Key factors in the use of ICT in primary school classrooms

By

Ivan Webb

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Declaration

This thesis contains no material that has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis.

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Abstract

Over the past three decades governments, school systems and schools have made considerable investments in providing computer based information and communication technology (ICT) to support teaching and learning. These initiatives have been strongly endorsed by national and international organisations and authorities across the world. The major aims of this provision have been to enhance the quality of teaching and learning, and to better prepare students for participation in the emerging knowledge economy and information based society. Numerous studies have provided accounts of successful and impressive use of ICT in schools and classrooms yet there is little evidence of a sustained transformation occurring. In particular, the literature emphasises the necessity for teachers to change their pedagogies for the potential of ICT to be realised.

This study of primary school classes (N=50) in Tasmanian government and Catholic schools (N=32) used a social constructivist approach to investigate the factors that shape the successful and sustained use of ICT in classroom teaching and learning practices. The findings are elaborated using activity theory. The study was undertaken as part of the ARC Linkage project (PL0210823) *Children, Online Learning and Authentic Teaching Skills* (COLAT). Observations covered ICT provision and working arrangements in the classroom, and teaching and learning practices in use. These in-class observations were supplemented by interviews of key school staff members including the participating teachers, principals and other school leaders, ICT coordinators, technical support staff and others involved with the use of ICT in the school.

As an original contribution to knowledge the study identifies a set of key factors that together influence the success or otherwise of the use of ICT in teaching and learning. At the class level, there are four key factors: the purpose of the teaching and learning practices (and the rationale for using ICT to achieve the intended purpose); the availability of technology that matches the practices; the working

knowledge required to select, operate and troubleshoot the technology being used; and the cost effectiveness of doing so. Four additional factors that are largely determined outside the classroom were also found to be significant including: governance of ICT and its use across the school; 'reliability' of devices, arrangements and practices; professional learning that results in a transfer of learning into practices; and collaboration as a key characteristic within classes and the school as a whole.

Several of the key factors are largely outside the classroom and beyond the control of teachers. Such factors operate at the school, community and school system levels and thus it is unreasonable to hold teachers responsible for realising the potential of ICT. Nor can the use of ICT in teaching and learning be addressed as if it were an engineering problem: educative practices involving the successful use of ICT are socially co-constructed and emergent rather than designed and implemented. While in-class practices are central, the key factors require organisational learning on the part of the school as much as professional development on the part of teachers. Thus, it is appropriate for schools and school systems to be informed by local communities of practice that are addressing the key factors in order to co-construct the emergent practices and arrangements.

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My hope is that the generosity of all concerned will be 'rewarded' by the passing on of this knowledge. Ideally, this will help reduce the need for others to invest quite so much time and effort in uncovering what is desirable, possible and feasible in terms of new or improved in-class practices using ICT.

Glossary

ACOT	Apple Classrooms of Tomorrow
ARC	Australian Research Council
APA(I)	Australian Postgraduate Award (Industry)
Becta	British Educational Communications and Technology Agency
COLAT	Children Online Learning and Authentic Teaching (ARC Linkage Project)
DEST	Department of Education, Science and Training
DEETYA	Department of Employment, Education, Training and Youth Affairs
ICT	Information and communication technology
Governance	Decision making within a school in relation to the infrastructure provided, and the capabilities and purposes of those involved
OECD	Organisation for Economic Co-operation and Development
Practices.	The everyday activities and processes undertaken by teachers and students as in teaching and learning
Reliability.	The capacity to rely on being able to use the ICT within the 'window of opportunity' available
Working knowledge.	The knowledge required to select, operate and troubleshoot ICT

Chapter 1 Introduction

> Why is the idea that ICT can raise standards and student attainment "a belief instead of a reality after the investment of so much in terms of both money, time, commitment and energy in ICT over the past twenty years?" (Reynolds, Treharne, Tripp, & 2003, 2003, p. 166).

1.1 Introduction

Over the past three decades governments, school systems and schools have made considerable investments in computer based information and communication technology (ICT) to support teaching and learning. Many national and international organisations and authorities across the world strongly endorsed these initiatives. The major aims of this provision have been to enhance the quality of teaching and learning, and to better prepare students for participation in the emerging knowledge economy and information-based society. Numerous studies have provided accounts of successful and impressive use of ICT in schools and classrooms, yet there is little evidence of a sustained transformation occurring. In particular, the literature emphasises the necessity for teachers to change their pedagogies in order for the potential of ICT to be realised.

The focus of the study

There is an inconsistency between the widely accepted promise of ICT to transform teaching and learning and actual experience in the field. The Reynolds *et al* question (above) has the possible implication that teachers have not changed their pedagogies sufficiently. Even if this is the case, some additional explanation is called for. Teachers are generally highly professional and deeply committed to the success of their work with students. Many classrooms are adequately equipped with ICT, and many teachers have participated in substantial professional development activity around the use of ICT yet the question remains largely unanswered.

Case studies have confirmed the potential of ICT to have a major impact on classroom practices (Becta, 2001, 2003; Cox et al., 2004a, 2004b; Cuttance, 2001; Dwyer, 2000) but no reports of such transformations being readily generalised across large numbers of classes and schools were found. As with all innovation, the use of ICT in classrooms attracts a range of responses from the intended users. For example, Rogers (1995) developed categories of respondents including innovators, early adopters, early majority, late majority, and laggards. In-class practices associated with the successful use of ICT were, of necessity, significantly different from conventional practices and tended to attract innovators and raise doubts in the minds of more conservative practitioners who were likely to fall into the latter categories of innovators. However, this is unlikely to be an adequate explanation for the inconsistent outcomes achieved to date. Some of the literature explicitly reported that the use of ICT in classes was not easily sustained even when and where transformation had been achieved and also that schools struggle to keep up with technological change that makes previous arrangements redundant (Hayes et al., 2001; Papert, 1997).

Hypothesis

ICT has been widely provided in classrooms yet its use varies considerably and many classrooms remain largely unchanged, thus, we can conclude that ICT is not causal as implied in some discourses around ICT, teaching and learning. Despite the ongoing attribution of outcomes to the use of ICT, the everyday evidence is that ICT per se, cannot raise standards and student attainment. However there is evidence that some use of ICT can raise standards and student attainment (Cox et al., 2004a). That is, some uses of ICT have benefits and while other uses of ICT do not have discernable benefits. Hence, the author hypothesises that

There are identifiable factors that are significant in enabling and/or constraining the successful use of ICT in class programs.

This study is an attempt to understand the factors that contribute to the use of ICT

in class programs and investigates the factors that shape the reportedly 'successful' use of ICT in classes.

Indications of success in using ICT

At the most fundamental level, ICT must first be used in order to have an impact on standards and attainment and the focus of this study is at this level. This study adopts a constructivist perspective on the basis that the practices in which ICT is used (particularly teaching and learning), and the arrangements that support these practices, are socially constructed (Duffy, Lowyck, & Jonassen, 1993). As will be shown, the construction of these practices (teaching and learning) and arrangements (class and school organisation) vary considerably and are highly dependent on the construct of 'ICT' itself. For example, the resulting practices and arrangements are very different depending on whether a 'computer' is seen as a single user device or a shared point of access to tools and services.

Thus the indicator of 'success' adopted in this study is that the *use of ICT is reported as being successful* by participants in the study in relation to their own classes and schools. That is, the extent to which participants reported that they were able to use ICT as intended and to achieve their purposes in doing so. Participants reported success or otherwise as being associated certain approaches, practices, arrangements and other situational factors. It is the analysis of these reports together with related observations that form the basis for the findings of this study. As well as leading to the identification of eight key factors the analysis revealed important and complex interactions between the factors.

This study does not investigate specific aspects associated with the use of ICT that may specifically raise standards and student attainment. Few participants made direct reference to student standards and attainment. Rather they tended to report higher levels of collaboration, initiative, and novelty together with significant activities, experiences and products as indicators of the successful use of ICT.

It is true that when teachers in two different schools or classes report successful use of ICT they may mean different things by it, casting doubt on the ability of this study to produce generalisable results. However, the study focused on those factors that participants believed (or appeared to) contribute to the successful use of ICT in their class programs. Comparisons between cases, and triangulation of observations and reports within cases, enabled the results to be analysed in a way that retained the validity of the investigation while allowing for different meanings of success from case to case.

Significance of the study

The significance of this study is that it challenges several commonly held beliefs about the use of ICT in primary school classrooms and provides an alternative perspective from which to reconsider implementation of the use of ICT. For example, there is widespread agreement that in order to make full and productive use of ICT teachers must change their pedagogies with the implication that teachers are actually in a position to do so. This study supports the need for new pedagogies but challenges the capacity of teachers to make such changes without significant initiatives at the school, community and school systems levels. Similarly, much of the professional learning in relation to ICT uses 'expert-novice' arrangements: teachers participate as 'ICT novices' in workshops run by 'ICT experts'. However, the action learning projects undertaken in this study show that a community of practice approach is far more likely to achieve the transfer of professional learning into classroom practices. After all, communities of practice emerge around a shared interest in improving practices. The transfer of professional learning into in-class practices is the measure of the success of professional learning used in this study. Similarly 'reliability' is generally taken to be associated with the operational state of ICT devices but this study shows that arrangements for the use of ICT and everyday classroom practices are more common causes of 'reliability problems' than are faulty devices. Many instances of reliability issues involving properly functioning devices were observed in the course of the study.

It is a common expectation that the use of ICT will increase the level of collaboration in classrooms since the 'C' in ICT stands for communication: a central aspect of collaboration. From the in-class observations it was found that the converse was more likely to be true in two senses: firstly, in many classrooms the arrangements for students to use ICT effectively isolated students from their classmates thus reducing (rather than increasing) the level of collaboration. Secondly, the use of ICT is likely to be more successful in classrooms (and schools) that already practice high levels of collaboration: increased collaboration is likely to increase the use of ICT. The same finding was made across various levels and in various contexts.

In response to such observations that challenged commonly held beliefs and assumptions, the study was able to identify a set of eight factors associated with the successful use of ICT:

1. A purpose for using ICT together with a sound rationale explaining how the use of ICT will enable that purpose to be achieved
2. Available technology that matches the purpose and practices involved
3. Adequate working knowledge to select, operate and troubleshoot the technology involved
4. The cost-effectiveness of using ICT warrants its use
5. Sound school governance in relation to the provision and use of ICT including consideration of its use at the school, class program and activity levels
6. The 'reliability' of the available technology such that the users can rely on being able to use it for the intended purposes within their window of opportunity
7. Professional learning to enable all concerned to make good use of the available technology and to contribute to its use by others

8. Finally, extensive and on-going collaboration at, and between, all levels involved: system, school, class and user activity

Properly considered this set of factors provides a framework for reflecting on initiatives and experiences, and for planning future initiatives.

Limitations of the study

In order to start the larger COLAT project and to 'map the territory' an initial set of in-school observations (N=6) were completed within a short period. Most of these early observations were largely unstructured and open-ended. They were recorded simply as notes and/or taped interviews. This was a conscious decision aimed at increasing awareness of what subsequent observations might be able to reveal. These initial observations revealed matters requiring further attention and there was a need to undertake some further development of instruments. The tentative early findings in the pilot study (Cases 1-6) provided a basis for the subsequent investigation, that is, a qualitative approach that focused on the factors that appeared to enable and/or constrain the use of ICT into teaching and learning. Observations of fifty classrooms in twenty-eight schools over a total of approximately 140 days represent substantial data gathering.

At the same time, the school selection process resulted in a major limitation. Participating teachers were drawn from leading practitioners with ICT in teaching and learning. The participating teachers and classes were likely to be more successful with ICT than other teachers and classes in their respective schools. Similarly, participating schools were more likely to have the use of ICT as a school development priority: several such principals identified ICT as 'strategic' to the future of their schools. Thus, the participating teachers, classes and schools cannot be assumed to be representative of all teachers, classes and schools. At the same time, it is reasonable to assume that the participating classes and schools would include factors that are significant to the successful use of ICT and that the differences between the more and the less successful would highlight these factors.

There may also be another way in which the school sample is unrepresentative: it contains very few high Educational Needs Index (ENI) schools and there were major difficulties in undertaking observations in those high ENI schools that did participate.

Implication: change as a fundamental requirement and experience

All visions around the use of ICT include implications for change that have implications for both schools and teachers. The OECD (2001) report *Learning to Change: ICT in Schools* provides three overlapping rationales for why schools should adopt ICT: economic, social and pedagogical. The report cites three dramatic changes in education associated with ICT and notes that these changes differ from any previous reform. Firstly, that ICT, having arisen outside the world of education, has presented an irresistible case for adoption within schools based on the above rationales. Secondly, that students are often more comfortable with these developments than are their teachers. Thirdly, pervasive ICT has implications across the entire learning environment. Facility with ICT is becoming a pre-requisite for participation in society and the workplace because of the economic significance of information. At the same time, ICT has the potential to contribute directly to the processes of teaching and learning (p.10). These rationales, and consequent investments by governments in ICT for schools, raise the issue of how to establish conditions under which quality outcomes are achieved. In attempting to answer this question, the report reaffirms the significance of schools and teachers in the lives of learners but identifies the need for major organisational changes in schools and a different role for teachers through the integration of ICT.

Starting with assumptions about the potential of ICT the literature on change acknowledges that although ICT had arisen outside education "the pervasive nature of ICT has profound implications" (for change) "…across the ethos and organisation of the whole of the learning environment" (OECD, 2001, p. 10).

While the various stakeholders share a common goal of incorporating ICT in education, their respective rationales differ. The economic rationale focuses on the

knowledge and skills needed for the economic growth and a knowledge society. The social rationale highlights everyday competence with ICT as a prerequisite for participation in society and in the workplace. The pedagogical rationale concentrates on the role of ICT in enhancing teaching and learning (Becta, 2001; Cox et al., 2004b; Dwyer, 2000), particularly as an aid to mediating learning as in e-learning (DEST, 2005; Roschelle, Pea, Hoadley, & Gordin, 2000).

1.2 School development and change

Regardless of the positions adopted, there are increasing expectations of schools and teachers in relation to the use of ICT in teaching and learning(Mulford, Silins, & Leithwood, 2004). The positions, explicit or implied, describe the future in terms of what teachers are expected to achieve with ICT. Despite the widespread use of imperatives for teachers in the literature, Roblyer and Edwards (2002, p.2), state that, "In a field with a wide range of powerful and complex tools, experts cannot help but disagree about what teachers need to know and where they should begin" . In practical terms, this means that many writers, being unable to answer such questions definitively, place responsibility for making the right choices on the shoulders of teachers. It would appear that few writers have considered the difficulties and dilemmas this presents. Teachers have to meet today's obligations (with current policies, resources and technologies) and at the same time move their practices towards a possibly very different and somewhat uncertain future: one in which the policies and technologies may be very different from those in play today. These difficulties and dilemmas are not helped by the fact that the content and degree of detail of the respective visions varies considerably. For example, the "principled vision" of Papert and Caperton (1999) has virtually no detail and its implementation strategy is simply that having "faith in America…we most deeply believe: if we build the vision, the people will come." (p.2). Such a belief is significant given Papert's experience with ICT in education for more than three decades. The general implication is that as the technology develops so there should be a pedagogical response. However, what enables or constrains such a pedagogical response?

Teachers and change

As indicated above, in so much of the literature reviewed, the focus moves rapidly from the potential of ICT itself to the need for professional initiatives by teachers. Watson (2001) argues the converse, that is, for placing pedagogy before technology in order to rethink the relationships between ICT, teaching and learning. On both sides of this issue, much of the discussion proceeds as if it has only two dimensions: technology and pedagogy. Yet many of the factors that shape the work of teachers are decided outside the classroom at the school or school system level and may be only indirectly related to technology or pedagogy. These factors include curriculum, funding for ICT, the actual ICT provided, support provided; assessment requirements, and other requirements or expectations that compete and/or conflict with ICT use. Furthermore, policies and accountability systems reinforce these requirements and expectations: they are not matters of simply free choice for the teacher. Nor are they trivial: consider the situation of the teacher who is expected to arrange for students to undertake highly collaborative rich tasks using ICT and at the same time provide highly individual assessment reports of the students' learning and other achievements.

It is at the school level that accountability systems are activated, resourcing constraints are shaped, policies developed, priorities established, purposes negotiated and communicated with other stakeholders (families, communities, government)…all of which shape both planning and assessment. The use of activity systems to manage change and development (Engestrom, 1999) is based on the notion that some elements that mediate activity within any social or organizational situation are likely to be in tension creating disturbances. Engestrom's cycle of expansive learning models a structured process for systematically identifying and resolving such tensions and disturbances. Without such a systematic approach to resolve tensions and overcome disturbances, individual teachers may opt for a certain approach based on one preferred expectation even though it is in conflict with other hopes and expectations. For example, individual reporting and assessment requirements may provide the teacher with a 'rationale' for using

classroom computers as single user devices because it is easier to monitor and account for student knowledge, skills, activities and products related to their use of ICT. At the same time, such teachers frequently reported being concerned that students were not making greater and more significant use the classroom computers. Single-user approaches are the least time efficient in this regard because each student is required to have an isolated turn. This also limits the richness of learning tasks: rich tasks are generally undertaken as collaborative endeavours.

At the same time, many teachers do achieve significant changes because of incorporating the use of ICT into their classroom practices. As the results will show, such changes are socially constructed by these teachers in collaboration with their students, colleagues (past and present), family and friends and other associates, hence the significance of collaboration as significant factor in its own right. At the same time participants (particularly ICT co-ordinators and Principals) referred to teachers who were somewhat resistant to the in class use of ICT. Such reports seemed to imply that such teachers might be socially constructing their non-change in the face of the school's hopes and expectations.

ICT as catalyst for change?

At the time of the study, all classrooms in both participating school systems had ICT and all teachers had received training in its use. Yet the use of ICT in classes was observed (and reported) to vary greatly from class to class, and from time to time. The implication is that the successful utilisation of ICT requires much more than the deployment of technological devices and training users in their operation, albeit that these are important. The fact that certain ICT makes a particular desirable practice possible and the technology is available is not always sufficient to ensure the practice will develop in a specific situation: other factors play a part. This raises an important line of investigation: the role of organisational, social, cultural, and historical factors in shaping change. A discourse is taken to be an institutionalized way of thinking, often defining what can be said about a specific topic (Gee, 1996). The various discourses relating to ICT and change range across

various combinations of what may be possible, desirable and/or feasible in the use of ICT. These three dimensions of change frequently emerged throughout the study:

- What is desirable relates to purposes and values: "It would be good to …"
- What is possible relates to potential: "… can be done"
- And what is feasible relates to practice: "… can be done at reasonable cost within the available window of opportunity"

Watson (2001, p. 264) casts doubt on the assumed role of ICT as a 'catalyst for change' and proposes that "Re-thinking the position of ICT should allow teachers to be more comfortable with, and contributors to, a purpose which accords with their professional self" (p. 264). Advocates for the use of ICT frequently include the caveat that teachers will need to change their practices. Thus, both proponents and doubters agree that ICT will not cause transformation. However, the surrounding discourses frequently imply otherwise. Rather there is general agreement that ICT simply creates a potential for change; that teachers play a key role in realising that potential; and that the required change involves teachers choosing to use new pedagogies. Hence, the widespread agreement that achieving this capacity will (at least in part) involve significant professional learning. Such an argument can become circular and therefore tends to reduce consideration of other factors that might also play a vital role in realising the potential of ICT. Perhaps as a result, the literature contains more about professional learning than about other factors identified in this study (Watson, 2001).

Key factors

Having formulated the above hypothesis, the focus moved toward identifying factors associated with the successful implementation of the use of ICT in teaching and learning. Three such factors emerged consistently from the literature:

- the provision of ICT in the classroom
- associated professional learning for teachers

- the need for teachers to be innovative.

The literature was rich in case studies providing exemplars for best practice at the classroom level. Although not always made explicit the case studies also indicated two more factors: considerable support for the users and considerable effort on the part of the users. Such factors are necessary and but there was no direct evidence that, as a set, they might also be sufficient to realize the potential of ICT to result in a sustained transformation of teaching and learning. As reported in this and other studies, the classroom use of ICT can result in a transformation of teaching and learning but participants frequently report difficulties in sustaining the initial transformation. That is, initial success is an episode rather than as the achievement of substantial change. In Chapter 5 of this thesis, a case study is analysed to elaborate this point.

About best practice

Studies of best practice attempt to identify and/or elaborate ways to enhance existing practices and processes. For example, particular ways of using ICT might contribute to the enhancement of teaching and learning. In this study, the selection process was such that virtually all teacher participants were recognised by their schools and school systems as leading practitioners with ICT. Best practice can be an appropriate strategy when the phenomena and their causalities are well known (or substantially knowable) and largely independent of the context. This would provide a basis for confidence that the 'best practices' were applicable and readily transferable from one context to another equivalent context. Applications of 'best practice' approaches to change are possible for some aspects of ICT use in classrooms, for example, computer maintenance and network management. However, in real classes teaching and learning are socially constructed activities that are highly situated in specific social, cultural and historical contexts (Lave & Rogoff, 1991; Rogoff & Lave, 1984). This casts doubt on the transferability of best practices between classrooms.

As one teacher, skilled and successful in the use of ICT in his classroom, wisely stated "I have to plan every lesson on the basis that the technology will fail". At face value this sounds like an 'engineering'-type issue but the results will show that there are many reasons why the '"technology will fail". Only a small number of these reasons are technological. As the results (Chapter 4) will show, the majority of reliability issues are to do with the socially constructed practices and arrangements associated with the use of ICT in the class.

From a constructivist perspective (Williams, 2001) there are concerns regarding the discourse around best practice. For example, the 'best-practice' discourse generally has an implication that the recipients are largely passive in relation to best practice and can simply receive and apply the 'best practice' provided. However, from a social constructivist perspective (Wood, 1998, p. 277), the recipients would need to reconstruct any received practice before they were able to use it. Moreover, those involved are continually constructing and reconstructing all social practices both consciously and/or unconsciously. Teaching, learning, the operation of classes and schools as well as the actual use of technology are all socially constructed practices. It is for this reason that this study has taken a social constructivist perspective rather than attempting to identify 'best practice'.

The use of 'cases'

In order to be open to the discovery of as many key factors as possible it was important to make extensive and wide-ranging observations of classrooms and schools. Each set of observations may be understood as a 'case' in which an attempt was made to gather rich data about the realities of teachers' lives as they attempted to utilise ICT. From these it became possible to extract emergent themes and to identify paradoxes surrounding the use of ICT in class programs. Some of the participating teachers reported 20 or more years of experience with ICT in their classrooms yet there was little sense of transformation of teaching and learning resulting from such use. In a sense, this validated the Reynolds question (2003) and provided some hope that the cases in this study might reveal some answers.

Extending the range of matters under consideration beyond the immediate use of ICT in classrooms created the possibility of identifying factors that were outside the classroom. By including classes and their schools as related cases, the methodology created the possibility of understanding how to achieve improved consistency and alignment between classroom and external factors. For example, how professional learning might be aligned with teaching and learning practices; and how school governance might be contribute to improving the reliability of the classroom technology and the capacity (or otherwise) of teachers to change their classroom practices.

1.3 The author's motivation and background

The author has approached this study from an extensive background in education including thirty-seven years as primary and secondary teacher, principal and superintendent in various schools and regions within Tasmania. In addition, the author was the Australian College of Educators Teacher of the Year 2000 for Tasmania. He has an on-going personal and professional interest in schools and schooling and a particular interest in how to promote and support the development and application of school and classroom practices. At the heart of this interest is a hope to make some small contribution towards teaching and learning that are 'delightful' to the teacher and learner, both now and in the future (Fluck, 1998; Webb, 1999). The social constructivist approach used in this study is consistent with the author's approach to his own professional practices and professional learning during his time working with schools, their staff members, students and communities. The author's practices involved working closely with others to identify factors enabling and/or constraining the construction of insight on which to base successful action.

1.4 Outcomes

This thesis draws on extensive in-school observations; related action learning projects; and a broad body of literature to elaborate leadership, professional (individual) and organisational learning in schools (DEST, 2005; Dwyer, 2000;

Kolb, 1984; Kozulin & Rand, 2000; Lave & Wenger, 1991; McGill & Beaty, 1992; Mezirow & 1981, 1981; Mulford & Silins, 2003; OECD, 2001; Tasmanian. Dept. of Education., 2000; Wenger, 1998). The thesis will show that errors of judgement about the causality of phenomena frequently impair professional and organisational learning. An implication is that professional learning is better understood as the ongoing construction and application of new or improved professional practices rather than a process of transfer of knowledge from experts to novices. The thesis will also show that successful use of ICT requires considerable organisational learning on the part of the school in order to address the several key factors that individual teachers cannot be readily manage for themselves.

1.5 Conclusion

This introduction has described the context for the use of ICT in schools, the expectations of stakeholders and the apparent lack of sustained and transformative progress in the past two or three decades. Such an outcome appears paradoxical given the clearly demonstrated potential of, and support for, the use of ICT in schools.

Chapter 2 provides a systematic review of the literature to elaborate the use of ICT in teaching and learning in primary education. Some key implications of the emerging technology are examined and the perspectives adopted by several key stakeholders (governments, industry, educators…) are outlined. Historical links between ICT and education are considered. The review shows that while teachers do need to change their pedagogies there is also a need for sound school governance to complement their efforts. The review provides a basis for the use of activity theory as a means of summarising observations and insights.

Chapter 3 describes the methodology employed to investigate the factors that are significant in the use of ICT in classes. It begins with a summary of how ICT is organised in the participating schools and how the insights gained from the initial observations provided a basis for the main part of the study. The design and use of surveys, interviews checklists and case notes to collect appropriate data are

explained. Action learning projects used to explore the issue of professional learning are described.

The results of the study are presented in Chapter 4. The results of the early observations challenged several of the initial expectations and this led to consideration of a broader range of factors related to the use of ICT in classes. Several significant themes emerged from the observations. These include the impact of how users thought about ICT, the challenges for teachers in using ICT, and the significance of the particular school as a context. The results of the self-directed action learning projects provide a set of guiding principles for professional learning in schools. A professional learning 'cycle' emerged in each project. A rich set of dynamic roles also emerged to challenge the more traditional 'expert-novice' basis on which much professional development has been provided in relation to the use of ICT in schools. The results of both the in-school observations and the action learning projects are summarised using Engestrom's Activity System model.

The results are analysed in Chapter 5. The analysis identifies two sets of four key factors as being significant in the use of ICT in classrooms. The primary set (purpose and rationale, matching technology, working knowledge and cost effectiveness) apply more directly to the classroom situation while the secondary set (school governance, reliability, professional learning and collaboration) have major implications for others outside the classroom.

Finally, in Chapter 6, conclusions are drawn concerning the factors that relate to the sustained and successful use of ICT in teaching and learning. These conclusions provide a basis for several contributions to knowledge, including

- a frame of reference for considering the use of ICT in teaching and learning
- guidance for those responsible for the key factors outside the classroom
- a sound and rich basis for collaboration between those involved.
- directions for further research, and

The following chapter begins with a review of the literature related to ICT, teaching and learning.

Chapter 2 Literature Review

> If I have seen farther than others, it is because I was standing on the shoulders of giants" – Isaac Newton in a letter to Robert Hooke (February 1676)

2.1 Introduction

All researchers owe a debt of gratitude to those who have gone before for the knowledge that have contributed. This chapter examines a representative range of literature on ICT in teaching and learning. The following matters are considered:

- the cases for the use of ICT including transformation of teaching and learning
- the underlying assumptions involved
- the hopes and expectations of practitioners, school systems, policy makers and other stakeholders
- school and school system governance and how these impacts on policy implementation
- implications for professional learning to support the use of ICT in classrooms will also be considered.

The aim is to provide insights to support planning and implementing initiatives that will result in teachers (and others) having the required capacity to design, develop and implement effective and efficient teaching and learning practices that are enhanced by the use of ICT.

2.2 ICT in teaching and learning

Educators initially engaged with digital information and communication technology (ICT) for reasons of curriculum. For example, teaching computer programming using mainframe computers became common in senior secondary colleges in Tasmania in the early 1970s. With the emergence of personal computers in the 1980s, a wider range of educators engaged with ICT for reasons of pedagogy based

on its envisioned capacity to transform both curriculum and pedagogy. Seymour Papert's *Mindstorms: children, computers and powerful ideas* (1980) was something of a milestone in response to the pedagogical possibilities arising from the emerging technologies. In recent times, many educators have become more circumspect in relation to the contribution of ICT to teaching and learning. For example, in *Oversold and Underused - Computers in the classroom*, Cuban (2001) reports a number of case studies that demonstrate some of the challenges, complexity and uncertainty for teachers and schools involved in incorporating the use of ICT into their programs. Interestingly, this study was undertaken in schools in Silicon Valley, a location synonymous with leading-edge information technology at the world level. Even Papert acknowledges the difficulties involved (1997) yet maintains a commitment to the potential of ICT to contribute to the transformation of teaching and learning (Papert & Caperton, 1999). In responding to a question about the present uncertain effectiveness of technology in schools, they write "…technology doesn't work. Technology doesn't do anything. People do". They identify the critical success factors as "vision and the courage to take advantage of the opportunity…" made available by the emerging technology (1999, Section VIII).

ICT and Primary Education

Enhancing learning outcomes and overcoming constraints are both highly desirable goals. Large-scale studies of the use of ICT in schools (Becta, 2001; Cox et al., 2004a; Dwyer, Ringstaff, Sandholtz, & 1991, 1991) and numerous smaller scale case studies demonstrate that these goals for using ICT are also possible. Other studies of how young people are using ICT to mediate their own learning in new and creative ways outside of school settings (Robertson & Williams, 2004) also confirm the possibilities for enhanced and less constrained learning arising from the use of ICT. Studies of the connections between effective teaching, learning and the use of ICT all indicate that a fundamental requirement is the need for teachers to change their pedagogies in order to make these desirable goals possible. Using ICT to do familiar tasks in traditional ways is unlikely to transform learning. This raises the questions:

- How likely is it that teachers will change their pedagogies and curricula in order to achieve the desirable things that ICT makes possible?
- In addition, what would make such changes feasible?

To answer these questions, it is necessary to know something of the likely changes involved. According to Fluck (1998), the content of literature specifically relating to ICT-based learning by primary school-aged children (4 to 12 years) tends to give consideration to

- presenting material to young learners in interesting and interactive ways, such as hypermedia material for drill and practice activities
- research as information acquisition, such as Webquests
- communication, such as ePals
- local or extended project based activities

Schools, school systems and professional organisations have developed learning outcome frameworks to support teacher planning and classroom observations. For example, in Tasmania, Fluck (1998) developed the Key Information Technology Outcomes (KITOs) as a framework that outlines ICT-based tasks and activities appropriate to the respective grade levels in the following six areas of ICT use: operations (with computers); publishing; communicating; researching, problem solving and independent learning. Such guidance can be useful to schools and teachers in helping them to develop their class program and, in the process, achieve appropriate changes to their pedagogy and curricula.

However, as was reported by schools participating in this study, the rate of development in the technology itself can challenge the on-going usefulness of such frameworks. Upgrades of devices and applications generally make them more user-friendly so that younger children can then make greater use of them. Similarly, some participating schools and teachers reported that dramatic changes in the knowledge and skills of respective student year groups also made the school's current frameworks outdated. Ensuring that such frameworks match the current needs of

the teachers and students was, reportedly, a significant challenge. Correctly relating teaching, learning, ICT and activity is another challenge in developing and using such frameworks. Learning requires activity but a device (or application) may be used in a range of learning activities. Consider a student using an email application: observation does not readily reveal whether the focus of student's learning activity is simply learning to operate the application, communicating with another party, using email as a minor step in solving a problem, and/or undertaking some independent project. One or more (perhaps all) may apply. The student's actions and products with respect to the technology will be similar but the learning activity may be significantly different.

Developing technology expands the possibilities

Digital technologies are combinations of hardware, software, media, and delivery systems (such as the Internet) that support the emergence and development of a wide range of applications. ICT devices contain embedded technology customised to particular purposes and situations in ways that address operational, social, spatial, and temporal considerations. As an outcome of ongoing technological innovation, there are no clear endpoints in sight for the use of ICT in teaching and learning. For example, Moore's Law (Hutcheson, 2005) suggests that technology will continue to increase in capacity and decrease in cost thus making it more useful and accessible.

Visions of future education enhanced by the use of ICT tend to be about increasing independence of the learner and increasing flexibility of opportunity so that times and places for learning would become more open-ended. In addition, ICT will enable the presentation of richer learning materials and an increased capacity to meet the needs of the learner at lower cost. These relate to matters of pedagogy, opportunity (convenience and equity) and economics. At the same time there is a the link between the availability of ICT and industrialisation in the developing world. This in turn leads to a focus on using ICT to achieve educational outreach and economies of scale. In the industrialised world where access is more or less guaranteed the focus tends to be more on individualisation in education (Delors,

2000, p. 170). Thus, the same technology may assist the achievement of different purposes in different contexts for different stakeholders.

The IT industry as a contributing stakeholder

Major players in the information technology (IT) industry have supported, and actively promoted, the use of (their) products and services in schools: special pricing arrangements are common for education; and direct support for action research around the use of ICT in classrooms has been widespread. For example, Telstra was a stakeholder in the larger COLAT[1] research project of which this study is a part. *Apple Classrooms of Tomorrow* (ACOT) was another industry-supported project to research and develop use of ICT in teaching and learning. The project involved extensive collaboration amongst public schools; universities, research agencies and Apple Computer Inc beginning in 1985 and concluding in 1998, culminating in *Changing the Conversation about Teaching Learning and Technology* (Dwyer, 2000). Based on the ACOT results Apple Computer now offers several educational products in professional development[2] Similarly, Palm Inc., makers of handheld computers, contracted SRI International to conduct research into the usefulness of handheld computers as an educational tool and to aggregate the knowledge base of teachers in 102 classrooms in the 2001-2002 academic year. The results were favourable to the devices in terms of their "potential to have a positive impact on student's learning" (Vahey & Crawford, 2002, p. 17). The project also found that handhelds, used for science-based curriculum or for writing based activities, were most effective and that elementary school teachers were more positive than middle or high school teachers about the devices. Many of the participants in the study confirmed that the use of ICT has the potential to enhance educational provision and practices.

[1] COLAT "Children, Online Learning and Authentic Teaching Skills" an ARC LINKAGE project (PL0210823)

[2] http://www.apple.com/education/apd/

An Australian perspective

National reports largely mirror the international perspectives. For example, the Australian report *Learning for the Knowledge Society* (DETYA, 2000, p. 10) adopts the OECD position (2001), that education is recognised as a fundamental key to wealth creation and competitiveness in the emerging global information economy. In response, the DETYA report identifies five strategic action areas focusing on people; infrastructure; online content applications and services; policy and organisational framework; and a regulatory framework. The key outcomes for education and training are articulated in terms of 'citizens' (p. 20) rather than 'students'. The report emphasises the need for educators, trainers, industry and government to work closely together to ensure that "all citizens are able to use technology confidently and creatively…" (p. 20) and that "sufficient numbers of competent ICT specialists are being produced" (p. 21). Together these, and related outcomes and strategies in the report, indicate the Australian government's commitment to achieving the benefits of ICT use throughout the Australian society and economy and to do so by reducing some of the traditional demarcations (e.g., between industry, training and education).

At the national and state levels parallel initiatives have been underway for some time (DEST, 2002; DETYA, 2000)

International hopes for ICT in education

The United Nations is optimistic about the use of ICT to achieve increased well-being and success of people across the world. UNESCO's *World Communication and Information Report* (1999) highlighted the "significant challenge in preparing students and teachers for our future knowledge-based society" (Blurton, 1999, p. 46). The UNESCO report also emphasises that while digital ICTs are quickly becoming more accessible it is also important to note that earlier ICTs, such as radio and television, continue to play a critical role in education worldwide. New or improved digital devices are emerging, for example, mobile phones, global positioning

devices, cameras, networks… and these also have considerable potential to contribute to learning. Blurton concludes that

> digital ICTs…are inspiring remarkable transformations in education around the world… [in addition, they] …hold promise for the improvement of lives of the rich and poor whether living in developed or developing countries (p.43).

An important issue is the nature of any causal relationship between ICT and transformation and Blurton's attribution is noteworthy, namely that ICTs "…are inspiring remarkable transformations…" (Blurton, 1999, p. 43). Perhaps Blurton's statement implies that the transformations are emergent in response to the possibilities created by the new or improved digital devices, rather than actually caused by them.

Wide support for ICT

Educators, industry, school systems and governments have exercised major initiatives in relation to the use of ICT in teaching and learning. Some stakeholders see ICT as a means of improving efficiency in the educational process: for example, e-learning promises to expand the range of possibilities in relation to how, when and where teaching and learning may be undertaken. For example, on its website the Australian Department of Education, Science and Training (DEST) states

> Flexible learning expands choice on what, when, where and how people learn. It supports different styles of learning, including e-learning. Flexibility means anticipating, and responding to, the ever-changing needs and expectations of VET clients – enterprises, learners and communities. (Department of Education Science and Training, 2005)

Others see the use of ICT as a means of meeting community expectations for education to be contemporary (part of the information-age); or as strategic in the development of a nation's participation in the global information economy (DETYA, 2000). For adherents of the new technologies, the introduction of ICT into the classroom has engendered an entirely new and positive dimension to the art of teaching (Wheeler & 2004, 2001, p. 8). The implication is that the use of ICT in

teaching and learning is being developed in the midst of wide-ranging and overlapping stakeholder agendas including political, economic, professional and personal. Endorsement by educationalists concerned with pedagogy and preparing students for participation in their later lives is complemented by the beliefs and hopes of local, national and international authorities regarding the 'flow-on' of significant economic and social outcomes from the use of ICT in teaching and learning.

Some history of ICT in teaching and learning

In some parts of the world, including Tasmania where this study was undertaken, the use of computer-related ICT in teaching and learning in schools has a 30+ year history. Other forms of ICT pre-date current computer-based notions of ICT in education by some decades. For example, the School of the Air has used radio to provide tuition to children in the Australian outback since 1951 (Department of Culture and Recreation, 2005). The trends during the recent era have been increasingly towards digital technology. Over time, the use of IT has focused on teaching about computers and programming; learning to operate new ICT devices; using computer-based ICT to improve existing teaching and learning practices; and more recently applying computer technology strategically to transform teaching and learning.

Dissent in the literature

The majority of the literature considered focuses on elaborating the case for using ICT in teaching and learning, and included claims and reports of more good things, and less undesirable things. Difficulties are reported as obstacles to be overcome or needs to be met… rather than as reasons for reconsidering the general purposes and direction of incorporating ICT into classroom programs and practices (Tearle & 2004, 2004). That is, the majority of voices are positive with respect to the use of ICT. They also encourage problem solving in relation to less than perfect applications of ICT in classrooms. At the same time, proponents indicate

confidence in a significantly improved future that will include better, more convenient and meaningful learning supported by technology that is more effective.

At the same time, a small number of voices call for reflection. Watson (2001) claims that "the rhetoric for change has been too associated with the symbolic function of technology in society, which sits uncomfortably with teachers' professional judgements" (p. 1). He reports that ICT is "… still an imposed and novel 'outsider' in the pedagogy of schools" (p. 1). Watson also raises the issue of "Why has it proved hard for a … role for Information Technology (IT) to emerge in education?" (p. 1). In answering this question, Watson raises a possible connection between support for IT and the desire for change. This raises a more general question regarding ICT: is it a driver, or catalyst, or is it an enabler? In response, Watson proposes that "What is needed is an intervention of educational philosophy and debate. Teachers themselves must contribute to this debate, one for which they are both well suited and informed" (p. 13). This suggests that there is, currently, little in the way of debate and teachers may not be the major contributors to the growing body of knowledge involved.

The core issues

1. Thus the core issue arising from the introductory question to Chapter 1: Why is the idea that ICT can raise standards and student attainment "a belief instead of a reality…?" (Reynolds et al., 2003, p. 166) leads to two major questions: What is the impact of ICT use on teaching, learning and student outcomes?

2. What factors might shape the successful use of ICT in teaching and learning?

The Impact of ICT

In addition to the Becta report on ICT and Attainment (Cox et al., 2004a), referred to above, other major studies, meta-analyses and longitudinal studies have also

confirmed the potential of ICT to raise standards, but that potential is often not achieved, and the reasons are not well known.

The ICT Impact Report: A Review of Studies of ICT Impact on Schools in Europe (Balanskat, Blamire, & Kefalla, 2006) reviews seventeen studies and surveys carried out at the national, European and international level. The review considered a range of research: large scale impact studies; evaluations on national ICT programmes or initiatives; national inspection reports; evaluation of national initiatives, national research reviews, international and European comparisons and European case studies. Key findings (2006, p3) relating to the impact on learning and learners include:

1. ICT impacts positively on educational performance in primary schools, particular in English and less so on science and not in mathematics.
2. Use of ICT improves attainment levels of school children in English (when it is their first language) and in Science and in Design and technology between ages 7 and 16, particularly in primary schools.
3. In OECD countries, there is a positive association between the length of time of ICT use and students' performance in PISA mathematics tests.
4. Schools with higher levels of e-maturity demonstrate a more rapid increase in performance scores than those with lower levels.
5. Schools with good ICT resources achieve better results than those that are poorly equipped.
6. ICT investment impacts on educational standards most when there is fertile ground in schools for making efficient use of it.
7. Broadband access in classrooms results in significant improvements in pupils' performance in national tests taken at age 16.
8. Introducing interactive whiteboards results in pupils' performance in national tests in English (particularly for low-achieving pupils and for writing), mathematics and science, improving more than that of pupils in schools without interactive whiteboards.

In addition to the above, the review reports many other findings based on the opinions of teachers, students and parents. For example, "Academically strong students benefit more from ICT use, but ICT serves also weak students" (2006, p4). The studies indicate benefits for learning and learners in terms of motivation and skills, independent learning as well as teamwork. Similarly, the review identified considerable evidence of the impact on teachers and teaching in terms of increased enthusiasm, efficiency and collaboration, as well as teachers' competency and use of ICT. Barriers were also identified at three levels:

- teacher: usually to do with competence, motivation and training
- school: especially limited access to ICT and the absence of an ICT dimension to the overall school strategy
- school system: rigidity of the school system especially rigid assessment structures

The review also identified "a growing gap between high and low e-confident teachers and schools" and "a clear finding that teachers' practice is not changing much when they use ICT" (2006, p. 6).

Recommendations from the review include the following:

1. Plan for transformation and for ICT
2. Include new competencies in the curricula and assessment schemes.
3. Implement new forms of continuous professional learning in a workplace environment as part of a culture of lifelong and peer learning
4. Motivate and reward teachers to use ICT
5. Integrate the ICT strategy into the school's overall strategies
6. Transform positive attitudes towards ICT into efficient widespread practices
7. Create closer links between research and practice
8. Rethink the approach to evidence and its relation its relation to decision making

While the Balanskat report draws heavily on European studies, *The Impact Of ICT On Learning: A Review Of Research* (Eng, 2005) report reviewed studies from the

United States and the United Kingdom. The American studies confirmed that higher scores were attained by student receiving computer assisted instruction (CAI). In particular, Byraktar reviewed forty two studies of about 7000 students "finding that teaching and learning with technology had a small, positive, significant effect on student outcomes when compared to traditional instruction." (Eng, 2005, p. 642). The British ImpacT Project found that "there was evidence of a positive contribution to attainment in English, with a statistically significant effect of using word processing for pupils aged 8-10 years but only a partial non-significant effect for pupils aged 12-14 years"*(Eng, 2005, p643)*. The results provided significant evidence of a positive impact of ICT on pupils' learning in mathematics where ICT were being integrated into the mathematics curriculum.

Eng also reported on ImpaCT2, a longitudinal study involving 60 schools in England. Small positive effects on school achievement for higher usage of ICT were found at both the individual and school level. However, the relationship between levels of ICT usage and effectiveness was not consistent across all stages and subject area at the school level. The study also found that there are significant differences between students' use of ICT in school and outside of school.

Other large-scale studies and meta-analyses report similar findings although many highlight qualitative aspects such as favourable changes of behaviour, attitudes and relationships. For example, the NCREL report *Critical Issue: Using Technology to Improve Student Achievement* (2005) report Schacter's finding that students with ready access to ICT showed positive gains on researcher constructed tests, standardised tests and national tests (p6). The NCREL report highlights factors to be considered including the challenge of reaching all students (p8-10), ICT literacy (p4), possible provision of technology to students (p6), and the complex nature of change (p11). It found that use of technology is more effective when embedded in a broader education reform movement with implications for teacher training, curriculum, student assessment and a school's capacity for change (p7). In response to these

findings, the report sets out implications, recommendations and action options for those involved in developing the use of ICT in teaching and learning (pp12-18).

The above major studies and meta-analyses provide "clear evidence from the present findings that ICT has a positive, although small, effect on the learning of students" (Eng, p. 646). And furthermore,

> it is pertinent that ICT contributes positively to the learning in schools and for it to be effective, it requires the conscious effort of all the species in the school ecosystem, that is the principal, teachers, parents and students to make it work. (2005, p649)

In summary, there is consistent evidence that ICT can raise standards but the potential is often not achieve and the reason why ICT is, or is not, successful are not well known. The two issues of frequently unrealised potential, and the uncertainty regarding the reasons for success (or otherwise) in using ICT, provide the rationale for investigating the research question and the associated study reported in this thesis.

Key Factors

The second issue provides the focus for this study. There are several reasons for wanting to achieve a better understanding of the key factors. Different stakeholders need to be able to address issues and challenges from an informed basis. Governments and other funding bodies are responsible for the way in which they deploy resources in support of ICT in schools. Those responsible for the governance of schools share that responsibility. Accountability arrangements need to be fair and reasonable.

The leaders and administrators of schools and school systems need to provide appropriate support to ensure the success of teachers and students. This means more than specifying what teachers and students will do. It means that teachers will have the appropriate ways (practices and strategies) and means (facilities,

equipment, services and other resources) to achieve what is expected of them. Teachers need to make well-informed day-by-day judgements about which activities and experiences are appropriate for those students with whom they work. Such judgements require consideration of what is actually possible in that time and place with the ways and means at hand. Ideally this will provide a basis for engaging the others involved including students; their families; and colleagues. There are many parties directly involved and their engagement takes place within a number of discourses in which elaborate (construct and re-construct) purposes, activities, and beliefs including beliefs about possible relationships between ICT, and teaching and learning.

Three major discourses

Three main discourses relating ICT to teaching and learning based on a particular construct of ICT shape the search for a better understanding of the key factors. Typically, ICT is understood to be (1) a driver, (2) an enabler, or (3) a catalyst of new or improved teaching and learning.

1) ICT is a 'driver'. This construct attributes the present or future outcomes directly to ICT, largely independent of the situation. The assumptions are that the users simply need to have access to ICT, and to learn how to operate various devices and the rest will follow. The key development strategy based on this construct has two major elements. Firstly, the provision of technology and, secondly, professional learning focused in ICT related knowledge provided by IT experts. The construct implies all else should follow since ICT is deemed to be largely causal in the situation. The simplicity of this construct is attractive and tends to appear in marketing, political and senior management discussions and decisions. However, if ICT was a driver then the Reynolds question would be redundant: after the so much investment of in terms of money, time, commitment and energy in ICT over the past twenty year, the idea that ICT can raise standards and student attainment would indeed be a reality rather than a belief.

2) ICT is an 'enabler'. This construct attributes possibilities to the use of ICT. That is, ICT is believed to make certain outcomes possible. The availability of ICT is associated with 'potential' and in a sense, ICT changes the situation or context: ICT makes new ways and means available to those in the situation. This leads to a possible response to the Reynolds question. Whether an outcome is a reality or simply believed to be possible depends on whether the possibility has been realised. This study is based on the notion that ICT can indeed be an enabler. In turn, this leads to the second core issue (see above) and the focus of this study: What factors (in addition to the provision of the technology and ICT related knowledge) are necessary for the successful use of ICT in teaching and learning?

3) ICT as catalyst. Between these constructs of ICT as driver and as enabler is that of ICT as 'catalyst' implying that ICT is an enabler and that the devices (and/or the potential they create) are a stimulus. In this discourse, the availability of ICT is often seen as motivational. Student motivation is often attributed to their use of ICT. Clearly some (perhaps many?) students enjoy using ICT in their learning and in this situation ICT may be understood as a catalyst for learning and achievement. However, the matter of ICT and student motivation is neither simple nor universal. Some students are indifferent to ICT and others would prefer not to use it. Whether ICT is a catalyst depends on the response of the user. ICT can be understood as 'catalyst' in a second context. In many commercial and industrial situations, the availability of ICT may enable costs to be reduced and/or productivity to be increase resulting in a competitive advantage for those who adopt the use of ICT. In turn, others may adopt similar practices in order to remain competitive. In effect, the availability of ICT is a 'catalyst' for change in order to achieve an advantage or to avoid a disadvantage. A similar phenomenon can occur in schools: some teachers achieve greater status through their use of ICT, and some schools may use their ICT as part of a marketing strategy, or to meet the expectations of others.

These constructs have associated rationales for the use of ICT in teaching and learning: use of ICT as catalyst causes improvements in student attainment; use of ICT as enabler makes improved student attainment possible; and use of ICT as catalyst will result in changes (such as increased student motivation) that (may) subsequently result in improved student attainment. With varying degrees of clarity each discourse includes considers and addresses of the three core questions identified in the previous chapter: what is desirable; what is possible; and what is feasible?

Visions, but of what?

The literature advocating the use of ICT includes visions of computers as tools in the hands of learners being guided and supported by well-informed teachers. Such teachers would have a good understanding of how the learner might use the available ICT to enhance their learning by accessing the tools, services and resources that are available to the learner. According to Papert and Caperton (Papert & Caperton, 1999), most writers adopt one of the three types of vision. Firstly, visions of ICT as headlight, in which ICT is used to solve problems, such as, limited access to education (Nunan, 1996). Secondly, visions of ICT as a driving force. In such visions, the use of technology results in enhanced teaching and learning (ACOT, 2000). Thirdly, vision of ICT as possibility. This approach involves well thought-out education taking advantage of the potential of current and emerging technologies to make profound pedagogical progress as in Papert and Caperton (1996).

Advocating vision as possibility, Papert & Caperton place the central contemporary issue within education itself and not within technology. That is, they propose a Vision of Education in which the "primary commitment of education should be about vision." They propose that every citizen should enter the world with "A proud vision of self as a powerful life-long learner; a vibrant vision of a worth-while life ahead; an optimistic vision of a society to be proud of, and the skills and the ethic needed to follow these visions." (Papert & Caperton, 1999, p. 1) . Their

support for ICT arises from its potential to be useful in achieving "a worth-while life".

Thus the greater part of the reviewed literature arranges itself around various visions of the future in which ICT will have profoundly changed the 'what and the how' of education. These visions include a future in which teachers and learners draw on ICT to achieve new capacities to acquire, share, organise, and communicate information and undertake tasks over both time and space (Becta, 2001; Yelland & Swaminathan, 2003). Just as ICT has impacted on products and processes in virtually all other areas of human endeavour, so too there is an increasing expectation that education will undergo a matching transformation and soon. (OECD, 2001, p. 11). Such approaches are consistent with

> "the dominant view in the organizational world" (in which) "the future is split off" (from the present) "and exclusively focused on in the form of vision, simple rules, values and plans, so distracting attention from the present and reducing the future to simple aspects that can be manipulated to determine the present" (Griffin, 2002, p207).

Griffin is highly critical of such approaches given the complexity of the phenomena involved in everyday activity within organisations. This 'dominant view' ignores the reality that phenomena within organisations are largely emergent from the everyday activity and interactions of those involved. This makes prediction highly problematic (Snowden, 2005; R. D. Stacey, 2002) which has implications for the Reynolds question in that beliefs often incorporate predictions. Much of the literature is predictive in that it indicates the need for change but in doing so does little to make sense of the present: the starting point. Elaborating predictions and/or the need for change does have some possible merit in that the visions involved can become 'strange attractors' in a complexity sense, at least for some parties such as early adopters. Certainly, many of the schools and teachers participating in this study have been attracted to the possibilities associated with the use of ICT.

Hopes and reality

The paper *ICT – the hopes and the reality* (Reynolds et al., 2003) identify many official claims made for the effectiveness of ICT by politicians, industrialists, policymakers, civil servants, the media, related ICT support bodies and national agencies as 'optimist-rhetoric'. Very substantial investments have been made in the technology on the basis of such claims. The authors highlight two consistent aspects of the optimist perspective: firstly, the rhetoric highlights the potential of ICT to lead to substantial improvements in student attainment and secondly, and it highlights the need for teachers to adjust their pedagogies to ensure "different types of learning…related to the proposed use of ICT" (p. 152)(p. 152) in order to achieve the potential. The authors also identify an alternative discourse, the 'pessimist-rhetoric', which warns "against the danger of educators being drawn into the corporate trap" in which the use of ICT is identified as "distracting parents and teachers from the provisions of children's basic needs" (p. 153). Reporting on a study of the use and management of ICT in a number of British schools, they report cautious grounds for optimism for the widely held belief that ICT can raise standards. At the same time, they wonder, "why is this is a belief instead of a reality after the investment of so much in terms of both money, time, commitment and energy in ICT over the past twenty years?" (p. 166). This is the significant question that this thesis will attempt an answer, at least in part.

Could it be that some of the key factors relating to the use of ICT in teaching and learning actually lie outside the technology itself? As indicated above, some researchers suggest that the issues might be fundamentally pedagogical rather than technological, while others such as the OECD point to the need for organisational changes. Moreover, what are the implications especially for professional learning? After a review of research literature covering hundreds of reports of studies and meta-studies Cox *et al* (2004b) found that rethinking the role of ICT is necessary for professional learning to be transferred into in-class practices. The authors concluded that "…further substantial support for continuing professional development is necessary in order that teachers integrate the use of ICT and

improve pupils" attainment…" (p. 5) [however] "…little is known about the relationship between their [teachers'] experiences within professional development and their subsequent pedagogies when using ICT" (p. 36).

2.3 The focus of this study

This study focuses on identifying possible key factors involved in the successful use of ICT in teaching and learning. That is

> What are the key factors in the successful use of ICT in class programs?

This in turn raises the issue of learning and ICT in two senses. Firstly, at the student level there is a need for learning about ICT in order to be able to use it. Such learning creates potential for the student to use ICT to assist and enhance their learning activities and experiences and hence their actual learning. Secondly, at the teacher level there are similar needs. The teacher needs to learn about ICT. The teacher also needs to learn how to use ICT to enhance his or her own teaching and the students' learning. Thus the use of ICT involves multilevel learning and it is perhaps prudent to heed Bruner's insight that

> Any model of learning is right or wrong for a given set of stipulated conditions, including the nature of the tasks one has in mind, the form of the intention one creates in the learner, the generality or specificity of the learning to be accomplished (Bruner quoted in McInerney & McInernney, 2002, p. 152).

In response to this insight, a particular aim of this study was to identify and elaborate ideal stipulated conditions in terms of key factors to be addressed in the implementation and successful use of ICT (in primary classrooms). A subsidiary aim was to clarify the nature of the professional learning that will enable teachers and others to achieve these conditions in their classes and schools.

Success with ICT is clearly possible

Sources such as *Changing the Conversation about Teaching Learning & Technology* (Dwyer, 2000) report very positively on the effectiveness of ICT use in terms of problems solved and/or outcomes achieved:

> …teachers and researchers found that an array of tools for acquiring information and for thinking and communicating allows more children more ways to become successful learners. But they also found that the technology itself is a catalyst for change—encouraging fundamentally different forms of interactions…. (p. 13).

The Dwyer report, based on a review of the previous ten years of the ACOT project, does little to elaborate the key factors that enabled these impressive outcomes to be achieved, once again implying that the ICT caused the desirable changes.

Paradigms

Thomas S Kuhn wrote that scientific paradigms "… provide models from which spring particular coherent traditions of scientific research" (Arora, 2001; Kuhn, 1970, p. 10). However, changed circumstances may require new paradigms. In this sense ICT has brought about a situation where industry and commerce have had to find new paradigms for their endeavours, For example, the print based publishers of Encyclopaedia Britannica had to become electronic publishers in a very short period of time or fail as an enterprise (Arora, 2001). Education is being challenged to find a new paradigm that provides a new set of 'traditions' of educational practice coherent within education and enabling engagement in a world in which the use of ICT is increasingly influential and expected. The schools participating in this study had received considerable systemic funding for the very purpose of enabling the use of ICT in their class programs. For many schools and classes the provision and initial use of ICT preceded the development of well-understood sound classroom ICT-related practices. This same tension exists elsewhere as confirmed in an OECD report: "The neglect of teacher ICT training, which tends to lag behind physical investment, is often considered a major obstacle" (OECD, 2001, p. 93). The possibility is that teacher ICT training is only one of several factors that must be addressed in order achieve a new educational paradigm that will (in Kuhn's words) "… provide models from which spring particular coherent traditions of" educational practice.

2.4 What factors are significant in the implementation of ICT in classrooms?

Concerns and responses

John Daniel, Assistant Director-General for Education, UNESCO identifies three key concerns about the use of ICT in education: access, quality and cost (Daniel, 2002). In addition, he identifies several key issues such as "Why should we want to use technology? How should we use technology for learning and teaching? What are the basic principles? Who can benefit most from educational technology? Where should we apply it? Which technologies are best?" (2002). Achieving the best outcomes is, according to Daniel, fundamentally a matter of quality, that is, "fitness for the purpose at minimum cost to society" and he relates educational purpose to the creation of both human and social capital. At the same time, he identifies tensions between access, quality and cost. For example, increasing access and/or quality for a user is likely to increase the production and delivery costs involved. In response, Daniel proposes four principles. Firstly, to start from the position of the learner, and to use technology to create a stimulating environment for study where learners are in their own social situation. The second principle involves giving priority to technology that is actually available, and thirdly, to use the available technology in such a way as to minimise cost including the costs of production. Daniel cites the popularity of audiocassettes in some parts of the world because the technology is widely available and production costs are modest. Daniel's fourth principle involves attending to the quality of the teaching that can be delivered using the available technology. Thus, Daniel is calling for well thought-out situated rationales and strategies for the use of any technology in education.

ICT as strategic

The implementation in Australia of the Learning for the Knowledge Society plan includes *The Framework for National Collaboration and Flexible Learning and Vocational Education and Training 2000-2004* (DETYA, 2000). The aim of this framework is to "help our industries and citizens make a rapid and successful transition to the information economy by adding value to Australia's VET system of flexible learning" (DETYA, 2000p. 71) to be achieved by the strategic use of new learning

technologies, strategic partnerships, leveraged investment, employee involvement, and by being responsive to demands. Thus, at both the national and international levels, there is a clear understanding that responding to the potential of ICT requires more than simply adoption of the use of ICT. Collaboration and (flexible) learning are seen as central to the successful adoption of ICT in two ways: firstly, in order to be able to use the technologies effectively; and secondly, in achieving the personal, organisational and societal changes required (pp. 68-70).

Teaching and learning include the practices of design, development and implementation of teaching and learning environments and these are, in fact, a set of social practices. "Keeping social practices afloat requires the active involvement of skilled actors, but these actors are in turn dependent on the structuring properties of 'rules' (and resources)" (Giddens & Cassell, 1993, p. 11). At the local level, schools have responsibility for stewardship of the ICT resources provided and for developing 'rules' that will guide their use.

Policy

A 2002-2003 study of the institutions involved in the InterActive Education Project (Dale, Robertson, Shortis, & 2004, 2004) reported that, in relation to ICT and teaching and learning, policy exists at three levels: supranational, national and local. From this, there is an implication of the need for shared governance at least between these three levels. However from examination of the respective policies it was concluded that the "intrinsic educational mandate was, by comparison with the political/economic/social mandate that education was to carry, considerably restricted and unelaborated" (p. 463). The educational mandate was, by default, largely a local responsibility and thus local school governance was important in attempting to resolve it.

The study concluded that the "official policy ensemble shaped the management challenge for the schools" (Dale et al., 2004, p. 464). That is, the 'new' responsibilities and logistics resulted in a need for local school governance to attend to reframing the relationship between ICT and teaching and learning so that new

things would be enabled, and old things would be done better. The management issues arising from centralised policies centred on "achieving optimal combinations of hardware, software and human resource (comprising professional development, technical support and teacher attitudes)" (p. 464). Effective school governance has a vital role in resolving the "ways that ICT might augment or combine with existing approaches to teaching and learning to bring this about … national economic and social development and competitiveness" and "how these changes might be different from other curricular and pedagogic changes" (p. 469).

Governance, ICT and transformation

The school is the unit with the greatest potential for producing substantial student growth. In exploring the link between student achievement and staff development Joyce and Showers (1998) state that the failure to monitor implementation of curricula, instructional strategies, and other innovations has cost school improvement dearly in the past. These authors highlight the importance of governance in school improvement with respect to three components: individual professionals, the collective based on the school, and the systemic (e.g., school district or school system) since each of these has a direct impact on teaching, learning and administrative practices in a school with implications for school improvement. Thus it is clear that governance is a function that is shared across the school, its members, its community and the community/society in which it exists (Blase & Blase, 1997, p. 58) .

Most schools experience the incorporation of ICT into teaching and learning as a challenge and school governance has an important role to play in enabling schools to address the challenges they face. In this sense governance is the 'how and by whom' a school's people, activities and resources are coordinated to achieve the desired ends. And also, how these are "prioritised and combined into sets of documents, guidelines, advice, targets and indicators" (Dale et al., 2004, p. 459). Through policy and resource provision, many school systems have effectively mandated the use of ICT in teaching and learning in their schools. Similarly, schools

may also require teachers and students to use the ICT provided. The challenges concern the detail of how, and by whom, the available ICT will be used and to what ends.

The promotion of the use of ICT is based on a widespread hope or intention of causing a transformation of teaching and learning through the use of ICT. Similarly, reinventing governance has been central to many initiatives aimed at transforming schooling including less centralised approaches to school management aimed at reducing the separation of schools from their communities (Beck & Murphy, 1995, p. 85). Thus, both ICT and governance initiatives attempt to transform teaching and learning. It is perhaps ironic that the introduction of ICT into schools places new challenges on the school governance in order to resolve the restricted and unelaborated educational mandate (see above) accompanying the local, national and supranational ICT initiatives and policies affecting the school.

Teachers must change their practices

In addition to learning about ICT, and planning for and supporting its use in the class program, there is a need for teachers to acquire new knowledge and skills and a capacity to fulfil the changed and extended role in which the "teacher functions more as a facilitator and less as a lecturer" (OECD, 2001, p. 74). This requires substantial professional learning and more teacher networking and cooperative practices to support the diffusion and development of methodologies that incorporate the use of ICT. Teacher professional learning in relation to ICT needs to begin in initial teacher education and to be extended through continuing (in-service) professional development. Expertise with ICT frequently lies with students. However, this does not undermine the central role of teacher enthusiasm and skills, especially in association with skilful application of ICT within the teacher's subject expertise. Students strongly confirmed this observation (p. 86).

Pedagogy

Emerging new expectations of the teacher

That beliefs shape responses to proposed changes was frequently highlighted in the literature, for example, "Implementing change in education must include changing teachers' practices and beliefs" (Dwyer, Ringstaff, & Sandholtz, 1997, p. 11). With few exceptions, most writers are proponents of the use of ICT generally, and in education in particular. The rationales focus on expected and/or demonstrated benefits (Dwyer et al., 1997; OECD, 2001). The proposed changes include new roles and working relationships for teachers and learners, in which there is an increased emphasis on collaboration, shared meaning and undertaking joint projects or personal projects with the support of others (Kirsh, 1999). Thus, in this context, the teacher's role moves from instructor/director of students to that of facilitator/collaborator and co-constructor of knowledge with learners (Dwyer, 1994, p. 9).

While there is broad agreement that technology can be the means of improving education this literature review found very little on the non-financial costs of incorporating ICT into educational programs. This study will report on several such costs identified from the observations and will show that cost effectiveness (a combination of both improvement and cost) is a significant factor in the use of ICT in most classrooms. The issue of critical success factors is touched on, but these relate more to teacher responses than the management of ICT provision and its use across the school. The financial costs of acquiring ICT can be considerable, but other costs are rarely identified in the literature. The internet is recognised as having considerable potential to reduce the costs of educational provision, and this may well be true in relation to the delivery of learning materials and the means of communication. However, preparation and packaging of materials for online learning can be very costly in terms of time and energy (Nichol & Watson, 2003).

A Learner-Centred Pedagogy

Some ICT learning devices such as computer assisted learning (CAL), CDROMs using drill and practice exercises can retain a behaviourist orientation for specific purposes (McInerney and McInerney 2002). In these situations the (individual) learner focuses on a computer screen and works with highly structured content managed by the computer, resulting in stimuli limited to those strictly deemed relevant to the learning task by the designer/developer.

Much of the literature relating to pedagogy and ICT adopts a learner-centred perspective since the learner is the user of the ICT. Such a view is consistent with the works of cognitive psychologists such as Piaget, Vygotsky, and Bruner. As a result, the tendency is towards social cognitive learning theories. *The 14 Learner-Centred Psychological Principles* (APA, 2002) provide a balanced framework for considering actual pedagogies from a cognitive and social cognitive perspective. They focus on psychological factors that are primarily internal to and under the control of the learner, rather than on conditioned habits or physiological factors. However, the principles acknowledge external environment or contextual factors that interact with these internal factors. These fourteen principles consider:

1. The nature of the learning process;
2. The goals of the learning process;
3. Construction of knowledge by the learner in association with others;
4. Strategic thinking by the learner;
5. Thinking about thinking by the learner;
6. The impact of the context of learning;
7. The learner's motivation and emotional influences on learning;
8. The learner's intrinsic motivation relevant to personal interests,
9. Provision for personal choice and control;
10. The effects of motivation on effort: the influences of the learner's development on learning;
11. The social influences on learning;

12. The individual differences in learning between learners;
13. Consideration for diversity; and,
14. The integration of appropriately high and challenging standards

All these principles are integral parts of the social constructivist learning process. Points 3 and 11 are explicit in this regard and other points have social and constructivist implications. The word 'teacher' occurs only four times in the full statement of the principles, whereas the word 'learner' occurs 37 times. Many of the claims made in the literature for the use of ICT, may be aligned directly to several of the above principles. The implication from much of the literature is that ICT can be used to make better provision for a wide range of factors that impact on learning: motivational and affective, cognitive and metacognitive, developmental and social, and individual student differences.

Collaboration and ICT

"Constructivist views of learning emphasise the active role of the learner in building understanding" (McInerney & McInernney, 2002, p. 4). In particular, "social constructivism (Engestrom, 1991; Huitt, 2003; Shotter, 1993) focuses on the learner's construction of knowledge in a social context, with the individual making personal meaning from socially shared perceptions." (p. 5). The recent use of the term ICT, rather than just IT would appear to reflect the increasing importance of communication and collaboration underpinning the use of technology. The successful use of ICT reported by ACOT typically took place in collaborative situations in which participants enjoyed considerable support from their schools and external members of project teams. Indeed, a number of developmental frameworks for both the integration of ICT into class programs (Dwyer et al., 1997, p. 4) and for the development of the curriculum itself (Seaton & 2002, 2002, pp. 4-12) indicate increasing expectations of higher levels of collaboration and the achievement of shared meaning between teachers and learners, and between learners.

There is widespread agreement in the literature that the use of ICT ideally contributes to increased independence of the learner complemented by higher levels of collaboration with teacher and peers, often in relation to their community of interest (McInerney and McInerney 2002). ICT enabled communities of interest such as those around online gaming clearly involve substantial collaboration learning to learning in the form social construction of knowledge: participants readily share their existing knowledge and collaborate to solve problems and enhance their knowledge and skills.

Technology / infrastructure

Infrastructure may be necessary but it is not sufficient. In responding to a question about the present uncertain effectiveness of technology in schools (Papert & Caperton, 1999) write: "…throwing a lot of computers into an otherwise unchanged school will just leave you with an unchanged school" (p. 2). Rather, effectiveness relates more to the ways in which the elements of the infrastructure may mediate learning. The contribution of ICT to teaching and learning involves some implication of computer mediation of activities leading to learning. This ranges from computer-mediated communication (email, websites containing course materials…) as used in distance learning to the notion of learning objects. The latter are generally stand-alone online multimedia interactive devices within a learning management system (LMS). As students engage with learning objects, the LMS usually automates feedback to students and manages the students' progress through the learning activities involved. In the early days of learning objects, students were expected to be able to learn with little or no outside assistance. In recent times the notion of learning object has been moderated towards "online curriculum content to encourage student learning and support teachers in … schools." (The Learning Federation, 2006). Clearly, this more recent perspective has shifted a substantial part of the mediating role from the technology back to the interaction and collaboration between teacher and learner.

Home use of ICT

The benefits arising from home-school links using ICT are bi-directional. *Primary Schools of the Future– Achieving Today* (Becta, 2001) states that ICT has an

> impact on those factors which research outside the area of ICT identifies as having a direct impact on learning, viz, motivation; subject knowledge; teaching; pupils' effectiveness; school effectiveness; home-school relations *(p. 32).*

Central to the need for change is the potential for schools to be integrated with students' homes and other community facilities "in support of a new complementarity between formal learning in school and informal learning outside" (p. 15).

ICT increases the opportunities for strengthening the fruitful links between schools, homes and communities while extending the opportunities for students to learn at home or in the community. In this sense, "ICT encourages - and ultimately requires - a rapprochement between formal education and the learning that takes place outside the school" (p. 101) and this "underscores the seriousness of the situation for students who have no home ICT facilities and are therefore on the wrong side of the 'digital divide'. From this and other literature, there is a clear need for this study to consider home access to ICT as a potentially significant factor.

Classroom practices

The incorporation of ICT use into teaching and learning practices involves considerable change for most schools and the approaches adopted will be shaped by beliefs about change; assumptions made about ICT itself; notions of pedagogy; together with arrangements for the ongoing operation and development of the school including school governance. Ultimately, these school level developments must be consistent with, and supportive of the intended changes in classroom practices that will be enabled and/or enhanced by the use of ICT. The close connection between the use of ICT, activity and practices have been highlighted by numerous authors (Chaiklin & Lave, 1993; Engestrom, Miettinen, & Punamaki-Gitai, 1999; Lim, Hang, & 2003, 2003)

Activity theory – a developing framework

First generation activity theory was based on the work of Vygotsky (Daniels, 2001; Vygotsky, 1978) and provides a basis for understanding an activity in terms of the agent or subject (person) undertaking the activity mediated by artefacts (such as tools and/or texts) to achieve an object and as a result making progress toward a larger objective or outcome. This famous model (Figure 1) has been widely used to elaborate mediation of activity.

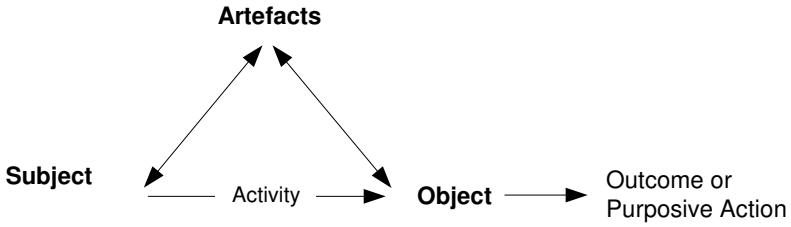

Figure 1 Mediation of activity by artefacts (after Vygotsky)

In the early work of the cultural-historical school, mediation by other human beings and social relations was not theoretically integrated into the triangular model of activity of Vygotsky. The triangular model of action gave little recognition to the part played by other human beings and the social relations in the activity. Such integration required a breakthrough in the concept of activity by distinguishing between collective activity and individual action.

This second-generation activity theory was developed by Leontiev (Bannon, 1997) and involved consideration of a division of labour between the individual and the collective as a fundamental historical process behind the evolution of mental functions. This related to the identification of three levels of activity. Firstly, the level of the whole *activity* carried out by a community towards an objective. This activity will include actions carried out by individuals, or groups towards the achievement of the shared goal. The third level of activity involves specific *operations* addressing conditions and carried out by human routines or machine functioning. For example, seeking employment (activity) may involve applying for a specific position (action) which includes the preparation of a CV (operation) that is well

presented in that it meets the requirements of the others involved. The computer and embedded word processor (artefacts) mediate the user's activity by automating some operations, such as checking the spelling, and enabling the user to carry out specific actions such the creation of a CV, or the retrieval of key information in relation to the activity of improving one's career possibilities. Thus, the use of the computer mediates the person's activity with the object of achieving a significant outcome such as career progress. Similarly, teaching and learning are also activities within which the parties carry out various actions to develop specific knowledge or skills. These actions may include specific operations involving in the use of specific ICTs, e.g., gathering information, using particular software, printing documents, communicating and collaborating with others, presenting information in certain ways, and so on.

Activity systems, as modelled by Engestrom (Figure 2), extend Vygotsky's notion of artefacts (tools, texts…) mediating the activity of a subject towards an object leading to the achievement of an outcome or some purposive action (see Figure 2 The activity system, below). The model incorporates the work of Leontiev to show the crucial difference between an individual action and a collective activity. The model includes the mediating influence of community, the division of effort and social, cultural, historical and 'rules' (principles, agreements, regulations…) applied to the subject as agent. Such rules are accepted or negotiated between the subject and the community in which the activity is taking place. Rules may apply to any other elements of the activity system on the activity and/or the relations between. In effect, rules become artefacts that mediate activity by enabling and/or constraining the division of labour, reshaping boundaries of the community involved, challenging or validating the object, and so on.

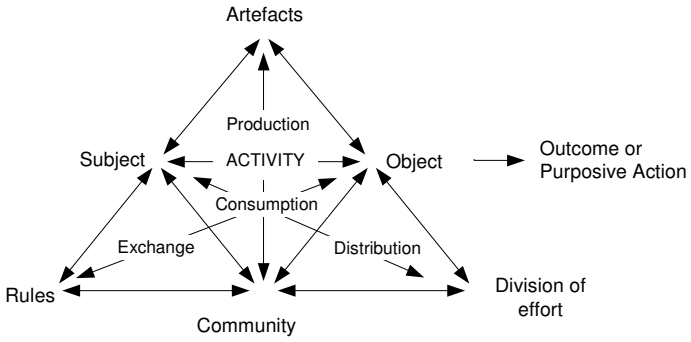

Figure 2 The activity system (University of Helsinki, 2002)

The activity system (Figure 2) provides eight constructs with which to consider the data relating to an activity: subject; activity; object; objective; artefacts; rules; community and division of effort. Thus, the elements of the activity system model are helpful in placing the subject, activity, object and artefacts in a social context.

The value of this contribution lies in extending the psychological perspective of the earlier Vygotsky model to include sociological (and organisational) considerations. While teaching and learning clearly involve major psychological considerations, classes and schools are social entities, and schooling is a socially situated process, there are major sociological considerations arising in relation to the use of the use of ICT in teaching and learning. Indeed the elements of the activity system are themselves are socially constructed in a dynamic and ongoing way. Engestrom represents this social construction as networks of activity systems (University of Helsinki, 2002).

Conceptualising the use of ICT in schools as mediated activities appears to be one useful structured way to organise observations. Therefore this approach was used to as a technique of analysis. The activity system model was particularly useful in summarising the practical implications of the findings in relation to the in-class use of ICT (Figure 5) and organization and management of professional learning (Figure 7).

Summary of ICT in teaching and learning

Numerous studies make the case for the use of ICT in enabling significant improvements in classroom practice through enhanced pedagogies, and improved student engagement and attainment. National and international studies of student attainment related to ICT have been comprehensively reported, as in the Becta report *ICT and Attainment* (Cox et al., 2004a). Such reports consistently endorse the potential arising from the use of ICT in teaching and learning that usually with explicit qualification. Few studies claimed to confirm outcomes as the direct effect of using ICT in teaching and learning. In most instances the potential is reportedly dependent upon "innovative and challenging uses of ICT" (p. 26) or some similar qualifier that refers to new pedagogies and, by implication, to professional learning extending beyond than operational knowledge required for managing and operating ICT in classrooms.

From this it follows that the uses made of ICT in teaching and learning are highly dependent on the pedagogical perspective and practices of teachers. There is widespread (but not quite universal) agreement that the use of ICT has the potential to significantly enhance student attainment but this belief is qualified by similar widespread agreement that substantial pedagogical innovation is required in order to achieve improved student attainment. The required pedagogical innovation is in turn dependent upon enabling professional learning of teachers. There appears to be little explicit agreement on the nature of the pedagogical innovation required. Examples abound but generalisations are few. As shown above, some authors envisage a very different future for schools and schooling, for example Papert & Caperton (1999) and Delores (2000). Other stakeholders focus on the capacity of ICT to overcome constraints such as time and place in providing teaching and learning (Blurton, 1999). Others outside of education, such as the OECD (2001), appear happy to leave the pedagogical detail to the pedagogues, without serious consideration of what may be involved. Little consideration is given to what enables and/or constrains pedagogical innovation. The desire for new professional practices leads rapidly to consideration of professional learning. Initiatives largely avoid

organisational, cultural and historical aspects of teaching and learning, and schools and schooling, by focusing on the knowledge and skills that teachers require in order to be effective in class. What are the implications of ICT for professional learning?

2.5 Professional learning and ICT

Integration of Information and Communication Technologies (ICTs) Through Teacher Professional Development (Pacey, 1999) provides a comparative analysis of issues and trends in seven APEC countries for the Canadian Council of Ministers of Education (CMEC). The study reports general agreement that the growth of technology in all societies was contributing to the pressure to adopt ICT in teaching and learning and that responding to this pressure posed both opportunities and challenges for the teacher in the classroom. The report identifies access, teacher readiness and sustainable professional development as three groups of interrelated issues. The report concluded that the "use of ICTs is believed to require significant changes for teaching professionals and that these changes cannot be achieved through a top-down approach" (p. 20).

Similar studies and reports have drawn similar conclusions. There is almost universal agreement that the incorporation of ICT into class programs requires substantial professional development (Cox et al., 2004b). Professional learning is necessary to ensure that teachers have the operational knowledge required to support the implementation of innovative pedagogies. Schools and school systems participating in the Cox study all provided workshops and seminars for staff to acquire knowledge of ICT. On a wider scale, structured local, national or international programs enable certification of the knowledge acquired. For example, the International Computer Drivers Licence[3] (ICDL) is a competency standard endorsed by the many governments, corporations and professional associations such as computer societies. The ICDL has been utilised by more than 4 million

[3] In Australia the ICDL is endorsed by the Australian computer Society: more information are available at https://www.acs.org.au/icdl/

participants worldwide and is the standard for computer literacy in over 150 countries. Similarly, the Pedagogical ICT License[4] is an international system of in-service training for teachers combining pedagogical knowledge of ICT integration with basic ICT skills training. Some 55,000, half of all teachers and educators in Denmark had participated during a period of three years and while not compulsory, it has become a formal and nationally recognised certificate.

In some countries, school systems have developed their own arrangements for the professional development and accreditation of staff members in relation to the use of ICT. For example, the Tasmanian Education Department provided a five-module arrangement for the acquisition and recognition of professional learning related to the use of ICT. The early modules covered knowledge and use of computing (e.g., word processing, email, the web…) with supporting training provided as required; later modules focused on the integration of ICT and classroom practice with accreditation being based on evidence of successful in-class use of ICT provided by the participants. Suitably trained mentors in each school provided support and leadership and carried out accreditation. The Tasmanian Education Department's *ICT in Education (K-12) Strategic Policy 2000-2005 (Education, 2002)* required an individual professional learning plan for each staff member and these were managed at the school level. The policy also required each school to have a learning technology plan. At the system level, several departmental units were required to carry out a wide range of supporting, enabling and monitoring functions in relation to the provision of technology and its successful the use in schools. Despite this very comprehensive, equitable and consistent approach to the provision of technology and support for its use, the Tasmanian situation still showed enormous variation from class-to-class and school-to-school in relation to the use made of ICT, as the results of this study show. The provision of up-to-date technology and extensive professional development were not sufficient to achieve a transformation of practices throughout the school system, hence the importance of this study's search for additional factors.

[4] Details of the Pedagogical ICT License are available at http://www.school-ict.org/

ICT changes the context

As indicated above, learning that utilises ICT requires some redefinition of the roles of teacher and learner. However, these roles involve situated activities and processes. The lack of an agreed generic pedagogical process model or framework constrains systematic examination roles and the reconsideration of what may be feasible when the ICT is introduced into the context. As a result, rather than transforming teaching and learning in an informed and coherent way, pedagogies tend to move (or do not move) in relation to the existing practices as result of the interactions of those involved. Such a view of organisational change has been developed by Stacey and colleagues who would see pedagogies emerging as a result of the complex responsive processes in organizations such as classes, schools, school communities, school systems and society (R. D. Stacey, 2002). These complex responsive processes include teaching and learning. They also include organising, playing, conversing, confronting… in fact all the interactions between all those involved and those who play a role in shaping the context.

Professional Development

Schools, their communities, school systems and other authorities expect teachers to acquire knowledge and skills in relation to the technology and its use in teaching and learning. In some instances, this includes addressing issues of student access to education largely independent of time and place. Another major use of technology is to support increasingly independent learners by enabling them to acquire resources and to construct their own knowledge, often in collaboration with others. As well as being used in classes, such approaches have been applied in professional learning. What follows is a brief review of relevant literature that reinforces the broadly held social constructivist view of learning as it applies to professional learning.

Forms of Professional Learning

Clearly, teachers play a role in rethinking the position of ICT in relation to their own teaching and the learning of their students. According to reports such as the

Apple Classrooms of Tomorrow studies[5] such rethinking is best carried out collaboratively: "When teachers work with colleagues and administrators who actively support fundamental change, there is far greater opportunity for successful growth of new beliefs and practices" (Dwyer et al., 1997, p. 11). Action research projects undertaken in this study are consistent with this proposition. One profound yet rarely noted implication arising from this idea is that rethinking the position of ICT is a situated activity in its own right. Few if any systemic initiatives appear to address this implication strategically. Rather, attempts are made to identify best practice and to make exemplars available to all teachers. In addition, policies consistent with the best practices are sometimes developed with the intention of achieving progress though compliance. However, this latter approach is often counterproductive It usually requires little in the way of genuine rethinking of educational purposes and practices since this has been replaced by the need to comply with policy.

Professional learning as a response to professional concerns

Professional learning may be understood in several ways. Typically, professional learning affects an individual teacher's career progression related to some frame of reference with particular dimensions. The dimensions may include levels of concern, or categories of behaviour such as demonstrated competencies, abilities and/or application of their learning. For example, the *Concerns Based Adoption Model* [CBAM] proposes seven developmental stages in adopting an innovation such as the incorporation of ICT into class practices (Loucks-Horsley & Hergert, 1985, p. xi). The developmental stages are indicated by the concerns (or interests) expressed by the adopter of the innovation. The seven CBAM stages may be summarised as follows:

1. Becoming aware is the initial involvement with a new practice.
2. Seeking /acquiring information.
3. Considering the personal ramifications of the innovation
4. Learning the processes and tasks of the innovation.

[5] See ACOT website: http://www.apple.com/education/k12/leadership/acot/

5. Gaining insights into the innovation's impact on students.
6. Cooperating with others in implementing the innovation
7. Considering the benefits and additional alternatives that might work even better.

While often useful as a communication device, such frameworks are not necessarily developmental in a linear sense. Rather the 'stages' may well be states of functioning that in turn depend on contextual factors. For example, changes in contextual factors may raise concerns associated with the earlier stages of CBAM. A class that has been fully integrating the use of ICT in its program may be required to return to learning about ICT because of upgrades or changes of devices or software.

Professional learning as a response to curriculum

Alternatively, Seaton (2002) sees transformation in terms of reforming the curriculum as a result of teachers acquiring (through professional development) the ability to utilise four curriculum forms. The use of ICT can be used to illustrate his four forms as follows:

1. (Subject) focused learning such as learning to use ICT
2. Transdisciplinary investigations such as in using ICT to investigate a topic or issue
3. Community development such as using ICT to undertake activities that further develop the learning community and/or the wider community of which the learners are a part
4. Personal learning projects initiated and undertaken by individuals using ICT based on key abilities including understanding; multi-literacies; problem solving; creativity; self-management; and community participation.

The use of ICT in each of the curriculum forms requires an appropriate construct of 'ICT'. For example as something to be studied; as a means of acquiring information; as a way building relationships and networks for collaboration; and, as a set of tools and services to extend one's capabilities. From this perspective, professional learning is seen as the key process in achieving the transformation

required as demonstrated through the delivery of a reformed curriculum. Seaton's framework is potentially useful in two ways:

- it provides the means for implementing a transformation of the curriculum
- it can be used to plan and implement professional learning.

Communities of practice

Other approaches to professional learning focus on managing arrangements to facilitate learning each based on particular assumptions and strategies. An emerging and widely used form of professional development involves the development of communities of practice (Onge, 2002; Stuckey, 2002; Wenger, 1998, 2002). These are groups of people (a 'community') sharing a body of knowledge (such as about teaching and learning and ICT) and engaged with each other as members of a (professional) learning community focusing on the sharing and development of a particular set of practices. Individual members participate in such learning communities in ways that involve the collaborative negotiation of meaning around activities and experiences involved (Wenger, 1998, 2002) . Wenger elaborates four dimensions of learning in communities of practice:

- learning as belonging (to the community)
- learning as becoming (identity arising from personal histories in relation to the community)
- learning as experience (elaborated in negotiating its meaning);
- learning as doing (practice as mutual engagement).

Such learning is clearly social and therefore highly situated and it can utilise a wide range of pedagogical strategies. Expertise may be shared through tutoring while individuals and subgroups may be assisted in meeting their day-to-day challenges with the support of mentors from within the community of practice. While systems can support such an approach to professional learning there are limits to what (school) systems can do to promote and support the development of communities of practice. Systemic initiatives tend to change groups from communities of practice to project teams. The resultant learning is therefore often constrained and the basis

of roles tends to shift from expertise to organisational authority and responsibility thus lessening the 'community' dimension of the group.

Professional learning for activity

Regardless of its perceived forms, professional learning is clearly a form of activity, and hence may also be considered in terms of Activity Theory (Lim et al., 2003). Specifically, professional learning initiatives may be understood as activity systems (Engestrom et al., 1999) with interaction between tools and artefacts, rules, the division of effort, the extended community as the subjects (teachers) engage in (professional learning) activities with an intended object in order to achieve specific outcomes. Such an approach is flexible yet consistent, and will be used to elaborate the results of this study in relation to professional learning. In particular, the results will challenge the 'training' (learn then apply) approach adopted in much professional learning related to the use of ICT. Engestrom's revised cycle of expansive learning (1999) is a developmental approach that integrates organisational development, improvement of activity (practices) and (professional) learning on an ongoing basis. The strategy is collaborative and highly situated in contrast with some other models of professional learning in which learning is assumed to be individual and is somewhat separated from day-to-day practices (at least in time).

Approaches to professional learning - summary

These examples show that professional learning can itself take many, often overlapping forms including: the acquisition of operational knowledge and skills; the resolution of concerns experienced in transition; the development of constructs of phenomena such a new notions of curriculum; engaging in arrangements that support the sharing of professional expertise. In addition, these different professional learning frameworks often overlap. For example, a group of (professional) colleagues functioning at Stages Six and Seven of the CBAM approach is largely consistent with being a well-developed and mature community of practice.

Professional learning results in new knowledge

Teaching and learning are purposeful activities requiring knowledge. Some of the required knowledge may be generic, that is, applicable in wide range of situations. For example, some aspects of operating an IT device (e.g., a particular word processor) are largely independent of the context in which it is being used. Similarity of equivalent devices means that some knowledge of such devices is generic. On the other hand, in order to implement a pedagogical strategy a teacher must acquire, construct and/or develop knowledge covering a wide range of phenomena occurring in, and relevant to, the specific teaching and learning activity being undertaken with the particular application or device in the specific situation. Some of the required knowledge will relate to operational steps based on an understanding of the technology and devices being used. Other knowledge relates to the moment-by-moment context and practices occurring in actual classes in local schools in local communities (Kirsh, 1999).

Thus, some of the required knowledge is known or knowable, as is the case of the knowledge required to operate specific ICT devices. Such knowledge is also largely independent of situational factors and may have usefulness over considerable periods of time and in a wide range of other situations. The phenomena involved are predictable and the associated practices are likely to be readily transferred to new situations. Related information may be provided through training workshops, in publications, and on the Internet. Professional learning in relation to such knowledge is often successful on an expert-novice basis.

On the other hand, the use of ICT in teaching and learning also requires knowledge of the class, school, school system…in terms of their histories, cultures, purposes, relationships and interactions, values and norms … and so on. Such knowledge is likely to be highly situated in both place and time. Consideration of these elements may require understanding their nature, their interaction, tensions and disturbances between them in order to provide some opportunity for achieving progress or improvement.

Best practice and professional learning

Best practice is often identified through case studies and is reported in numerous national and international academic and professional journals and reports. Such reports tend to focus on the demonstrated successful use of educational technology thus reinforcing (by implication) the potential of ICT. Studies of best practice attempt to identify and describe ideal technological provision and/or successful teaching practices. Major national and international reports draw heavily on identified best practices to provide exemplars, guidance, recommendations and policy in relation to school initiatives, in-class practices and the provision and management of professional development. The Australian publication *Making Better Connections* (DEST, 2002) is a good example.

There is an underlying assumption on which this strategy is based, namely the provision of exemplars will encourage, promote and perhaps enable the development of similar provision and practices elsewhere through emulation. That is, that best practice is readily transferable and that emulation is a feasible transfer strategy. However, emulation may not be sufficient to enable the effective transfer of arrangements and practices since such activity is highly situated requiring social reconstruction before use in new situations. For example, few schools enjoy the kind of provision and support enjoyed by participants in the ACOT initiatives, yet the studies imply what is possible in other situations.

Transferability of practices

Where the phenomena are consistent over periods of time, emergent patterns are often discerned enabling the phenomena to be dealt with as if 'known'. Identified practices may simply be patterns of interaction that are consistent in particular situations over time. Patterns of interaction existing in a specific situation act on, and are acted upon, other phenomena in the situation (R. D. Stacey, 2002) and the outcome may be continuity and/or change. As a result, the transferability of practices based on situated phenomena is in doubt because of the inevitable differences between situations. A pattern of interaction that has emerged in one

situation will necessarily emerge, even in a 'similar' situation. It is highly likely that differences relate to phenomena that are critical to the success of the practices being transferred.

Successful practices may be identified by their outcomes without identifying the contributing or key factors involved. Moreover, even if known, it may not be possible to replicate the same conditions in a new situation. For example, one school may be highly successful in developing and implementing a highly innovative initiative. Another school may attempt to adopt the same practice yet have only modest success. Most innovation is in response to a need. The 'need' may not be experienced in the adopting school. Nor is the adopting school likely to experience the same level of challenge and achievement in simply implementing the practice. At the most basic level schools/classes to which a best practice is 'transferred' by decree may simply comply. In relation to the range of responses to technology and associated practices Sandholtz, Ringstaff, and Dwyer (1997) identified five stages of adoption: entry, adoption, adaption, appropriation and finally invention (pp. 6-10). Professional learning is significantly different at each of the stages. For example, at the entry level professional learning focuses on the basics of using the technology and/or the practices whereas at the invention stage professional learning is about discovering new uses for the tools and practices. The developer achieves a new practice at the invention stage on the basis previous professional learning and experience. An adopter of the new practice must start at the entry stage with respect to a new practice. The transfer of practices cannot be a direct process: clearly the recipient must begin by reconstructing the practice (entry level) in order to adopt, adapt and appropriate the practice, all of which may involve considerable professional learning.

2.6 Conclusion

From this review of the literature, it is appropriate for the use of ICT in primary education to be seen as a 'work in progress', with neither ultimate goals nor a comprehensive set of agreed practices in sight. The literature highlights the

necessity for teachers to change their pedagogies in order for the potential of ICT use to be realised. The literature also guides initiatives to meet the challenges involved in changing pedagogies. In the classroom, the teacher plays a key role in shaping the incorporation of ICT into class practices. A key part of this role involves providing access to online resources and services in support of the teaching and learning in the class program. Figure 3 below represents some key relationships diagrammatically. Several of the relationships are less well elaborated in the literature extant, and this helps to focus the particular research question for this study. While it is supportive and encouraging in terms of outlining the potential benefits, the literature gives less consideration to the challenges for schools. Indeed, many case studies were not studies of schools but of teachers and classes. Classes are very much situated within the schools to which they belong. Thus, there is a need to consider both classes and schools at the same time.

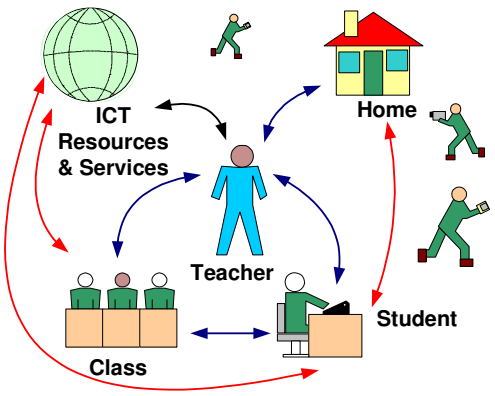

Figure 3 Online learning relationships

In this chapter, a number of significant themes have been identified relating to what is currently believed, known and/or understood about the use of ICT in teaching and learning. In particular, the review elaborated a wide range of local, national and international major stakeholders with an interest in the use of ICT in teaching and learning. Their specific agendas are in some respects disparate while having the common thread of hoping to enhance student attainment in the quality of teaching and learning. The agenda of educators focuses on improved quality and availability

of teaching and learning as an outcome. The agendas of other stakeholders tend to focus on social and economic matters, but all agree that the use of ICT to enhance education is important and strategic to achievement of their respective goals.

The stakeholders' base their commitments on the widely held agreement that the use of ICT has considerable potential to contribute to improved teaching and learning. To support this agreement and the underlying beliefs, there is a substantial body of case studies (Cuttance, 2001) and meta-studies reporting improved student attainment (Cox et al., 2004a) associated with the use of ICT. Another widely held belief is that the successful use of ICT in teaching and learning will require teachers to change their pedagogical practices. However, these are situated practices: they occur in particular classrooms, in particular schools, with particular students at particular times… and these in turn shape the conditions for classroom learning and professional learning referred to by Bruner.

There remains something of a mystery regarding the uncertain and widely varying outcomes arising from all the efforts and investments to implement the effective use of ICT in teaching and learning in schools. This includes the issue of sustainability of the use of ICT in teaching and learning in specific situations. Successful efforts and experiences are frequently not sustained for extended periods.

From the review of the literature, the implications are that, the potential to use ICT to enhance teaching and learning is real but the lived experience is often something considerably less. Perhaps the article *Computer Meets Classroom; Classroom Wins* (Cuban & 93, 1993)may still be valid after all. The following chapter outlines the methodology used to investigate the conditions under which the use of ICT is more likely to be successful and the implications arising for the professional learning of teachers.

Chapter 3 Methodology

> Interview topic: Experiments on live animals
> Interviewer: Why don't you only do those experiments that will tell us what we need to know?
> Scientist: We cannot know what we need to know until we know what there is to know.
>
> ABC Radio National (circa 2002)

3.1 Introduction

The Introduction (Chapter 1) developed the hypothesis that there are significant and identifiable factors that are in enabling or constraining the successful use of ICT in class programs. In the Literature Review (Chapter 2) the research question was further developed:

Research question: What are the key factors in the use of ICT in class programs?

The use of ICT involves socially, culturally and historically situated activity mediated by artefacts (including ICT devices) in order to achieve an object related to a purpose. In response, the study takes a social constructivist perspective and makes some use of activity theory. It should be noted that the use of activity theory in this study differs somewhat from some more conventional applications. One common use of activity theory is in accounting for intervention and change in organisations over time, for example, in terms of Engestrom's cycle of expansive learning (Engestrom, 1999). This study uses activity theory to account for differences between a range of situations rather than accounting for change within a specific situation over a period of observation.

The following sections describe the methodology used to answer the research question in two distinct contexts: firstly, in 50 classrooms in 28 schools; and secondly, in action learning projects in four other schools.

A small number of consistent themes around the use of ICT in teaching and learning emerged from the literature reviewed in the previous chapter. Firstly, as information and knowledge economies develop throughout the world, the use of ICT has become a fundamental requirement for successful and sustainable government, business and industry. Secondly, access to and competence with ICT is fundamental to one's success and well-being as a member of increasingly information based communities and a knowledge society in general. Opportunities for employment, education and actual participation in contemporary society, are increasing associated with the use of ICT. Such participation requires the ability to acquire and produce information, to communicate, to interact and respond. Thirdly, there is widespread support for the use of ICT in teaching and learning for the above reasons and because it is believed that its use will enhance learning outcomes. Fourthly, the use of ICT will also help overcome some of the constraints associated with traditional education, for example, the limitations of time and place associated with traditional schooling.

ICT organisation in schools – the context of the study

The typical organisation of ICT within participating schools provided for two to four internet-connected computers in every classroom. Users were able to print from these computers. Because of major state-wide funding, the dominant software had become Windows-based Microsoft Office and MS Internet Explorer in government schools and equivalent software for the Macintosh operating system in Catholic schools. Educational software and CDROMs were also available in but these were used more extensively in the Catholic schools. The range of peripherals available varied considerably from school to school with leading schools typically having more and better managed devices available. Both school systems had previously provided hardware and software more specifically developed for

classroom use. For example, at the time of the study government schools had only recently changed over from BBC & Acorn computers to mainstream PCs

Schools and classes received support in three main forms. Technical support was provided by visiting technicians who were responsible for maintenance of the school network and troubleshooting problems with hardware and software. In-school resource teachers (IRTs) provided professional leadership and support related to the use of ICT in teaching and learning. In addition, each school system provided professional learning opportunities for teachers largely on an expert-novice basis.

Choosing an approach

There are significantly differing views on how to understand educational research. For example, Gall and Borg understand research to be the generation of useful facts, and science as the generation of theory (1996, p 12). Their understanding is that some research may be scientific while other research is merely practical in terms providing an accurate account. Ticehurst and Veal (1999, p.2) avoid consideration of scientific issues and adopt the view that research may be understood as "a systematic, careful enquiry or examination to discover new information or relationships and to expand/verify existing knowledge this some specified purpose". Langenbach and Vaughn (1994, p.1) acknowledge that research is difficult to define and their perspective is that it is "an activity that makes an impact on theory" (p. 1) where the role of theory is to describe or explain the phenomena. From these three examples, it is clear that notions of research may be expressed in terms of methods and/or outcomes. Thus research activities may attempt to answer questions, verify or disprove hypotheses, establish the conditions under which certain phenomena may occur, replicate previous studies. The intended outcomes may include achieving a better understanding of particular situations (market research is a prime purpose) or to provide a 'theoretical' basis for understanding and thinking about specific phenomena.

Of these possibilities, this study focuses on identifying the conditions under which the use of ICT in classes is likely to be successful . This would provide a basis to

- inform the design and development of support for teaching and learning practices that incorporate the use of ICT
- enable the substantial expectations of ICT use in teaching and learning to be rationally considered and initiatives to be well designed and implemented
- understand the widely varying responses in the classes and schools
- improve the provision and management of the ICT infrastructure in schools.
- shape professional learning to support the use of ICT in class programs.

To these ends, it was decided to adopt a qualitative approach.

Qualitative research

The methodology adopted has several features of a grounded theory approach in which "theories and models should be grounded in real empirical observations" (Ticehurst & Veal, 1999, p.105). Data was collected by observing and recording classroom activity and interactions, examining written documentation and literature, and by obtaining perspectives from various people involved in the social interaction in an attempt to empirically ground the study (Strauss & Corbin, 1998). Properly managed, such an approach enables a study to meet several criteria (p.270-2):

- the concepts are generated from the data gathered
- the concepts are systematically related
- the categories are well developed and have conceptual density; the concepts have been examined under different conditions
- the conditions under which variation can be found are built into the study and can be explained; the research process itself has been taken into account
- the theoretical findings appear to be significant and judgement can be made about the extent to which they are significant
- the theory generated has the potential to stand the test of time and to become part of the discussions and ideas exchanged among relevant social professional and stakeholder groups.

Strauss and Corbin (1998, p.7) have also identified several characteristics required of a qualitative researcher in order to become a grounded theorist. Such a researcher needs to be able to step back and critically analyse situations, to recognise the tendency towards bias, to think abstractly, to be flexible and open to helpful criticism. There is also the need for the researcher to be sensitive to the words and actions of respondents and to have a sense of absorption and devotion to the work process (p.7). A qualitative approach has the capacity to challenge the initial assumptions and many commonly held beliefs identified in the literature. It also brings together the wide range of data necessary and available to uncover patterns and contradictions through the intuition and feelings of both subjects and the researcher (Ticehurst & Veal, 1999). To be well grounded, the researcher needs to be familiar with the data, the subjects, and the cultural context of the research.

This study goes a long way towards meeting these criteria but differs in that direct observations of in-school activity form a substantial part of the data collected. In contemporary grounded theory, it has become common practice to investigate phenomena by collecting and analysing coded versions of participants' accounts of the phenomena. As such, the data represent people's thinking and experience in relation to certain phenomena, rather than the phenomena themselves. That is, the processed data is somewhat removed from the phenomena it purports to represent.

This study remains as grounded as possible by retaining direct observations of the phenomena involved. Results are reported as cases illustrated by specific observations related to other specific observations.

There is minimal use of quantitative methods in any form of summative numerical 'result'. One reason for this is that observers were conscious that, while it was possible to identify certain instances of a phenomenon, it might not have been valid to conclude that no observation was evidence for the absence of the phenomenon.

Cases

Cases are widely used in social science research to examine real life situations through multiple sources of evidence. That is, data gathered from a number of sources are used to gain greater depth of insight and understanding, especially in relation to questions of 'how' and 'why'. As a result, each set of the early (Phase One) observations was written up as a case study in its own right, and the teacher and school were invited to respond in ways that might help ensure that the best possible record of the whole situation had been made.

Burns (1994, pp. 313-314) outlines several reasons why cases are valuable. Cases are valuable as preliminaries to major investigations, and this study formed part of a much larger investigation: *Children, Online Learning and Authentic Teaching Skills* (Robertson, Fluck, & Webb, 2006) . Case studies have the aim of probing deeply and analysing intensively, and this study was attempting to gain significant insights into relatively new territory. Cases may provide anecdotal evidence that illustrates findings that are more general. The focus of this study involves the activities and experiences of a range of teachers, students, classes and schools with a view to improving the use of ICT in class programs across stakeholder school systems in the first instance. Cases may refute a universal generalisation. Some of the literature refers to teacher resistance to, and lack of confidence in, the use of ICT in the classroom, and one intended outcome of the study was to achieve greater clarity on this issue. There would be value in understanding the extent to which teacher 'reluctance' may be a matter of reluctance as a personal response and/or, as a reasonable response to contextual factors such as local culture or school management and organisation. Cases are preferred when the relevant behaviours cannot be manipulated. This study was not trialling any intervention. Rather, the study was designed to have minimum impact on the subjects and teachers and class programs. Teachers were strongly discouraged from giving special attention to ICT during periods of in-class observation. Finally, Burns states that a case study may be valuable in its own right as a unique case. This study involved a series of fifty in-class observations in twenty-eight different schools and action research projects in

each of four different schools. While some similarities were expected and found, each class and project was unique in its social, cultural and historical factors. Examination of these similarities and differences using activity theory provided valuable insights. As will be shown in the Results chapter, the observations of individual cases can be elaborated using activity theory and the overall results can be readily summarised using Engestrom's activity system model. Thus, the reasons for using a modified case study approach are congruent with the nature of this study.

Ethics

All the observations made in this study were completed as an intrinsic part of *Children, On-line Learning and Authentic Teaching in Primary Education*, an Australian Research Council (ARC) Linkage project: LP0210823. The Chief Investigator for this project was Dr Margaret Robertson. Her associate researcher was Dr Andrew Fluck. Both researchers were members of the Faculty of Education, University of Tasmania and in early 2006 Dr Robertson moved to La Trobe University in Melbourne. The project received ethics approval on 29 July 2001: approval number H6116. The study also satisfied the ethics requirements of the industry partners: the Tasmanian Education Department, the Tasmanian Catholic Education Office and Telstra Australia.

Methodology - an overview

The research question is intentionally open-ended. It is not constrained to classroom factors, teacher best practice, or to the impact of the technology. Having established the research question, the subsequent study was designed to investigate two contexts from which data would be gathered. The everyday use of ICT in classes was addressed through in-school observations and the implications for professional learning by observation of action learning projects. Data gathered from each of these two contexts helped elaborate data gathered in the other context.

As summarised in Figure 4 (below), the methodology included the use of Activity Theory. Step 1 involved the collection of data. In Step 2, categories of phenomena related to the research question were identified. Theses categories were analysed further using elements of activity theory to develop a framework for considering the use of ICT in Step 3. The framework relating the categories was used to summarise the findings and implications thus providing answers to the research question in Step 4.

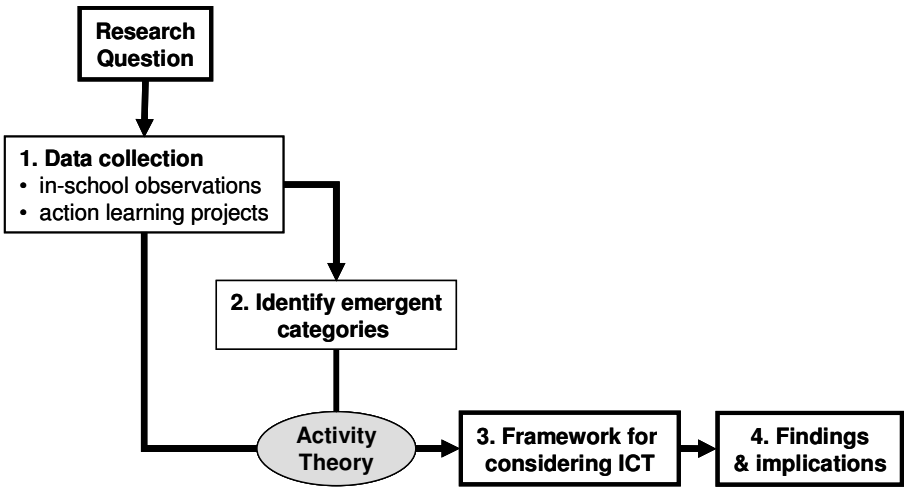

Figure 4 Methodology

In-school observations

Extensive observations were made in year 3 and year 5 classes (N=50) within a range of schools (N=28) (see Step 1 in Figure 4 above). The design of tools and methods used in the early observations aimed to collect data that would reveal factors that were likely to be significant. These observations challenged some initial assumptions and as a result, observation tools and methods adjusted accordingly. Categories of key factors were identified and refined in Steps 2 & 3.

Further analysis using categorisation and activity systems modelling enabled the development of some notions (a framework) to explain the relationships between the key factors (Step 3) and to elaborate the implications (Step 4).

Implications for professional learning

An equivalent methodological process was used for the action learning projects (Step 1) undertaken by schools (N=4). Each project focused on the school's particular professional learning needs at the time of the projects. The projects included consideration of some of the key factors emerging from early in-school observations. The projects were treated as case studies and analysed using a categorisation approach (Step 2). The combined results of all four projects were subject to activity systems modelling in order to develop a framework for considering professional learning in relation to in-class use of ICT (Step 3). A second outcome of these projects was the elaboration of a professional learning cycle (Step 3) with significant implications (Step 4) for future professional learning.

The methodology outlined below explains the selection of participants (data sources) and the means of making observations and analysing the results in two contexts. The first context concerns the in-school observations and this is followed by elaboration of the action learning projects that were used to investigate professional learning.

3.2 Participating schools and classes

The classes & schools

Senior officers of the respective education systems selected the participating classes in consultation with the principals of the schools. Classes were identified on the basis that they included Year 3 and/or Year 5 students and that the teachers of the classes were known to be well regarded, and to have had some experience and success in using ICT in the class programs. In most instances, the teachers were also sufficiently confident about their practices to allow an observer to participate in the class for two or more days. This meant that the issue of the incorporation of ICT into the class program was unlikely to be overshadowed by other factors such as limited experience with ICT, a lack of confidence in using technology, or anxiety in relation to judgements that might be made by the observer. These 'conditions'

helped to ensure that the "subject's ability is reflected in the data and that other extraneous factors had as minimal an effect as possible" (Burns, 1994, p. 203).

In addition, the selection process meant that the participating teachers (with some exceptions) were leading practitioners in the use of ICT in their schools. Most were clearly confident about the potential of ICT to contribute to teaching and learning and were committed to its use.

Data Sources

Table 1 below, lists the data sources and provides the following detail

- Participating, schools (in order of observation)
- School system of which they were a part:
  - Department of Education or Catholic Education Office
- Classes observed in the school: Year 3 and/or year5
- School size:
  - Small = less than one class per year level
  - Single Stream = one class at each year level
  - Medium = one to two classes each year level
  - Large = more than two classes at each year level
- Location: rural, rural/urban or urban
- Educational Needs Index (ENI): percentile
  - Higher indicates disadvantaged school (low socio-economic indicators)
  - Lower indicates advantaged school (high socio-economic indicators)

Table 1 Data Sources

Phase One – Schools 1-6 (a 'pilot' study)						
School	System	Yr3 class	Yr5 class	School Size	Location	ENI
1	DoE	1	n/a	Medium	Rural/Urban	15
2	CEO	2	n/a	Single Stream	Urban	n/a
3	DoE	3	n/a	Large	Urban	25
4	CEO	n/a	4	Single Stream	Urban	n/a

5	DoE	n/a	5	Large	Rural	51
6	DoE	6b	6a	Medium	Urban	29

Phase Two – Schools 7-28						
School	System	Yr3 class	Yr5 class	School Size	Location	ENI
7*	DoE	7b	7a	Single Stream	Urban	94
8	DoE	8a	8b	Medium	Rural/Urban	43
9	DoE	9b	9a	Small	Rural	10
10	DoE	10b	10a	Large	Urban	28
11	DoE	11a	11b	Medium	Urban	24
12	CEO	12b	12a	Single Stream	Urban	n/a
13	CEO	13a	13b	Single Stream	Rural	57
14	CEO	14b	14a	Single Stream	Rural/Urban	n/a
15	CEO	15a	15b	Single Stream	Rural/Urban	n/a
16	DoE	16a	16b	Single Stream	Rural	52
17	DoE	17a	17b	Medium	Rural	46
18	DoE	18b	18a	Single Stream	Rural	15
19	DoE	19	n/a	Medium	Rural	8
20	DoE	20b	20a	Medium	Urban	78
21	DoE	21b	21a	Large	Urban	17
22*	DoE	Withdrawn		Medium	Urban	99
23	DoE	n/a	23	Medium	Rural/Urban	3
24	DoE	24a	24b	Medium	Rural	76
25	CEO	25b	25a	Medium	Rural	n/a
26	DoE	26b	26a	Small	Rural	13
27	DoE	27b	27a	Large	Rural/Urban	79
28	CEO	28b	28a	Large	Rural/Urban	n/a

Phase Three – Action Learning Projects						
School	System	Yr3 class	Yr5 class	School Size	Location	ENI
29	DoE	Action Learning Project 1		Large	Rural/Urban	82
30	DoE	Action Learning Project 2		Large	Urban	11
31	DoE	Action Learning Project 3		Large	Rural/Urban	70
32	DoE	Action Learning Project 4		Medium	Rural	14

*Note: The observations in school 7 (ENI percentile=94) and 22 (ENI percentile=99) were incomplete due to difficulties experienced in the schools. This may suggest that the challenges faced by these schools are such that the use of ICT becomes problematic.

For example, one teacher had abandoned use of the classroom computers because the children in the class had major difficulty taking turns (TQ7b).

3.3 In-school observations

Selection of classes

Informal observations in most schools indicated that most participating teachers were not representative of teachers in the school or of teachers generally. It was highly likely that the participating schools and teachers were having greater success incorporating ICT in their practices than may have been the case for the majority of schools. This raises questions about the extent to which observations made in these schools and classes can be generalised across all schools and classes. The principals of the participating schools were generally more optimistic about the potential of ICT to transform teaching and learning than were the participating teachers (Robertson, Grady, Fluck, & Webb, 2006).

The students

In each of the participating classes, the class teacher selected eight children to represent the class in closer observations. These subjects included a boy and a girl from each quartile in terms of general performance, using the following guidelines provided in the information provided to teachers (see Appendix 2):

> The most capable (in an overall sense) boy and girl the least capable (in an overall sense) boy and girl a boy and a girl a 'bit above average' (doing OK most of the time), a boy and a girl a 'bit below average' (sort of doing OK but sometimes requires a bit of extra effort on the part of the student and/or support from the teacher to ensure that things go well for these two).

The teachers were also advised that there was no need to take the students' interest in ICT (or lack thereof) into consideration. Acting within these guidelines, teachers were wise enough to not select children with high learning needs. An issue arose in terms of the representation of all four quartiles in some classes, where the year 3 or year 5 component contained less than eight students in its entirety and there were no students representing some quartiles of the general population. In response to

this difficulty, the teacher estimated in which quartile each students would be placed.

Other subjects

The process of having senior system officers identifying the participating classes effectively also selected the schools, principals and ICT coordinators, Principals and ICT coordinators were consulted in the course of the selection process and were supportive of the exercise. As indicated above, these members of the school staff were frequently enthusiastic about the possible contributions of ICT in class programs and in this sense tended to parallel much of the literature reviewed, even to sharing the range of positive visions and rationales described in Chapter 2. In a number of schools, it appeared that the principal was keen to have the achievements of the school and the teacher recognised through their participation in the study. Thus, it is unlikely that staff subjects are representative of the total group of their peers, and indeed some of the principals made the claim, with supporting evidence, that they were not representative of their fellow principals but rather leaders in the field. Therefore, data gathered from these sources may not be consistent with data that could be gathered from all schools and classes. It is also likely that the education system officers approached particular schools and principals because of their standing in the system as a way of identifying possible classes to be observed. There appears to be a phenomenon common that many schools use students' ICT-based work and activities in the leading classroom to illustrate the school's capacity and position in relation to ICT.

The class programs

Given the title of the parent investigation *Children, Online Learning and Authentic Teaching Skills* of which this study is a part, most participating teachers felt some obligation to demonstrate the use of ICT in the class programs. Observers went to considerable lengths to minimise the Hawthorn effect by encouraging teachers to undertake their normal class program during their observation time in classes: "We are keen to observe what the class would be doing if we were NOT here". It is

difficult to judge the extent to which this was successful. It was apparent that some class programs included more ICT use during the periods of observation than would have generally been the case.

In observing class programs, note was made of the extent and purposes of ICT use and of the arrangements made for students to access the ICT available. Over the course of the in-class observations, several themes or dimensions emerged that enabled similarities and differences between classroom practices to be identified and categorised.

The breadth of the data collected in each school resulted in something of a profile that served the needs of the participants as advocated by Rudduck (1993, p. 12). The in-school observations prompted participants to reflect on purposes, rationales, methods and experiences through a range of interactions with observers:

- interviews
- informal discussions
- visit reports
- materials available from the project web site
- workshops based on the school observations
- linking participants with similar interests in different schools
- linking participants within the same school (a significant feature of each of the action research projects).

Two phases of in-school observations

Phase One (effectively a 'pilot' study) – First six classes

After a brief search of the general literature in relation to the use of ICT in teaching and learning an initial set of six class observations were carried out to explore the impact of the use of ICT on the interactions between teachers and students, students and students and between students and other adults. In addition contextual information was gathered from the students, teachers, principals involved, and from other members of the school communities with a view to gaining insights into

possible factors impact on the use of ICT. Attempts were also be made to discern teachers' knowledge and skills that were enabling them to successfully implement the use of ICT in their class programs.

In effect, Phase One was a pilot study for the subsequent in-school observations. It was undertaken with a view to achieving a general understanding (background knowledge) of the current everyday use of ICT in class programs as a basis for further observations. This included:

- how the technology was being provided, used and managed in classrooms
- what the impact appeared to be on collaboration and other forms of interaction in the classroom
- what other factors might be reported or observed as having potential significance in relation to the effective use of ICT in teaching and learning in primary classrooms.

The initial approach intended to provide robust data and a capacity to focus on specific aspects of the use of ICT in the classes with minimal disruption and/or additional demands on the subjects. Burns (1994, pp. 5-10) provides a suitable model for such a study in that having defined a research problem, the intended research would then proceed through a data gathering process focusing on quantitative data as much as possible, to be followed by analysis and evaluation of the data using quantitative methods leading to the development of the final report.

Traditionally, quantitative research has been seen as valid and reliable as well as replicable, and is based on the validity of defining the boundaries of the system to be examined through operational definitions (for example the classroom, class and class program in action) under consideration. Such an approach may allow for hypothesis testing, replication and the extensive use of logic.

However such an approach, by itself, does not readily take into account the human element of the researcher's ability to "interpret experiences, construct meaning and act on these" (Burns, 1994, p.10) when investigating specific issues. This is a

concern to many researchers and early observations showed that attempting to limit the investigation to a classical scientific approach would prove to be a severe constraint. By contrast, qualitative research enables the researcher to take human individuality and thought into account, and thus develops different understandings from a variety of forms of research to take advantage of the data available. The chosen indicator of 'success' adopted in this study relies very heavily on individual thoughts, intentions and understandings of actions and achievements. The qualitative approach adopted in this study enabled the researcher to utilise the rich data available in order to address the research question.

In keeping with a pragmatic approach, interviews of eight selected students using the student questionnaire (SQ) supplemented the quantitative data gathered through the Student Computer Access survey (SCA). The purpose of these interviews was to provide some qualitative elaboration of the data from the class survey. In this sense, the study uses a mixed methodology in order to be pragmatic.

That is, it became apparent that a combination of qualitative and qualitative methods would be required in order to gain insights into possible links between ICT use and the extent of collaborative classroom arrangements. This would also give insights into the possible impact of such arrangements on learning outcomes, and on the impact of the teachers' knowledge and skills on the use of ICT in their class programs. While considerable quantitative data was gathered, the results (Chapter 4) draw more heavily on qualitative data consistent with the social constructivist perspective adopted in this study.

Phase Two: Consolidation and deepening insight

Examination of the data gathered in Phase One provided little support for continuing the focus on teacher-student and student-student interactions in the classroom. In addition, the initial data challenged some early expectations and highlighted the complex challenges facing schools and teachers, as they tried to incorporate the use of ICT into teaching and learning in class programs. Since important but incomplete insights had been gained through the observations made

in Phase One, the data gathering methods remained largely unchanged in Phase Two with the exceptions that detailed monitoring of the in-class interactions was abandoned and some aspects identified in Phase One received more attention. With the abandonment of Galton *et al* observations, and the refined perspective adopted in Phase Two, the number of days required for each set of class observation was reduced from four to two.

The attention of observers was significantly increased in relation to the challenges for teachers including 'reliability of the technology', and in-class organisation for student access to the technology. During subsequent observations and based of earlier insights, some of the instruments used to gather data were refined to allow for more detail.

The data gathered in Phase Two was used to refine the tentative 'key factors' that had emerged from observations in the previous phase. These observations confirmed widespread variation and inconsistency within individual class programs over time, between class programs across schools at the same time, and between schools. This led to an interest in the causality of the phenomena occurring within classrooms.

In school observations – a summary

Table 2 Observation Phases

Phase	Description	Focus
One	Observations 1 to 6 – initial insight	Classroom interactions ICT in the classroom Developing tools for Phase Two
Two	Observations: 7 to 50 – deepening insight	Potential key factors Refining observations & clarifying data Emerging notions of causality

The data gathering instruments facilitated the development of a comprehensive profile of the use of ICT in each class program, the provision that had enabled the

incorporation of ICT into teaching and learning, and the contribution of the school towards that end. In addition, interviews enabled the gathering of insights into the hopes, intentions and initiatives of the teacher and students and how these were being enacted in the classroom in relation to the use of ICT. These observations related closely to the definition of 'success' as used in this study. As a result, it was possible to identify features of schools, classes, class programs, ICT provision that appeared to be associated with success and well-being in relation to using ICT for teaching and learning.

Methods – In-school Observations

Extensive observations were made in year 3 and year 5 classes (N=50) in a range of schools (N=28) over two to four days in each classroom. The observer was present in each class while it was in session during each day of observation. During this time, structured observations were made using checklists to capture student use of the classroom computers as well as the summarising the ICT provision. These observations were supplemented with journal notes that captured unstructured observations, such as the way in teachers managed and led their class program, disruptions and competition for time and attention between elements of the class program and with school events and activities.

Other unstructured observations covered a wide range of matters relating directly or indirectly to student use of ICT. A common difference between classes was the extent to which student ICT use occurred within the main class program or in parallel with the bulk of the class program. There were differences between the use of ICT within the class program and during non-class time such as before school. In this regard, differences frequently related to time and energy invested, levels of collaboration, software used, and so on.

In addition, the observer interviewed the participating teachers, the principal, and the school ICT coordinator. Staff interviews were recorded on audio tape, and later transcribed. When mutually convenient, the observer also interviewed

representative students (8 per class) during class time. Student interviews were summarised initially in note form and later using the student interview form. All students in each class were surveyed and the class program observed in operation. The ICT provision for the class was noted and its use within the class program was monitored. Other observations were also made as a result of informal conversations and direct observations.

Methodology – data collection from in-school observations

Table 3 Data collection

	In-school observations	
Focus	Phase One: Mapping possible key factors Phase Two: Refining key factors and their interactions:	
Method	**Instruments (see Appendix 4): code**	**Resultant data**
Observations, surveys (verbal) & checklists covering • Interactions • Class ICT • Use of ICT • ICT & class program • School context • Classroom practices	Galton checklists: (discontinued Phase Two) - Student interactions - Staff interactions	Interactions in the classroom
	Student diaries (discontinued in Phase Two)	Student use of ICT
	Class discussion	Student knowledge and use of ICT
	Principal (and ICT Coordinator) Interviews: CQ & PQ	School history, practices and hopes with respect to ICT
	Checklist: Classroom ICT Environment:: IT	Classroom ICT
	Checklist: Computer Usage in the Classroom: CU	ICT usage in the classroom
	Student Interviews: SQ	Student access to, use of, ICT out of class
	Teacher Interview: TQ	ICT, learning and student use ICT and teaching and learning
	Direct observation: NC & NS Informal /incidental observations: case notes	Student's operation of ICT Case notes Student characteristics Class characteristics School characteristics

Methodology – analysis of collected data

The analysis of the data collected was undertaken in two phases that match the two phases of in-school observations.

Initial Analysis (In-school observations classes 1 – 6)

Table 4 summaries the purposes of the observations and the related method of analysis used to examine the observations made in the pilot study Phase One: Schools 1 to 6.

Table 4 Analysis of initial in-school observations

Aim of initial analysis	**Method of analysis**
Confirm the existence of anticipated phenomena	Gather data indicating the existence of the anticipated phenomena using initial instruments
Examine the nature of anticipated phenomena	Consider the data gathered with respect to the anticipated nature of the observed phenomena
Assess the likely significance of anticipated phenomena	Compare the apparent relationships between the observed phenomena with the anticipated relationships
Identify other phenomena emerging from observations that appeared likely to be significant	Consider the data gathered and attempt to identify additional significant phenomena
Provide a basis for refining the data collection instruments and processes accordingly	Where possible develop scales and categories to aid in collecting, recording and processing data

Subsequent Analysis (In-school observations 7- 50)

The analysis of data collected in Phase One provided a basis for refining the subsequent observations and the analysis of the results.

Table 5 Subsequent analysis of in-school observations

Aim of the ongoing analysis	**Method of analysis**
Refine the understanding of the nature and relationships of phenomena under consideration	Activity Theory - examination of cases Modelling of observations as activity systems

Refine the understanding of the significance of phenomena under consideration	Examination of activity system models

3.4 Design and development of instruments for in-school observations

In order to address the research question, instruments of several different types were developed to ensure the collection of a broad range of data to be available for analysis. Instruments included surveys, checklists, interviews and case notes as outlined below.

See Appendix 4 for copies of all instruments used.

Surveys

Initially, a decision was taken to adopt Galton's frameworks (Galton *et al.*, 1980) for gathering data about the teachers' and the students' in-class interactions. These data relate to the teacher style and pupil type and the extent of 'collaborative classroom arrangements' associated with the use of ICT in the class. This framework was abandoned in Phase Two as inappropriate as mentioned above.

Each of the following surveys used coding and recording methods that enabled data to be collected in a consistent and efficient manner thus making it amenable to further analysis.

Survey 1. Computer usage outside the classroom (diaries)

This survey (see Appendix 4.6) was developed to collect data about student access to, and use of, computers and online resources outside the classroom. Initially students were provided with diaries (recording sheets) to be utilised in the week leading up to the observations. Only a small number of teachers distributed the diaries to students and encouraged them to keep a log of their use of computers in the class and elsewhere for each day (including weekends). This process was abandoned when it proved ineffective due to the immaturity of the younger students, and the competing demands on the time and attention of both students

and teachers. This survey was subsequently replaced by the Student Computer Access survey (SCA).

Survey 2 Student Computer Access Survey (SCA)

In each class, the observer led a whole-class discussion about ICT after which all students were asked to complete the SCA (see Appendix 4.5). In doing so, they provided information about where and why they had used computers in the previous two weeks, including:

- their gender
- the number of computers at home
- whether home had internet connections
- the number of computers used at school (in class, library, computer lab, other classrooms)
- the number of computers used at other location such as friends' houses, the homes of relatives, work places, town library, neighbours' houses
- the kinds of uses made of the computers (games, email….) in each location
- the names of their three favourite internet sites (if applicable).

This validity of the data gathered using this instrument is likely to be high since it focuses on the recent specific use of computers by the respondents. The observer managed the use of the survey with the support of the class teacher who knew the children well. All classes received consistent instructions and advice from the observer. These data are judged reliable in that the surveys were completed individually, and there was strong encouragement to record accurate responses. In addition, some apparent anomalies were resolved by prompt follow-up discussions with the respondents. For example, one girl reported having six computers at home. In discussion, she explained that she had actually added the number of computers in each of the places that she deemed to be her 'home'. She regularly spent time in each of four homes: mum's place, dad's place, and the home of each pair of grandparents (four 'homes' with six computers in total). The instrument had in fact captured the relevant data accurately.

Checklists

Checklists were developed and used to monitor computer use in the classroom (CU) and to record the ICT provision in the class (IT). The data gathered using these instruments provide information regarding the teacher's incorporation of ICT into the class program. Each of these checklists also used coding and recording methods that enabled the data to be collected in a consistent and efficient manner, thus making it amenable to further analysis.

Checklist 1: Computers use in the classroom (CU)

The Classroom computer Use checklist (see Appendix 4.6) was used to record the number of students using each classroom computer at frequent and regular intervals during the course of each school day. The observations included the kinds of activities being undertaken by the students categorised by the *Key Information Technology Outcomes (KITOs)* for school students (Fluck, 1998). The actual tasks being undertaken, of which the activities were part, were also identified according to the Curriculum Forms framework (Seaton & 2002, 2002). Each snapshot also recorded the nature of the class program at the time of the observation.

Table 6 Tasks and activities involving the use of ICT

Tasks (Seaton 2002)	Activity (Fluck 1998)
1. Using ICT (e.g., learning to use an email application) 2. A transdisciplinary task (e.g., using presentation software to report on a recent class excursion) 3. A community development task (e.g., using a spreadsheet to summarise a research project about 'how we get to school') 4. A personal learning project (e.g., gathering information from the internet), or simply recreation (e.g., playing an online game).	• Operations • Publishing • Communicating • Researching • Problem-solving • Independent learning • Games

Checklist 2: ICT provided in the classroom (IT)

The class IT provision was recorded using the ITP checklist (see Appendix 4.7). The data collected includes the number of computers was recorded, their features and performance as well as an indication of the range of software and peripherals that were readily available to students. Data collection involved appraising

classroom workstations and associated devices, arrangements and services. Records were made of the make and model RAM [Mb], HDD (free space), operating system, processor speed, peripherals, including speakers, microphone and CD-ROM, web-browser and other installed software. Three measures of performance were used. Individual computer performance was indicated by the time from power on to login and the time to load MSWord. Internet performance was measured as time to load the homepage at www.acce.edu.au. Observers made a plan of the classroom layout indicating the locations of computers, and photographs taken showing the working arrangements supplemented this.

Interviews

Sets of questions were devised to guide interviews with each of the selected students (SQ), their teachers (TQ), principals (PQ), and ICT coordinators (CQ). The aim of these questionnaires was to gather beliefs, perceptions, intentions and anecdotal information from the various parties involved.

Student interviews (SQ)

A whole group discussion of ICT with each class provided an overall or general impression of the role and significance of ICT in the lives of the students. This discussion was followed by individual interviews with eight selected students, deemed to comprise a representative cross section of the class in terms of gender and academic ability. Teachers were specifically asked not to use interest in ICT as a selection criterion. As the study continued, insights emerged into the range of ways in which students were accessing ICT; their purposes in doing so; and the (working) relationships involved especially around learning and support for the use of available ICT.

As a result, these interviews became richer and more structured. In its mature form, the student questionnaire (see Appendix 4.1) was used to gather detailed information about

- the role of ICT in the lives of the students; their computer access outside the classroom
- the extent of collaboration with respect to the use of ICT
- possible incorporation of their use of ICT outside the classroom into the class program.
- the student's access (if any) to ICT at home
- their perceptions about computers including
    - things they liked about using computers
    - and things that were of concern
- the difference between their in-school use of computers and their use of computers elsewhere
- whether the school was their main opportunity for accessing computers
- their prime source of support in using, and learning to use, ICT
- who they assist to use ICT
- their 'best activity' at school using ICT
- any recommendations they would have for novice users of ICT
- their other out-of-school interests and pastimes such as hobbies, sports, pets, reading, music…

Students were also asked to speculate on the likely implications should computers cease to function worldwide. This question was an attempt to gauge their insight into the role ICT plays in the world.

Staff interviews

Interviews with teachers, principals, and ICT coordinators provided data about the possible enhancement of student learning outcomes (staff hopes and concerns), the impact on learning of the teachers' incorporation of ICT into the class program (staff experiences), and the skills, competencies and experiences that teachers need in order to be able to integrate online learning into classroom practice.

Teacher Interview (TQ)

The teacher questionnaire (see Appendix 4.2) was designed to enable the interviewee to address a range of issues relating to his/her decision-making about the incorporation of ICT into the class program. The aim of this interview was to provide insights into the teacher's perceptions and purposes relating to the current and possible future use of ICT in their class programs. In order to achieve this, the teacher received the questions as part of a project information package for schools

before the observations were made (see Appendix 2). The questions were discussion starters rather than as the basis of a closely controlled verbal survey. Questions addressed a range of topics including

- effective teaching strategies used in the classroom
- the teacher's rationale for using ICT in the classroom
- the forms that ICT use takes at present teaching; assessment strategies in relation to the use of ICT
- the impact of the introduction of ICT on the teacher's practices, the operation of the class and the class program in general
- the teacher's position in relation to students' use of computers at home and its possible impact on ICT use in the classroom
- any difficulties that had arisen in relation to the use of ICT in the class program.

The reliability of the data obtained from the use of the interview was likely to be high since "face to face interaction assists in the establishment of rapport and a higher level of motivation among respondents" (Burns, 1994, p. 362). In addition, the interview process has sufficient flexibility to cater for teachers at various stages of development in using ICT in their class programs. All respondents could make meaningful responses to this set of important core questions. These questions covered the decision-making, challenges and achievements that are likely to be part of the introduction of major development such as the extensive use of ICT in their class programs. In addition, it was possible to cross-reference the interviewees' responses where the other related observations, and with other sources of information such as colleagues and students. The extent of the involvement of the researcher with the teacher, the class and the class program meant that there were many opportunities to seek further clarification where the data were uncertain, ambiguous or inconsistent. On the other hand, any particular teacher's responses were likely to be highly individual, being about their own thoughts, decisions, practices and experiences, and so not immediately subject to widespread generalisation.

Principal (and ICT Coordinator) Interviews (PQ & CQ)

During the time in the school, the observer also had similar discussions with the principal (representing the school), and/or ICT Coordinator. These interviews focused on managing ICT provision and providing leadership with respect to ICT within the school. The principal and the ICT coordinator questionnaires (see Appendices 4.2 and 4.3) were designed to gain insights into the history, culture, practices and actions of the school in relation to the incorporation of ICT into class programs.

The purpose of these interviews was to gain a better understanding of the possible impact of the school on the use of ICT in class programs. Matters discussed included the school's expectations in relation to the use of ICT and its support through ICT provision and opportunities for professional learning. Discussion in these interviews included

- the expected role, rationale and importance of ICT
- online learning observations and school experiences so far
- the history of ICT in the school current arrangements
- current hopes and associated developments being undertaken
- expectations with respect to ICT in class programs and
- hopes and intentions in relation to ICT for the next 3-5 years.

Case notes

In the course of the in-school observations, additional information became available informally and independently of the above instruments. Much of this information was summarised as case study notes. Where earlier case study notes led to the identification of significant themes (e.g., 'reliability') efforts were made to systematise the observations and recording of data related to these themes in subsequent observations.

Anecdotal Observations: ICT and other Online Tasks

Observers made additional notes about the actions, activities and tasks of students during the normal use of ICT in the class program. These records complement the data gathered the Classroom computer Use survey (CU). The observations were confirmed by gathering supporting data from related observations and brief 'interviews' with the subjects and others while attempting to minimise the disruption to the activity. The resultant data are properly considered anecdotal. Such data are valuable as they enrich the cases by providing a short account to illustrate points of interest.

In school observations – a summary of the instruments

Using the above instruments, observers made the following observations.

Table 7 Summary of in-school observations

Observation instruments	Data	Method
Simple school demographics - NS, PQ, TQ	The basic school characteristics including • school system • enrolment • type [primary, district...] • and location [city, suburban, rural]	Direct observations and inquiry as required
School history with respect to ICT - PQ, CQ, TQ	Previous school decisions, initiatives and associated rationale • school experiences and insights • the current stage of development, with respect to adopting ICT • school hopes and commitments for future development.	Principal &/or an ICT Coordinator Interviews, informal conversations and school documentation as available.
Class characteristics - NC, IT, CU…	• Year groups, • class layout, • ICT provision, • use of ICT within the class program, • class routines • a general description of the class program. • an impression of the students' knowledge and experience of ICT • the role of ICT and extent of ICT use in their lives.	Formal interviews, discussion with class and class teacher(s), direct observation, other interviews, and informal conversations

Student access to ICT out of class SCA & SQ & NC	Each student's • capacity to access to ICT at school • capacity to access to ICT out of school [and home, in public and workplaces, and elsewhere] • purposes for accessing ICT	Other Computer Use
ICT in teaching and learning - TQ & NC	Teacher's beliefs, hopes, intentions • practices and experiences • possible links between general teaching strategies used by the teacher and the use of ICT • the impact of utilizing ICT was on the teacher's practices. • student use of computers at home, • any in-class experiences with ICT that involved problems [reliability]	Taped teacher interviews (20 min) [later transcribed]
Student characteristics - SQ	Eight students selected as a representative sample of the class. • the ICT provided at home, • what they thought was good about ICT, • what they disliked about ICT • from whom they learned about ICT who they taught about ICT, • the best ICT based activity they had undertaken at school • what advice they would give to an absolute beginning user of ICT.	Individual student Interviews (5 min) – 8 per class
ICT usage in the classroom - CU	Time-slice observations were made [typically at fifteen minute intervals] • the number of students using computers, • the size of the student groups involved, • the nature of the activities • the nature of the tasks being undertaken with the assistance of ICT.	Recording Sheet
Classroom ICT environment -IT	Class information included • the number of computers, • their configuration, general performance, • software available • and attached peripherals.	Recording Sheet
Interactions within the classroom	In the first six classrooms observations were made of nature of the interaction between • students and students, • students and adults, • adults and adults.	Recording sheet (see Note 1 below)
Informal observations - NS and NC	Casual conversations and other forms of informal observations are carried out during the time spent in participating schools. Data gathered supplemented other more systematic observations	Case notes recorded in note book

Note: Interactions within the classroom. The framework for these observations was developed from the work of Galton *et al* (1980). On considering the initial results, it was decided to abandon the collection of these data. Perhaps ironically, a student's use of ICT frequently resulted in a reduction of interaction with others in the classroom. Rather the use of ICT involved individual activity or interactions with others including others outside the classroom, for example, email correspondents. The Galton instruments did not capture these latter interactions.

3.5 Reliability and validity

Reliability of instruments

Burns (1994, p.201) explicitly links the concept of reliability to notions of consistency, dependability, accuracy, and predictability, and suggests three possible approaches to reliability. Firstly, the researcher needs to consider whether a score is a stable indication of performance rather than a score that would be significantly different at different times. Secondly, whether a score is an accurate indicator of a subject's true capacity, and thirdly, whether there is a significant amount of error in the scoring. All of these approaches to reliability raise issues for this study as explained below.

Student interactions

The data on student interactions were gathered as sets of nine observations of each selected student within a period of four minutes. Over three or four days, observers collected six sets of data for each of the eight representative students selected by the class teacher. Actual observations of the same student frequently obtained very different data within a very short period, raising a question about the reliability of this instrument over the range of observations made. A student's circumstances often include structural arrangements managed by the teacher for the student including task, location, instructions, requirements...and so on.

Such arrangements varied from moment to moment, and there was often a marked difference in student interactions depending on whether they are on-task or off-task. For example, on one occasion the interactions of a particular child in a small

group were being observed. The group had lost its way in relation to their teacher-assigned, complex and lengthy activity and they had reverted to social interaction. The data (if recorded) would have been dramatically different a short time later when the teacher reprimanded and isolated the same child. He was then required to proceed with the same task, which he did (under very different structural arrangements) without any interaction with other class members. Thus, the data gathered could not be considered a stable indication of performance for this particular student, raising doubts about the reliability of the instrument. This was a second reason for abandoning interest in the details if classroom interactions.

Student access to ICT

A similar issue arose with respect to the instrument (SCA) used to gather data about student access to ICT. It was initially assumed that student access to ICT outside the classroom would be indicated by the existence (or otherwise) of a home computer and internet access. However, these proved to be unreliable indicators of the student's actual access to ICT outside the classroom, or even at home. Various student interviews showed that many factors play a part in shaping the students' access to ICT including:

- parental supervision
- which of their 'homes' is being discussed
- competition with siblings for access (younger siblings are frequently at a disadvantage)
- sources of support in learning to use the technology (younger siblings frequently have an advantage)
- alternative opportunities (neighbours, extended family, friends, workplaces, community…)
- competing interests (hobbies, sport…)

Because of this insight, the student computer access survey (SCA) was revised and extended for use during in later observations to make it more reliable.

Interviews with the students (SQ) were initially summarised in note form. In later interviews, a record sheet was used to summarise and categorise responses. These interviews were undertaken with the explicitly confirmed permission of the subjects and their families. In order for the students to be comfortable, interviews took place in the classroom (their familiar environment). Students appeared to engage in the discussions in a natural fashion and the interviewers were confident that the student responses were authentic in almost all cases. Some cross-referencing with other sources (for example, class teacher and classmates) was also possible and used on occasions. Based on the careful in which the interviews were carried out, the data obtained are believed to be acceptably reliable.

Validity

Burns (1994, p.219) identifies five types of validity: predictive, concurrent, content, construct and face. The question of construct validity was a major issue in this study. A construct is an "abstract or general idea inferred or derived from specific instances" (Websters, 2006) . Evidence of an instrument's construct validity may be provided by correlation with other instruments that are accepted as achieving measures of the same construct, by correlation with other characteristics of the subject, and/or correlation with factors in the subject's environment. Construct validity was an issue with the original survey of student 'access to computers' (the construct being addressed) outside the classroom. The original concept behind this survey was the construct that 'a computer at home' would be the prime alternative for students to access the ICT. However, the initial set of observations made it clear that this construct was far too simplistic. A more comprehensive instrument was developed for use in subsequent data gathering: the survey (SCA) was designed to adequately reflect the barriers to access at home and extent of the opportunities taken by students to gain access to computers and online resources and services.

Similarly, an original check-sheet developed to monitor computer use in the classroom proved too simplistic. It highlighted the difficulty of identifying the task being undertaken by students, and the learning activity involved, from the observed

use of a computer application. For example, one might assume that a student using an e-mail application (tool) was in fact communicating (task). In several instances closer examination revealed that students working with an e-mail application were not communicating, but simply learning to use the application and this is a different task. Thus, the action of a student using a computer may be observed but the task and learning activity cannot be observed directly. While the actions may be observed, making valid links to tasks and (learning) activities requires additional insight and interpretation that would be highly disruptive to the observations themselves in order to match the observations to the appropriate situated construct (the learning activity being undertaken)

Observations of learning activities require a model of the learning in order for the activities to be identified and models are made up of constructs, however, "Any model of learning is right or wrong for a given set of stipulated conditions" (Bruner & 1985, 1985, p. 6). Thus, the validity of this instrument was brought into question because of the uncertainty involved in dealing with a complex set of possible constructs in conditions that were subject to continual variation and disruption. Indeed, from a constructivist perspective, the purpose of actions, the meaning of the tasks (activities such as communication, research, publishing…), their relationship to any learning to be accomplished, and the means for achieving the intentions are largely constructs continually developed (and redeveloped) by those involved. While the use of a particular software application could be readily observed and some estimation made of the ease with which the user could manage the activity, the computer use record sheet (CU) proved doubtful in relation to providing firm evidence that might be useful in validating any construct connecting computer use and learning.

3.6 Investigating Professional Learning

During interviews, teachers and schools consistently reported the provision of professional learning as a significant issue. As the study progressed, it became clear that many school or systemic professional learning initiatives were seen as largely

ineffective. Teachers consistently reported difficulties with transferring their professional learning into classroom practices. It also became clear that the working arrangements and relationships in which teachers were engaged had a marked impact on their use of ICT. The teachers of classes in which ICT was reportedly being used easily and well, consistently reported having a network of colleagues and others who supported their professional learning. It was noted that such networks were not necessarily located entirely, or even in part, within the school in which the teacher was working. In addition, the professional learning involved was not restricted to workshops and seminars although these played a part

Action Learning

In order to examine the significance of these reports and observations, Phase Three involved action learning projects in four primary schools. These projects involved each school focusing on a current need in relation to the provision of professional learning for its staff members. Each of the projects had unique characteristics reflecting significant cultural and historical factors at play in the particular school. For example, one school had a long history of achievement with ICT resulting in it receiving awards for its development of innovative class practices. However, changes of staff and less funding had greatly reduced its capacity to continue previous initiatives. As a result, the school was keen to develop low cost ways of supporting professional learning across all staff. In each project, a team of three or four leading staff members (including the Principal) engaged in developing and implementing an action plan to meet its identified needs.

Project schools

Invitations to participate in the action learning projects were widely distributed and several Department of Education schools expressed interest. Ultimately, four schools undertook similar but unique action learning projects. Each project focused on a priority aspect of professional learning within the school with a view to transferring the learning into in-class practices.

The process

Each school was provided with an introductory workshop (approximately 2.5 hours) for their project team during which they were introduced to the theoretical notions emerging from the in-school observations made earlier in the larger *Children, Online Learning and Authentic Teaching* project. In particular, schools were introduced to the notion that the use of ICT in schools requires three levels of consideration. That is, in order for schools to incorporate the use of ICT into class programs it is necessary for the use of ICT to be considered at thee levels within the school, namely,

- School level: governance, infrastructure, knowledge & skills and applications
- Class level: students, teaching & learning, student outcomes
- Activities level: activities, knowledge, experience, products and insight

In addition, the teams were introduced to four likely key factors that had been identified consistently across all the observations. The possibility that they were 'key factors' was also supported by responses to the CCCI survey (Robertson, Fluck et al., 2006, pp. 56-63) of all Tasmanian Year 3, 5 and 7 teachers. In order of significance, the factors were:

- Shared purposes and practices relating to the use of ICT for teaching and learning
- Matching and available technology for the intended purposes and practices
- Adequate working knowledge to operate and troubleshoot the use of the technology
- Cost effectiveness of its applications

In the course of the workshops, the school teams developed an action-learning plan that included the following steps

1. Assess the current situation (general) - initial workshop and follow-up reflection
2. Choose a professional learning focus for action

3. Gather information about the present situation (focus)
4. Implement initiatives
5. Study results
6. Act in response to findings

The members of the research team provided minimal ongoing support and advice during the course of the action learning projects.

Each of the schools provided a presentation at a project workshop, *RazzamaTas 1,* and most project teams were fully represented. The research team and some other stakeholder representatives also participated in the workshop.

Projects as Case Studies

Each action-learning project was treated as a case study in its own right and the results and outcomes of the associated workshop were collated and summarised (see Chapter 4 Results).

Professional learning methodology

Methodology - overview

Case study observations were made of the development and implementation of (professional learning) action learning projects in schools (N=4). Particular note was taken of the experiences of the participants, the thinking and decision making involved, the roles and relationships of participants, products and processes, and the impact of the projects on the schools involved. These observations were analysed and the results were summarised as an idealised activity system model (Figure 7, p. 162) and as a learning cycle process (Figure 9, p 192). Project participants assisted with observations, presenting data and informing the analysis. The researchers acted as participant-observers for some stages of each school's action learning project.

Methodology – data collection

Table 8 Data collection - professional learning

Phase Three	**Professional Learning (Schools 29-32)**	
Focus	Exploring implications for professional learning based on initial findings of the in-school observations	
Method: action learning projects	Instruments	Resultant data
Introductory Workshop	Case studies (4 schools)	
School designed & implemented PL projects Review of, and learning from, each project	• Workshop outline • Notes, summaries & products • Introductory school workshop (similar to all schools) • Project outlines (as designed by each school) • Results as reported by school teams (Utas workshop) • Project notes and findings	Workshop summary Individual school project plans Individual school project products School surveys Teaching devices Student products School project reports Project report by COLAT team

Methodology – analysis of data collected from action learning projects

Table 9 Analysis of data - action learning projects

Aim of the analysis	**Method of analysis**
Refine the understanding of the nature and relationships of phenomena involved in professional learning	Examination of projects (as case studies) Activity Theory: modelling of professional learning projects as activity systems
Refine the understanding of the significance of phenomena involved in professional learning	Examination of activity system models

3.7 Conclusion

This chapter has presented a summary the methodology used in this study. First, the methodology used to investigate the everyday use of ICT in some fifty classrooms in twenty eight Tasmanian schools was outlined. Second, the use of action learning projects to study self-managed professional learning initiatives in

four schools was presented. Reasons for choosing the particular approaches have been provided and the characteristics and some limitations of the methods and associated instruments to carry out the observations have been elaborated.

In the next chapter, the results of the observations will be summarised in order to provide a basis for subsequent analysis leading to the formulation of answers to the research question.

Chapter 4 Results

Advice is judged by results, not by intentions.

Cicero (106 BC - 43 BC)

4.1 Introduction

The previous chapter outlined the methodology used to make observations related to the use of ICT in teaching and learning in a range of Tasmanian primary schools. Over the course of the investigation, some data collection techniques were refined on the basis of insights gained from the earlier observations. These refinements related to the identification of factors that appeared to distinguish schools and classrooms in which ICT was being used easily, consistently and well from those schools and classrooms in which the use of ICT appeared, and was reported to be, less successful and a struggle for those concerned.

This chapter summarises the results of observations undertaken in the period July 2002 to September 2004. During this period observations were made of Tasmanian classes (N=50) having Year Three or Year Five students in Department of Education and Catholic Education Office primary schools (N=28). Subsequently four schools took part in action learning projects focusing on professional learning related to the use of ICT in teaching and learning.

The results reveal that the implementation of ICT in classrooms is a complex and challenging task. As will be elaborated in the following sections, early observations challenged some 'expectations' and this had implications for subsequent observations. Several important inter-related themes emerged from the in-school observations including how participants thought about ICT; different ways in which ICT was used in classes; the challenges involved particularly the cost and effectiveness of using ICT in teaching and learning; the link between professional

leadership and staff confidence; and the importance of school governance. The results of the action learning projects show that undertaking professional learning, as a collaborative ongoing endeavour is important. They also show that learning about technology is more meaningful in the context of the professional practices of the participants. A useful professional learning cycle emerged from the results, as did a rich and dynamic set of roles undertaken by the participants. The major findings for use of ICT and for professional learning are summarised as activity systems.

Coding data sources

The following codes (Table 10) are used throughout this chapter to indicate sources of data: numbers denote the particular school from which the data were collected using the instrument.

Table 10 Instruments used: codes & instances

Instrument	Code	Instance
Student Computer Access	CA	class
ICT Coordinator Interview	CQ	school
Classroom Computer Use	CU	class
Class ICT provision	IT	class
Notes - Class	NC	class
Notes - School	NS	school
Student Interview	SQ	class
Principal Interview	PQ	school
Teacher Interview	TQ	class
Project Report	PR	school

In-school observations refer to schools 1 to 28 and the action learning projects were undertaken by schools 29 to 32. Thus:

- SQ6b identifies one source as an student interview (SQ) in the second class (b) observed in school 6;
- CQ7 identifies the source as the ICT Coordinator interview (CQ) in School 7;
- PQ30 refers to an interview with the principal (PQ) of a school (30) participating in the action learning projects.

- PQ1,8… identifies some particular sources PQ1, and PQ8 and also indicates that several equivalent sources could also have been listed

The instruments provided a rich source of data from multiple complementary and overlapping perspectives. For example, the data gathered from students using the Student Computer Access (CA) survey was closely related to data gathered from interviews (SQ, CQ, PQ and TQ) and notes made by observers (NC and NS). Thus, the instruments do not represent separate themes, topics and categories. From the very earliest observations, the themes, topics and categories were emergent and this continued as the study progressed.

4.2 What phenomena are significant in the implementation of ICT in classrooms?

Initial 'expectations' and actual observations

At the time of the study, ICT was a major focus for the participating schools and school systems. There were substantial systemic initiatives in terms of funding and policy development and the provision of professional and technical support. From the literature review and examination of systemic plans and policies, it was concluded there were a number things assumed or expected and that these could be confirmed by observation. The design of the early instruments was guided by such tentative 'expectations'. However, the first few observations showed that several of these assumptions and tentative 'expectations' were ill-conceived or inadequate. For example, with computers provided for all classes it seemed reasonable to expect that students would make considerable use of the classroom computers. The observed reality was somewhat different. Classroom computers were often in use for substantial periods when the class was present giving the impression that students were using ICT almost continuously. However, when the student was chosen as the unit of observation a different picture emerged. In most classes, individual students had quite limited opportunity to use computers, typically 2-4% of their school week (CU2,3). The discrepancies between several similar 'expectations' and actual observations are listed in Table 11 below.

Table 11 Expectations and early observations

'Expectation'	**Early observation** (initial source)
School would be where most children learn how to use ICT	For many students knowledge about ICT was substantially acquired outside the classroom from family and friends (first revealed in SQ1)
Home and school would be the prime opportunities for students to access computers	Students accessed computers is a wide range of situations: at home, work places, with friends, extended family, neighbours… (SQ2, CA2)
Students would make considerable use of computers in the participating classes	In most classes students had very limited opportunity to use computers, typically 2-4% of their school week (CU2)
The home computer would be readily available to students	The existing home computer was not readily accessible for many students (SQ2)
Computer use would be part of the class program	Student computer use in many classrooms occurred in parallel to the class program (CU1)
In-class computer use would enhance interactions between - teachers and students, and - students and students	Working in parallel to the class program combined with the concept of the computer as a single user device greatly reduced interactions (CU1)
The use of computers in the classroom would enhance collaboration	The converse was more often true: collaboration in the classroom enhanced the use of ICT (CU3, NC3, TQ3)
Computers use would be associated with student motivation	Students were discerning re the available technology; some students are not interested in computers (SQ3, CQ2, TQ3)
Reliability of ICT would be a technical issue	'Reliability' as expressed by teachers was more a matter of school organisation, user knowledge, user practices, teacher confidence… (TQ2, NC2)
The use of ICT in the classroom would save time in the class program	The use of ICT for teaching and learning involved extensive preparation time for the teacher and greatly extends the time it took for the class to complete some tasks (TQ1)

The gap between what was anticipated and what was actually observed led to an expansion of the range of factors to be considered and how such factors might interact. Many teachers understood and managed the classroom computers as single-user devices. A typical classroom provision was three computers to be shared

amongst approximately 28 students. This meant that if all three computers were in full and effective use for 100% of the school week, students would be using computers for approximately 10% of their school week. While most classroom computers were available for student use for 100% of the school week, the students themselves were not available to use the computers for more than perhaps 50% of the school week. Students had other competing commitments: special lessons, special events, other tasks and activities (class meetings, duties, setting up, packing up, preparation, reporting back…) that prevented them from using the classroom computers, or, for which computer use was simply inappropriate. As inexperienced users, students frequently had operational difficulties: the need for assistance was often high and at the same time limited; there were reliability problems, consumables (ink, paper…) needed to be replaced; problems with passwords and networks. Therefore, it was common to see that even though students were at the computers they were not able to use them. All of these factors resulted in individual students making purposeful use of the available computers for typically 2-4% of their school week. Another implication of such observations is that some of the key factors are not directly related to the class program or the classroom: indeed many of the key factors are outside the classroom.

The classroom impact of ICT – early impressions

Hence, rather than considering the impact of the use ICT on the class program, in most instances it was for more meaningful to consider the impact of the school, teacher, students and class program on the use of ICT, and this was confirmed by subsequent observations.

For example, in many classrooms student computer use occurred in parallel to the main class program. In this sense, students were virtually (and sometimes physically) withdrawn from the class in order to make use of ICT. Classroom computers are generally located around the walls of the classroom, in a corner of the classroom or in an associated annexe. As a result, most students had little support available while using ICT (NC11) or, as was the case in a small number of classes, they could only

use the computers if adult support and supervision (parent or teacher-aide) was available (TQ2, TQ13). Some classrooms were designed to facilitate this withdrawal through the provision of quite separate classroom computer annexes (NS13). As a result, many students had quite limited opportunities (if any) to interact with peers or adults if they were using ICT. The common concept of the computer as a single-user device further reduced opportunities for student interaction with others. Yet the successful use of the computers often depended on the provision of assistance: a particular type of interaction. In some classes, computer use appeared to be greater for those students needing less assistance. In some classes, computer use was permitted when basic tasks had been completed. More capable students tended to complete their basic tasks sooner because of their general ability (NC11a).

It was common for the provision of assistance to disrupt the student helpers' participation in the class program (NC2, NC3). While there were positive aspects associated with class leadership and team building it was a source of unease for some teachers (TQ3). Despite generally consistent ICT provision (two to four networked computers with printing capability), class practices and experiences related to the use of ICT devices varied enormously. This suggests that it is too simplistic to think in terms of the devices as being ICT. Rather, 'ICT' appeared to be a construct that shaped the use of the available devices in particular classes. The physical, organizational, social and cultural aspects of the class program were clearly more significant in determining the implementation of ICT in classrooms than the ICT devices provided.

Implications from early observations

As indicated above, early observations challenged several initial 'expectations' and this resulted in an extended range of factors to be considered. Factors such as reliability, the construct of ICT, time constraints, availability of support, and the need for supervision… appeared disparate in nature, situation specific and somewhat removed in time and place from the actual use being made of ICT. Participants reported factors lying outside the class room and hence beyond their

control (e.g., aspects of reliability, availability of consumables) and outside the technological domain (e.g., the construct of classroom ICT, its role and purposes)

Thus, the use of ICT in classrooms has both technical and non-technical aspects that were often not clearly understood and differentiated. As a result, a school's technical support staff often failed to resolve the challenges faced by teachers and classes. Teachers consistently reported that technical support staff should work *with* teachers and classes rather than simply solve the technical problems that arose *for* the teacher and class. Competent technical support staff with 'good people skills' were very highly valued in all schools. In times that are more recent, this factor had become a matter of sound governance rather than luck. In earlier times, the process for selecting support staff had focus largely on their technical expertise. At the same time, some teachers expected technical staff to have answers to what were fundamentally pedagogical questions. Thus, inappropriate expectations arose as a result of failing to distinguish between the operation of ICT devices and the use of the devices in the classrooms for curriculum and pedagogical purposes. Some schools were less than clear about their institutional hopes and expectations for the use of ICT (NS13). Such schools tended to delegate decision making to individual teachers, or technical staff members, and the focus tended to remain limited to what the technology could do.

The factors emerging as significant in the implementation of ICT in classrooms caused a re-examination of the literature. This in turn led to consideration of activity theory as a way to make better sense of the observed interdependence between activity, learning and knowledge. Activity theory was also useful in understanding a wide range of social, cultural and historical factors that also shaped the use of ICT in particular classes and schools, sometimes in paradoxical and idiosyncratic ways. For example, in a number of schools, initiatives to enhance ICT provision clearly resulted in a reduction in the use of computers by students (NS27, 28).

The initial observations raised more questions than they answered and identified many difficulties confronting teachers in their efforts to incorporate the use of ICT

in class programs on a sustained basis. While difficulties were consistently reported and easy to identify, the causes and appropriate responses were often less clear.

Thus, the initial observations suggested that individual teachers were unlikely to be able to achieve a successful implementation of ICT in their class programs. No such teachers were observed in any of the participating schools, nor were such teachers reported in any of the interviews or discussions undertaken in the study. At the same time, teachers who reported and demonstrated greater success with ICT tended to use different pedagogies based on ICT as a shared set of tools for supporting individuals, teams and the class undertaking challenging collaborative learning tasks. Thus the observations both confirmed and challenged a key, and commonly held, notion stated in the majority of policies and other reports - teachers are required to utilise new pedagogies in order to transform teaching and learning through the use of ICT. While supporting this core proposition the complexity and interaction of the factors involved challenged the capacity of individual teachers to do so.

Classes exist and operate within schools (and school communities). Factors shaping the use of ICT in teaching and learning emerged at three levels:

- school, e.g., governance, resource provision
- class, e.g., matching technology to tasks, managing access to ICT
- activity level, e.g., teaching and learning

4.3 Results: In-school Observations

This section summarises factors at the school and class levels that were identified as significant in shaping the successful incorporation of ICT into the class program. These factors were observed and reported as distinguishing particular schools and classes in relation to the use of ICT in teaching and learning.

In the following sections, the factors are related to particular instances of illustrative data reported by teachers, ICT coordinators and Principals as being associated with more and less successful implementations of ICT. As observed and/or reported in

interview these factors appeared to be present to a greater or lesser degree in most situations. That is, each factor occurred on a continuum in two senses. Firstly, each factor varied considerably from situation to situation. Secondly, each factor varied in the same situation over time. The identified sources of supporting data, referred to in the results, are simply explicit instances of the result.

Themes

The following themes emerged from the observations. As reported (and observed) the themes relate to differences between classes and schools in their success (or otherwise) with ICT:

T1. Thinking about ICT - concepts, purposes (values) and rationales

T2. ICT Provision - configuration of computers, internet and peripherals

T3. Use of ICT in the classroom - teaching style, learning ICT skills, extent of use, and class interactions

T4. Challenges, cost and effectiveness in using ICT devices

T5. Professional leadership and staff confidence – success, well being, support and working knowledge in using ICT

T6. Professional learning: supporting and enabling teachers

T7. The school as context

While not linear, the order of these themes may be the beginning of a developmental sequence. For example, informed and creative thinking about ICT led to astute provision of ICT in some schools. Similarly, the provision of ICT (what ICT and how it was made available and maintained) shaped the uses made of ICT in classes. And so on. Perhaps this could be the starting point for another study sometime in the future.

T1. Thinking about ICT

Thinking about ICT was a distinguishing feature of schools and classes. Views ranged from ICT as strategic to school development (PQ1,2,3,8) to ICT as an option for teachers to choose to use within their own class program (PQ13…).

Schools, and classes within the same school, varied considerably with respect to their concepts of ICT. Some saw using ICT ranging from a modern development students needed to experience (TQ2) through something to be learned (TQ5,PQ2) to a set of very useful tools that may be used to support the overall purposes of that class, school and even the school community (PQ1, 8, 14). Thus, in some classes the use of ICT was an end in itself or provided an improved means of doing things such as research (TQ9a). In other classes, the teacher and students were clear about their reasons for choosing ICT to undertake a task that could have been completed in other ways (TQ6a).

Some schools understood ICT as shared tools that could be used to develop community within the school (PQ1, PQ14…) whereas others simply saw ICT as a "good thing" (PQ9). The application of ICT in class programs revealed much about the actual beliefs underpinning the class program. At times, this appeared to be inconsistent with the school or class teachers' stated purposes. For example, publishing individual stories and acquiring information from the Internet were common uses of ICT. Such tasks generally required low order knowledge and skills, especially where computers were deemed single-user devices (NC6b, CU5…). An alternative way of thinking was to consider classroom computers as part of a complex set of tools to be shared by groups and the class (NC6a…) undertaking significant and real tasks (PQ1, 8, 16)

Schools varied considerably regarding the outcomes that the school intended to be achieved using ICT in class programs. The approaches to the use of ICT adopted by the school reflected these purposes. All schools received proportionally similar levels of systemic funding for purchasing and installing ICT, technical support services and professional development opportunities. However, the purposes for using ICT shaped the extent to which each school utilised, supplemented and leveraged the systemic support provided. Many schools added their own tangible and intangible resources including specialist facilities, other funding available to the school, attention, time, extra effort, as well as their capacity for team building, risk-

taking, innovation, and networking beyond the school. Schools that saw ICT as strategic to the ongoing development and success of the school (Schools 1, 8…) used their governance processes extensively to help ensure extensive and successful use of ICT in classes. Such schools held a transformational notion of ICT and worked to realize the potential of ICT through detailed plans, budgets, policies and priorities that were developed and closely monitored at the school level and implemented comprehensively throughout the school.

At the other end of the spectrum, a few schools accepted the ICT support provided by their school system and largely made the use of ICT optional for teachers to choose or ignore (PQ13). The majority of schools were somewhere in-between. Many were hopeful about the likely contribution of ICT to teaching and learning. They valued and encouraged those teachers who made good use of ICT; and to a greater or lesser degree accepted those teachers who made minimal use of their ICT provision. Some schools reported initial steps to confront the latter issue (PQ3)

Some schools highlighted the importance of students being able to use ICT (PQ3) often relating it to potential for future employment or simply to gain access to information. However most schools highlighted the contribution of ICT to teaching and learning particularly as a means of accessing information and undertaking collaborative projects such as ePals (linking with similar classes elsewhere to share and compare life styles and experiences)(CU6).

Table 12 Findings on thinking about ICT (Theme 1)

Factor	More successful	Less successful
1.1 ICT concept: the notion of technology as indicated by discourse and its use	ICT enables higher order activity	ICT as something to master. Some teachers find its possibilities overwhelming and cannot make a start.
1.2 School & class purposes for using ICT: the intended outcomes, arrangements and activities in class programs	ICT is strategic to teaching, learning, administration and building the school community	Purposes decided by individual teachers
1.3 Rationale for using ICT Reasons [if any] for ICT when undertaking tasks	Enable the achievement of high order thinking, more effective learning and communication	ICT use simply expected by the school or community
1.4 Consensus re the use of ICT Agreement across the school the use of ICT will help achieve these purposes	Whole school agreement and shared vision that includes community	To be decided by individual teachers
1.5 ICT application: the actual purpose is to which ICT was applied in relation to other class purposes	Satisfying current user needs: enhancing learning, collaboration and communicating.	Satisfying external expectations (e.g., school, community). Learning how to use IT as an end in itself
1.6 Computer concept: as indicated by their use, e.g., single-user device or group resource	Computer is a configurable device/tool for use by individuals and/or teams to access services and undertake activities	Computer is a single user device

T2. ICT Provision

Through good management and sometimes 'luck' many teachers extended opportunities by acquiring additional computers (IT4, PQ16) or by accessing computers elsewhere in the school (NC2, TQ12a) while some other teachers, even in the same school (TQ12b), were unable to make such arrangements. That is, classes varied greatly in terms of their capacity to acquire supplementary ICT for particular purposes as required in the class program. In some schools, there was considerable flexibility (CQ14…) whereas in other schools the provision was largely fixed (TQ6, 9…). In several classes some of the available computers were not used (IT3, SQ6) apparently because their performance was not acceptable.

The capacity [or otherwise] of the class to access resources and services through the Internet had a significant impact on what was possible in terms of the class use of ICT (NS16) and the purposes to which ICT can be put (PQ16). Over the two years of observations significant gains had been achieved (IT3 compared with IT27a, NS27) because of improved internet services and network provision in schools.

Classroom ICT provision (software and devices) was presumably chosen for it potential to contribute to the class program. In most schools, Office type programs tended to dominate. Catholic schools tended to make more use of computer assisted learning using CD-ROMs (CU12).

Table 13 Range of findings on classroom ICT provision (Theme 2)

Factor	More successful	Less successful
2.1 Classroom computers Number of PCs to which students have access while in class	2 to 12 up-to-date computers. Easily supplemented with other computers and peripherals	2 or 3 working computers. Little or no capacity to supplement
2.2 Internet Access Internet connection and its effectiveness and use	Fast to good connection. Used to access a rich set of information (sound research skills) and for communication as well as some online learning activities	Slow (resulting in time-outs). Very limited use, subject to availability of direct supervision. Simple individual 'research' = text as information
2.3 Core ICT configuration The software and devices provided directly to the class	Typically, 2 to 5 contemporary, well configured computers readily accessed and/or rearranged according to need so that ICT use is easily integrated in class activities as required.	Fixed in number and location; use is often separated from other class activities and may require separate scheduling, supervision and support
2.4 Supplementary ICT: Additional PCs and peripherals and the management thereof	Good access to, and use of, working peripherals including data projectors, cameras, scanner, printers…	Few or no supplementary devices are available because they do not exist, location is uncertain, not working, access is too difficult...

T3. Use of ICT in the classroom

Many aspects of teaching style shaped the in-class use of ICT. In particular, the extent to which students work independently and/or collaboratively with peers on rich tasks (NC6a, TQ1, PQ8…) is a distinguishing characteristic of the teacher, class and class program. In some classes, the use of ICT is limited by concerns for protection against exposure to inappropriate material (TQ2…) and by the associated need for supervision to ensure appropriate use of the computers (TQ13a). Physical arrangements also affect the use of computers. Some classrooms have very limited space making the location of computers and their actual use quite problematic (NC2). In other classrooms, reflections on computer screens are a common problem (NC8a) so that some times of the day are problematic.

Responsibility for matching technology to activity ranges from being well considered by the school and its staff teams (PQ16, CQ11…) to teachers simply choosing from what is available (PQ13)

Teachers consistently reported two major concerns about time. The time required for preparation of ICT related class activities was of concern although this was significantly reduced for those teachers who participated in a network of supportive colleagues (TQ1). Scheduling student access (TQ6b…) was frequently reported as difficult in that there is considerable competition for time and attention in every class program. So much so, that the amount of use of ICT varied enormously from class to class: ICT use was virtually continuous in some classes (CU16a, 16b) and only occasional in other (NC13a).

Schools addressed the challenge of assisting students in learning how to use ICT in one or more of three main ways. Firstly, by providing separate supplementary programs sometimes based in dedicated computer rooms (CU1, PQ27, 28…). Secondly, by the class teacher demonstrating a particular use of ICT to the class and providing incidental support as required (NC2, 3…). Thirdly, by integrating ICT learning with other learning tasks, that is, requiring students to use ICT (TQ6a…) in

other areas of the class program. This integrated approach to learning to use ICT was often informal and frequently involved the support of other class members who knew how to use the particular ICT acting as tutors for those who did not. Because of the specificity of the knowledge required to operate ICT devices much of the learning involved peer tutoring. Family members, others visiting the class, classmates, teacher aides, and technical support staff all contributed as tutors.

Schools varied considerably in terms of how their technology was matched to its uses. The matching of technology to activity ranged from being well considered by the schools at the governance level (PQ1,8,10,14…) to situations where individual teachers were simply choosing (or not choosing) from what had been provided (TQ15b). The former schools had a good understanding of their purposes and had selected and deployed particular technology to achieve those purposes. For example, one school was very clear that its use of technology should support higher order thinking, collaboration, communication and community building (PQ14). For this reason, the school had selected PowerPoint as its core software because it provided a rich multimedia environment for students to capture and share their experiences and learning. For similar reasons it had extensive involvement in robotics within the school program and the wider community.

Table 14 Range of findings on the use of ICT in classrooms (Theme 3)

Factor	More successful	Less successful
3.1 Teaching style: A brief description of the teacher's management & leadership of the class	Focused on enhancing interactions (see 1. above): ICT used to enable & support high level thinking & communication	Focused on students completing many short-term (learning) tasks
3.2 Learning to use ICT: How schools enable students to learn to use	Whole school skills program that complements class program (note school size)	Arrangements are made by individual teachers
3.3 Matching technology: How the technology is provided and matched to its uses within the class and across the school	Core applications are well matched to purposes & activities: extensive staff consultation, collaboration & initiative ICT has been chosen to facilitate and enhance the activity	Teachers expected to use ICT as provided (often with configuration and reliability issues) The activities have been created to provide an opportunity for the use of ICT.
3.4 ICT use in the class: the extent to which ICT was used in the course of the day	Ongoing, integrated into the everyday activities of the class & flowing over to other contexts: assemblies, community, families…	Little or no use most days. Times of more extensive use for a specific purpose
3.5 Suitability of the available ICT Matching technology to its purpose and associated activities	Available ICT is reliable and can be easily supplemented and reconfigured. People use it with confidence and purpose	Variable often a matter of luck rather than informed consideration. Office suite as core software
3.6 Classroom interactions The extent that students (and adults) collaborated with others when using ICT	Students work as teams around extensive, integrated, rich tasks Teacher as leader of the class	Students work as individuals (in groups in parallel) on short isolated tasks. Teacher as director

T4. Challenges, cost and effectiveness

Arranging for the use of ICT in class programs was not, reportedly, a simple matter for the class teacher (TQ1, 5, 7…). The difficulties were many and complex arising from uncertain or mismatched purposes (NC3), poorly matching technology (NC2, CU3), inadequate working knowledge (TQ15); performance of the technology (NC3); and/or that its use is not deemed cost effective (TQ11b).

'**Reliability'** of the ICT was a major factor constraining its use. Not being able to rely on the technology raised issues of its effectiveness and cost (especially in terms of time, effort, opportunity. These, together with teachers' doubts about the adequacy of their working knowledge, reportedly reduced teacher confidence. All schools and classes reported reliability as an issue. As one teacher explained it, "I have to plan each lesson on the basis that the technology will fail!" (CQ2). In some schools, issues of reliability were accepted as a 'fact of life'. Where sound governance was in place, teaching and technical staff worked together to address the issue systematically (PR31). That is, they worked to improve the quality of the technology provided (PQ1, 8, 16), the support provided (CQ10, 17) and the practices of users (PQ16) all of which have implications for the 'reliability' of the technology.

Analysing the discourse around 'reliability' was informative. Reliability relates to being able to rely on using the ICT as planned, that is, successfully within the 'window of opportunity'. Governance plays a major role by shaping the quality of ICT provided and the ICT support available (TQ2, 6). Several schools (PQ4, 8…) reported previous difficulties when they had attempted to utilise virtually any computers they could acquire by whatever means. This had usually resulted in a very mixed bag of computers with various levels of performance, different operating systems and other software, so that the reliability challenges became unmanageable and discouraging. Removing unreliable technology (NC6a) and reducing the variation of technology provided were common strategies (PQ4, 16) to improve reliability in a range of schools. Such initiatives were well supported by teachers and students. To forgo a computer was deemed better than a poor unreliable computer by many teachers and students.

Size of school was a related factor since resources for support were allocated by school systems based on enrolment. For example, some large schools (CQ17, TQ10a, and PR31) were large enough to be able to arrange 'full-time support' by carefully scheduling three part-time appointees. As a comparison, the smallest

school in the study received a single 3-hour visit from a technical support officer each fortnight (PQ9). When this school encountered major problems, the whole school had to wait several days before being able to proceed. Luck appeared to be a third factor affecting reliability. Some small to medium sized schools (PQ9, 15, 17, 26…) had teacher aides or library aides who had acquired considerable expertise with ICT through previous experience or a personal interest. This expertise enabled them to deal promptly with the majority of day-to-day reliability issues and to judge when more technical was required. This latter function was reported to be very helpful (PQ15): even though the aides could not solve the problem, they could identify the required course of action.

Uncertainty, about the problem and its resolution, was identified as a significant part of the stress associated with 'reliability issues' (TQ12b). As a result, the capacity of support staff to work with teaching staff to respond promptly to class needs was highly valued (PN30). Technical support staff members were valued at least as much for their interpersonal skills as for their technical competence. The confidence of staff to seek assistance when needed (TQ2) was reported as critical and this was shaped by the response most likely to be made by technical staff.

Several interviewees commented on the disruptive impact of **development** (TQ6a) in that new software and equipment often made previous knowledge and arrangements less useful (NS6) and so teachers were not able to rely on being able to use the new equipment at least initially.

Some teachers (TQ7a) reported that they were not confident about resolving difficulties they encountered, and often just accepted that the computers, printers…were not working and then made alternative arrangements to do something not requiring ICT.

The **effectiveness** of the technology varied considerably from class to class and involved issues beyond whether the computers were operating or not. Functionality of the hardware and software (PQ9), the configuration of opportunities (TQ13),

working knowledge (TQ14a, b) … all impact in significant ways. In some classes the use of ICT is highly disruptive (TQ12b) separating the users from the non-users. In others classes its use is well integrated into the ongoing class activities (TQ27) and enables higher order thinking and sophisticated products (PQ1,8,14, TQ6a,8a…) In a small number of classes the use of ICT greatly facilitated inclusion of students with special needs (TQ14a).

The use of ICT was shaped by the **sense of well-being** experienced by staff while using ICT and this involved two related dimensions as reported by staff: their confidence and comfort as users of ICT. Some schools assume a high level of responsibility for addressing this issue by providing direction, support and encouragement for staff, especially through team building; and the development and endorsement of consistent teaching and learning practices well matched with appropriate professional learning. Teachers appreciated school support that included the provision of quality reliable devices and prompt assistance when needed. In contrast, some schools (PQ13, NC 13) hoped that individual teachers would make their own arrangements and that all would be well.

Teacher confidence in ICT declines when their 'lessons fail' because of difficulties with ICT. Uncertainty about the cause of the difficulties tends to compound the discomfort because inexperienced users tend to blame themselves: "I don't know what I did wrong" implies a sense of ignorance and incompetence (TQ13a). Initially many teachers had not understood that things could go wrong with any device for a wide range of reasons: they had assumed any difficulties were their own fault. Many such teachers also reported understanding the error in their thinking as a milestone or transformation (Mezirow, 1991) in their development as users of ICT (PN29). Many teachers go on to become confident and competent users of a wide range of ICT. Others abandon particular instances of its use after a lack of initial success. Moreover, this phenomenon is not restricted to primary classrooms. Some senior tertiary lecturers continue to use overhead transparencies rather than presentation

software because of difficult experiences with lecture theatre ICT and to reduce the risk of repeating the unsatisfactory experience.

The **cost effectiveness** of ICT requires consideration of many interacting factors including the value of the experiences and knowledge gained by the students, the possible value of their products (to the students and/or others) and the ease with which these things can be achieved. Teachers also mentioned the common costs involved including disruption, time consumed, special arrangements required, and possible risks. Such costs in arranging and undertaking ICT activities may not be trivial (TQ11b).

Table 15 Range of findings on challenges, cost and effectiveness (Theme 4)

Factor	More successful	Less successful
4.1 Obstacles and constraints Factors impeding the use of ICT:	Factors are identified and addressed collaboratively resulting in new practices to utilise what ICT makes possible	Teacher isolation. Unreliable ICT, lack of working knowledge, the disruption & inefficiency of using ICT
4.2 Reliability / Usability of ICT: The extent to which users can rely on being able to use ICT as intended: activity, time and place	ICT works, and is used well. Prompt support from colleagues, technical support personnel: support is a team function. Problems valued as learning opportunities Ongoing monitoring by the school informs arrangements & practices enabling rapid supportive responses. Equipment is managed for users and according to its uses	Class experiences many problems with devices. Technical support only in response to reported problems with devices. Corrections made without learning or improvement of practices. Treated as a technical issue related to whether devices are working.: delegated to technicians
4.3 Effectiveness of ICT use The extent to which the use of ICT enhanced the overall effectiveness of the class program and the benefits of using ICT	Use of ICT is fully integrated into class activities focusing on real tasks and producing real products that are useful and valued beyond the class	Use of ICT is separate from most other class activity: it is disruptive, inefficient (e.g., writing), unreliable and costly time wise
4.5 Cost of ICT use The invested time, effort (including support), financial outlay…	Use of ICT results in multilevel returns to individual, group, class school and community	Varies enormously from class to class.

T5. Professional leadership and staff confidence in using ICT in the classroom

Some schools assume a high level of responsibility for addressing the issue of staff confidence and commitment by providing direction, support and encouragement for staff, especially through team building and the development of consistent practices (PQ1, 8, 9, 11, 16…). Other schools hope that individual teachers can and will make their own arrangements (PQ13). Personal knowledge and skills with respect to ICT may be necessary but are not sufficient for a teacher to be confident using ICT within the class program. Several teachers reported having some IT knowledge but lacked confidence in their ability to apply that knowledge within the class program (TQ15a, PN29). Other teachers lacked confidence in their current IT knowledge but felt well supported in their efforts and were confident to proceed (TQ2a, TQ9a).

Close consideration of participant comments; issues around reliability; and the role of the teacher's ICT in successful use of technology resulted in a notion of **working knowledge.** This is the knowledge required to select, manage, and operate ICT devices (hardware, software and services) together with the knowledge required to identify and solve the problems that arise in the use of ICT. More than simply ICT knowledge and skills: the effectiveness of working knowledge depends on the reliability and configuration of the ICT in use (NC2, NC16b), and the working relationships within the class (TQ7a&b, NC6a) and between the class and other sources of support (PR30, 31, NC4a). The sources of support for teachers using ICT may be many and varied including the school, colleagues, families and the school community… (TQ5, 9, 13…). The use of ICT involves working knowledge that is often specific to the device or application in use. Teachers frequently qualified their ICT competence by reference to particular applications and devices TQ1, 16a, 17a…). At least one school used this strategically (PQ14) by choosing a core set of devices, applications and practices that were used through the senior section of the school. Consequently, the required working knowledge was

consistent across the school. There was less use of ICT in schools that were less strategic (NC13).

Access to working knowledge reportedly depends on the culture of the school, the class and the arrangements in place (PN29, 30, 31). Sound governance and high levels of collaboration were consistently associated with high levels of working knowledge. In some schools, the working knowledge was simply the knowledge of individual teachers regarding the operation of ICT (NC13). In other schools, the available working knowledge was a substantial body of knowledge, skills and experience readily and easily shared between teachers, technical staff, students, and other members of the school community (NC14, PQ31, PN30…).

As mentioned in the previous section, establishing the cost effectiveness of ICT involves consideration of both tangibles (money, staff, space…) and intangibles (collaboration, effort, confidence and well-being, success, stress…). The use of ICT requires substantial investments in terms of time and effort (TQ1, 3, 6…), financial outlays (PQ1, 2, 3…), organisational arrangements (CQ1, 2, 3…), and operational adjustments (TQ1, 3, 4, 5…). Sound professional leadership leading to staff confidence and commitment required balanced attention to the tangible and intangible aspects of achieving cost-effectiveness.

In some schools (PQ1, 8, 10, 14…) these issues were well considered simultaneously at several levels including school governance; year and class programs; class ICT provision and organisation; and specific class activities. In such schools, the use of ICT was more likely to be well integrated into the teaching and learning activities (TQ1, 8, 10, 14…) rather than being a competing activity in its own right. In addition, supporting provision was explicit, effective and valued. Staff members at all levels were able to engage in informed discussions around the cost effective of ICT use in the school. Teachers were confident that the school knew of their efforts, and valued and supported them.

In other schools, it appeared that much less consideration had been given to the cost effectiveness of ICT use (TQ7a, 7b, PQ13). The ICT was provided by the school system as something desirable, however the level of use of ICT within these schools was reported, and observed to vary more - some teachers made little or no use of ICT; others made considerable use at times; while one or two classes were reported to make outstanding use of ICT.

In many classes, the use of ICT was highly disruptive in that students were 'withdrawn' from the class to use ICT (NC6b…) with the result that ICT based activities competed with other aspects of the class program resulting in reduced cost effectiveness. Withdrawal was a common means of scheduling ICT use, especially where computers were seen as single-used devices. In such classes, there are a greater number of single users than groups and so more opportunities are needed to cater for each student individually. This contrasted with the other classes in which the use of ICT was likely to be well managed and integrated into the ongoing class activities enabling the use of higher order thinking and sophisticated and useful products to be made (NC6a…): withdrawal and even scheduling were not required. An arrangement between these two extremes reportedly worked well in other classrooms: it involved scheduling groups to undertake specific ICT related tasks and activities in rotation with other group tasks and activities (TQ10a, TQ14a). In particular, the latter arrangement appeared to be a useful and efficient strategy for teaching and tutoring ICT knowledge and skills in class.

Table 16 Range of findings in professional leadership & staff confidence (Theme 5)

Factor	More successful	Less successful
5.1 Professional leadership: Sources of support and encouragement within the school for use of ICT	Sound school governance and strong leadership team including professionals and technicians focused on in-class practices	Very limited, initiatives delegated to individual teachers: results in large variation over place & time
5.2 Staff well-being using ICT The reported (TQ) and observed (NC) confidence and comfort of staff as users of ICT	The school monitors and learns from staff experiences responding with leadership, support & encouragement (sound governance)	Staff succeed or struggle depending on the availability of non-school support. Personal support networks are critical.

Factor	More successful	Less successful
5.3 Teacher well-being:	High: teachers believe in their efforts, are confident of being supported and are recognised for their achievements	Low: teachers are unconvinced about the effectiveness of using ICT; doubt their own ICT abilities; don't know where to start
5.4 Working knowledge How ICT is selected, managed, operated and problems solved	Extensive, readily available based on 'communities of practice': teachers, students, parents and technicians)	Limited to individual teacher with some access to technical support (problem solving). Some reliance on students.
5.5 Working Knowledge of ICT The capacity of users to select, operate and troubleshoot the ICT to be used	Teacher has a good working knowledge of ICT in use. Complemented by readily access to a range of knowledge support	Teacher has limited working knowledge and limited access to knowledge support
5.6 Sources of support for ICT use Factors promoting the use of ICT	Teaching colleagues and technical support collaborate to improve arrangements and practices. Technical personnel have good people skills.	Limited to teacher's personal support network (if it exists) and reactive technical support

T6. Professional learning

The theme of professional learning emerged strongly from the in-school observations because of its central importance in providing teachers with requisite knowledge and skills and because of its contribution to successful change strategies. Professional learning also emerged as an issue because of concerns about the effectiveness of contemporary professional learning initiatives. As reported in the in-school observations, the most common concern related to lack of genuine opportunities for teachers to apply their learning soon after the workshops they had attended in order to minimise loss of knowledge and skills gained in workshops or seminars. The second most common difficulty was loss of the working knowledge. Teachers' attempts to apply their learning were frequently defeated when some small but necessary step in operating the device or software had been forgotten. A third common difficulty concerned the fact that most ICT professional learning had occurred outside the teachers everyday working arrangements and even small differences such as different versions of software often became problematic. Even the extent of the possibilities created by ICT can be a problem, as one teacher

reported: "There are so many possibilities with ICT that I don't know where to start" (TQ13B).

In response, this theme became the focus of a supplementary study and the results are reported following the summary of the in-school observations (below).

T7. The school as a context –the role of governance

The use of ICT in teaching and learning practices depends on the availability and quality of resources, professional learning and the leadership and support provided by the school (and its community). Systemic funding had provided similar levels of networked computers to all classrooms, yet clearly, the use of ICT in classrooms varied enormously.

The school systems and all participating schools were hopeful of incorporating ICT use into all class programs. All classes in all participating schools had at least two computers. Some schools reported taking a whole school approach (PQ1,2,8… & CQ1,2,8, …) to strategy, policy, planning, resourcing, professional learning, curriculum, assessment & reporting…with the aim of achieving consistently high levels of ICT use in all classes in the school. Others schools took a sectional approach supporting high level collaborative use of ICT where it emerged in particular sections of the school (PQ14). The remaining schools promoted ICT use across the school but reluctantly accepted a wide variation across classes. Thus, it may be reasonable to categorise the three approaches as

- Type I = whole school approach + systemic implementation
- Type II = sectional + systemic implementation
- Type III = whole school approach + hopeful implementation

These three approaches represent differences in school governance with respect to ICT use in the school. Most Type III schools had a least one or two exemplary teachers and classes, whose work was often used by the school to present itself to the community. Such teachers generally had personal professional support networks largely outside the school. Some schools reported frustration with lack of progress

as Type III and were in the process of raising the level to expectations and requirements as part of an attempt to move towards becoming Type I (PQ3, 6, 15…). This is another aspect of school governance shaping the use of ICT within the schools' classes.

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Table 17 Range of findings on the school as context (Theme 7)

Factor	More successful	Less successful
7.0 The overall approach to the use of ICT in the life and work of the school, its classes & programs	Sound school governance facilitating and expecting high order, real time, multilevel collaboration, promoting meaningful activities, ICT use as a major school commitment: teaching & learning practices are sophisticated, consistent, comprehensive and valued.	Focus on isolated ICT knowledge, skills, and satisfying the expectations of others. ICT use is a teacher decision, practices vary greatly from class to class and time to time within a class

Summarising the above results – the use of the activity system model

Use of ICT in classes as an activity system

Analysis of the reported and observed interactions between the elements showed that dissonances and disturbances between the elements were very common and teachers were frequently struggling to resolve the difficulties involved. Sound school governance is fundamental to addressing these difficulties.

Figure 5 represents an ideal implementation of the use of ICT as an activity system. The details of the elements of the activity system model are based on the factors reported by participants as being associated with successful use of ICT in class programs.

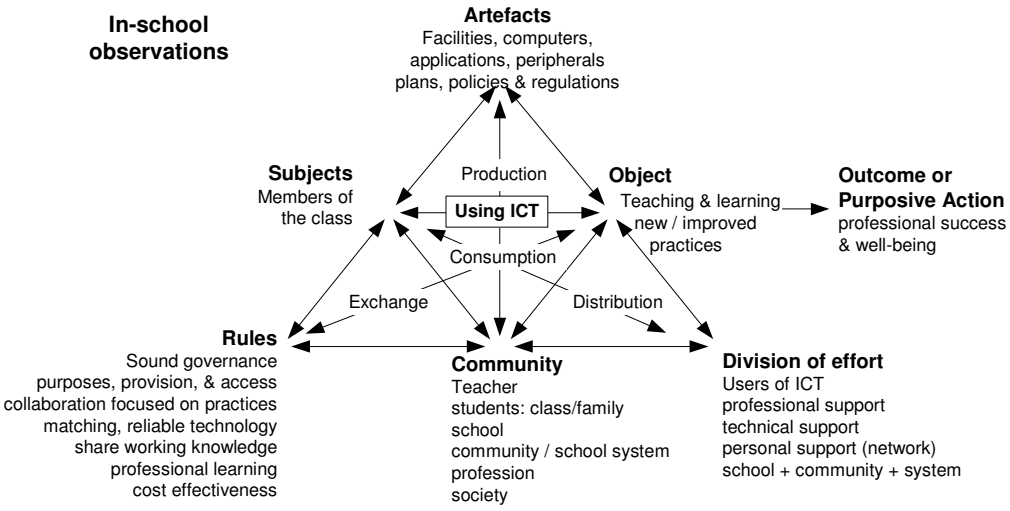

Figure 5 An idealised implementation of the use of ICT as an activity system

The following Table (18) provides examples of each of the elements in Figure 5 by reference to more successful and less successful instances, as reported and/or observed in this study.

Table 18 Implementation of ICT use in classes

In schools or classes that are more successful …	Element	In schools or classes that are less successful …
	Artefacts	
Facilities allow integrated use of ICT in class program (PN30, IT6a)	Facilities	ICT facilities are separate from the class (IT7b, IT13a&b)
Computers perform well and are properly configured (IT27a…)	Computers & applications	Computers of mixed capability &/or poorly configured (IT3, IT6b…)
A range of peripherals readily available (IT14b)	Peripherals	Availability of peripherals very limited or uncertain (
Products are real – used for other purposes (PN29)	Products	Products are simple evidence of activity and learning (CN8a)
	Subjects	
Class collaborates as a team of teams on rich tasks utilising ICT (TQ6a)	Members of the class	Class is a set individuals using ICT in parallel for specific tasks (CN3)
Shared knowledge of ICT is adequate for its effective use (CN14)		Inadequate working knowledge to ensure progress (TQ15a)
	Object	
Class uses ICT to do new things, and to do old things better (PQ1)	Teaching & learning	Teacher requires individual students to use ICT to do same tasks (NC5)
ICT is not used unless it is significant in teaching and/or learning (PN30)	new / improved practices:	ICT is used because its use is beneficial (TQ12a)
	Rules	
ICT use is a strategic school priority (PQ1,8,14)	Sound school governance	Teachers make isolated individual choices about ICT use (PQ13)
Adequate provision of computers and peripherals (TQ14a)	Adequate provision	Available ICT is inflexible and of varying or doubtful quality
Easy access to ICT (TQ1)	Ready access	Access to ICT is conditional on schedules, support, supervision (TQ28b, TQ13a)
Purposes include higher order thinking and community building (PQ14)	Clear collaborative purposes	The use of ICT is its own purpose (NS13)
Achieved through collaboration focusing on practices (NS8,14,29,26)	Focused on practices	Focus is on use of ICT per se (response to expectation) (PN28)
Technology is reliable and well matched to its use (NS1,8,14,26)	Matching reliable technology	ICT is used because it is, rather than because it enables the achievement of
Knowledge of ICT use is freely shared within the class; across the school; and	Shared working knowledge	other higher order purposes, e.g., community building (TQ11b)
into the school community (NS2,14)	Professional learning	Limited sharing of ICT knowledge – individuals use ICT in isolation (CN6b)
Professional learning for staff is effective and on-going (CQ1, 6, 8…)	Cost effective	Professional learning is ad hoc, episodic and external to the school (TQ15a)
Time, effort and $ costs are justified by achievements (TQ1, 6, 10…)		The use of ICT does not make a significant difference (TQ11b)
	Community	
The class is a community of practice focused on learning (TQ6, PQ16, PN29)	Teacher / students / class	Class is an organisational structure managed by the teacher (TQ11b)
The school & families express interest and contribute (PQ4)	School / families	The school & families make minimal contributions (PQ12)
The school system provides support and encouragement (PQ10)	School system	System support is limited (PQ9)
The teacher is part of an extensive professional network (TQ1)	profession	The teacher has a very limited professional network (TQ7b)
ICT is used to build links with school community (PQ1,14,17)	community / society	ICT use limited to within school (or even within class) (TQ13)
	Division of effort	
Teachers and students as mutually supportive users of ICT (TQ6,14a)	Teachers & students	Most ICT use by students is individual and isolated (TQ11a)
Professional and technical support, collaborate & overlap (CQ1, 2…)	Professional support	Professional and technical support are separate functions (PQ9)
Technical support solves problems and provides advice promptly (TQ10)	Technical support	Technical support only solves some problems (TQ9)
Users have extensive support from family and friends (TQ4)	Personal support network	Limited other support available (TQ9a)
People from outside the classroom contribute to ICT use (PQ1,2)	School/system /community	Little impact from outside the class program (TQ13a)

4.4 Results: Professional Learning

With one brief exception (NC13a), no professional learning was seen in the course of the in-school observations (schools 1-28). However, staff consistently reported several issues around professional learning in relation to the use of ICT in class programs. Initially systemic professional learning had focused on providing teachers with ICT knowledge and skills but in the course of interviews and other observations undertaken in this study, teachers and other school staff reported that

- It was very difficult for many teachers to transfer their learning into classroom practices (TQ11b,15)
- Individual learning from one-off professional learning (workshops and seminars) was reportedly the most difficult (CQ2) to transfer into the classroom
- Professional learning was enhanced by being situated within the school environment and the school program (CQ2, CQ6)
- Professional learning is enhanced when managed as an on-going iterative process (TQ6a,14a,10a)
- Teachers who reported success, comfort and confidence with using ICT in their classes also reported receiving ongoing receiving support from a personal professional support network range of others: present and past colleagues, family, friends… (TQ1, CQ1)

With two exceptions (TQ11b, TQ15b) all participants reported having had some success in transferring professional learning into their class practices. They also reported that many colleagues in their schools had not had the same degree of success. This is taken as further confirmation that participants in this study are unlikely to be representative of teachers in general, nor of the schools in which they worked.

In-school observations - professional learning for the use of ICT

Just prior to, and during the early stages of the COLAT study, virtually all teachers had engaged in systemic professional learning and accreditation programs. Indeed professional learning in relation to ICT was a specific element in a salary agreement

for the teachers in one of the participating school systems. The professional learning provided tended to adopt a training mode and to focus on introducing the recently provided ICT: networked desktop computers, 'Office' type applications, the internet (browser and email) and printing capability. Government schools were provided with PCs and the Windows operating system. This made the schools' older Acorn and Archimedes based applications no longer usable. Access to the internet together with the newly provided applications had changed the balance of classroom computer use from mainly computer assisted learning (CAL) to research and publishing. As a result, teachers reported being less certain about the experiences that the students would encounter while using the classroom computers. Assisting students to research frogs on the internet was far less predictable than supporting students working their way through CDROMs such as *Granny's Garden* or *Convicts* or *Settlement* (TQ6b).

Teacher descriptions of their professional learning experiences indicated that the common practice in systemic professional learning was to adopt an ICT expert - ICT novice approach to which some teachers (especially those participating in the study) had responded positively. Other colleagues in the same school reportedly (and by observation) had not. Despite the impressive things demonstrated in seminars and workshops and the expertise of the seminar leaders, teachers consistently reported having had difficulty transferring their professional learning into practices in their own classrooms. In-school professional learning was reported to be more collaborative and less likely to be based on expert-novice roles. Many ICT coordinators saw themselves more facilitators and not experts (CU17). As a result, school-managed professional learning generally involved brief focused workshops and discussions in which teachers shared their knowledge and experience (CU6, CU8) followed by in-class application of the learning.

Teachers reporting success with ICT had developed workable responses to a wide range of challenges involved. These teachers were informed by their professional learning. In addition, they were supported by a network of family members, friends

and colleagues elsewhere (TQ1, 8a, 10a…). Some of their colleagues had not achieved such arrangements and were uncertain as to how to proceed (TQ15a) and, as a result, were clearly less successful in their use of ICT in the class programs.

Table 19 Range: of in-school observations on professional learning

Factor	More successful	Less successful
6.1 The school's contribution to the professional learning of its staff	On-going, negotiated, inclusive, embedded in (and focused on) everyday practices; achievements acknowledged	Individual staff offered PL opportunities with 'experts' in isolation and away from the school itself
6.2 Professional Learning of teachers (as indicated by their capacity to use ICT in the class program)	Ongoing, situated in the teacher's everyday practice, complemented by engagement in a 'community of practice' and supplemented by occasional workshops and seminars*	Episodic, experienced as isolated events, usually external to the school, little successful implementation. (TQ12b, 11b, 15a)
6.3 Opportunity and support for professional learning in relation to the use of ICT	Extensive range of support • Reflection of own practice • Personal support network • Colleagues – teaching team members • School development teams/projects • Workshops & seminars	Limited largely to formal workshops and seminars organised on basis of • Acquisition of required knowledge • From expert-to novice • Achieving transfer of 'best practice'

Note: These results are almost certainly skewed by the process for selecting participants. Participation was voluntary and participants volunteered because they were confident and had an interest in the use of ICT in teaching and learning. Because of that interest, the vast majority of participating teachers and ICT coordinators had been involved in considerable professional learning in times just prior to the study.

As a systemic initiative, all schools had ICT coordinators with some responsibility to provide leadership, coordination and facilitation of professional learning in relation to the provision and use of ICT in the school. The more confident and experienced coordinators ran numerous in-school workshops for staff (CQ1, 6, 8…). Less confident and experienced coordinators tended to simply organize rather than lead professional learning. Several coordinators reported a shift towards a greater role in professional learning partly because of decreasing demands to provide technical assistance: the devices and school networks were becoming more reliable and support was becoming more readily available from technical staff appointed to support schools. That is, over the duration of the study the focus of

ICT coordinators tended to move from managing the provision of ICT to its use in teaching and learning. Other participants confirmed and endorsed this shift in the role of ICT coordinators.

Systemic and school initiatives meant that all teachers had been involved in some formal professional learning activities and/or accreditation processes. In addition, all schools had some level of technical assistance with installation and management of networks, hardware and software. Thus to a greater or lesser extent all teachers had colleagues, in-school or elsewhere, with whom to engage re their use of ICT.

Teachers consistently reported that most systemic professional learning had been managed on the basis of ICT expert-novice, had taken place as events outside the school and involved few if any colleagues from the teacher's own school. Many teachers and some coordinators (CQ2) reported that this arrangement was problematic given the difficulties associated with transferring the learning into their class programs (TQ15a). As a result, several participating schools reported initiatives to place most professional learning within the school (CQ2, PQ8, PQ16…) on an ongoing basis. School-based professional learning ranged from training on the operation of ICT devices and applications to ongoing collaborative school development (projects, peer tutoring and mentoring, communities of practice…). The more highly valued school-based professional learning aimed to focus more on improving in-class practices incorporating the use of ICT (CQ6, 8, 11…).

Three factors appeared to play an interactive role in relation to professional learning: governance, school size and luck. Professional learning is influenced by school priorities and the deployment of resources and these are matters for school governance. However, governance requires some appropriate expertise that may or may not be readily available in smaller and rural schools. There were some very successful smaller schools (NC14, 16, 26) in which school-based professional learning was extensive and ongoing largely because of decisions at the governance level of the school. A possible implication is that, when governance plays the major role (and they have suitable expertise), smaller schools may have an advantage in

implementing plans and decisions. It may be that in-class practices are potentially more responsive to the governance initiatives in smaller schools.

Not withstanding these instances, the capacity or otherwise of the school seemed partially related to its size. Larger schools appeared to be able to aggregate significant resources and expertise to enhance provision; to solve problems; and to support specific activities and initiatives. Larger schools appeared likely to have more working knowledge, and a greater ability to provide local examples of sound practice. In some larger schools (PQ1, 8, 11…) the professional learning was enhanced by the existence of a computer room program, that is, the specialist staff member who ran the computer room program for students also played a leading role in professional learning and the two programs were clearly related.

Staff changes also appeared to be related to the availability of expertise in many schools. Thus, 'luck' may have played a significant part in the schools' achievements. Teachers reported that 'We are lucky …' (TQ1, 2, 3) to have colleagues as leaders and technical support. Other schools had reported loss of expertise because of staff changes (NS31). Luck also played a part in terms of facilities for working with ICT. Some older buildings were able to yield suitable spaces (NS3, 6, 14, 30) that were not available in some newer buildings in the same school. Some larger schools had declining enrolments and were able to release a room for redevelopment of a computer lab (PQ8, 11, 28). In one large school, built in the 1960s, the central corridors shared by blocks of classes were large enough to create a shared computer area using the computers from the six adjoining classes (PN30) at the same time releasing additional space within the classrooms. Large school size appeared to reduce the luck factor in terms because of an increased probability of suitable personnel being available (NS11). Some smaller schools had managed to offset the luck factor by deliberately selecting staff to address the need for leadership and expertise (PQ2).

It is interesting to note that the outstanding achievement in the professional learning projects was one of the Tasmania's largest primary schools with fully

committed governance in relation to successful use of ICT across the school (PN30).

The action learning projects

The results of the in-school observations showed that there was a wide range of factors that were significant in the implementation of ICT in classrooms. The range of the factors indicated that it was not possible to identify a generic professional learning package of teacher knowledge and skills that would ensure the successful incorporation of ICT into class programs. The school systems had attempted such an approach for teacher professional learning but it appeared to fall short for two main reasons:

- the range of key factors extended beyond teacher knowledge and skills;
- many teachers found it difficult to transfer their newly acquired knowledge and skills into in-class practices.

The issues were simply too complex with professional, technical and organisational factors interacting in widely varying contexts. The variation in purposes, capabilities, needs and practices, from school to school, and even within schools, was clearly too great to be met by a single professional learning program focusing on teachers' operational knowledge and skills.

A decision was therefore made to offer supporting guidance for schools to undertake action learning projects of their own choosing - projects addressing a current school priority in relation to professional learning and ICT.

The purposes of this supplementary study were to

- trial action learning as a basis for professional learning
- explore factors related to the transfer of professional learning into in-class practices.

Each of the four schools considered its own professional learning arrangements in two ways: firstly, by drawing on ideas emerging from the earlier in-school

observations and, secondly, by gathering some basic data about teachers' hopes, needs and resources associated with the use of ICT in their own in-class practices. Based on this information, each school designed and implemented a professional learning initiative to meet some immediate professional learning need(s) and to provide a basis for likely future developments in the school. A report of the study was published by AARE (Webb, 2004) and the project website (Webb, 2003) and a related article has been published by the Journal of In-Service Education (Webb, Robertson, & Fluck, 2005).

The action learning plans and preliminary results for each school are summarised in Table 20 below. While the information in the table is somewhat simplified it represents a broad-brush summary of the school, the background to each project, the goals and action plan together with the preliminary findings and conclusion as reported by the participants.

Table 20 Summaries of Action Learning Projects

School	29	30	31	32
Description	One of two government primary schools in a rural service town outside capital city, established for some time recently underwent redevelopment.	Government primary school (~600) in outer suburban area of a major city. History of successful use of ICT. Experienced staff; strong support for use of ICT in classes.	The original government primary school in a large rural service town just outside the capital. Its present enrolment is approximately 350 students	Long established government primary school (~200) in a small residential village 20km from a major centre.
Background	Principal has been in the school a few years and is working to develop a whole school approach to teaching and learning. Efforts to date have had mixed success and the staff has failed to achieve consensus on a number of vital educational issues including the use of ICT	Strong commitment to use of ICT to enhance class programs. School & community have both made substantial investments in ICT. Need to maximize the effectiveness of professional learning as a major concern arising from reductions in available resources.	A proud history in the use of ICT for teaching and learning. Maintaining previous levels of expertise and practice had become difficult with a loss of skilled staff & reduced resources.	Recently appointed Principal identified need to address a number of historical issues relating to ICT: previously strong technical focus on ICT but loss of expert teacher and now no basis for planning & decision making
Goals	To gain insights into the purposes concerns & confidence of staff. To use these as a basis for discussion with staff leading to the development of consistent practices involving the use of ICT.	To design, develop and trial a more effective way of delivering professional learning based on convenience, relevance and usefulness to the participating staff members	To make better provision for ICT professional learning leading to a more consistent integration of ICT intellectual teaching and learning in classes throughout the school.	To be better informed about ICT provision and practice, staff competences and hopes and thus to better support use of ICT across the school
Action Plan	Simplest possible method. Staff to respond to two key questions regarding the use of ICT in their class programs. • Firstly, current purposes that involve the use of ICT in classes: to map the current practices across the school]. • Secondly, staff invited to share their concerns regarding the use of ICT in their class programs	Develop a professional learning process around that the use of Inspiration ('visual thinking' software): • Survey staff - select mixed staff • Arrange a 'buddy system' • Workshop: introduce software and plan for its use (next 2 wks) • Review progress as a group • Devise ways of capturing the learning, experiences & issues through a shared online journal • Shared achievements with staff	Project team devised an action plan with three steps: • Survey staff re their confidence with, & use of, currently available ICT (software and devices) • provide an training & planning use of Kidpix with buddies where possible • provide support for the participants to take their professional learning into their class programs	Develop a comprehensive staff survey covering aspects of ICT in work of the school: • Applications & devices • Uses & confidence • Basic task competence • Mentoring & support • Certification • Access (out of school) Attend to short term matters where possible

School	29	30	31	32
Preliminary results	Teachers reported using ICT • To enable students to acquire, present and or store information and for communication. • To extend and motivate students, as a tool for activity • For students to learn how to use ICT NB. Purposes were not consistent & apparent significance varied Concerns reported by staff: • availability and reliability of ICT • concern about themselves as users of ICT • own knowledge of ICT & ability to use ICT wisely in class • use of time, & groupings • resulting delays • significance s of the products from student use of ICT Low comfort → teacher focus on ICT High comfort → focus on education	Very positive response from staff: • Professional learning related to class programs was very meaningful & highly valued. • Participating as peers → collegial support (tutoring & mentoring) incidentally throughout the project. • All participants achieved effective transfer of their professional learning into in-class practices. • Buddy system expanded naturally and was highly motivating. • Participants universally agreed that the short time line assisted them to act on their professional learning and reinforced their learning.	Survey showed the expertise varies considerably. All participants successfully transferred their professional learning into the class program: • Project leaders started with the teachers' strengths, and building on from there • Participants were members of a section of the school and their success suggested there is value in addressing the needs of natural teams where possible Ongoing challenges identified • Difficulties in catering for part time and casual staff; • 'stretching the resources' to provide support in the transfer phase; • moving from focusing on the technology to the teaching & learning practices.	Responses collected and collated as staff & school profiles: • Some staff yet to achieve accreditation of any level • All staff members indicated the need for more training • Teaching staff generally felt more comfortable and knowledgeable about ICT than did ancillary staff • Every staff member had a PC & peripherals at home but variation was large • Staff considered 3 to 5 PCs per classroom to be ideal • Five months later the school reported good progress: it had introduced a calendar, online resource sharing, improved support systems
Conclusions	Some responses were quite negative but provided an opportunity to deal with ICT as a staff The school resolved several matters relating to the availability and reliability of ICT in the classrooms. Teacher comfort with ICT may well be the significantly underestimated issue.	Redesign professional learning processes. Initiatives and experience → 'pedagogy' for PL. PL best undertaken as a situated co-learning task. Build collaboration around learning that focuses on current practices. Share learning across the organization to embed the practices	The knowledge & skills required to use ICT are quite specific. There is value in • working with natural teams • a mixture of expertise, • more time to work together. • having a specific focus • understanding of how the professional learning fits into the life and work of the school	The School has developed a short but informative survey tool. Attention to staff comfort with ICT has been significant The process has enhanced engagement with ICT The school has demonstrated its commitment to the use of ICT to enable staff members to 'work smarter – not harder'

Professional Learning projects - Findings

Each of the participating schools provided presentations of their case studies for *RazzamaTas 1 - Capturing and Sharing the Learning*, a project workshop held at the University of Tasmania, Launceston (November 2003). Each project was ongoing at the time of the workshop. However, the experiences of the participants and the findings of the projects were such that the projects virtually redefined local professional learning in several important ways. The workshop considered the case studies individually and collectively and the following findings emerged.

The action learning projects were significantly different from many traditional professional learning initiatives. Participants focused on how the use of ICT might enhance their own practices, or enable new teaching and learning practices to be introduced. This was in contrast to the more common experience of workshops that presented teachers with ICT knowledge and skills. Participants engaged in the projects on a basis negotiated with the project leaders who co-planned the projects with the participants. Each project developed its own quite specific learning focus: planning and applying how the chosen ICT application or device would be used in specific practices within the actual class programs of the participants. That is, the professional learning was situated within the participants' own current class programs into which the new or improved practises were introduced. Rather than participating as individuals there was a strong emergence of learning as a group consistent with becoming communities of practice (Wenger). This arrangement extended the roles undertaken by those involved and made knowledge and other resources available on an on-going basis. Traditionally the roles in professional learning in relation to ICT had been largely fixed and limited to 'expert' and 'novice'.

In each of the projects, several roles emerged and these were observed to be dynamic and situational according to a member's capacity to contribute and other members' need for support. At times, individual participants acted as tutors by explaining 'How to…' When acting as mentors, participants explained 'What to do,

and why'. As facilitators participants assisted with arrangements, resources and the resolution of organisational arrangements. In addition, two additional and important roles were identified. The role of co-learner was reported as important in confirming the experiences of the learner, especially validating the difficulties and recognising and celebrating the achievements leading to sustained effort. Similarly, participants reported that recognition by a supervisor (Principal) was also important in that it validated the learning achieved and use of practices developed. Everyone, including the leaders, identified themselves as learners.

Much traditional professional learning is episodic, that is, it occurs in isolated workshops without specific connection to previous learning, current needs and actual real-time application. In contrast these projects attended to all these aspects by linking to and drawing on previous learning; attending to current needs; acting on the learning and jointly reviewing the experiences, difficulties and achievements in doing so. The cost effectiveness of this approach appeared very favourable since the participating schools did not need additional assistance and the learning was promptly transferred into actual in-class practices aligned with the school purposes and vision. Experiences and learning were shared beyond the learning group resulting in added value for the school and wider validation.

At each step, the roles, responsibilities and tasks changed according to the intentions, opportunities and capacities of the group. Management of the process was shared and collaboration readily allowed for customisation of activities to meet the needs of particular learners. Management was more a matter of leadership and facilitation rather than direction. Those responsible for the project expressed delight with the outcomes achieved. Leaders also reported the process was more cost-effectiveness than previously in terms of their own time and effort. The projects required less preparation, there was less stress in achieving the required organisation and it was easier to maintain momentum. Similarly, other participants reported improved cost effectiveness because the process provided them greater knowledge of, and easier access to, available knowledge resources. That is, the process enabled

people to uncover what they needed to know, and which colleagues were likely to be able to help them meet that need. In turn, this resulted in greater confidence and a reduced sense of dependency. The process was one of social construction and reconstruction of knowledge rather than simply knowledge transfer, training and skill development.

In more traditional professional learning the school need only identify the presenter as being suitably 'expert' and the participants as being suitably 'novice' to validate their participation in workshops. Having attended a traditional workshop, it was common practice for individual staff members to have full responsibility for applying the learning. There are significant implications for schools adopting an action learning approach. In order to validate new or improved practices, the school must have a useful concept of ICT, and be clear about what its purpose is in the life and work of the school. The school must also be clear about what practices will be supported with a view to achieving these purposes. This requires sound governance that can, through suitably authorised officers, support and endorse the prompt and sustainable transfer of the professional learning achieved into in-class practices. These finding are summarised in Table 21 below.

The difference between traditional professional learning that the participants had experienced in previously and their contributions and experiences in the self managed action learning projects can be understood in terms of the cycle of expansive learning. Engestrom's notions is that, in activity, the subjects experience tensions, or forms of disturbance or dissonance, between the elements involved: the object of the activity, artefacts involved, rules that apply, how the effort is distributed amongst the community involved. Progress or development is achieved by resolving these matters and the resolutions involve an expansion of the concepts involved. For example, traditional professional learning tends to focus on ICT knowledge but this is frequently inadequate for a teacher to be able to incorporate the use of ICT into his/her own practice. The resolution of this dissonance is achieved by delivering professional learning in which the development of ICT

knowledge and skills is firmly situated within everyday classroom practices and the hopes and needs of those involved.

Similarly, many of the limitations of what an individual can learn in a workshop or seminar are resolved by firstly expanding the learning group to include colleagues and secondly, by expanding the opportunity for professional learning to include the on-going day-to-day work of the participants. These expanded opportunities and support for learning are further complemented by follow-up sessions to jointly review and share knowledge and experience including problem solving.

Table 21 Comparison: traditional professional learning and action learning projects

Professional Learning	Traditional initiatives	Common reported tensions, disturbances	Action learning projects (resolution)
Content	ICT knowledge & skills	The learning achieved can be inadequate for many teachers to make a start and/or sustain their use of ICT	Practices: tools, artefacts, action & experiences
Learning Focus	General: e.g., the potential of software, or devices	The artefacts are often impressive, sometimes overwhelming, and not well situated with respect to the learner	Specific: ICT device + use + action → practice
Initiation	Offer of training	Teachers are looking for solutions to current needs rather than to overcome knowledge deficits (PN)	Negotiated, co-planned, situated
Intended outcomes	New ICT knowledge & skills	Often achieved but frequently incomplete and quickly lost	New or improved classroom practices
Participants	Individuals	Minimises shared experiences and on-going access to support	Learning group (collaboration)
Learning context	Institutional (push)	Learning distorted by other agendas; separated from the needs, interests and lived experience of the teacher	Community of practice (pull)
Participant roles	Largely formal & fixed roles	Associated with status, roles and abilities rather than needs and the capacity to contribute	Situational & dynamic (within working relationships)
	Novice & expert	High level of dependency and tends to isolate learners from more experienced and knowledgeable colleagues: also shapes the identity of the learner in deficit terms (with respect to ICT)	Learner, co-learner, tutor, mentor, facilitator, supervisor...
Timelines	Episodic	One of learning opportunity less likely to be successful: unnoticed gaps not addressed; no chance for follow-up	Ongoing & revisited
Learning cycle	Incomplete (event)	Usually little more than an introduction. Also learning requires action but this is usually separated from the professional learning opportunity	Complete, short and integrated into classroom/school practices
Cost effectiveness	Low (waste, rework...)	Frequently unsuccessful in terms of transfer of learning into in-class practices	High (practices, JIT, sustainable...)
Sustainability	Variable (often low)	Associated factors constrain ICT use. Isolated individual learners have only their own learning and experience to utilise so expanding application can be difficult... Little embedding of practices occurs – short term return only	High (embedded in culture, aligned with school purposes & vision...)
Information base	Variable (limited)	Limited to the individual him/her self	Participants share and co-construct knowledge and experience
Transfer of learning into practices*	Intended, optional, hoped for...	Needs to occur to justify investment of time, energy, ICT provision and resources as well as associated costs (e.g., opportunity).	Built into professional learning with direct or indirect support
Requirements of the institution (school)	Minimal	Responsibility assigned to the participating staff member (by default) may not be fair	Sound governance, clear concept of ICT, endorsed purposes in using ICT ...

The Professional Learning Cycle

A second major set of findings related to the sequence of steps undertaken in each project. The steps involved in each project emerged independently of each of the other projects. There was a high level of consistency in the steps taken by each school which can be largely accounted for by reference to the common approach taken – action learning (McGill & Beaty, 1992), action research (Adelman, 1993), and experiential learning (Kolb, 1984). All these approaches involve some learning and its application followed by reflection on the experiences and outcomes that then form the basis of a similar subsequent initiative such that the process has the potential to become cyclical. School 30 effectively completed a cycle of activities in the brief period of the action learning projects. The other schools each designed and began an equivalent set of steps intended to complete their projects in similar ways. All schools made commitments to apply the process and their insights to future professional learning. The following model (Figure 6) summarises the cycle of professional learning that emerged from the action learning projects.

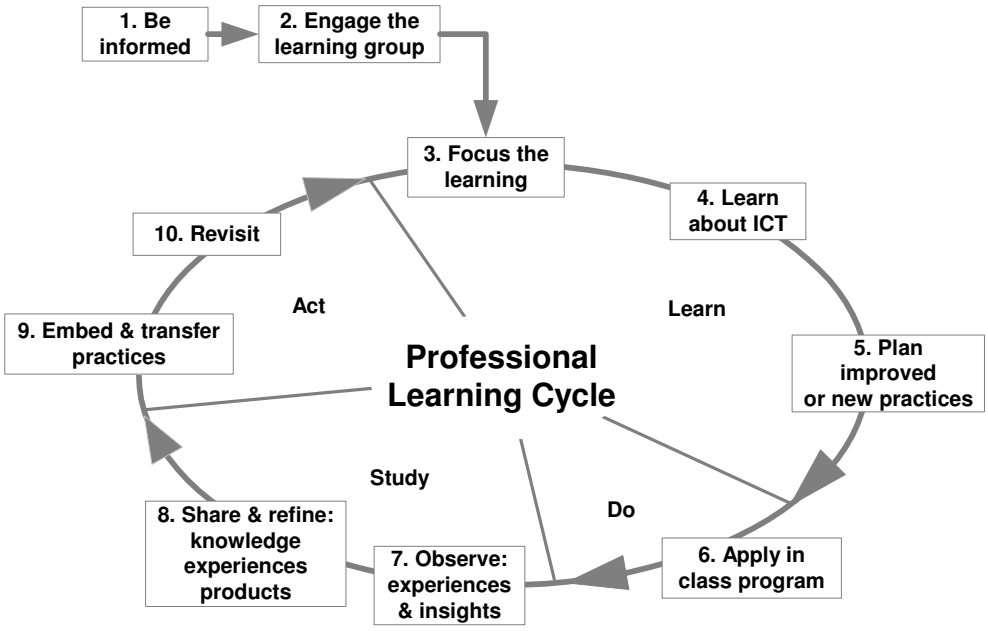

Figure 6 The professional learning cycle

It is important to understand the above model as a applying to the school as a social system rather than to an individual learner, that is, professional learning as a culturally, social and historically situated endeavour. The purposeful outcome from the activity of professional learning is that new (or improved) teaching and learning practices are embedded in the life and work of the school and that those practices are transferred to new contexts where appropriate. For example, in School 30 at the conclusion of their project the participants were invited to share their knowledge, experiences and products with having other members of the school staff. A "corridor walk" was incorporated into a staff meeting in which project participants displayed and discussed their class' work and activities and the teacher's learning and thinking behind it. The discussions resulted in affirmation for the professional learning and other achievements and endorsement of the new or improved practices that had been developed in the project. This in turn, helped to embed the practices into the life and work of the school by renewing interest amongst teachers who had used the particular application with previous classes. In addition, the range of uses on display (across various year groups, curriculum areas…) opened up interest in new possibilities thus prompting possible transfer of the application and practices on display to different contexts and for in different purposes. Given that School 30 had begun their project by exploring the possibilities of an application (Inspiration) that had been used in the school previously they were in part revisiting practices that had been embedded in the school previously, thus completing the above cycle (Figure 6). Situating the professional learning and outcomes in the life and work of the teacher and of the school itself is significantly different from the more traditional transfer of knowledge from the expert to the novice. In the latter instance the transfer of knowledge into classroom practices is a subsequent process and often problematic as was reported by many participants in the in-school observations.

The results of these projects are also consistent with the stages of development identified by Sandholtz, Ringstaff, and Dwyer (1997): entry, adoption, adaptation, appropriation and invention.

Planning professional learning

Insightful questions are a key element of action learning. Such questions enable tacit knowledge derived from activity and experience to be reformulated as explicit knowledge and thus made available to others. Questions may be insightful at two levels: firstly, the question results in an insight – it reveals knowledge that is previously unrecognised; and secondly the formulation of the question itself is a result of insight into the matter under consideration. Examples of insightful questions include

- What is the object of this activity?
- What factors enable and/or constrain this activity?
- How does this activity relate to other activities?
- How are the products of this activity used
- How does the activity shape the interactions of the participants (and vice versa)

The action learning projects, from which the above cycle emerged, also demonstrated several principles that had proved useful in implementing the projects. These principles emerged from insightful questioning in relation to the activities undertaken, the resultant experiences and the tacit knowledge derived.

Some basic principles associated with professional learning

1. **Professional learning results in new or improved professional practices.** This emerged strongly in all action learning projects as participants became more focused on actual practices. Experiencing success with the new or improved practices made the professional learning more meaningful, and strengthened the case for using ICT.
2. **ICT may provide practitioners with better or easier ways to do old things and the possibility of doing new things.** As the projects progressed this became the rationale for professional learning related to ICT. Based on their previous experience, participants were clear that knowledge of ICT might be necessary to ensure its effective use in classes.

They were also clear that knowledge of ICT had often been inadequate. During the course of the projects, participants became increasingly committed to learning about ICT in order to be able use ICT in their professional practices.

3. **Professional learning includes learning to manage better.** From the in-school observations, and confirmed by participants in the action learning projects, it is clear that using ICT can involve additional management tasks for teachers: negotiating and scheduling access; selecting suitable resources and making materials available, structuring learning tasks to match, managing the resources (including computers and other devices)… and so on. The project undertaken by School 31 provided additional in-class support to deal with initial management issues so that they could focus on students and their learning.
4. **Purposes and processes should be meaningful.** Participants consistently highlighted the importance of professional learning activities having practical meaning: something that they could apply in their class programs in the immediate future: professional action was seen the prime means of consolidating professional learning. Participants also wanted their learning and resultant practices endorsed, supported and encouraged by the school: things that are meaningful to others have added meaning.
5. **Being informed is essential.** In each school, the projects began with the project leaders gathering information from the school leaders and participating staff. From the in-school observations and confirmed by the projects, staff needs, interests, experience and capabilities (in relation to ICT) were not distributed in any consistent way. Hence, those arranging for professional learning needed be informed about who knew what, and who wanted to know what, and for what purpose. That is what hopes and needs should the professional learning address? This information provided a basis for negotiating participation, and for planning and managing the projects
6. **Build the outcomes into the school culture through collaboration.** The collaborative arrangements in all four projects helped to ensure that

outcomes of the professional learning were being transferred and embedded into the school culture. In each project, collaboration was promoted by working & learning with meaningful groups or shared or related practices thus developing communities of practice. Participants attended to similar learning tasks simultaneously and extended opportunities for collaboration across teaching, technical & other staff. Collaboration made the activities easier and more productive while reducing the risks involved. For example, it greatly increased access to the required working knowledge. Participants judged collaboration very significant and recommended that it should be highlighted during the induction of new staff.

7. **Start with (locally) situated samples and credible experiences.** Being able to identify with the intended possibilities was important for the engagement of the participants. Sharing locally situated examples and credible experiences provided meaning rather than just illustrating potential of ICT. These also help to bring out existing knowledge, shared purposes and common or related experiences. Participants indicated that this was different from being informed by experts who lacked knowledge of the local situation and had experiences that were situated elsewhere.
8. **Keep timelines short and the focus specific.** Somewhat to the surprise of the in-school project leaders, participating staff reported that shorter time lines "worked better". Staff explicitly expressed their appreciation for the short timeframes used in some of the projects. They found it easier to manage because effort is more sustainable over a shorter period; and there are more people doing similar things simultaneously (overlap of activity; easier to share experience…). Participants also reported that the shorter time span led to greater consciousness of what is happening; more informal sharing of experience; more incidental learning; increased assistance with troubleshooting; and less distraction, disruption and competition for time and attention. In turn, more attention resulted in greater awareness of success and more familiarity with the ICT leading increased confidence and

comfort because of support and shared experience. Sharing the load was also easier: "Tutoring means learning again and more!" (workshop participant).

9. **Take ICT into the classroom with modelling and support.** This was a consciously designed feature of the project in School 31 and occurred less formally in all other projects. Many factors can impact on the teaching and learning situation especially when technologically based innovation is being attempted. Modelling ICT use with the teacher's class demonstrated that "it worked with my class" (workshop participant). Providing in-class support for the teacher's initial attempts allows contingencies to be managed easily and well and reduces the 'risks' being taken by the teacher (see also 3 above).
10. **Apply, learn, share and take it forward.** One of the aspects of professional practice is that learning continues beyond the trialling of a new practice in the classroom. There will be different things to learn each time ICT is used: things about the technology itself; the management of devices; the use of technology; and how it mediates activity and learning and teaching. That is professional learning; action learning and professional practice cannot be meaningfully separated. As demonstrated in each of the action learning projects, collaboration enhanced the progress of the learning; the actual projects; sharing within the learning group and into the wider staff and community. It was important to share & review the experiences and results within the learning group and beyond the learning group.

Professional learning as an activity system

Much of the conventional professional learning in relation to the use of ICT in teaching and learning is undertaken as an event (e.g., a workshop as a single activity) by individual teachers (as 'ICT novices') lead by 'ICT experts'. Thus, conventional professional learning activities tend to adopt an expert-novice division of labour.

Most workshops are external to the school program and physically located outside the school in which the ICT is being used, that is, somewhat removed from the community in which the learning is to be applied. The workshop involves the use of artefacts that differ to a greater or lesser degree from those in the participants' schools and classrooms. Small differences can be significant for those with limited skills, knowledge and experience of ICT (CQ2). Responsibility for transferring their professional learning into professional practices is usually left to the individual participants – a division of labour that is unhelpful and minimises the relationship between the teacher (subject) and school (community) and between the school and the activity of professional learning.

In contrast, the action learning projects demonstrated the importance of participants learning as a group (subjects + division of effort) within their school (community), over a period of time during which the learning (activity) was to be achieved and transferred into in-class practices (object). It should be noted that this object is somewhat different from the object of more conventional professional learning. The latter tended to focus on helping the teacher gain operational skills and knowledge of the potential of ICT. In some instances, achieving such an object can be counter productive – as one teacher put it: "(I now know) there are so many possibilities with ICT I don't know where to start" (TQ15a).

In order to embed the new practices into the life and work of the school it was shown to be important for the learning group to engage with the wider school. The success of the projects was clearly related to

- the use of familiar and available artefacts (including actual examples of a wide range of class work)
- the rules agreed explicitly (or implicitly) between the participants,
- the rich and dynamic management of the division of effort (based on roles beyond the more traditional expert and novice) within the learning group (subjects).

Participants also emphasised that the school itself had a key role to play in two ways. Firstly, they reported that official recognition legitimized the efforts and achievements of the learning group thus helping them to sustain the transfer of their learning. Secondly, endorsing the new or improved practices promoted their use more widely in the life and work of the school. Explicit endorsement provided permission to use the practices and implied a school expectation or hope that the new or improved practices would be used. These latter items are appropriately accounted for in the 'rules' component of the activity system model

Summary - Professional learning as an activity system

The following diagram (Figure 7 Professional Learning as an Activity System) consolidates and summarises the key findings of the action learning projects. It would have been interesting to use the activity system to analyse previous professional practices used in each the schools with a view to 'measuring' the changes resulting from the action learning projects. Such a study would have had potential to understand the development of professional learning practices in each school as 'learning by expansion' (Engestrom)

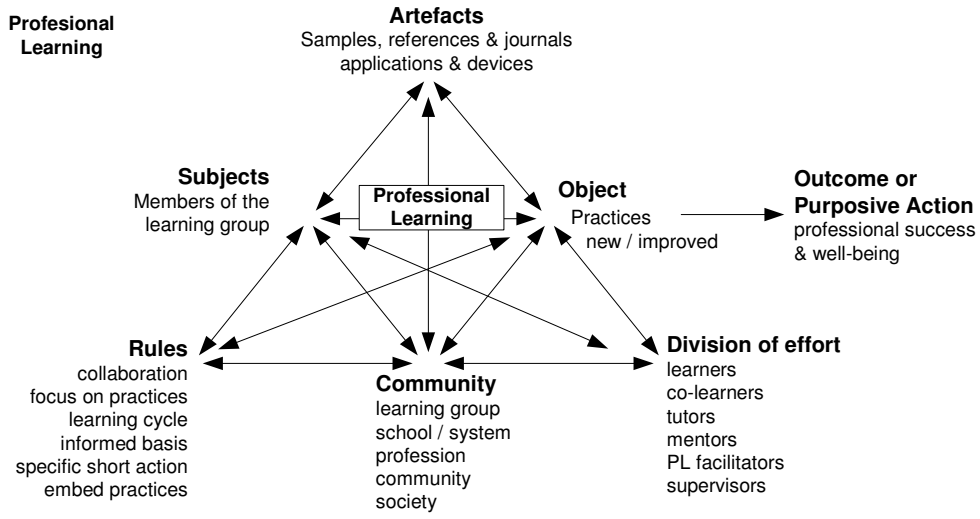

Figure 7 Professional learning as an activity system

4.5 Overview of observations – success with ICT was highly variable.

Success with ICT clearly varied from school to school, from class to class within all schools, and from time to time in many classes. Schools 13 and 14 were very similar in many respects (size, system demographics, ICT funding…) yet the use of ICT was very different in the two schools. In School 14, ICT use was extensive, consistent and fully integrated in teaching and learning in years 4 to 6. Uses ranged from robotics for the more capable students to specialised computer support for students with disabilities. Students regularly used ICT to communicate and present their learning and experiences to other members of the school community. In the same school, the younger students made only limited and occasional use of computers (PQ14). In School 13 use of ICT was limited and intermittent in most classrooms with one exception in which there was reportedly very extensive, innovative and comprehensive use of a wide range of ICT (NS13).

Success with ICT also varied considerably from time to time within particular classes. For example, one class (13a) had enjoyed a period of high-level use of e-mail and other internet-related research activity because of that teacher's parents touring Australia. The parents maintained an e-mail communication with the class throughout their tour prompting a whole host of research and communication activities and other learning on the part of the students. Computer use in the class declined dramatically when the parents completed their tour and the teacher was finding it difficult to regain the momentum and integration of ICT use that had existed within the class program during her parents' holiday (TQ13a).

The parents' holiday had created a temporary set of conditions that enabled the teacher & students to make good use of ICT for both research and communication. This in turn enlivened the in-class activities improved collaboration, enabled new practices (emailing, requesting information, engaging with the activities and experiences of others in remote locations) and improved existing practices (in-class writing & research) by making them more useful and meaningful. These in-class activities involved higher order purposes (genuine communication, responding to

opportunities, understanding the activities and experiences of others (the teacher's parents). The reality of the situation, the richness of the tasks, the ease of communicating with the teacher's parents and the value of the exchanges in terms of teaching, learning and relationship building all made the use of ICT very cost-effective.

This final account is just one example to confirm that, in relation to the successful use of ICT, practices, strategies and degrees of success varied considerably from school to school; from class to class in the same school; and within particular class programs from time to time. Many of the important factors are largely contextual, outside the classroom and beyond the control of the teacher or class concerned. They may include such disparate factors as a holiday taken by a teacher's parents, the 'reliability' of the available ICT, and the school's purposes, policies, hopes and expectations.

4.6 Other results not fully reported in this thesis

Clearly, the extensive observations resulted in the collection of large amounts of data, only some of which have been used in this thesis. Some findings are outside the specific main focus of this thesis.

For example, data gathered from early student interviews (N=97) enabled comparison between grades (year groups). As elaborated in Chapter 3 Methodology, these students were selected by their class teachers to represent the range of students in each of 7 grade 3 and 6 grade 5 classes in 3 Department of Education schools and 4 Catholic primary schools (S9 – S15)

The data below represent the students' prime response to each issue and is presented as indicative only. There is further work to be done on these data to incorporate later interviews and to prepare findings for other audiences.

Note. The code indicates the instrument used to collect the data. For example SQ is the Student Interview.

(a) ICT at Home – Source CA

ICT at Home	Grade 3		Grade 5		Total	
None	5	10%	6	13%	11	11%
PC only	11	21%	10	22%	21	22%
PC + Internet	36	69%	29	64%	65	67%
Totals	52	100%	45	100%	97	100%

Possible implication: Home provision appears similar for both grades

(b) Prime student perceptions of the best things about computers

Best thing about computers	Grade 3		Grade 5		Total	
No response	1	2%	1	2%	2	2%
Games	26	50%	10	22%	36	37%
Information	14	27%	23	51%	37	38%
Applications	10	19%	10	22%	20	21%
Other	1	2%	1	2%	2	2%
Totals	52	100%	45	100%	97	100%

Possible implication: The shift in preferences from Games (50% in Grade 3) to Information (51 % in Grade 5) may be significant

(c) Where student use computers – Source SQ

Student use of ICT	Grade 3		Grade 5		Total	
More at school	16	31%	10	22%	26	27%
About the same	2	4%	5	11%	7	7%
More elsewhere	34	65%	30	67%	64	66%
Totals	52	100%	45	100%	97	100%

Possible implication: Students who use computers outside of school regularly report that the proportion is five to ten times the use of computers in class. See (f) below for other related data.

(d) Who students primarily learn from (about computers) – Source SQ

Students learn from	Grade 3		Grade 5		Total	
Family adult	24	46%	20	44%	44	45%
Older sibling	10	19%	3	7%	13	13%
Teacher	10	19%	13	29%	23	24%
Friends or classmates	2	4%	5	11%	7	7%
Self	5	10%	3	7%	8	8%
Other	0	0%	1	2%	1	1%
Total	52	100%	45	100%	97	100%

Possible implication: Families play the major role in students learning to use computers: Grade 3 = 65% and Grade 5 = 47%. It is clear from student comments that computers at home provide a basis for collaborative learning activity that regularly crosses generational boundaries, overcomes sibling rivalry (at times) and links into extended families. Grandparents are a frequent source of support for students learning to use computers.

The shift (if any) is towards school based learning in Grade 5

- Teacher 19% in Grade 3 to 29% in Grade 5
- Peers (friends and classmates) 4% in Grade 3 to 11% in Grade 5

Note: the figures for Teacher as prime supporter of student learning about ICT were skewed by one school (S11) which had a very well developed ICT program with specialist ICT skills teaching and the community has made it clear to the school that they hoped the school would provide for the children allegedly to 'save the expense for the families' (PQ11)

(e) Who students primarily teach (about computers) – Source SQ

Teach	Grade 3		Grade 5		Total	
Family adult	5	10%	7	16%	12	12%
Younger sibling	17	33%	18	40%	35	36%
Friends & Classmates	16	31%	11	24%	27	28%
Extended Family	3	6%	4	9%	7	7%
Others	2	4%	3	7%	5	5%
No-one	9	17%	2	4%	11	11%
Total	52	100%	45	100%	97	100%

Possible Implications: This table suggests that students become more active as teachers about computers as they move from Grade 3 to Grade 5. These students were more likely to teach their parents, younger siblings and extended family members. Similarly they were less likely to teach 'no-one'. On the other hand the reduction in the likelihood of teaching friends and classmates may be a response to the increasing role of the teacher as primary source of learning about computers for many students.

(f) Access to ICT – Source CA

Access to ICT	Grade 3		Grade 5		Total	
School only	2	4%	3	7%	5	5%
School and home	23	44%	11	24%	34	35%
Extended access	27	52%	31	69%	58	60%
Total	52	100%	45	100%	97	100%

Possible Implications: Only 5 % of these students relied on the school as their prime access to computers. The significant shift from Grade 3 to Grade 5 is the reduction in the number of students who only have access home and school (44% in Grade 3 to 24% in Grade 5) and the corresponding increase in the number of students with more extensive (beyond just school and home) access to computers in Grade 5 (69% in Grade 5, up from 52% in Grade 3).

The above findings are based on quantitative data and appear to contain interesting possibilities and thus warrant further investigation. However, the main findings that specifically address the research question are based on qualitative data and it is for this reason that minimal use has been made of quantitative data in this thesis.

Also other findings have been reported elsewhere. For example, there are a number of factors that shape the way in which computers are used in classrooms. The students' working knowledge of ICT together with their capacity to use the computers with minimal assistance and/or supervision enable or constrain the teacher's way of structuring the students' learning that incorporates the use of classroom computers (Webb & Fluck, 2003, p. 3) , Table 22 below, summarizes the minimum requirements for the use of a particular learning structure:

Table 22 Learning structures using ICT and the minimum requirements

PCs	Learning Structure Using computers	Working Knowledge	Student Independence
1-3	Withdrawal from class	Low-Medium	Medium
4 or more	Rotation of Scheduled tasks in groups, e.g., webquests	Medium	Medium
3 or more	Rotation of Team tasks, e.g., group projects	Medium to high	Medium +
3 or more	Collaborative class projects With dynamic groupings	Medium to high	High

4.7 Conclusion

In this chapter, the major results of the in-school observations and the action learning projects have been presented. Characteristic instances have been provided to indicate where supporting data were gathered. However these instances are only examples. With observations made in 50 classrooms in 28 schools and in the four action learning projects, it is beyond the scope of this chapter to provide a full set of

all results. In addition, a wide range of phenomena was reported to be associated with successful use of ICT in class programs. These same phenomena were often observed in less successful situations but to a lesser degree; less often; and on a less sustained basis. It would be misleading to suggest that certain factors only existed in some classes and not in any others.

In the next chapter (Analysis), the above results will be analysed in order to answer the research question. Analysis of the results reveals a set of factors that are consistently associated with successful use of ICT in classes.

Chapter 5 Analysis

> The real point is that "nothing works all the time and everything works some of the time … (and) it is the task of the teacher to know when". Research is critical in this context "not in telling us what to do, but in helping us determine what questions to ask so we can decide what to do, when". – Sue Willis (Zbar & 2006, 2006, p11)

5.1 Introduction

In this chapter several interacting and mutually complementary factors associated with the successful use of ICT will be elaborated. These factors will be used to elaborate the implications for professional learning.

In the previous chapter, the major results of the in-school observations were presented along with the results of four action learning projects. The in-school observations of 50 classes in 28 schools involved extensive use of surveys, interviews, and direct observations that were recorded as case notes. Constant comparative analysis (Strauss & Corbin, 1998) was used to associate particular observations and reports with the successful use of ICT in class programs. Where appropriate, selected comments were used to illustrate and elaborate particular findings.

In the action learning projects, schools addressed some of their professional learning needs related to the use of ICT in teaching and learning. In planning their projects, the participating schools took into consideration the emergent findings from the in-school observations. Subsequently, the results of the action learning projects enabled further elaboration of some of the factors identified from the in-school observations. For example, collaboration was identified as a significant factor from the in-school observations: teachers reporting success with ICT also consistently reported higher levels of collaboration with colleagues and others. This

in turn, is further confirmation of the validity of taking a social constructivist approach to this study.

Similarly the action learning projects showed that collaboration is fundamental to successful professional learning firstly in terms of actual learning such as acquiring new knowledge and skills; developing new or improved ways of doing things… and secondly, in the transfer of such learning into in-class practices. Many participants had identified this latter aspect of professional learning as a major challenge. They reported having struggled, and often failed, to apply their newly acquired knowledge and skills following some professional learning event or activity.

Research question:

5.2 What are the key factors in the use of ICT in class programs?

Based on the in-school observations, eight factors were identified as being significant for the successful implementation of ICT in class programs. These factors were identified in situations where participating schools, staff and students were confident and pleased with their arrangements for, and achievements resulting from, the use of ICT. These same factors were often absent, uncertain or confused in those situations in which participating schools, staff and students were less convinced and convincing, about their arrangements, efforts and achievements in relation to the use of ICT. It should be noted that the factors interact, complement each other and in a practical sense, overlap. They are potentially valuable starting points for considering the use of ICT in class programs.

The factors fall into two main groups. Four primary factors directly affect the efficiency and effectiveness of ICT use in the classroom:

- Purpose and rationale for using ICT
- Matching technology to purpose and activity

- Working knowledge of ICT
- Cost effectiveness of using ICT for the activities

Four secondary factors shape the organisational and professional context in which users are using ICT

- Three levels of consideration with respect to ICT starting with school governance
- 'Reliability' of the available ICT
- Professional learning for the use of ICT
- Collaboration around the use of ICT

All eight key factors affect practices involving the use of ICT.

5.3 Four primary factors

There are four primary success factors associated with the implementation of ICT in class programs in which the teacher had successfully developed, managed and used ICT in teaching and learning.

Factor 1: Purpose & rationale for use of ICT

The purpose and rationale for using ICT in a particular classroom practice are shaped by the thinking of the users (teacher, students, families…) including their clarity of purpose within the overall purposes of the class (and school); their concept of ICT; and how and why the use of ICT might contribute to the achievement of these purposes in acceptable ways. Acceptability involved matters of cost including time, effort and disruption as well as benefits such as experience, knowledge and skills gained, and broader matters such as strategic advantage, school marketing and building community within the school and with the local community. Purposes and activity systems also shape classroom practices (Ares & Peercy, 2003). That is, purposes that are rich, complex, challenging and achievable using ICT, are typical of the thinking more successful users of ICT (Table 12 Thinking about ICT).

Thinking in turn is shaped by attitudes and experience. Not all students enjoy using computers - as one student put it, "Only when I have to!" (SQ5). Another student in the same class played online games at his friend's house because his friend had two internet-connected computers in the same room at his house. Their purposes in playing online games included learning from each other, enjoying the challenges and experiencing their opponent's emotional responses during play. The particular ICT arrangements at the friend's house made their purposes achievable. Playing the same games online but remotely from each other, each in their own house was possible but not as satisfying. A student from another class thought computers were great for playing games but far from ideal for class work (NC3).

The thinking within the school's wider community also influences thinking about ICT within the school. Staff members demonstrating more success with ICT were often very highly esteemed throughout the school community. Such staff members were usually clear about what was desirable, possible and feasible. Less successful users of ICT often adopted rationales provided by others. Some simply attempted to comply with the expectations of the school /school system rather than to develop a professional response to the opportunities afforded by the provision of ICT.

Successful users of ICT were more able to transfer their purposes into action, often as a three-step process to resolve key questions about the use of ICT in teaching and learning. Firstly, being clear about what was *desirable* (purposes) and secondly, establishing what was *possible* (identifying and/or creating opportunities). The third step involved judgements about what was *feasible* in the situation (available and acceptable activities/actions). What was both possible, desirable and feasible in turn depended on the match between the available technology and the activities (Factor 2) , the capacity of the users to select, operate and troubleshoot the appropriate technology for the tasks (Factor 3) and the cost effectiveness of doing so (Factor 4).

Factor 2: Matching technology

Successful users of ICT tended to reduce the challenges involved by choosing from a limited but well considered range of reliable, well-configured, up-to-date technology: computers, peripherals and applications (Table 13). The technology was typical chosen in relation to specific, collaborative, often negotiated, purposes, that is, the technology was well matched to the purposes and activities (Table 14). There was little evidence of ICT use as an activity in its own right in more successful classes. It was more common to observe open-ended and exploratory use of ICT in less successful situations.

More is not better! Some teachers were glad to have problematic computers and printers removed from their classes. In other situations, older less functional computers, and whole libraries of out-of-date software were ignored, and remained unused. One outstanding class had only two classroom computers. The teacher was able to supplement these computers with a range of additional computers as required and to select from a good range of peripherals according to the need. Students in this class could also negotiate access to computers in other classrooms as required.

Factor 3: Working knowledge

Working knowledge is required to select, operate and troubleshoot the technology used in the various **practices** (tasks and activities). In classes that were more successful such knowledge was understood as both an individual attribute and a class resource to be made available through teamwork and collaboration. The consistency of the technology (classroom computers that are identical) and its proper configuration and reliability all combine to reduce the range of working knowledge required. Classes that were more successful tended to integrate the full functionality of a limited number of devices and applications into the class program. At the same time, this deliberately limited provision was used for a wide range of purposes often leading to the creation of useful products and the achievement of higher order purposes. This commonality of purpose, technology, activity, and

collaboration all help to ensure that less working knowledge was required and was readily available to all in the class in order to achieve higher order purposes (Table 14). Where the use of ICT is an individual activity, the lack of adequate working knowledge can easily obstruct the use of ICT.

Teachers in less successful classes were more likely to introduce new devices and applications for the novelty associated with experience of the technology itself. The least desirable situation would be one in which an individual student (or teacher), without adequate working knowledge was attempting to use unreliable technology, poorly matched to the task being undertaken without ready access to prompt support. Teachers who had had such experiences reported having largely abandoned the use of ICT.

While this study focused on working knowledge directly related to the selection, operation and problem solving in relation to the use of ICT, it should also be noted that the context in which teachers acquire and apply working knowledge requires other forms of teacher knowledge. For example, Leach and Moon (2000, p396) show that the teacher knowledge used in creating a pedagogic setting includes subject knowledge, school knowledge, pedagogic knowledge brought together as the teacher's personal constructs of educational goals, views of mind and learning and their prior experience. Little wonder that teachers consistently reported the shortcomings of professional learning focused primarily on ICT.

Factor 4: Cost effectiveness

The use of ICT can be costly in terms of the time and effort required to prepare for and use ICT; the financial investment in facilities; professional learning; professional and technical support; and the provision of hardware, software and peripherals. Some teachers indicated that use of ICT also involved an opportunity cost. For example, teachers identified desktop publishing as very time consuming and some had doubts about its relative value when compared with other literacy activities. They also identified disruption as an additional cost. Few classes were able to provide access to ICT for the whole class at the same time. In most classes, only some of the students could use the computers at any one time. Such use frequently

occurred in parallel to the main class program resulting in the need to additional management particularly for scheduling and monitoring ICT use. Helping students to complete class work missed while using the computers added to the cost in some situations.

Dealing with the above costs often appeared to involve compromises including parallel scheduling (some students initially missed out on parts of the regular class work) and using students to support their classmates who were using ICT. The peer helpers were not doing their own class work while being helpful to their classmates. Computer use in some classes was mainly an activity for students who had completed their regular class work while students who had not finished had less or no computer activity. These computer activities were often of a lower order and more routine nature such as playing educational games and by implication less significant.

Costs and benefits are not always mutually exclusive. The above compromise of using peer helpers to support students using ICT had benefits recognised in some classes. The teacher could attend to the main body of the class and progress the class program and the helper gained additional ICT knowledge and leadership skills from being a helper. In addition, the collaboration was seen as building the supportive culture of the class. Despite the obvious benefits overall, some parents of helpers had expressed concern about the possible cost to the helpers and their progress in the main class program (TQ3).

The value of using ICT is associated directly with its effectiveness. ICT can enable new activities or practices such as students using email to communicate with the travellers. The use of ICT can enhance the effectiveness of some existing activities or practices such as students gathering up-to-date weather information about a location from the internet.

An indirect benefit of using ICT in some situations was that it met the expectations of third parties including families, the school or school system, and the school community. There are many stakeholders interested in ICT to being used in teaching and learning. Many schools had highlighted their ICT provision and its use

as part of presenting themselves to their communities and school system. Related to this, several teachers reported experiencing guilt when the class program did not include the use of ICT. In contrast, at least one school was deliberately modest about its ICT for similar reasons (PQ12). In this school, some parents had expressed concern about the possibility of "too many computers". Assessing cost effectiveness involves considerations of finance, and in-class practices. It also involved the hopes, preferences, and expectations of a wide range of other stakeholders with an interest in continuity and/or change. The implication is that cost and value can be issues for both the use and the non-use of ICT.

The Primary Factors - an illustrative case study (revisited)

The case study (13a) used in Chapter 4 is also useful in illustrating the Primary Factors. It describes a classroom in which there had been a very successful use of ICT in previous times. However the earlier success was not sustained and indeed there was minimal use of ICT at the time of the in-school observations. That is, the case study is an example of the introductory quote used at the beginning of this chapter: "nothing works all the time and everything works some of the time …". The account is significant in several ways. Successful use of ICT was reportedly the exception, rather than the rule for this particular class. As such, it provided an opportunity to identify factors that may be significant, in particular those factors that were present during the more successful use of ICT and were largely absent during less successful use of ICT in the class. That comparison could be made of the same class in the same school at different times was particularly helpful. It controls for the possible significance of some other factors including the school, the teacher, the students, the room and associated facilities, support services, colleagues, community, professional learning… all of which are common to both times and hence both levels of ICT use.

1. Purpose and rationale

The school's purpose in relation to the use of ICT in class programs was very limited: computers were provided to all classes, and computer annexes had been constructed so that pairs of class could share sets of computers. In addition,

teachers could choose from a substantial collection of electronic learning materials (mainly as CD-ROMs). Decision-making, including choosing purposes and rationales in relation to the in-class use of ICT, had been delegated to individual teachers across the school. On the other hand, the Principal had three strategies for getting value from the very substantial investment (cost) in hardware and software. These included reducing maintenance costs by disposing of older, high maintenance equipment, using ICT at the school level in administration, and in presenting the school to the community (school reports and school website). The Principal had deployed the work of ICT coordinator to these ends rather than to supporting in-class use of ICT. In contrast, the journey around Australia undertaken by the teacher's parents provided a unique opportunity for the class to use ICT in a purposeful way including using email for communication and the internet for additional research related to the travellers' location, progress and likely experiences. The class undertook a largely self-managed collaborative learning activity about different parts of Australia and at the same time, acquired skills and knowledge about online communication and the ICT involved. The teacher's rationale for using ICT was that it would enable genuine research and communication to be undertaken easily and well by the class.

2. Matching technology

The available in-class technology was well matched to the practices involved. The class had access to the internet for research and email for communication as did the travelling parents. Text (comments, questions and responses) and images could be exchanges cheaply and frequently. In addition the technology used by the class and the travellers proved to be satisfactory, that is, functional and reliable, during the course of the class activities.

3. Working knowledge

The working knowledge available to the class (teacher and students) was adequate, that is, they were able to select, operate and troubleshoot the technology they used in the various **practices** (tasks and activities) involved in particular researching the

locations visited and communicating with the travellers. The commonality of tasks in this particular account, the consistency of the technology (the classroom computers were identical) its reliability all combined to reduce the range of working knowledge required. At the same time, the commonality of tasks and collaboration at group and class level helped to ensure that the working knowledge in the class was readily available to all.

Situations had been observed, in this and other classes, where the use of ICT had been obstructed by a lack of adequate working knowledge. A student from this same class unwittingly highlighted the simultaneous three-way link between working knowledge, technology and task when he expressed frustration that "I can't find anything on these computers" (SQ13). His difficulties arose because the schools' computers had a different operating system from his home computer. Thus, working knowledge is also related to the matching of technology to task and experience. The least desirable situation would be one in which an individual student (or teacher), without ready access to prompt support was attempting to use unreliable technology, poorly matched to the task being undertaken, without adequate working knowledge.

4. Cost effectiveness

Many participants reported that the use of ICT was costly in terms of the time and effort required to prepare for and use ICT. The financial investment in facilities, professional learning, professional and technical support, and the provision of hardware, software and peripherals (Table 15) were also recognised as significant. Some teachers indicated or implied that use of ICT also involved an opportunity cost. For example, desktop publishing can be very time consuming and some teachers had doubts about its relative value when compared with other literacy activities. Disruption was identified as an additional cost. In most classes, only some of the students could work with the computers at any one time and this often occurred in parallel to the main class program resulting in the need for additional teacher tasks such as scheduling access and monitoring ICT use while teaching

other students. The need to help students to catch-up on class work missed while using the computers added to the cost in some situations. Catch-up frequently involved reteaching something that that the rest of the class had already completed. Dealing with the above costs often appeared to involve compromises. Parallel scheduling meant that some students initially missed parts of the regular class work. Using other students to support the use of ICT means that the peer helpers are not doing their own class work. Computer use in some classes was mainly an activity for students who had completed their regular class work and as a result students who had not finished their regular work had less or no computer activity and such activities were often of a lower order. It also suggested that computer activities were not prime activities.

The above compromise of using peer helpers to support students using ICT had benefits recognised in some classes. The teacher could attend to main body of the class and progress the class program and the helper gained additional ICT knowledge and leadership skills from being a helper. In addition, the collaboration was seen as building the supportive culture of the class. Despite the obvious benefits overall some parents of helpers had questioned the cost in terms of their children's progress in the main class program.

The value of using ICT is associated directly with its effectiveness. It can enable new and real activities or practices such as students using email to communicate with the travellers. The use of ICT can enhance the effectiveness of some existing activities or practices such as students gathering up-to-date weather and climate information about a location from the internet.

Another indirect benefit of using ICT in some situations was that it met the expectations of third parties including families, the school, school system, and/or the school community. Such stakeholders are likely to expect ICT to be used in teaching and learning. Many schools reported highlighting their ICT provision and use as part of presenting itself to its community and school system. Related to this several teachers reported experiencing guilt when ICT was not being used in the

class program. In contrast at least one school was conservative about its ICT (PQ12) because some parents had expressed concern about the possibility of "too many computers". The implication is that cost effectiveness is an issue for both the use and the non-use of ICT.

The following table (23) summarises the difference between the two contexts, that is, during the parents' journey and after the journey had been completed.

Table 23 Four primary factors in the illustrative case study

Factor	During reported case study	During in-school observations
Purposes & rationale	Clear and significant: - undertake research and communicate with travellers sharing information as text and images	Vague and uncertain: - use ICT? Other?
Matching technology	Appropriate (easy to use) and effective: internet, email and web-browser	Uncertainty of purpose leads to lack of significant activity hence not matching technology did not apply*
Working knowledge	Possessed and shared by class as required; able to use the hardware and software that were reliable	See above – lack of significant activity results in little or no use of ICT, similar level of working knowledge required
Cost effectiveness	The significance, effectiveness and real time nature of the use of ICT together with the products and the value of experiences more than compensated for the time and effort involved.	The lack of purpose and high cost of small groups using ICT (required supervision and support in separate annexe) dramatically changed the cost-effectiveness balance against the classroom use of ICT

Note: The above case study helps to elaborate four common ways in which technology and its use in activities may be matched according to the purposes involved:

1. Unfamiliar technology is used in an activity that achieves a separate purpose. During the parent's journey the students used ICT to learn about Australia and to improve their knowledge and skills in relation to internet research and the use of email for communication

2. Familiar technology is matched to an activity that achieves a separate purpose. During the in-school observations, there was discussion about the possible use of the internet to gather information about an upcoming local event. Given the previous experience is likely that students would have been successful with this activity and that the ICT would have simply been 'a means to an end'

3. The tasks and activities are matched to unfamiliar technology. During the in school observations a visiting consultant used a data projector to teach a demonstration lesson focusing on the use of some particular software. The demonstration involved the class in some minor activities using the software. In this context, the particular ICT was a curriculum component in its own right.

4. There is no matching of activity and technology because the activity does not involve any use of technology. Much of the class program fell into this latter category. One contributing factor was the location of the technology: the classroom computers were in an adjoining, especially constructed annexe that could not be overseen from the classroom: as a result, students could only use the computers when additional assistance was available. It should also be noted that the teacher did not have access to a data projector and would not have been able to repeat the demonstration lesson nor apply at least some of the professional learning from the demonstration.

In the following section, four secondary factors that are significant in the implementation of ICT are discussed.

5.4 Four secondary factors

The successful implementation of ICT in teaching and learning is more than adding devices to the class resources. As shown above, it involves establishing purposes and the rationale for using ICT to achieve those purposes. To make the purposes feasible the technology needs to be matched to the tasks and activities that will achieve the purposes. The users require adequate working knowledge to be able to select, operate and troubleshoot the matching technology to undertake the tasks

and activities involved in a way that is cost effective, that is, the purposes are achievable at reasonable cost.

In addition to the primary factors impacting directly upon the use of ICT in classes, four secondary factors were identified that also had a significant, if somewhat less direct, impact on the implementation of ICT in classrooms.

Factor 5: School governance - three levels of consideration

The use of ICT in classrooms requires consideration at three levels: school governance, the class program and activities. Sound school governance underpins leadership in relation to purposes and practices the greater the clarity and consistency of the application of ICT at each of these levels within the school the more successful the use of ICT was reported to be. Governance is concerned with school values and therefore its purposes. It also matches policies, plans and resource allocations, all of which are connected with the vision of the school and how those responsible would like the school to be perceived by its community. Governance is also concerned with the competence, motivation and confidence of the people in the school and addresses these matters through the initiative such as professional learning, technical and professional support and ICT infrastructure including technology (hardware, software and peripherals), information, facilities, access for resources and services and support.

Sound school governance attends to the success of the people involved and thus provides guidance and support to those responsible for the delivery class programs. In terms of ICT, this means consideration of the impact of using ICT on teaching and learning. This in turn implies the existence of a conscious (or an unconscious) program logic: assumptions/beliefs → input → activity → outputs → outcomes → impact (McCawley, 1997). That is, any use of ICT is related to some notion that the provision (input) and use of ICT in classroom (activity) will result in certain desirable outputs and outcomes and that these outcomes would have a significant (educational) impact. In this study, successful use of ICT was consistently associated with greater clarity and higher order thinking (logic) about of the use of ICT in class

programs. In such schools and classes, the use of ICT was explicitly related to aspects of the class and its operation:

- factors pertaining to the students and to the teaching context
- the process factors relating to the approach to task including teaching and learning practices
- student achievement as part of the learning outcome for students, class and school.

Factor 6: 'Reliability'

There are two notions of reliability that emerged from the study. Firstly, the common understanding of reliability as a characteristic of the technology: the technology (hardware, software or device) would function properly - it would work. Secondly, reliability as part of the experience of using the technology: that one can rely on being able to use the technology as intended and expected.

The difference in these notions caused some communication difficulties between stakeholders. IT support, senior officers from the school systems, and the industry partner (Telstra) were keenly interested in reliability in terms of whether the technology was working. Teachers, on the other hand, used the second notion of reliability since they needed to be able to rely on being able to use the technology within their 'window of opportunity'. Investigation of the factors associated with reliability as experienced by teachers showed that with only a few exceptions reliability was an issue of in-school and in-class practices and arrangements rather than technology that was not working. Consider the following factors that were observed to impact on the capacity of classes to use ICT:

- **Access for users**: denied; unknown; lost or forgotten passwords; authority not available
- **Configuration**s: inconsistency; incompatible software versions; incorrect language (US by default?); auto-correct override; inappropriate saving defaults; configuration or problem: unsure?; software/computer mismatch; device unable to perform to meet demands; lost shortcuts ...
- **Connections**; slow; dropping out; time-out; cables missing...

- **Development is disruptive**: new OS; new server set-ups; new versions of software installed...
- **Equipment**: not connected; consumables exhausted (paper...); components missing; insufficient devices; broken (being repaired); not returned; no booking system; booking system ineffective; cannot be located; not accessible (e.g., locked away, out of the school…)
- **Equipment differences**: impact of user preferences; user expectations, e.g., class computers very inferior to home computers, different operating systems
- **Files & shares**; structure & organisation; damaged; lost; deleted; not saved; default names; inappropriate or misnamed files
- **Memory failure** (the human kind)
- **Maintenance**: no preventative maintenance; insufficient disk space; fragmented files; minimal levels of support; fault reporting systems; long delays…
- **Operational knowledge**: inadequate training; accessing (JIT); don't know how to use ...; unfamiliar versions of software;
- **Software**: compatibility of versions; compatibility of applications (word processor and graphics); range too limited or too extensive (confusion/uncertainty); approved applications; compatibility - none, partial;
- **Troubleshooting**: the computer "freezes"; drivers missing or not installed; globe blown; battery flat ...; not plugged in; component not switched on; power supply needs to be reset; can't identify problem; don't know how to solve it; assistance not readily available; uncertain who should fix it ...; uncertain whether one should attempt to fix it ...;
- **Working Knowledge**: unable to select; unable to operate; and/or unable to troubleshoot the use of the technology
- **Windows of opportunity**: too small (task design, groupings…); not open (inadequate preparation); closed (by a technical problem or the time available simply elapsed); not a genuine opportunity (required equipment or facilities not available); too large (little sense of purpose and urgency)
- **User routines**: not known; not followed; limited access to recommended practices

As one very IT capable teacher put it, "I have to plan each lesson on the basis that the technology will fail!!" While this statement does not accurately represent the most common causes for concern (the technology will fail), the frequency with which this idea was expressed indicates the significance of reliability as a factor. That is, reliability is a critical and complex issue that should be managed comprehensively within a school. Such management needs to be well informed

regarding the current situation (practices, arrangements and experiences) supported by technical and professional support and professional learning. Ensuring that all the available technology is working is only a small part of the challenge. Improving the available technology or upgrading to the latest versions of applications can be counter productive: as reported earlier, development was consistently reported as being disruptive. Thus, there is a need to anticipate future needs and to manage progress carefully. Because of the specificity of ICT devices and applications, the integration of new ICT devices and applications cannot be treated as simply additive. More is not always better; newer is not always an improvement; and adding can subtract from previous arrangements.

Factor 7: Professional learning

Participating teachers who reported success and comfort in incorporating ICT into their class programs also consistently reported having a personal professional learning support network that provided them with encouragement and support. The networks were typically made up of 'expert' colleagues, their teaching colleagues, friends and family members. Membership of the networks usually included peers who are at a similar stage of development and thus co-learners. Out-of-hours access to an internet-connected computer, frequent use of email and social contacts all enabled this network to be effective beyond the immediate school to which the teacher was appointed. Many teachers reported being discouraged when receiving assistance from 'technical experts' who did not explain the assistance they have provided. The problem may have been fixed but the teachers were none the wiser regarding its cause or solution. They were no better prepared to deal similar situations in the future. Similarly, teachers are often daunted or made to "feel guilty" by the work of other teachers who are able to demonstrate their success with ICT well beyond the teacher's current level of practice.

The implication is that the use of ICT is fostered by membership of one or more professional learning communities with some interest in ICT (communities of practice). In communities of practice, groups of people collaborate to improve their

knowledge (tacit and explicit), shared repertoire of actions... about the practices that they share. Participation usually makes a positive contribution to the teacher's identity. As knowledge is gained and the network expands, teachers have an awareness of increased personal knowledge and skill and resilience. They do this through participation as learners and 'teachers' in the community where teaching and learning involve negotiation of meaning in contrast to expert-novice arrangements that are intended to simply transfer specific knowledge and sometimes 'best practice'. Consistent with being a community of practice, the benefits of belonging to a support network include easier access to resources; prompt support for problem solving; and encouragement to be innovative in the introduction of new teaching practices. This aspect of teacher confidence and competence appeared to parallel the way in which many children reported learning about ICT from family and friends. Thus, key professional development for many teachers was often social, informal and loosely organised by the participants themselves in response to their own immediate and local needs and provided 'just-in-time', often in response to a discovery or query. While teachers that are more successful valued learning from experts, most learning was reportedly from (other) practitioners.

Factor 8: Collaboration

Early in the COLAT research project the following question emerged: "What is the impact of the use of ICT on collaboration in the classroom?" Because of the extensive in-class observations, it has been concluded that it is more significant to consider the converse question:

What is the impact of collaboration on the use of ICT?

From the observations, the complexity of incorporating ICT into teaching and learning is such that the level of collaboration in a school or class has a greater impact on the use of ICT than vice versa. Indeed some teachers (TQ7a, 7b) reported that they had reduced or curtailed student use of ICT because of problems the students had collaborating in the class.

Collaboration is usually characterised by shared purposes; enthusiasm for the activity (a sense of achievement often demonstrable through the products of the activities); confidence in one's ability to contribute (knowledge, skills...); and a sense of belonging as a result of having contributed.

Collaboration builds professional learning into the culture by making planning, problem solving, improvement...better informed and better supported. It was clear from the action learning projects, and from reports of personal professional support networks, that collaboration is fundamental to professional learning. In both contexts, learning together meant acquiring or sharing knowledge, experiences & products in order to do current things more easily and better; and/or to do new thing.

Action learning participants reported that learning together felt more 'natural' and recommended that ICT use should be considered as a part of collaborative planning. As much as possible, staff should work in pairs, teams and other natural groups. In addition, they should share within and beyond the learning group. Collaboration was valued for more that the social benefits - it enables both staff and students to build their knowledge of who knows what (a key resource!). Collaboration and learning together makes change easier & safer … "It is OK to have problems because…" That is, others validate good, bad or indifferent experiences and help to solve problems by contributing knowledge and experience available. Shared achievement leads to shared celebrations of success; and everyone can be a contributor and a beneficiary (the hallmarks of belonging).

Collaboration also provides for flexibility and resilience through the creation of roles according to need. For example, a number of roles involved in the delivery of effective professional learning emerged in each of the highly collaborative action learning projects (see Table 23). In addition, these roles are not limited to formal professional learning activities. They frequently emerge from the everyday collaborative interactions in which teachers are engaged (PN30). Such situations

include teachers' personal professional learning networks, other formal meetings and processes, and everyday interactions.

Personal professional support networks are informal collaborative professional learning arrangements based on shared purposes and an interest in how to achieve them. As part of the ongoing interactions, sources of knowledge and other forms of support become better known. As a result, collaboration in both formal and informal professional learning is likely to lead to more sustained and consistent practices, thus supporting the development and sustained achievement of (professional) standards. Even when practices are not successful, collaboration has value. It increases the likelihood of gaining some insights into the experience itself and may help to reduce the likelihood of the 'failure' being repeated. That is collaboration is likely to result in improved practices and greater cost-effectiveness under a wide range of circumstances.

Collaboration increased the availability of working knowledge resulting in improved selection and operation of technology. The ready availability of working knowledge also assisted problem solving and thus increased the likelihood of the practices being successful.

In summary, in situations where there are high levels of collaboration there are also likely to be significant successes, i.e., purposes are achieved (value gained). Collaboration reduces the effort involved through better arrangements (division of effort) and more effective operation and troubleshooting. Improved troubleshooting reduced rework and other losses. In collaborative situations the knowledge, skills, experiences and products of professional learning can be made available to support colleagues in their endeavours thus providing additional value at little or no cost: knowledge is not consumed when it is shared with others.

Just as collaboration enhances the use of ICT, so technology may be used to support and enable collaboration. However, what is the connection between collaboration and ICT? Based on the in-school observations it would appear that

success with ICT is more likely where there is an interest in the use of ICT and high levels of collaboration. On the other hand, few observations provided any evidence that the use of ICT appeared to have a sustained impact on the level of collaboration. In the short term, the novelty of attempting to incorporate the use of ICT into teaching and learning practices may promote higher levels of collaboration as in the illustrative case study above.

The close link between action and learning means that, in a collaborative culture, learning and action are both likely to be valued by members of the culture. Learning matched to shared purposes is more readily translated in to new or improved practices. As a result, in collaborative cultures it is likely that new knowledge becomes a sustained part of the culture and is more readily available to its members. Similarly, collaboration supports the rapid and extended deployment of the improved or new practices into the life and work of the group. Collaboration enhances other aspects of the school through better-informed governance and well-considered development of an infrastructure well matched to shared purposes. It also results in astute deployment and application of new and improved practices.

5.5 Complementary relationships between the factors

As indicated in the introduction and in the above analysis the eight factors are complementary in many ways. Consider as an example the impact of **purpose & rationale** on the other seven factors:

- **Matching technology**: The purpose and rationale inform the selection & management (distribution, configuration…) of technology so that it better matches the uses to which it will be applied
- **Working knowledge**: The purpose and rationale provide a focus for working knowledge (not simply learning about latest developments): what one needs to know in order to select, operate and troubleshoot the use of the technology to achieve the purposes
- **Cost effectiveness**: Clarity of purpose increases the significance of particular uses of technology and a rationale may improve the effectiveness (a sound rationale informs practices) and together these improve the cost effectiveness

- **Three levels of consideration**: The purpose and rationale are higher order constructs that have the potential to be meaningful across, and therefore integrate and inform, the three levels of considerations
- **Reliability**: The purpose and rationale for using ICT provides guidance to those who contribute to its 'reliability'. Higher order purposes bring greater attention to matters such as device configuration, working arrangements, user practices, prompt support and ready access to peripherals all of which contribute to improved 'reliability'. In addition higher order purposes tend to lead to windows of opportunity well matched to the activities being undertaken, all of which increases the likelihood that the class can rely on being able to use the technology within the window of opportunity.
- **Professional learning**: The purpose for the use of ICT provides core guidance to any professional learning initiatives by helping to match the required expertise to the desired use of ICT and the associated rationale.
- **Collaboration**: The purpose and rationale provide a focus for collaboration. Shared purposes and associated understandings promote, enable and constrain collaboration. The actual participation by the schools in the action learning projects involved attending to purposes and rationales for ICT use in the school (in a general sense) and in the particular initiatives of the individual projects. This explicit engagement of the school with purposes and rationales provided a powerful basis for collaboration amongst participating staff members and with other members of the school staff.

Similar analyses could be undertaken in relation to each of the other seven factors and this suggests that there are twenty-eight complementary dyad relationships ($8x7/2 = 28$) between the factors however it is beyond the scope of this thesis to undertake such an analysis. In addition, the mutual impact of the factors is such that the members of each pair enable and constrain each other. As shown in the above example, this is likely to have a 'flow-on' impact on the other factors. The significance and clarity (or otherwise) of the school's purposes for using ICT in class programs has an impact on the effectiveness of governance which in turn shapes the 'reliability' of the technology. Attention to 'reliability' leads to consideration of professional learning as a means to achieve the requisite working knowledge. And so on.

5.6 What are the implications for Professional Learning?

Some key implications for professional learning are summarised in the following list:

- **Purpose and rationale for the use of ICT:** Achieving the purposes of using ICT requires in-class practices (organising, teaching and learning) that will achieve those purposes. Implementing and managing such processes is aided by knowing and understanding the purpose and the rationale behind using ICT to achieve the purposes. Professional learning is about acquiring such knowledge and understanding and the capacity to implement the **practices** involved.
- **Matching technology**: Technology is used in activities and activities are the elements of practices. Thus, a key aspect of professional learning is about the capacity to match the activity and the technology to the practices.
- **Working knowledge**: Professional learning is fundamentally about teaching and learning practices in the classroom. As part of being able to use ICT in teaching and learning, it is essential to be able to select, operate the appropriate technology and troubleshoot problems that may arise. Professional learning includes the acquisition of the requisite working knowledge.
- **Cost effectiveness**: Professional learning that enhances the capacity of teachers to improve teaching and learning using ICT contributes to the cost effectiveness of its use. Such professional learning attends to higher order purposes; sound rationales; the teacher's capacity to match the use technology to practices; and the working knowledge required to lead and manage the endeavour easily and well.
- **Three levels of consideration**: Arising from the need to consider the use of ICT at three levels (school governance; class program and activity) is the need for appropriate professional learning for those who contribute at each of the levels. The levels are complementary and consistency is important. The 'higher levels' are intended to assist in enabling those at the 'lower' levels. Thus, the ability to contribute at a particular level requires considerable understanding of each of the other levels. Principals and technical support personnel who have a good understanding of class programs and in-class activity are highly valued for their ability to make better contributions at the class and activity level. Similarly, classroom practitioners who have a good understanding of the school, and broader curriculum and pedagogical issues are able to make significant contributions beyond their classrooms, and particularly in relation to school governance and professional learning. Many in-school coordinators have such abilities and as a result have significant opportunities to contribute and to learn more. They are frequently recognised for their knowledge, skills and contributions.

- **'Reliability'**: As shown above reliability is often about working arrangements and user practices. It is not simply a matter of whether a device is operational or not. A significant part of professional learning is about the development of in-class arrangements and practices that will minimise the need for troubleshooting. That is, ways of managing and using the technology that will not create unnecessary problems. Every problem with technology is a distraction and possibly a disruption from the core classroom endeavours of teaching and learning. At the same time, ensuring that the available technology is reliable in a technical and user sense (well managed, working as it should, configured properly, available…) will reduce the need for professional learning that focuses specifically on technology. Another significant implication is that the professional learning undertaken in the participants' school using their own equipment is more 'reliable' because the professional learning environment and the teachers' classroom are the same. They are not subject to unforseen differences. Several teachers reported such differences as an obstacle to the transfer of professional learning into in-class practices.
- **Professional learning**: There is a case for learning about learning. The action learning projects involved such learning and this enhanced the professional identity and confidence of the participants as practitioners. In at least one instance (PN30), attention to the learning assisted with the transfer of the professional learning beyond the immediate group of participants. Such meta-learning is less likely to occur where professional learning occurs as isolated events undertaken by individuals and focusing on specific technology. Meta-learning is more likely to occur when professional learning is embedded in the everyday practices of the learners.
- **Collaboration** is at the heart of professional learning and the successful transfer of that learning into in-class practice, as shown in the action learning projects. As reported in Table 21, those participants reporting greater success in using ICT in their class programs also reported more opportunity and support for their professional learning in relation to the use of ICT. Apart from personal professional reflection on their own practice, the opportunities and support involved significant levels of collaboration others: members of their own personal professional support networks, their teaching teams, school development teams as well as other participants in collaborative workshops & seminars. And in each of these situations collaboration promoted and facilitated reflection on their own practice in order to develop and implement the new and improved practices that were the object of the professional learning

The above list tends to focus on the professional learning of teachers for teaching purposes, but this is not intended to suggest that the list represents all that needs to be considered. Just as the use of ICT requires multi-level consideration (school governance, class programs and activity level for example) so professional learning

needs multi-level consideration. Thus, there is a strong case for professional learning of teachers in relation in relation to each of the factors. Practice is always situated and teachers who have a good understanding of their situation are likely to be more successful in managing their practices. The factors identified in this study are significant in the context of a teacher's practice. Secondly, there is a case for consideration of corresponding professional learning of those responsible for each of the factors in the school.

Learning from practice

The practice of teachers who were successful in using ICT was often a form of unconscious competence in advance of their explicit knowledge, understanding and know-how (their conscious competence) (Campinha-Bacote, 2002). This was demonstrated by several participants by their limited capacity to explain and justify their practices. In a sense, this may be a characteristic of capable professionals (unconsciously competent).

Such initially informal and unconscious learning from practice suggested that action learning might provide a suitable framework for reflection and analysis because teaching and learning practices involve activities; and activities result in experiences, products and the acquisition of explicit knowledge. Furthermore, experiences can be elaborated as tacit knowledge enabling explicit and tacit knowledge to be compared, related, reconciled, enriched and thus given meaning (and possibly made useful) through insightful questioning: insightful questioning is at the heart of action learning. The following model is an attempt to summarise the above notions:

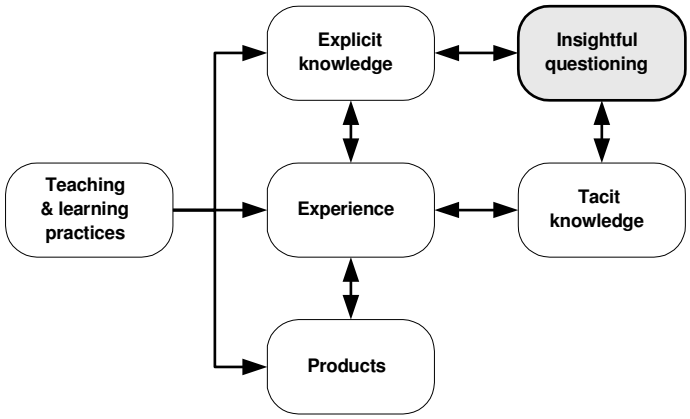

Figure 8 Action learning model (Webb, 2003a)

The model also appears to be consistent with the work of Vygotsky (1978) and others, in that his proposed maturation of concept involves their appearance at both abstract (as explicit knowledge) and concrete (tacit knowledge) levels. The implication from Vygotsky is that the 'insightful questioning' is undertaken as social construction of knowledge (learning) in which action, learning, knowledge and social engagement cannot be meaningfully separated. For Vygotsky the insightful questioning is undertaken through scaffolding activity and mediating experiences.

The activities and experiences of the participants in the action learning projects together with the resultant findings are such that the projects have, in a sense, redefined professional learning in several important ways as outlined in Table 21.

A pedagogy for professional learning

This 'redefinition' of professional learning (Table 21) by the action learning projects was supported by in-school observations. Teachers who were more successful with ICT focused on their in-class practices rather than the classroom ICT. Their educational focus was broader and richer than simply learning to use ICT. They were also more innovative in developing new applications and practices in relation to their use of ICT rather than simply following the recommendations of experts or attempting to meet expectations.

As well as suggesting that professional learning should be undertaken as a cycle (Figure 6, p. 155) this 'redefinition' of professional learning also suggests some principles for the design and delivery of professional learning (see Chapter 4 Results).

From the case studies and from other in-school observations it was possible to derive a general ten-step process for managing and designing professional learning:

1. Build collaboration between leaders and learners
2. Be informed regarding the learners' hopes, experience & prior knowledge...
3. Choose a specific focus – involve the professional learners
4. Design a short and specific learning task leading to new practices
5. Make collaborative arrangements – scaffolding for knowledge sharing
6. Undertake as a situated co-learning task then learn and apply in class
7. Provide tutors, in-class to support and mediate progress
8. Check on learning – share experiences and review insights (& share more widely)
9. Transfer the learning into new and/or improved practices in new or different situations
10. Revisit and refresh from time to time as required

Together, these steps are represented in the Professional Learning Cycle (Figure 6). They also suggest a possible process model of 'pedagogy for professional learning'. Early in the study, attempts were made to identify a generalised process model of pedagogy but without success. One possible explanation for the dearth of such models is that the process is not linear as suggested by the above ten steps. Rather many steps overlap, they are iterative and recursive as suggested in the process model of a pedagogy for professional learning (Figure 9, below.) Interestingly, the model is a good representation of the core processes developed independently by each of the four schools participating in the action learning projects. It is also a reasonable representation of the initiatives undertaken much less formally within the personal professional support networks of the more successful users of ICT.

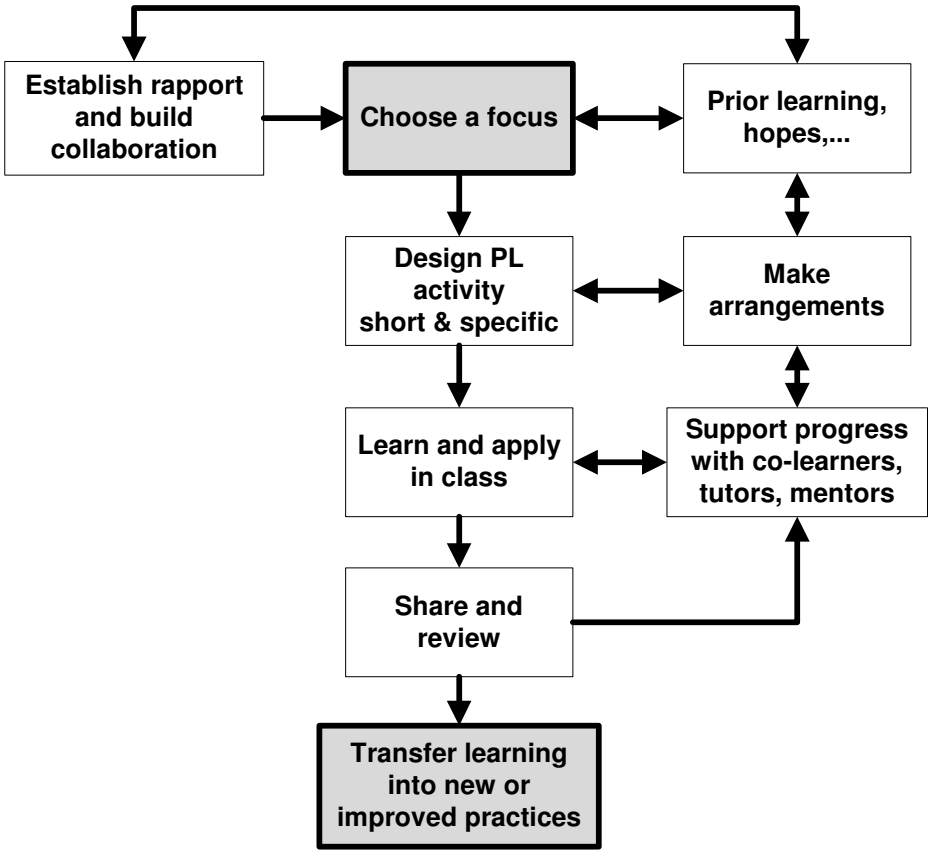

Figure 9 A pedagogy for professional learning

Just as collaboration was fundamental to in-class success in using ICT, so it was in relation to the action learning projects. Rather than being based on the traditional expert-novice arrangements typical of so much professional learning for teachers with respect to ICT, the roles of the participants in the projects were many, varied, dynamic, situational and often informal such as in most of the tutoring situations. Other roles, such as Principal and In-School Mentor appeared more formal. The In-School Mentor provides professional support to teachers. These roles related formally to the professional learning activities in the context of the school. At the same time, these officers readily move out of their official roles to fill other roles (see Table 24 below) according to need

Table 24 Common roles and their purposes in professional learning

Role	Focus	Need: provides the learner with
Learner (ongoing)	Self as practitioner	Personal professional motivation - relevant knowledge and experience
Co- Learners (shared)	Sharing learning & experience	Encouragement, understanding, shared perspectives, finding useful opportunities, little problems solved...
Tutors (informal and workshops)	Doing	Operational knowledge of 'How to...'
Mentors (ongoing)	Professional knowledge	What practices to use and why: guidance, backup, trouble-shooting, access to support, resources…
Supervisors (as required)	Endorsement & clarification	Clarification of expectations & purposes, opportunities.... Appreciation & validation of efforts and of achievements

These roles 'overlap' in a developmental way, especially in a collaborative learning context. Co-learners are also learners, tutors are also co-learners (with the person they are tutoring), and mentors provide tutoring (often as a demonstration) and are co-learners and so on... There is a sense in which the in-school observations and action learning projects highlight some of the essential elements of collaboration itself, especially being able to change roles according to context, need, task and the capacity to contribute.

In many ways, the redefinition of professional learning represents a move to what might well be a second generation of professional learning in relation to the use of ICT in teaching and learning:. That is, moving from provision based on expert-novice arrangements to the development and utilisation of communities of practice. In the context of professional communities of practice, it is likely that the required teacher knowledge used in a pedagogic setting will be developed and applied as members bring together their subject knowledge, school knowledge and pedagogic knowledge to enrich their practice and associated personal constructs (Leach et al., 2000).

5.4 Summary

Analysis of the results has led to the identification of eight complementary factors that are consistently significant in the implementation of ICT use in class programs through their impact on the teaching and learning practices. The complex interaction of the factors is situated physically, historically, socially and culturally. These factors enable and/or constrain the development and implementation of new or improved practices. In addition, the practices enable and/or constrain each of the factors. As a very simple example, the routine practices associated with file management can have a significant impact on whether the teacher or student can rely on being able to find a file the next time it is required (NC9a)

While not suggesting an underlying mechanism other than the everyday interactions of those involved, the following model (Figure 10 below) suggests some of the dynamics between the factors involved in the use of ICT in class programs. In particular, the model is intended to show that the prime relationships are best understood as being between each of the factors and the practices involving in-class use of ICT. In addition the relationships between the factors are significant to the extent that they enable of constrain the in-class practices. The placement of the secondary factors (shaded) in the model is not entirely arbitrary: The consideration given to the in-class practices using ICT are largely about using the technology in practices in order to achieve the purposes and this required an adequate rationale and should be cost effective. Similarly, reliability is largely about matching the technology and practices and this requires an adequate working knowledge. Collaboration is mostly about sharing purposes and practices and making the required working knowledge available as, and when, required so that the practices will be successful in a cost effective way. In addition, professional learning is largely about matching practices to the purposes with a rationale that makes the use of ICT cost effective within the class program. In addition, there are flow-on relationships between the factors that can be used strategically. One school (NS8) chose (a governance decision) to position itself just behind the leading schools in terms of innovation and the acquisition of leading edge technology. This enabled the school

to learn from the leading schools ensuring that it was better informed at the three levels involved. As a result the technology was well matched to its practices in this school. It was also generally more 'reliable' there being fewer unanticipated difficulties and expectations were better informed. The strategy also resulted in improved cost effectiveness: there were fewer failures because of inappropriate choices and staff were able to easily adopt and adapt practices developed elsewhere.

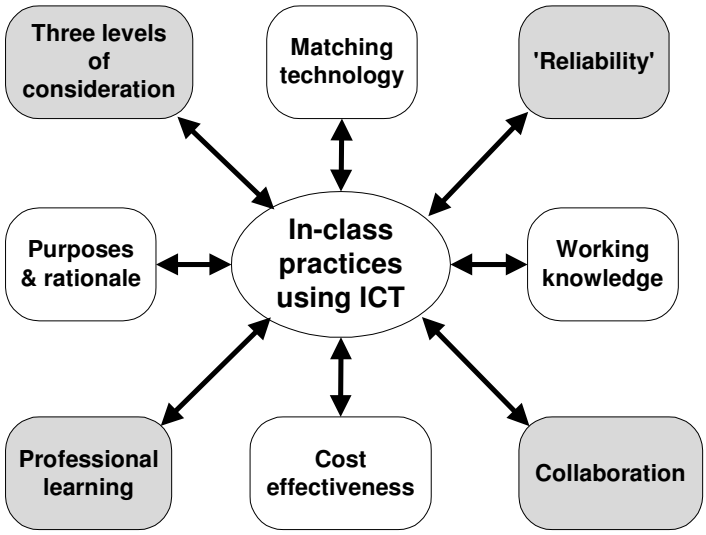

Figure 10 Key factors in the use of ICT in class programs

At the same time the two dimensional model is inadequate in many senses. Indeed, it could be re-formulated in such a way that any one of the factors was at its centre. Regardless of such limitations, the model is likely to prove useful for reflection and action learning by prompting 'insightful questions' regarding the many things that are involved in the in-class use of ICT.

Conclusion

In this chapter, six major ideas have been developed and elaborated from the results in response to the initial research question: *What factors are significant in the implementation of ICT in class programs?*

1) There are four primary (in-class) factors that affect the use of ICT in class programs:
    - purpose and rationale for using ICT
    - the availability of technology that is well matched to the activities involved
    - the working knowledge to select, operate and troubleshoot the use of ICT
    - the cost effectiveness of doing so.
2) There are four secondary (contextual) factors that impact in the use of ICT in class programs:
    - the consideration given to the use of ICT at the school, class and activity levels
    - the extent to which the users of ICT can rely on being able to use the technology within their window of opportunity
    - the professional learning required to be able to implement new or improved practices involving the use of ICT
    - the level of collaboration around the use of ICT.
3) Practices should be the focus for all initiatives related to the in-class use of ICT rather than ICT *per se*
4) Collaboration is fundamental to any successful initiative with respect to each of the factors (including professional learning) and thus to the likelihood of success in the implementation of ICT use in class programs
5) Professional learning is best understood and managed
    - as an ongoing collaborative and cyclic endeavour

- undertaken by a group of learners;
- situated in their everyday context
- with the aim of developing the learners' capacity to utilise new and/or improved practices in class programs.

6) Finally, this suggests that formal and informal communities of practice around the use of ICT can provide much of the support required for schools and individual teachers to be able to change and develop their pedagogies. In the right context, this means realising the potential provided by the available and emerging technology.

In the next chapter (Conclusion), these major ideas emerging from the study will be explored further. Recommendations will be made and possible avenues for further investigation will be suggested.

Chapter 6 Conclusion

> I hear and I forget. I see and I remember. I do and I understand."
>
> Confucius (Chinese philosopher 551 - 479 BC)

6.1 Introduction

This thesis is offered as a contribution to knowledge. Knowledge is of value when it provides a sound basis for action. This chapter summarises the knowledge gained from the study and suggests two forms of action for which the study forms a basis. The following section summarises the study and elaborates matters requiring attention and action by those who would enhance the teaching and learning practices in their schools with ICT. Later in the chapter, future areas of research are suggested as another set of possible actions based on the findings of this study.

6.2 An overview

This thesis began with a key question (Reynolds et al., 2003) that called for an explanation of the difference between expectations, and the experience, of ICT in education and its association with the raising standards and student attainment. Expectations of ICT are shaped by the associated discourses around ICT, its potential, and its use. Examination of these discourses reveals three main expectations that ICT is a driver, enabler or catalyst for change. From the literature and from many of the case studies in this investigation, some of the commonly held expectations of ICT are not always met. Even when the expectations are met, sustaining the achievements is frequently problematic.

In response to the above, the author hypothesised that there are identifiable factors that are significant in enabling the successful use of ICT in class programs. This study has shown that ICT is an enabler depending on eight key factors:

- purpose and rationale for using ICT
- matching available technology to the practices

- working knowledge required to use ICT
- cost effectiveness of using ICT
- governance (three levels of consideration)
- reliability of using ICT
- professional learning, and
- collaboration.

These factors interact with each other and, more directly, enable and constrain the practices in which ICT is used. When well managed, they have a collective potential to enable the transformation of the practices of teaching and learning. ICT is only one of these eight factors and to be an enabler it must be available, reliable and well matched to its use as well as being used by those well prepared to do so. As the results showed, each of these factors can be problematic for a whole host of reasons beyond actual ICT itself. A decision to utilise ICT is associated with decisions about actual in-class practices, their purposes and some rationale that the use of ICT will enable and enhance the practices so that purposes are achieved.

In a context where the purposes are high order; the practices are rich; and ICT plays a significant role in enabling the practices to be successful, then ICT may be deemed catalytic: it makes a significant difference. For example, the use of ICT in one professional learning project (PR29) enabled the classes to seek community development funding for a local project. It is unlikely that the classes would have attempted such a challenging activity, nor would it have been as so well received, without the capacity to produce high quality presentations and associated materials using ICT. The use of ICT enabled the achievement of a high order purpose (significant engagement with the community). The classes' purpose was the driver – the ICT the enabler.

Cost effectiveness was shown to be another significant factor. The cost of using ICT involves the establishment and maintenance costs to make the ICT available, together with the time and effort involved in preparing for and managing its use. The latter costs include professional learning to develop mastery of new or

improved teaching and learning practices made possible by the use of ICT, and to acquire the necessary working knowledge to be able to select and operate the devices and solve problems that arise during its. Disruption to other arrangements in order to be able to use ICT was also reported as a significant and frequent cost. That is, the use of ICT frequently involves an opportunity cost in terms of decreased opportunities to engage fully in some other worthwhile activities. Whether the cost is acceptable depends on the value of what is achieved (effectiveness) and the efficiency of the practices involved. That is, cost effectiveness involves professional judgement of the value of what is achieved and the costs involved. In this study, there was a wide range of responses to the issue of cost effectiveness reported by participants despite quite consistent ICT provision; considerable technical support; in-school mentoring; and almost universal professional learning for all teaching staff. Staff who reported doubts about the cost effectiveness of using ICT tended to minimise its use by their classes. Some schools were in the process of confronting such responses by becoming more specific about the schools' expectations of in-class and administrative use of ICT. Clearly, universal agreement on the cost effectiveness of using ICT has not been achieved, nor can it be.

The remaining factors, governance and collaboration, are the keys to the successful use of ICT since they directly underpin the other key factors and the practices involved. Governance and collaboration shape the interaction of the organisational, human and technical dimensions of ICT use. Sound and effective governance helps to establish purposes and meaningful rationales; makes matching and reliable technology available for use; arranges for professional learning that result in improved practices and the achievement of the requisite working knowledge; and sound governance promotes collaboration as a way to maximise organisational learning and to develop and transfer successful practices. An additional outcome of sound governance is improved cost effectiveness since people and classes are well equipped with the ways (knowledge and practices) and means (technology & infrastructure) to achieve their purposes at minimal cost. The moment-by-moment

decision making involved in the use of ICT in class programs to support rich tasks is sufficiently complex that it is generally inappropriate for school governance to take a directive approach. Exceptions to this principle include routines such as file saving, care of equipment, proper management of shared resources, and matters related to security. Well managed, such routines have the potential to minimise difficulties encountered when using ICT. With such routines in place it is easier to remain focused on the prime purposes, making full use of the available technology, enjoying greater reliability and thus needing less working knowledge, and so on.

Sustainable transformation

That transformation of teaching and learning is possible has been widely demonstrated. That such transformations may be difficult to sustain has long been a matter of concern. As early as 1993 it was recognised that "technological innovations have never been central to national school improvement movements, and that the dominant cultural belief about teaching, learning, and proper knowledge and about the way schools are organized for instruction inhibits computer use." (Cuban & 93, 1993, p. 192)

In interviews around the use of ICT and particularly those relating to hopes for the use of ICT three closely related question emerged often by implication:

- What is possible (and under what conditions)?
- What is desirable (and why)?
- What is feasible (how and when)?

That certain practices and outcomes may be possible does not necessarily make them desirable or feasible. Young children using word processors for story writing is an example of the former. In a class of 25 students with four classroom computers, it may be possible and desirable to provide each student with access to computers for 10% of the school week however this but not be feasible because of competing demands from other aspects of the class program. The observations made in this study indicated that individual access for 2-4% of the school week was much more realistic. It is important to note that the answers to these questions are

never simply technological. These questions are about placing the use of technology into pedagogical practices within working relationships within organizations made up of classrooms and schools. Hence, the answers to these questions simultaneously involve technological, pedagogical, social and organisational dimensions. The complexity involved means that is very unlikely that any particular person can assume the role of expert in implementing the use of ICT practices of the organization. Expert-novice relationships may assist with respect to a particular element such as the operation of a particular digital camera. However, such relationships are inadequate to deal with the complex aspects of using ICT. As was demonstrated in the action learning projects, communities of practice are more likely to meet the needs of the participants as members share their learning and work to meet each other's needs thus making valuable contributions to the overall task of integrating ICT into the everyday practices of the enterprise.

Components of sustainable transformation

Several schools claiming to have achieved substantial gains in the use of ICT over the longer term had several features in common. They were more likely to have a vision for the use of ICT that focused on the core endeavours of teaching & learning, rather than on the potential of ICT itself. Some had made commitments to investing considerable time, energy and material resources into developing their use of ICT because doing so was seen as strategic. In addition, these schools reportedly had increasingly sound knowledge, experience and deeper insights into the links between teaching and learning and the use of ICT. Their initiatives frequently included addressing constraints faced by teachers and students in their attempts to bring about the transformation. Thus, these schools tended to take reliability and the management of resources seriously and were keen for professional learning to meet specific current needs rather than just add to the teachers' knowledge of ICT. Underpinning all these efforts were high levels of collaboration.

Managing transformation

In his article *Computers Meet Classroom: Classroom Wins*, Cuban (1993) acknowledges the familiar issues of resourcing, teachers' confidence, administrative support and inadequate training and experience as areas of challenge to schools' efforts to use ICT to enhance student learning and these continue to be reported in more contemporary literature. However, he goes on to identify more fundamental challenges that reside in the prevailing cultural beliefs about the teaching and learning process, in the roles of teachers and students, and the incompatibility between traditional beliefs and the more constructivist use of computers. The incompatibility is often reinforced by ill-matching accountability systems and demands for demonstrated curriculum coverage. One implication is that the use of ICT requires new constructs for 'ICT' and 'teaching and learning' and contemporary evidence suggests that the task of developing these new constructs is far from complete (Dale et al., 2004). The results of this study support such a claim.

The use of technology embedded in artefacts has potential to mediate on the roles, and respective activities, of teacher and learner by enabling and/or constraining ways of relating & mediating their individual and shared activities. The intentional design and promotion of any form of learning requires pedagogy, that is, a working framework that relates teacher, learner and their respective purposes, activities and artefacts in their shared contexts.

Considering constraints

A common argument for the use of ICT is that it will reduce some significant contextual constraints such as time, place and motivation. Students will be more motivated and real time and place face-to-face classroom teaching and learning will be replaced by always on, connected, virtual workspaces that will work as well or better than current timetabled face-to-face arrangements. While such possibilities are well demonstrated it is clear that they are not universal. The introduction of new technology frequently elicits some initial motivation from students but this is often

not sustained. Teachers reported that many students were initially motivated but most tended to remain so for shorter periods than adults did. Teachers also reported that some students were simply not motivated by technology: it seemed that having experienced ICT as a part of their lives for as long as they can remember many children do not perceive recent technological developments as 'new' – there is little or no perceived novelty to provide a basis for motivation. In this study, when students were asked to identify 'good things about computers', many were hard-pressed to answer the question. Some even appeared a little bemused by the question itself. It may be that, for these students, computers had been part of their lives to such an extent that they are taken for granted. On the other hand, some students clearly disliked computers. One such student, in response to an invitation to talk using computers simply replied, "Only when I have to!"

Similarly, some online provision may well be configured as 'always-on virtual learning spaces' but students need to engage by becoming connected. The personal and social context of individual students varies enormously in relation to the availability of, and access to, appropriate technology and enabling support. For example, this study found that students with older siblings tend to be more comfortable and more skilled with computers, that is, it appears to be helpful to have older siblings since much learning about computers occurs at home and older siblings are likely to have helpful working knowledge. However, it can be detrimental to have too many older siblings: some students report reduced opportunity to use computers because older siblings had priority.

The implication of the above is that the use of computers at school does not result in corresponding home use for all students, even for some of those students with a computer at home. This is another example of the fact that something is possible and desirable does not necessarily mean that it is also feasible for all. The feasibility or otherwise is often influenced by situational factors – factors associated with the context. It was a frequent observation in this study that many teachers failed to

acquire particular ICT knowledge and skills yet all agreed that gaining such skills would be both desirable and possible. The most commonly reported reason for their failure was competing demands for the teachers' time, attention and energies. What was possible and desirable was simply not feasible for many teachers because of their own contextual factors

Collaboration

The use of ICT in teaching and learning (and other) practices may change what is done, the way they are done and/or who does what. If the changed practices are adopted as 'everyday' practices, the result may be understood as a sustained cultural shift. Many of the notions of ICT as a driver seem to be related to the hope for such an outcome. From the observations made in this study, widespread adoption of new forms of practice is more likely to be achieved where there is a high level of agreement and collaboration: especially where the technology is well managed and there is sound governance. These conditions are likely to strengthen purposes and confidence and minimise uncertainty and distractions. In turn, the use of ICT can promote further development of collaboration if the user identifies with the shared tasks being attempted, and with the purposes they are intended to achieve. As was demonstrated in the action learning projects, the contributions can be in terms of supporting joint activities using ICT, working together to use tools and other resources, and the creation of sharable and meaningful products and experiences

A collaborative school and/or class culture greatly increases the likely success of incorporating ICT into class programs. This is because its students are already familiar with collaborative approaches and having shared purposes is the norm. Everyone's preparation to use ICT is likely to be better informed leading to better matching of technology to tasks. With collaboration there is a greater likelihood of the technology being available within the window of opportunity and the school/class members will have ready access to an increased working knowledge of ICT. Action learning is more 'natural' in such contexts and the resources are more

cost effective when shared than when computers and peripherals are seen as single-user devices

Collaboration and sustainability

Practices incorporated in the school culture are easily sustained – they are part of the way things are done in the normal course of events. Hence, the way to achieve sustainability of new or improved practices is to ensure that they become part of the culture. This suggests an operational definition of implementation. Something has been implemented when it has become part of the culture – the way things are done on an everyday basis. However, there is potential tension here around practices involving the use of ICT. To be part of the culture the practices must be perceived as being ordinary while at the same time technology is undergoing constant development and is often promoted on the basis of its novelty and innovation, that is, that it is not ordinary. Some schools and teachers seem to resolve this tension by using technology to innovative things as a matter of course.

Collaboration adds value. Where there are high levels of collaboration and attention to practices, there is ongoing value adding. This emerges from action learning as part of everyday professional experiences in the field. Ongoing collaboration leads naturally to 'communities of practice', which means that important knowledge and experience are readily available to support professional learning, that is, close to the practices and the learners. This in turn significantly increases the value of the professional learning since it becomes a resource readily available to others. In addition, collaboration gives benefit to the provider who learns from the experience of being a co-learner, tutor, mentor... and the well-known quote applies: "To teach something is to learn it twice" (Joseph Joubert. French Essayist and moralist, 1754-1824)

Collaboration also decreases costs. For example, as a result of being continually negotiated (and renegotiated) between those involved, collaborative professional learning is more in line with the needs of participants. Moreover, there is less need for special arrangements, which means there is less disruption - those involved

make arrangements as required. There is more 'just in time' and 'just in place' learning that results in less waste since provision is in response to actual needs rather than a third party's anticipation of the learners' needs. Successful transfer of learning into actual practices means less rework, that is, less need to re-learn since the experience of the practices reinforces the original learning and informs future learning. In addition, less management is required - collaboration leads to the emergence of communities of practice in which organization is negotiated agreement between learners and helpers.

Collaboration in professional learning - Summary

Collaboration makes professional learning more efficient and effective since learning is supported in the work place closer to where and when it is needed. The required (working) knowledge is readily available from co-learners, on-site tutors, mentors... and learning and action are more likely to attract formal endorsement further empowering the learner. Thus, the transfer of professional learning into in-class practices is faster with fewer delays in the transfer process. There is also greater likelihood of improved follow up at all stages of the learning process. On-going collaboration makes the learning (as knowledge, skills, practices and strategies) more widely available to others. And collaboration makes learning meaningful since, as part of the process of developing and sharing knowledge and practices, communities of practice engage on the negotiation of meaning (Wenger, 1998). In relation to education, this suggests the possibility of understanding of pedagogy as the negotiation of meaning and action.

Ongoing challenges of professional learning

Collaboration and the emergence of communities of practice are fundamental to successful professional learning. The action learning case studies have revealed some powerful insights into principles and processes of professional learning. The projects also revealed some associated challenges that are consistent with observations made in the in-school observations as part of the larger COLAT

research project (Robertson, Fluck et al., 2006; Webb et al., 2005). These challenges include...

- Building collaboration across staff groups
- Accommodating staff changes
- Providing the rationale for change: modelling ways and means and negotiating meaning
- Selecting and arranging the most appropriate technology
- When and how to upgrade the technology: development is disruptive!!
- Creating and promoting opportunities for learning, belonging & leadership
- Arranging for the inclusion of all staff in professional learning, that is, achieving equity of opportunity for all staff can be problematic for some groups such as part-time teaching staff
- Arranging release from fixed duties for some staff such as part-time hourly specialist staff including special needs aides
- Building supporting and sustaining 'communities of practice' appropriately
- Managing individual performance in the context of collaborative professional learning
- Specifically accounting for individual professional learning in collaborative learning initiatives

It is not possible to be definitive about likely future developments in professional learning because there is considerable uncertainty about the future of schools, their management, teaching and learning, ICT and its use to enable and support new teaching and learning practices. As indicated in the literature review (Chapter 2), the Apple Classrooms of Tomorrow (ACOT) studies identified the five stages of development in the use of ICT in class programs: entry, adoption, adaptation, appropriation and invention. Similar frameworks also exist providing developmental stages in relation to the curriculum (Seaton & 2002, 2002) and professional learning (CBAM) While the detail of what is involved will change as the technology changes it is likely that such developmental frameworks will continue to be meaningful and useful in relation to professional learning as elaborated in this study.

The use of ICT and activity systems

In this study, Engestrom's activity system model has been used to summarise the findings in relation to the use of ICT in teaching and learning (Figure 5, p.138) and professional learning (Figure 6). These models represent ideal systems and as such may prove useful in evaluating existing situations and planning development initiatives. A benefit of these models is that they show that using ICT and professional learning are complex and situated endeavours in which a number of factors interact to enable or constrain the achievement of the object of the activity. These factors have cultural and historical origins as well as being currently situated in time and place. Thus, activity theory offers a major avenue for future development and research associated with the use of ICT in class programs.

Limitations

This study was based on observations made in fifty classrooms in 28 schools and four school-based projects. The schools were part of two primary school systems in Tasmania, Australia. Participating schools and teachers self-selected in response to invitations to participate. It is highly likely that their use of ICT represents more successful classroom and school practices. There was a strong impression that participating teachers were also among the most successful users of ICT in their respective schools. When reflecting on the data, allowance was made for the skewed nature of the sample to the extent that it may be possible.

The findings are the result of considering the things that the participants indicated were significant (either overtly or by implication) in relation to their use of ICT examined in the light of direct observations and the reports of others involved in their situation (colleagues and students). The things indicated as significant included:

- ways in which ICT use had (or had not) achieved the users' purposes
- the sustainability of its use over time
- the development of new practices and/or the enhancement of existing practices incorporating the use of ICT
- the challenges involved in using ICT including

    - professional learning
    - reliability
    - achieving an adequate working knowledge
    - matching ICT to the intended purposes and available practices
- the costs (time, effort and material) and benefits (achievement, satisfaction)
- rationales for including the use of ICT in the class program
- constructs of ICT itself
- the role of the school in providing
    - the infrastructure: computers, peripherals, network, support services
    - the opportunities for staff and students to become capable users
    - clarity regarding the role of ICT in the life and work of the school
- cultural dimensions such as the extent of collaboration involved

Clearly, the use of ICT in class programs is a complex matter potentially influencing, and being influenced by, numerous aspects of the school and its community. No participating school or class had identified, nor given explicit attention to all identified aspects. In addition, this is hardly surprising given the large number and range of factors identified as being significant in one or more cases. There was considerable variety in the ways in which ICT was used in different places and times: from class-to-class; from school-to-school; and from time-to-time in the same class. In some senses, the major studies and meta-analyses reviewed in Chapter 2 also reflected this variation. Many studies indicated that the use of ICT might make a positive, if modest, contribution to the learning outcomes and student attainment in some subject areas and at certain stages of student development. However, similar results were not found in other areas and stages. Other studies focused on gains in non-subject areas such as student motivation and collaboration. At all levels, there are different notions of effectiveness associated with the use of ICT.

The range of factors involved together with the variation in purposes, practices and levels of use of ICT observed and reported in this study and reported elsewhere provided support for the approach taken in this study. It is for this reason that this

study does not attempt to appraise effectiveness of ICT. Rather, the aim of this study has been to gain insights into the factors that influence, promoting, enabling and constraining the use of ICT in the classroom. There were two major reasons why schools, teachers and students chose to use ICT in their teaching and learning. Firstly, some users had hopes of being more effective through their use of ICT. For some, effectiveness focused directly on improved student attainment; for others effectiveness meant increased engagement in learning (motivation) and better ways of learning such as collaboration. The second major reason for using ICT was to meet the expectations of others (the teacher, the school, its community and/or the school system), the implication being that others had decided that the use of ICT would improve classroom practices including teaching and learning.

The use of ICT involves activity by the user. This in turn will be influenced by the users' perceptions of the potential or actual effectiveness of ICT use. Perceptions of potential or actual effectiveness of ICT use are shaped by the experience of the users. For example, 'reliability' was a major constraint for many teachers although their perception of reliability included factors other than whether the devices were working (see Chapter 4 Results). Thus, it is valid to rely on observations and perceptions of 'effectiveness' in order to better understand the factors that influence people's use of ICT in the classroom.

The action learning projects were highly collaborative in each of the schools and the results were presented to all participants. This allowed participants to seek clarification, compare their respective activity and experiences and to postulate insights that were meaningful in the light of their activity and experience. At the same time, the study was limited by its openness to what may be significant. Initially, no particular theory was assumed and no specific framework was adopted as a lens through which the observations would be made during the pilot study (Phase One). As the study progressed it became more oriented towards social constructivism and utilised some aspects of grounded theory and activity theory to analyse and summarise the results. Thus, the results are subjective and warrant

further investigation. Subsequent studies should be undertaken using an activity theory approach to explicate the mediating impact of the key factors identified in this study.

Significance

Subject to the above limitations, the study is significant for at least three reasons. Firstly, it has taken a fresh look at classrooms and schools in which teachers were attempting to incorporate the use to ICT into their everyday practices. Secondly, this 'fresh look' involved overlapping observations covering three main levels: school, class and in-class activity. These observations indicate that attempting to understand or manage the use of ICT at any one of these levels is unlikely to be successful. Initiatives at each of the levels complement, supplement, enable and/or constrain initiatives at each of the other levels.

Thirdly, based on the observations it appears possible to propose a number of principles. For example, specific uses of ICT are likely to be more meaningful, successful and sustainable, when they are situated in a purposeful collaborative class program that reflects the values and purposes of the school. Other important principles elaborated in Chapter 5 (Analysis) – include the following:

- The focal point for initiatives and decision making in relation to ICT needs to be the activities of the practitioners who use (or intend to use) the ICT provided
- There are two sets of four factors that are significant in the successful use of ICT in teaching and learning:
- In-class factors: purposes (& rationale); matching technology; working knowledge; and cost effectiveness
- Other complementary factors: sound school governance; reliability; professional learning and collaboration
- Of these, sound school governance and collaboration, both focused on practices, appear to integrate the two sets of factors
- Many of these key factors are centred beyond the classroom

- Many of these factors are beyond the immediate control of the practitioners using ICT

Professional learning is best understood as an on-going process, occurring within a community of practice, in which learning is transferred into in-class practice.

Comparison with other studies

Much of the literature related to the use of ICT tends to focus on the teacher's uptake, or otherwise, of ICT (Goos & Bennison, 2006; Jones, 2004; Scrimshaw, 2004). The discourse almost suggests that the use of ICT is something that a teacher chooses. While it is true that teachers play a central role in what happens in classrooms, this study has not adopted such a specific focus. Rather this study has been open to the possibility that key factors may be largely independent of the teacher. One reason for such an approach is that the study was undertaken during a period in which both participating school systems had used specific federal government funding to equip all schools and classes with ICT and all stakeholders were expecting wholesale uptake of its use.

Nevertheless, allowing for slightly different orientation, the results of this study are largely consistent with previous studies but may offer additional possibilities as indicated in Table 25 below. As an illustration, the table compares the finding of the Becta review of research literature on barriers to the uptake of ICT by teachers (Jones, 2004; Scrimshaw, 2004) and the corresponding findings in this study:

Table 25 Comparison with Becta findings (Jones, 2004)

Becta (from the Executive Summary)	**Corresponding findings in this study**
Teacher confidence is very significant determinant factor (Jones)	Reports and observations confirmed this finding
Confidence is related to many other issues which can be barriers (Jones)	Confirmed and elaborated as the key factors identified in this study
Levels of access to ICT are significant	Confirmed and elaborated to include reduced opportunities associated with competition for time and attention within class programs. For a given level of provision, access is effected by the construct of ICT: a single user devices or a shared set of tools and services
Inappropriate training…courses which lack pedagogical aspects are likely to be unsuccessful... bust also need ICT skills	Confirmed and extended by highlighting the value of professional learning undertaken in a situated community of practice focused on current teaching and learning initiatives: new or improved practices
Time for preparation and research is a major constraint	Confirmed. This was reported almost universally by participating teachers
Technical faults with ICT equipment lead to lower levels of use	Confirmed and extended to include many other factors that also prevent equipment being used within the user's 'window of opportunity'
Resistance to change is a factor	This was reported by participants but the selection process meant that participants were non-resistant schools and staff
Teachers who do not realise the advantages make less use of ICT	Confirmed. This study showed that having a high order purpose, together with a matching rationale for using ICT to achieve that purpose, was a key factors
There are close relationships between the identified barriers	Confirmed. There are a corresponding close relationships between the key factors identified in this study.

The Becta report also suggests possible directions for further research that "…could lead to possible interventions that might help increase ICT use in schools" (p. 4). It is possible that such interventions could be designed and implemented on the basis of one or more of the key factors identified in this study. A particular recommendation arising from this study is that all such interventions should be undertaken as highly collaborative initiatives focused on actual teaching and learning practices in the context of sound school governance.

6.3 Recommendations based on this study

All recommendations are for the future and thus involve some consideration of the three key questions as elaborated above, that is,

- What is possible?
- What is desirable?
- What is feasible?

Recommendations are statements about suggested future action and all action is situated historically socially and culturally. Recommendations are not simply stand-alone statements of some form of knowledge. Rather they are addressed to the reader for consideration. The reader must consider the key questions when considering the validity and relevance of the following recommendations

6.4 Recommendations regarding in-school initiatives

Governance

Governance is concerned with values and purposes, vision, policies, plans and allocations such that its people are competent, motivated, confident and can function with an adequate consensus to ensure that the practices are shared, effective (and perhaps efficient). The resources for the use of ICT must be organised and related in order to be an effective infrastructure that provides access to hardware, software, information, facilities, services and support. Many participating schools had given comprehensive attention to professional learning leading to a working knowledge of ICT and to the development of the school's ICT infrastructure. Despite this, in-class use of ICT remained highly variable across the school. Attending to the people's knowledge and skills and the infrastructure appeared to be insufficient to achieve a sustained transformation of teaching and learning.

Where school governance had given little consideration to ICT there was generally even less use across the school and the use was at a low level typically involving individual students in some basic publishing using a word processor or low level research in which information was simply acquired from the internet. At the same time, many of these schools had one or two classes in which the use of ICT in class programs was highly successful despite the minimal consideration given at the school level. These outstanding classes were highly regarded for their ICT related activity and products: the teachers were typically enthusiastic about the potential to enhance their class programs and students' experiences and learning through the use of ICT. In interview, these teachers had personal/professional networks that supported their initiatives in relation to ICT and its application in enhancing teaching, learning and reshaping the class program (curriculum).

Implications:

1. Sound school governance that attends to both people and infrastructure contributes to substantial, and consistent use of ICT but only if it promotes, supports and endorses the use of ICT for rich tasks; problem solving; negotiated studies; collaborative projects; significant (useful) products; community building, and meaningful learning. These purposes are also the focus of the personal/professional support networks over and above sharing knowledge of ICT devices.

2. Attention to the application of ICT makes for sound School governance within a school. Schools that were clear about their purposes for using ICT reported (and demonstrated) greater confidence and clarity in their decision making regarding the selection and deployment of ICT and the provision of professional learning.

Purposes & rationales

Technology, support and professional learning are only parts of what is required to promote the use of new or improved practices. Clear significant shared purposes and adequate rationales for the use of ICT in practices are also vitally important.

Purposes are closely related to values. A sound rationale includes understandings of the teaching and learning practices that relate ICT to pedagogy, curriculum and learning outcomes. From a social constructivist perspective purposes and rationales are constructed in the discourse around ICT and teaching and learning.

Implication:

3. Purposes and rationales warrant considerable attention and deliberation since they provide a key point of reference for understanding, collaboration and decision making at three major levels of activity in the school: school governance and administration; classroom programs; and in-class activity.

Provision of ICT

The ICT as used successfully in class programs has two significant characteristics – it matches the practices being undertaken and users can rely on being able to use it to complete their activities within their window of opportunity. These criteria are shaped by other factors such as working knowledge and professional learning. There are a number of implications relating to the provision of ICT for in-class use.

Implications:

4. Provision of ICT needs to be understood as an ongoing management process.

5. The provision of new ICT should not be limited to steps to select, purchase, and install hardware and software. It needs to be managed as a process that includes arrangements for training, on-going maintenance, the provision of consumables, the care and distribution of shared resources and evaluation of effectiveness.

6. Provision of ICT includes providing the means to access the technology: individual passwords; group shares; borrowing of centrally stored peripherals; keeping batteries charged and cables

handy; replacing consumables; and so on, all require well managed and known arrangements.

7. The disruption associated with the introduction of new technology needs to be minimised. It is easy to underestimate what is involved in achieving a smooth transition when upgrades occur. Involving users in managing the upgrades is a sound strategy – surprises simply add to the disruption.
8. Similarly, developments can create greater demands such as when there are significant differences between similar devices in the same class or school. Upgrading some items and not others needs to be a well consider decision and a well managed process: upgrading all items in one area is likely to be less disruptive than upgrading some items in all areas
9. Configuration of devices can be an important aspect of their provision. Default configurations are often inappropriate with respect to language, saving options and other settings.

Working knowledge

For the observations working knowledge is the capacity to select and operate ICT appropriate to the activities being undertaken; and to troubleshoot its use in those activities. Sources of working knowledge include formal professional learning; reference materials; technical support staff; personal experience as a user of ICT; other members of the class; other colleagues; family members and friends. Working knowledge includes knowledge of specific devices and applications: their functionalities, limitations and foibles. It also includes routines that ensure proper use of their functionalities as well as workarounds that enable the limitations and foibles to be addressed as required. Working knowledge enables the functionalities of the devices or applications to be matched to the activities being undertaken.

Somewhat ironically, solving problems encountered by users adds to the working knowledge available.

Implications:

10. Working knowledge is a valued shareable asset that is critical to the successful and sustained use of ICT.
11. Access to working knowledge is enhanced by participation in communities of practice – no one has all the working knowledge they are likely to need.
12. A collaborative culture focusing on practices enhances the quality and availability of working knowledge.
13. Thus, class programs utilising ICT, and professional learning that includes the use of ICT, are best undertaken as communities of practice.

Three levels of consideration

As indicated above there are three levels of consideration in relation to the use of ICT in a school: school governance and administration; the class program; and the activity level. Decisions and initiatives at each level shape and are shaped by decisions and initiatives at each of the other levels. Thus sharing of knowledge, experiences and hopes across levels and between levels is very important in constructing, reconstructing and sharing purposes and practices. Schools or sections of schools in which ICT is being used extensively, easily and well, tend to have sound governance resulting in effective and efficient administration, purposeful class programs, and a capacity to attend to detail in relation to activity. These details include sound preparation for activity, explicit understanding of the purposes of the activity, clarity about what is involved in the activity, and the capacity to manage and evaluate the activity in relation to the intended purposes. As a result, there is considerable learning from action that then informs future activities, decisions and initiatives at the same and other levels. With such an approach, particular activity is not undertaken and experienced as episodic. It is related to other activities and the

achievement of a range of purposes. In one class, the preparation of a brochure on local native species was part of a group's contribution to whole class endeavour about local natural history that was shared extensively within the school and with the school community.

Implications:

14. The provision and use of ICT is a whole school matter warranting substantial attention by those responsible for school governance.
15. The deployment of resources and the provision of professional learning should be based on school and educational priorities.
16. The role of IT support is to provide advice on how ICT might be used to achieve the users' purposes.

Reliability

As the Results showed, reliability is a complex matter involving aspects of ICT provision, in-class practices, management of resources within the school, the users' working knowledge, and the nature of the class program. Less directly, professional learning and collaboration also shape reliability.

Implications:

17. Reliability of ICT is about the extent to which people can *rely on being able* to use ICT within their window of opportunity (the period available for the task or activity)
18. Reliability is an important matter for school governance and school management in several respects: the quality of ICT provided; arrangements for accessing technical support and services; day-to-day management of devices and consumables; professional learning and access to working knowledge.
19. Reliability is also improved by larger or more flexible windows of opportunity since these increase the possibilities of solving problems before the window 'closes'.

20. The windows of opportunity are a characteristic of the class program

    a. Highly segmented class programs made up of small isolated tasks completed by individuals tend to have small, inflexible, more problematic, windows of opportunity.

    b. Conversely, class programs based on substantial, rich tasks undertaken collaboratively by individuals, teams and the class as a whole tend to have larger, more flexible, less problematic windows of opportunity.

    c. The latter programs are also more likely to include the development of additional working knowledge through better preparation, negotiated ways and means and problem solving.

    d. Flexibility in terms of time and place for the tasks and activities to be undertaken further expands the window of opportunity for some students.

Professional learning

There are two common notions of professional learning. Firstly, professional learning occurs through participation in events such as seminars and workshops. Secondly, the professional learning occurs because of reflection on the experience of professional practice.

Implications:

21. The delay between professional learning and its transfer into class practices should be as short as possible in order to minimise knowledge loss and reinforce the professional learning with activity and experience.

22. Transferring (professional) learning into actual professional practice can be challenging yet remains the most meaningful indicator of professional learning.

23. Common difficulties with transferring professional learning into in-class practices appear to be associated with four main factors
    a. Undue attention to technology and inadequate attention to in-class practices
    b. The specific and detailed nature of the knowledge required to select, use and troubleshoot ICT (working knowledge)
    c. Differences between the ICT arrangements in which the learning occurred and the ICT arrangements in which the practices will be implemented
    d. Limited local availability of working knowledge to support the use of new technology
24. The above comments clearly refer to teacher professional learning but similar statements are also true for student learning in relation to ICT.
25. For this reason, student learning in relation to ICT should be provided in ways that coordinate with the class program.

Products, recipients and audiences

As elaborated in the discussion of action learning, activity may result in knowledge, experience and products (Figure 8). It was common classroom practice for the teacher to be the recipient of the products made by students using ICT. These products were generally received as evidence of learning. However, schools in which the use of ICT had been managed strategically were also keen to engage their students in rich and real tasks that resulted in useful products for other recipients. That is, some intended ICT products were useful beyond the immediate activity and learning involved. Some schools achieved this through project-based learning while other schools emphasised the use of ICT to share learning experiences and resulting products with the remainder of the class, the school and the school community as audience. Class projects, to which individuals and groups contribute products, provide a context that includes producers, audience, recipients and significant products. Occasionally student use of ICT was part of a larger school endeavour. In

one school students had prepared information about the school for use by the School Council while, in another, some classes engaged in seeking community development funding for a local project. The use of ICT for genuine communication can also involve significant products and recipients: each student in one class prepared personal invitations for their grandparents to attend an open afternoon.

Implications:

26. The products of ICT use by even young students can be significant depending on their usefulness to the student, their group or class and to others beyond the class.
27. The use of ICT can enable young children to produce very acceptable products.
28. Undertaking genuine and rich tasks with real products is likely to enhance, and be enhanced by, the use of ICT

Developing the use of ICT

Developing the use of ICT is not simply a matter of ICT provision; technical support; and professional learning. The remainder of the eight key factors need to be taken into consideration in relation to each other, and to the practices in which ICT is to be used. Knowledge and judgement are required. Drawing on reported successful development initiatives by the participants in this study it has been possible to discern a sequence of seven major steps involved in the ongoing development of the use of ICT in schools. Participants in the wider COLAT study (including some non-school organisations) provided additional insights. In addition, it has been possible to identify four major roles that contribute to the success of such developments: senior management, including the Principal and others responsible for school governance and/or the overall operations of the school; ICT

coordinators; practitioners who use ICT, especially the teachers and their students; and technical support staff.

Seven Steps – a proposed development process

Table 26 below summarises the contributions of various parties at each of the proposed '7 Steps' development process based on research into the adoption of information and communication technologies (ICT) into a range of learning communities including the schools participating in this study. The numbering of tasks at each step indicates the most likely order in which they would be undertaken. The details of this proposed development process have been published as *Seven Steps to ICT Integration* (Robertson, Webb, & Fluck, 2007). "The book presents a way to help schools, teachers and students harness this power to make the acquisition of new skills, knowledge and attitudes effective and transferable." (Introduction)

Table 26 The Seven Steps to ICT Integration

	Senior Management	**ICT Coordinators**	**Teachers & students**	**Technical support**
Contribution	Governance & strategy	Professional leadership	Teaching & learning practices	Technology: devices & arrangements
Step 1 Starting Out	1. Propose (initiate) & promote 5. Elaborate hopes and intentions (plans & policies)	2. Develop commitments actions, timelines, teams…	4. Identify opportunities, shape possible future practices	3. Support & advise: maximum potential at minimum cost ($, time, effort)
Step 2 Agreeing Outcomes	1. Propose outcomes & match with resource allocations	3. Refine and broker core process outcomes	2. Negotiate outcomes & timelines	4. Support, research & advise on technology
Step 3 Dealing with Constraints	3. Acknowledge constraints, endorse change process	2. Monitor, address & support , esp. change & learning	1. Identify, report & address	2. Acknowledge & address: reliability & usability

	Senior Management	ICT Coordinators	Teachers & students	Technical support
Step 4 Action Learning	3. Acknowledge, value and foster learning	2. Facilitate, capture and broker learning	1. Act, learn and share to achieve	4. Support & advise
Step 5 Professional Learning	3. Acknowledge & endorse transformation of practices	1. Facilitate, celebrate and embed practices	2. Focus on new and improved practices	4. Support & advise
Step 6 Sharing outcomes	3. Endorse sharing, celebrate outcomes	2. Facilitate sharing and embedding	1. Share outcomes & experiences	4. Support & advise
Step 7 Future improvement	1. Initiate &/or support	1. Initiate &/or support	1. Initiate &/or support	1. Initiate &/or support

The above table highlights the challenges involved in successfully developing the use of ICT in class programs. In particular, each contribution at each step requires knowledge and skills relevant to the tasks and activities involved. Consequently, there is likely to be significant professional learning involved in working through the Steps and the process is more likely to be successful if undertaken collaboratively, that is, as a community of practice.

This process challenges the widely held hope that teachers will change their pedagogies to take full advantage of ICT. Purposes and pedagogy are major considerations in each task at each of the 7 Steps. Clearly, teachers are not in a position to change their pedagogies in response to the potential that ICT offers. Firstly, any change of a teacher's pedagogy has implications for a wide range of others within the school and its community as shown in Table 26 above. Secondly, a change of pedagogy will have implications for a wide range of other matters such as curriculum, school organisation, professional learning, school culture, and the capacity to achieve significant change (transformation) while at the same time meeting the on-going requirements, expectations, and challenges facing the school.

6.5 Recommendations regarding future areas of research

Future studies might refine, extend and/or challenge this research in numerous ways. The particular value of this study lies in the breadth of its scope. In a sense it

has achieved some initial 'rough mapping of the territory' involved but there is still much to be done. The following areas suggest themselves for investigation.

School governance

It is clear from the case studies that sound school governance is required to achieve a sustained transformation of practices. In addition, there are implications for the notion of governance itself – in the more successful schools it appeared that governance related to the use of ICT was closely and dynamically linked to organisational learning. In the less successful schools, governance appeared more closely linked to provision of technology and the management of support. Thus there is potential to

29. Investigate, in more detail, the contributions of sound school governance to the use of ICT in class programs and the mechanisms involved.
30. Undertake an analysis of school governance as an activity summarising results as an activity system.
31. Investigate the response of school governance to technological innovation and associated curriculum and pedagogical innovation using the cycle of expansive learning.

Practices and reliability

Many participants hoped to improve the reliability of the 'technology' through better in-class practices. That is, they hoped that users would adopt well defined routines for simple common tasks such as saving files. Thus there is potential to

32. Investigate how routines associated with the use of ICT are established and utilised in classes and across schools
33. Undertake an analysis of in-school management of reliability as an activity summarising results as an activity system.

34. Investigate the achievement of improved reliability using the cycle of expansive learning.

Professional learning, working knowledge and communities of practice

Data gathered from participating students indicates that younger children are more likely to learn how to use ICT from older family members and while this reduces as the students become older, the shift is to peers rather than to the school. Students who identified their teacher as their main source of learning about ICT are much less likely to have a computer at home. Teachers who appeared to be successful with ICT with minimal support from their school reported having an extensive personal/professional network of colleagues, families, friends to support their efforts. It would be worthwhile to map when, where, how and from/with whom teachers undertake professional learning in relation to ICT. Thus there is potential to

35. Investigate (map) teachers' sources of learning about ICT and its use in class programs
36. Investigate the relationship, if any, between in-school and out-of-school use of ICT by teachers
37. Investigate the emergence of communities of practice within (and possibly between) schools for the purpose of enhancing the use of ICT in teaching and learning

Note: Undertaking the previous recommendation as a comparative study involving large and small primary and secondary schools could well be very valuable.

Development, activity theory and learning by expansion

Aspects of activity theory were used to summarise some aspects of the results. There is considerable potential to gain insights into the use of ICT using an activity theory approach. In terms of activity theory, development is associated with the

resolution of conflicts and disturbances between the various elements of the activity system. The cycle of expansive learning is a useful strategy for identifying and resolving various constraints that are encountered by schools, teachers and students as they incorporate the use of ICT into their everyday activities. Thus there is potential to

38. Investigate professional learning and school development as cycles of expansive learning.

In addition, activity theory has potential to assist in understanding re-conceptualisation of ICT, its use and associated practices. Achieving such understandings is an on-going task since renewing constructs, uses and practices develop, mature, and change over time. Both these possibilities relate to the development of practices at the individual, class and school level. The insights and understanding gained are likely to contribute to improved professional learning and improved school governance. Thus there is potential to

39. Identify common conflicts and disturbances associated with the use of ICT in teaching and learning as well as successful responses made by schools.

The role of conversation in organisation, practices and discourse

Collaboration is a significant factor that underpins each of the other factors, how they manifest themselves, and how they might be managed to enhance the use of ICT. The most common form of collaboration occurs in everyday conversation between people with a shared interest. Members of communities of practice engage in on going conversations as they jointly pursue their (professional) learning (Wenger, 2002) in order to improve their practices. The use of complexity theory (R. Stacey, Griffin, & Shaw, 2000; R. D. Stacey, 2002) to elaborate organisational emergence and change also leads to the conclusion that everyday conversations are fundamental to continual construction and reconstruction of the practices occurring in any organisation. Finally, 'ICT', 'teaching' and 'learning' and 'development' are all situated constructs and they may vary overtime and in

different places. Those changes are likely to be reflected in the discourses in which they are constructed. Examination and monitoring of conversations and other associated texts such as plans, policies and assessment procedures, are likely to provide insights into how these vital elements of the life and work of classes, schools and school systems are changing and developing. Thus there is potential to

40. Investigate prevailing discourses to reveal the way in which (student) learning and professional learning are conceptualised, their commonalities and differences, and how these may shape the activities and responses involved
41. Investigate the emergent qualities and characteristics of practices involving the use of ICT and the arrangements that enable and/or constrain them.
42. Investigate the ways in which naturally occurring communities of practice interact with formally created communities of practice around the use of ICT.

In relation to this last recommendation, both formal and informal communities of practice are to be found in association with change and development. While formal communities of practice may initiate development, actual implementation relies heavily on helpful responses from others within the organisation. A multitude of informal communities of practice emerges to construct responses to organisational initiatives.

6.4 Conclusion

This study investigated the possible existence of a set of key factors associated with the successful use of ICT in teaching and learning in primary school classrooms. In doing so, it identified eight situated and interdependent factors relating to in-class practices. Herein lies a possible answer Reynolds question with which this thesis began. ICT can be used to raise standards and student attainment but the potential itself is not sufficient to achieve a sustained transformation of teaching and learning.

The successful use of ICT is best understood as a complex situated endeavour. As such, it is constrained by a wide range of factors that are part of, or have an impact on, the situation in which ICT is being used. Prescriptions do not apply but rather the endeavour requires substantial and on-going organisational learning. The findings indicate that the use of ICT can indeed support a transformation of teaching and learning that results in significantly new or improved processes when supported by sound governance and management within the school as a highly collaborative organisation. The transformation requires substantial reconsideration of purposes, activities, practices, roles and working relationships. Achieving and sustaining a transformation will require ongoing construction and reconstruction of these elements, and is most likely to be achieved within a network of communities of practice attending to the eight factors identified. Secondly, the study also investigated possible implications for the design and implementation of professional learning so that learning is readily transferred into new or improved in-class practices. The findings show that there is a need to move away from the expert-novice arrangements to action learning undertaken within communities of practice. In such arrangements, participation is based on being able to contribute and to benefit according to capacity and need. On this basis, roles are not fixed but rather dynamic and knowledge and skills are acquired or constructed in a timely and convenient manner by negotiation and mutual agreement. In addition, experience is closely monitored for its potential to provide valuable insights. As a result, new and improved practices are embedded in the life and work of classes and the school as part of a professional learning cycle. In addition, that cycle is an integral component of the organisational learning that underpins the ongoing success of the school.

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Appendixes

1. The relationship between COLAT and this thesis

2. School Information Booklet

3. Participant Information Letter

4. Action learning projects – instruments

Appendix 1: The relationship between COLAT and this thesis

Children, on-line learning and authentic teaching skills in primary education (COLAT) is an Australian Research Council Linkage Project (LP0210823) project undertaken by the University of Tasmania, in partnership with three industry partners the Tasmanian Department of Education, the Tasmanian Catholic Education Office and Telstra.

Initially, Dr Margaret Robertson of the Faculty of Education, University of Tasmania was the chief investigator for the COLAT project. Dr Robertson was my supervisor for the majority of the time of my study but ceased this role when she moved to La Trobe University. Dr Robertson was appointed Professor in Education and Associate Dean of Research in the Faculty of Education at La Trobe University in April 2006.

Dr Andrew Fluck was a researcher in the COLAT project for its duration. Initially Dr Fluck was a co-supervisor for my work and he became my supervisor when Dr Robertson moved to La Trobe.

I undertook my investigations within the COLAT project as holder of an Australian Postgraduate Award (Industry) scholarship.

The COLAT project had four major strands:

1. An investigation of classroom arrangements and provision for computing using an index of classroom computer climate (CCCI) developed by Dr Fluck
2. Investigation of student responses to online learning objects
3. Observations in 50 primary school classrooms containing Year 3 and Year 5 students
4. Action learning projects to examine self management of professional learning in four primary schools

Dr Robertson provided overall supervision and assisted with the design and some implementation of all four strands. Dr Fluck led the design and implementation of Strands 1 and 2.

The majority of my work was focused on the design and implementation of Strands 3 & 4 with the assistance of my supervisors. I took part in the majority of the in-school observations often working with research assistants. The data gathered from these strands provides the basis for this thesis.

During the course of my study I developed and maintained a website (Webb, 2003) through which I was able to share emerging insights, experiences and thinking with participants and other stakeholders.

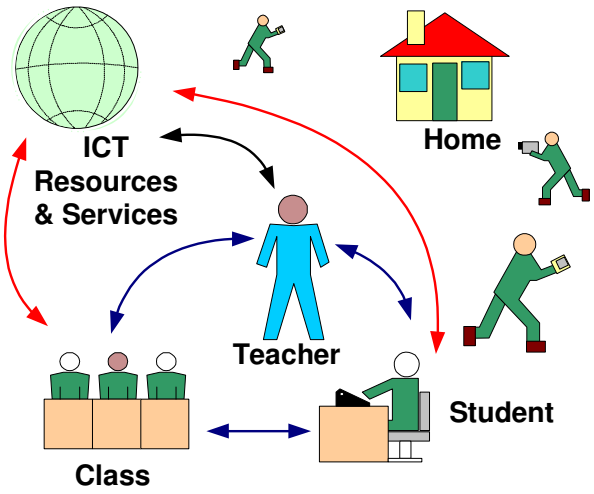
As a research team we wrote the book *Seven Steps to ICT Integration* (Robertson et al., 2007) as well as numerous papers and reports all of which were related to aspects of the COLAT Project. In addition, we ran workshops for industry partners and gave papers and presentations at a number of professional and research conferences.

Appendix 2. School Information Booklet

UNIVERSITY OF TASMANIA

Children, on-line learning and authentic teaching skills in primary education

Australian Research Council LINKAGE Project LP0210823



Information for Schools

2004

Proposed Outline of Observations

Ivan Webb
(In-school Observer)

Faculty of Education
Locked Bag 1- 308 Launceston
Tasmania 7250 Australia
Telephone 03 6324 3492
Facsimile 03 6324 3343
Email: Ivan.Webb@utas.edu.au

Project Website at http://www.educ.utas.edu.au/users/ilwebb/Research/index.htm

1. The classroom observations and intended project outcomes

Tool	Expected outcome
Task Design Execution and Evaluation	Mapping the type and extent of ICT use (including online use) and its distribution in the class
Individual Online Tasks	Observations of students using computers for specific learning tasks, how they construct knowledge and develop skills with and through the ICT medium
Interviews (with teacher, principal, ICT coordinator, and selected students)	Placement of teacher on Apple scale of ICT adoption & home computer attitude scale.
Student Computer Use Survey	Comparative measurement of school and outside school computer use

2. Typical observations timetable

Participating classes have Grade 3 or Grade 5 components. Observations will be made over two school days in each class. In some cases a single researcher will be in the school for a 3 or more days.

The Prime Focus: is not ICT per se, but rather how the use of ICT contributes to the class program. Teachers are expressly requested to simply continue with the same class program that would have happened if observers were not present, with one brief exception, viz,

Interruptions: Observations are made as convenient to the class. The only requested interruption to the class is a 15 to 20 minute session in which to gather information from students about their use of ICT outside the classroom in the last two weeks.

In class Observations:

Nature of the class program: activities, schedules, collaboration, decision making…
Computer Usage: activities and tasks being undertaken with the use of ICT
Interactions: Time slice observations of Teacher & Selected Student
ICT/Online task: interviews and observations and students

Other Observations:

Classroom Computer provision (includes some information about the schools management of ICT

Principal Interview (20 min)
Teacher Interview (25 min)
ICT Coordinator (20 min)

3. Observation of students

Students: 8 children selected by the class teacher in Grade 3 or Grade 5, a boy and a girl from each quartile in terms of general performance using the following guidelines:

- the most capable (in an overall sense) boy and girl
- the least capable (in an overall sense) boy and girl
- a boy and a girl a bit above average: doing OK most of the time,
- a boy and a girl a bit below average: sort of doing OK but it is sometimes requires a bit of extra effort on the part of the student and/or teacher to ensure that things go well for these two.

There is no need to take the student"s interest in ICT (or lack thereof) into consideration.
The teacher"s categorisation of each student will not be revealed to the observer until after all observations are completed.

Others from whom information will be sought by way of discussion and interview include by **Class Teacher**(s) & **Other Staff**, eg, Resource Teachers & Aides involved with the selected students in ICT/online learning situations and the **Principal** (see below)

4. Computer usage in the classroom

Method: time-slice observation ~ 15 minute observations

1. Total number of **students using computers** in the classroom (individually or in groups)
2. **Size of groups of students** using computers in the classroom
3. **Nature of activities** being carried out by students using computers
4. **Nature of tasks** being undertaken students using computers in the classroom

5. Student access to ICT out of class

Method: Informal discussions with the class and students complete an anonymous survey of their use of computers over the past two weeks:

- In-class
- Elsewhere in the school
- Home
- Other locations

Also the kinds of uses made, eg, email, publishing, games…and their favourite websites (if any).

6. ICT/online tasks

METHOD: The observer will observe and make appropriate notes about the actions of the subjects during the normal use of ICT in the class program. Areas may include…

1. **Publishing** (card or certificate)
2. **Problem solving** (eg, online puzzle)
3. Enrolled for **online learning** (Use interviews to check, demonstrate)
4. **Research** (webquest)
5. **Communicating** (responding to a printed letter from the Teacher)

7. Teacher interview questions

1. What general teaching strategies do you find effective in your classroom? Why?
2. What is the rationale for using ICT in the class program? That is, purpose of ICT in the classroom; how and why it works?
3. What teaching strategies specific to ICT do you find effective to employ in your classroom? Why? How do you know? Assessment implications?
4. Recent examples of how you use ICT in your classroom?
5. Have you needed to devise different ways of teaching to incorporate ICT effectively? How have you managed this?
6. What are your thoughts about the students using computers at home? How does this impact on ICT in the classroom?
7. What difficulties have you experienced with ICT in the classroom? In particular, what reliability issues have you experienced?

8. Principal &/or ICT coordinator interview

Informal discussions with the Principal and/or ICT Coordinator will attempt to better understand the impact of the School as part of the context on what happens in the classroom in relation to on-line learning, including,

1. History of ICT in the school
2. Role, rationale for online learning as understood by the school
3. Observations of school experiences so far (lessons learned, insights to share...)
4. Hopes & expectations with respect to the following:
    a. Use if ICT in class programs
    b. Acquisition and development of ICT in the school
    c. Online learning in the school in the future

9. Classroom ICT environment

The observer will collect the following information about the ICT provision in the classroom, based on appraising classroom workstations and associated devices, arrangements and services available to the teacher and students:

Make and Model	HDD (free) [Gb]
OS	Start-up – power on to login
Start-up login to desktop [s]	Time to start Word 2000 [s]
RAM [Mbytes]	Processor
Peripherals: CD-ROM	Peripherals: microphone
Web-browser	Other installed software
Time to load webpage	Peripherals: sound

Appendix 3. Participant information letter

Faculty of Education
Locked Bag 1- 308 Launceston
Tasmania 7250 Australia
Telephone 03 6324 3492
Facsimile 03 6324 3343

(date)

The Families of Students
Grades 3 & 5
…… Primary School

This sheet contains information for participants in the research project
"Children, Online learning and Authentic teaching Skills in Primary Education":
[Australian Research Council LINKAGE Project: LP0210823]

The University of Tasmania, in partnership with the Catholic Office of Education, the Department of Education, and Telstra, is undertaking this research.

The study aims to examine how ICT based learning can best be applied in primary school classrooms to enhance children"s learning. The aim is to observe approximately 50 classrooms across Tasmania in order to understand the factors that influence the use of computer technology in teaching and learning.

The study has the support of the University of Tasmania, the Catholic Education Office and the Department of Education.

Some Grade 3 and Grade 5 students will be observed in the classrooms on Monday 19 and Tuesday 20 July. In addition the Class Teachers will identify several students who will represent the class in more detail. These students will be

- interviewed about their use of computers and online learning (learning that involves the use of the internet or school intranet)
- observed in more closely going about their class activities, and
- may be asked to undertake some particular online tasks, eg, find some information about a particular country from the internet while being observed.

All data collected from the observations will be kept confidential and no student"s name will be used in any reports of the study. Students have the right not to participate in the study and may withdraw at any time.

The observer will be Ivan Webb (recently retired from the position of Principal, Riverside Primary School) and the supervisor of the study is Dr Margaret Robertson who may be contacted for more information regarding the study:

Email Margaret.Robertson@utas.edu.au
Phone: (03) 6324 3712
Address: University of Tasmania
Locked Bag 1-307.
LAUNCESTON TAS 7250

Dr Margaret Robertson
Chief Investigator

Appendix 4. Instruments

4.1 Student interview record sheet (SQ)

School: **Class:** **Date:**

Student:	**Gender** 1 =male 2 = female	**Interviewer:**	**Quartile:**	1 =most able 2 =above average 3 =below average 4 =least able
Item	**Response**			**Office Use**
Home provision	PCs: Internet: Printer: Scanner: Camera: Family websites: Other:			0 = Unknown 1= None 2 = Pc Only 3 = Pc + Internet
Good things about computers				0 = Unknown 1 = No response 2 = Games 3 = Information 4 = Applications 5 = Other
Concerns about computers				0 = Unknown 1 = Slow 2 = Crash/freeze 3 = Operation 4 = Welfare 5 = Other
Uses elsewhere, cf uses at school	Uses elsewhere: Uses at School:			0 = Unknown 1 = No response 2 = Games 3 = Information 4 = Applications 5 = Other
Greater use of computers (location)	School: Elsewhere:	0 = Unknown 1 = School 2 = School + Home 3 = Extended access		0 = Unknown 1 = More School 2 = Same 3 = More elsewhere
Learn from…		0 = Unknown 1 = Family adult 2 = Older sibling 3 = Extended family		4 = School staff 5 = Friends 6 = Self 7 = Others
Teach others…		0 = Unknown 1 = Family adult 2 = Older sibling 3 = Extended family		4 = School staff 5 = Friends 6 = Self 7 = Others
Best school activity using ICT				
Recommendation for novice users				
Other interests outside of school	Hobbies: Sports: Pets: Music: Reading: Other:			

4.2 Teacher interview questions (TQ)

1. What general teaching strategies do you find effective in your classroom? Why?
2. What is the rationale for using ICT in the class program? That is, purpose of ICT in the classroom; how and why it works?
3. What teaching strategies specific to ICT do you find effective to employ in your classroom? Why? How do you know? Assessment implications?
4. Recent examples of how you use ICT in your classroom?
5. Have you needed to devise different ways of teaching to incorporate ICT effectively? How have you managed this?
6. What are your thoughts about the students using computers at home? How does this impact on ICT in the classroom?
7. What difficulties have you experienced with ICT in the classroom? In particular, what reliability issues have you experienced?

4.3 ICT Coordinator interview (CQ)

Informal discussions with ICT Coordinator will attempt to better understand the impact of the School as part of the context on what happens in the classroom in relation to on-line learning, including,

1. History of ICT in the school
2. Role, rationale for online learning as understood by the school
3. Observations of school experiences so far (lessons learned, insights to share...)
4. Hopes & expectations with respect to the following:
    d. Use if ICT in class programs
    e. Acquisition and development of ICT in the school
    f. Online learning in the school in the future

4.4 Principal interview (PQ)

Informal discussions with the Principal will attempt to better understand the impact of the School as part of the context on what happens in the classroom in relation to on-line learning, including,

1. History of ICT in the school
2. Role, rationale for online learning as understood by the school
3. Observations of school experiences so far (lessons learned, insights to share...)
4. Hopes & expectations with respect to the following:
    g. Use if ICT in class programs
    h. Acquisition and development of ICT in the school
    i. Online learning in the school in the future

4.5 Student Computer Access survey (CA)

Places where I have used a computer in the last two weeks.		1. I am a **BOY**잴 **GIRL** 잴
2. Computers at home:		3. I use the Internet at home? YES잴 NO 잴
4. Computers at School	In Our Class: ___ Library : ____ Computer Lab : ____ Other Classes : ____	
Other places	**Computers**	**Things I did with the computer**, eg, games, email…
5. Friends houses		
6. Relatives		
7. Work places		
8. Town Library		
9. Neighbours		
10 My Favourite Internet Sites		

4.6 Classroom Computer Use checklist (CU)

Date: Class:

Activity (KITOs): What? Operations, Publishing, Communicating, Researching, Problem Solving, Independent Learning, Games

Task: Why (Curriculum Forms): ICT, Transdisciplinary, Community development, Personal Learning Project, Recreation

	PC1	PC2	PC3	PC4	Activities (times)
Students					
Activity					
Task					

	PC1	PC2	PC3	PC4	Activities (times)
Students					
Activity					
Task					

	PC1	PC2	PC3	PC4	Activities (times)
Students					
Activity					
Task					

4.7 Class ICT Provision checklist (IT)

Case Study: Class: School: Date:	Workstation 1	2	3	4
Make and Model				
RAM [Mbytes]				
Processor				
OS				
HDD (free) [Gb]				
Peripherals: sound				
Peripherals: microphone				
Peripherals: CD-ROM				
Web-browser				
Time to load www.acce.edu.au [s]				
Time to start Word 2000 [s]				
Other installed software				

Appendix 5 Sample data

5.1 Student Computer Access survey (CA)

After a class discussion about ICT each students in the class completed individual surveys (sample below) indicating basic information about their

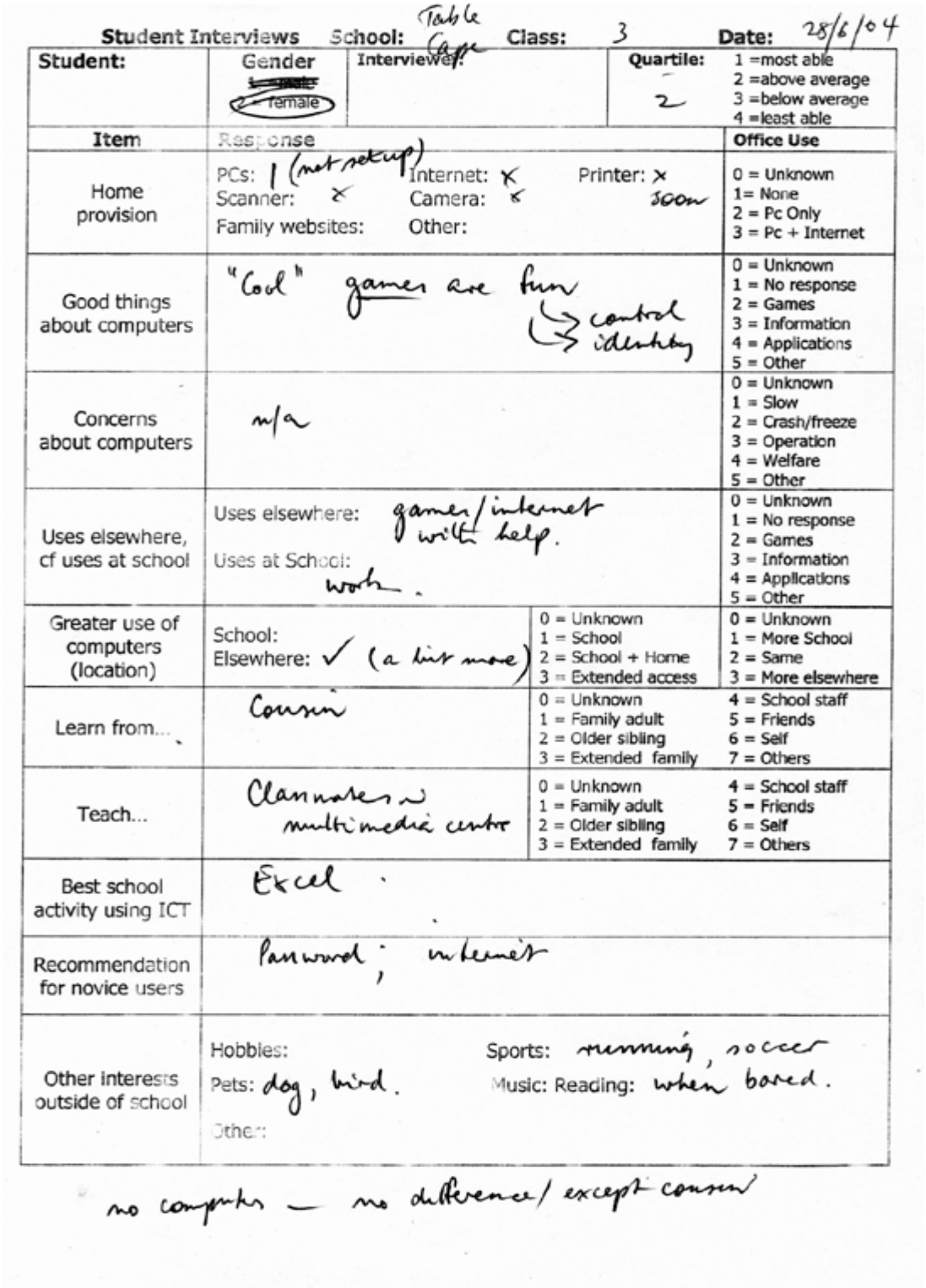
- Access to ICT at home
- Access to ICT at school
- Access and use of ICT and in other Places

Places where I have used a computer in the last two weeks.		1. I am a **BOY**☐ **GIRL** ☑
2. Computers at home: 3		3. I use the Internet at home? YES☑ NO ☐
4. Computers at School	In Our Class: 3 Library : 2 Computer Lab : 4 Other Classes : 0	
Other places	**Computers**	**Things I did with the computer**, eg, games, email...
5. Friends houses	0	I didnt do any thing
6. Relatives	2	I went on eg and played games
7. Work places	1	I played soliter games
8. Town Library	0	I havent been there
9. Neighbours	0	I dont have neighbours
10 My Favourite Internet Sites	0	I usely dont go on the internte

The data gathered in these surveys (CA) provided a starting point for the interviews (SQ) of the eight representative students in each class.

5.2 Student interview (SQ)

Each class teacher nominated eight students as a representative cross-section of the class. The observer conducted brief interviews of these students in the classroom when convenient during the course of the in-class observations. The following is a sample record of interview.



Student Interviews School: Table Class: 3 Date: 28/6/04

Student:	Gender ~~Male~~ Female	Interviewer:	Quartile: 2	1 =most able 2 =above average 3 =below average 4 =least able

Item	Response		**Office Use**
Home provision	PCs: 1 (not setup) Internet: ✗ Printer: ✗ soon Scanner: ✗ Camera: ✗ Family websites: Other:		0 = Unknown 1= None 2 = Pc Only 3 = Pc + Internet
Good things about computers	"Cool" games are fun ↳ control ↳ identity		0 = Unknown 1 = No response 2 = Games 3 = Information 4 = Applications 5 = Other
Concerns about computers	n/a		0 = Unknown 1 = Slow 2 = Crash/freeze 3 = Operation 4 = Welfare 5 = Other
Uses elsewhere, cf uses at school	Uses elsewhere: games / internet with help. Uses at School: work.		0 = Unknown 1 = No response 2 = Games 3 = Information 4 = Applications 5 = Other
Greater use of computers (location)	School: Elsewhere: ✓ (a bit more)	0 = Unknown 1 = School 2 = School + Home 3 = Extended access	0 = Unknown 1 = More School 2 = Same 3 = More elsewhere
Learn from...	Cousin	0 = Unknown 1 = Family adult 2 = Older sibling 3 = Extended family	4 = School staff 5 = Friends 6 = Self 7 = Others
Teach...	Classmates in multimedia centre	0 = Unknown 1 = Family adult 2 = Older sibling 3 = Extended family	4 = School staff 5 = Friends 6 = Self 7 = Others
Best school activity using ICT	Excel.		
Recommendation for novice users	Password; internet		
Other interests outside of school	Hobbies: Sports: running, soccer Pets: dog, bird. Music: Reading: when bored. Other:		

no computers — no difference / except cousin

5.3 Teacher interview (TQ) – part transcript

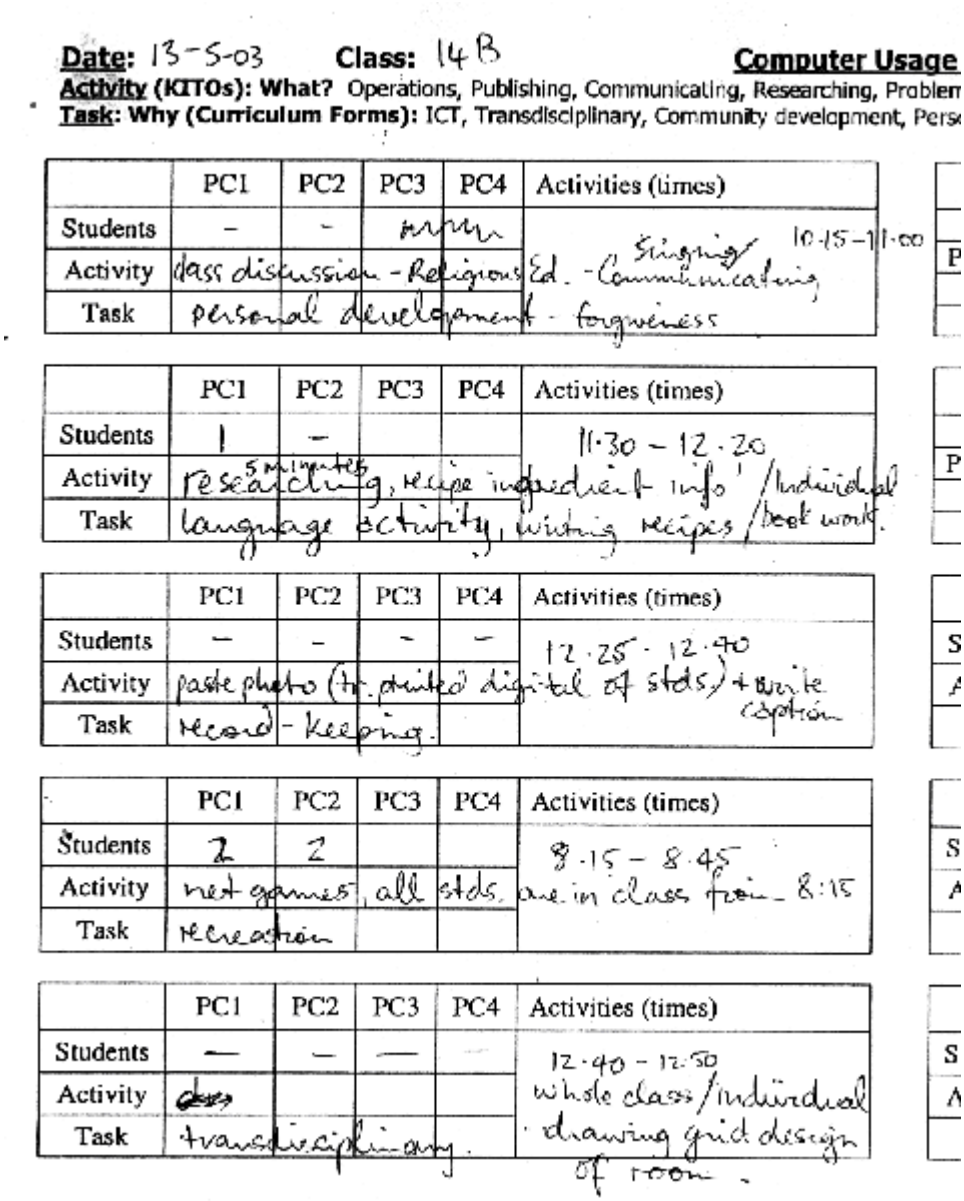
The following extract is from the transcript of interview with teacher T.6a (pp. 1-2). The total transcript for T.6a runs to seven pages. The interviewer is O.6a.

> ….
> OK, now if we turn to ICT in particular, what is your thinking? I mean, some people are doing it because it is an expectation. Other people are doing it because there is a particular advantage they can see, so what is your thinking? O.6a
>
> I have changed a lot over the last few years. I think I - like I worked fairly strongly with the old BCC and it has just always been a part of my teaching and it has just kept going and I have gone through the old Acorn so I don't feel like it is anything new to me. I don't feel I have to justify or qualify what I do and I would say that in the last few years I have moved away more from teaching the kids to word process and finding things like that important to just using them if that is what I need at the time. I mean, now that the school's net is here, I feel safer with these children. They got school's net here midway through so the internet searches, I am happy with and we just use that the same as I would say - run up to the library. Well, if the machine is free we just jump on and see how you go and word processing, if it is appropriate, we do it. I don't particularly fuss about presentation needing to be done on the computer. I try to give them time to work up their word processing skills but most of them in grade 3 are very good. They know which key is where so they will get there. T.6a
>
> It is interesting talking to a few of them this afternoon, they are happy to suss it out for themselves. O.6a
>
> Well I have always said - you tell them a little bit and they will find out what you don't know and I would say a lot of them are already like that. I learn what I need to know and they learn what they need to know. T.6a
>
> Now that was coming out very clearly from the handful that I spoke to today that, in fact, they were virtually saying what you are saying. They get a start, maybe at school or at home from big brother or from Mum and once they understand the software basics, they are prepared to explore and see what works and what doesn't. O.6a
>
> That's right and I mean all kids are like that and having taught in high schools I would certainly say that but they end up knowing far more than me. See the kids in this class taught me how to use clips on line. I had just never bothered with it and just went in and discovered it themselves. T.6a
>
> …

Other staff interviews, ICT Coordinator interview (CQ) and Principal interview (PQ), were also taped and transcribed.

5.4 Classroom Computer Use checklist (CU)

Observers recorded the use of ICT in class sessions during the two or more days spent in each class. Part of the record make in classroom 14b is shown below.



Date: 13-5-03 **Class:** 14B **Computer Usage**

Activity (KITOs): What? Operations, Publishing, Communicating, Researching, Problem

Task: Why (Curriculum Forms): ICT, Transdisciplinary, Community development, Pers

	PC1	PC2	PC3	PC4	Activities (times)
Students	–	–			10·15 – 11·00
Activity	class discussion - Religious Ed. -				Singing/ Communicating
Task	personal development - forgiveness				

	PC1	PC2	PC3	PC4	Activities (times)
Students	1	–			11·30 – 12·20
Activity	5 minutes researching, recipe ingredient info'				/individual
Task	language activity, writing recipes				/book work.

	PC1	PC2	PC3	PC4	Activities (times)
Students	–	–	–	–	12·25 - 12·40
Activity	paste photo (hr. printed digital of stds) + write caption				
Task	record - keeping.				

	PC1	PC2	PC3	PC4	Activities (times)
Students	2	2			8·15 – 8·45
Activity	net games, all stds.				are in class from 8:15
Task	recreation				

	PC1	PC2	PC3	PC4	Activities (times)
Students	—	—	—		12·40 - 12·50
Activity	~~class~~				whole class/individual
Task	transdisciplinary.				· drawing grid design of room.

Note: Sessions not shown indicate that in-class observations were not possible. Common reasons included

- The class was not in the classroom for that session
- The observer was not available to be in the classroom

5.5 Class ICT Provision checklist (IT)

Observers examined the classroom computers and recorded a range of information about each machine.

Children, Online learning and authentic teaching skills in primary education.

Class Computer Environment

Case Study: 2/3/4 **Class:** A **School** 16 **Date** 1/7/03

	Workstation 1	2	4	3	5
Make and Model	IBM	Compaq Presario 2417	Microbits	Microbits	Microbits
RAM [Mbytes]	128	60		64	64
Processor	PII	AMD-K6		Cel	Cel
OS	W98	W98	W XP	W 98	W 98
HDD (free) [Gb]	4.3	2.5	6.0	4.2	4.0
Peripherals: sound	✓	×	×	×	×
Peripherals: microphone	×	×	×	×	×
Peripherals: CD-ROM	✓	✓	✓	✓	✓
Web-browser	IE 5.0	IE 6.0	IE 6.0	IE 6.0	IE 6.0
Time to load www.acce.edu.au [s]	fair	poor	fair.	fair	fair
Time to start Word 2000 [s]	2J	6	8	4	2
Other installed software	MS Office Kidpix Kidspiration	MS Office Kidpix Kidspiration Phonics typing	MS Office Encarta	MS Office SACS Outlook Kidspiration Kidspix Encarta multitude of CD Rom startups	MS Office Outlook Kidspi
	800 x 600	800 x 600	800 x 600	800 x 600	640 x 480

- poor mice
- printer x 2
- no scanner
- camera available

.