea.

> Extract from Heather's Questionnaire: SVMS US which shows an ambivalent attitude to technology

8. A number of matrix intersection searches between attributes and codes were also performed. Below are the results of a matrix intersection, used not only to graphically represent data, but through the ability to return to the source data, allowed for further reflection on the student comments

This matrix shows the numbers of responses at the intersection between students and classes in each of the schools, with specific attribute items

Matrix - [29 16 6] /Search Results/Matrix Intersection/comparative data stud quest

File Matrix Selection

Display: Number of documents coded | Show Statistics

Row Header.

Column Header.

Matrix Table	1: C Fun = fun	2: C Like = Project	3: C Like 1 = Project	4: C Like = Group	5: C Like 1 = Group	6: C Like = Technology	7: C Like 1 = Technology	8: C Di
1:A school = SJV US	8	28	2	11	3	3	8	1
2:A school = JLS US	30	16	5	21	9	47	6	4
3:B class = JLS 7	14	10	1	3	3	16	1	1
4:B class = JLS 8	16	6	3	16	7	32	5	2
5:A school = PLC Aus	6	21	3	2	0	19	4	4
6:B class = PLC 7	5	21	2	2	0	12	4	2
7:B class = PLC 8	1	0	2	1	0	7	0	3
8:A school = BHSC Aus	2	0	0	0	1	3	0	0

Matrix Table	8: C Dislike = Project	9: C Dislike 1 = Project	10: C Dislike = Group	11: C Dislike 1 = Group	12: C Dislike = Technology	13: C Dislike 1 = Technology	14: C Dislike = Spanish
1:A school = SJV US	1	1	13	0	9	3	0
2:A school = JLS US	4	1	4	0	34	1	7
3:B class = JLS 7	1	1	4	0	15	0	0
4:B class = JLS 8	2	0	0	1	19	1	7
5:A school = PLC Aus	4	0	2	0	6	0	0
6:B class = PLC 7	2	0	2	0	4	0	0
7:B class = PLC 8	3	0	0	0	2	0	0
8:A school = BHSC Aus	0	0	0	1	1	0	0

Aggregated responses allowed for graph construction (see Chapter 8)

More importantly, access back to the original source or coding, for verification, was also possible.

So, for example 47 students at this school indicated they liked using technology in some way and 34 said they disliked it; some said both. I was able to go directly back to the sources codes and documents and consider what students had to say more closely.

That students often simultaneously 'liked' and 'disliked' using technology and what they say about this, is far more interesting I suggest than the graphical representation of like and dislike using technology alone.

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