Investigating Student Netbook Usage using Activity Theory

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Access to information and communication technologies (ICT) by students for learning has been acknowledged as being important in the 21st Century. Governments, education systems and schools have been moving to greater levels of access, including students having 1:1 computing access, referred to as ubiquitous or uLearning. As schools move to 1:1 computing, research is required to inform the design and provision of access and usage by students.

This study sought to determine whether or not ubiquitous access to netbook computers equated to ubiquitous usage of the devices and whether or not varying the pattern and ratio of access affected the uptake and impact of netbook usage. It also sought to determine whether or not netbooks were an appropriate computing device for early adolescent learners, and whether or not the use of the netbooks affected the classroom environment. Specifically, it examined the impact of the netbooks on student productivity, social activity, teacher control and individual learning. It also sought to further establish whether or not Activity Theory (AT) was an appropriate methodological and conceptual framework for classroom based research. Four classrooms received the netbooks in one of the following four patterns:

- 1:1 student to netbook access - 5 days per week for 6 weeks;
- 1:1 student to netbook access - 3 days per week for 10 weeks;
- 1:2 student to netbook access - 5 days per week for 6 weeks; and,
- 1:2 student to netbook access - 3 days per week for 10 weeks.

The study drew upon AT as the conceptual framework and employed a mixed method methodology.

The study, conducted in a South East Queensland Catholic Primary School, involved 120 Year 7 students and four classroom teachers. Throughout the 2009 school year data were collected about the students, the teachers, and the classroom environments via interviews, student forums, surveys, questionnaires, data logging software, researcher diary and classroom observations. Questionnaire data relating to classroom environments were analysed using SPSS and statistical significance determined using t-tests and correlational analysis. Interview, survey and observational data were initially coded using six Activity Theory nodes (Subject, Object, Tools, Division of Labour, Community and Rules and the eight NCEI sub-scales (Involvement, Innovation, Teacher Control, Teacher Support, Order and Organisation, Competition, Affiliation and Group Work. As analysis continued, further nodes emerged including student productivity, Technological Pedagogical Content Knowledge (TPACK) and the crowded curriculum. NVivo was utilised to assist in this analysis.

The study found that ubiquitous access did not equate to ubiquitous use with average daily use of the netbooks of between 60 – 90 minutes. The netbooks were considered as an appropriate computing device by the students and teachers in this study and provided a balance between mobility and functionality. Statistically significant changes occurred in three classrooms. These changes related to Order and Organisation in one classroom and Teacher Control and Involvement in two classrooms. The use of the netbooks had significant impact on student productivity and social activity but no impact on individualised learning. Minor changes occurred to teacher pedagogy in two of the classrooms. Varying the pattern and ratio of use was a significant factor in the findings noted above and the study recommends the allocation of computers in a 1:2 rather than 1:1 ratio.

This research is significant as it can inform other primary schools as they determine the most effective means in which to utilise new mobile technologies. It is also relevant to informing secondary schools as they consider the implementation of the Digital Education Revolution (DER). This research also informs the broader debate as to whether or not 1:1 distribution of computers is most efficacious in terms of student outcomes and whether or not netbooks are an appropriate computing solution for early adolescent students.
Statement of Originality

"This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself."

Signed: 

Date:
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I look forward to further adventures on my journey of learning.
Publications during Candidature

The following peer reviewed publications were completed during the period of candidature for the Doctor of Education.

Book Chapters


Refereed Conference Paper


Refereed Symposium Presentation


Dedication

To Dite, my muse; an endless source of inspiration, encouragement, and truthful comment. Your importance to me is immeasurable.
Chapter 1. 1:1 Computing in Primary Schools

Since the introduction of Information Communication Technologies (ICT) in schools in the early 1980’s there have been continual changes in the types of technologies used in schools to enhance student learning. These have included the use of personal computers, mobile devices, the Internet, and Interactive Whiteboards (IWBs) to name a few. These changes also include the movement towards greater access by students to computers, including laptop computers aimed at providing 1:1 access. 1:1 access means that each student has individual access to a computer for the duration of a learning activity. This project investigated in what ways the provision of students’ 1:1 access to computers translated to their classroom based usage. It investigated the influence of the pattern of access to the devices on the quantum and quality of their use. This project further investigated the appropriateness of netbooks as a computing device for early adolescents and the impact of netbook usage on four Year 7 classrooms. Early adolescence is a term which is used to describe students who are aged from 10 – 14 (Carnegie Corporation, 1995). This chapter provides an outline of this project, including a brief description of the primary school in which the research takes place. It presents the research questions which guide the research, suggests why these research questions are important and identifies the specific contributions this thesis makes to the current debate surrounding 1:1 computing.

The project was a component of a series of broader school initiatives towards Middle Schooling undertaken by the school where the research was conducted. Middle Schooling can be defined as a pedagogical approach that seeks to more thoroughly engage early adolescents in their learning which can lead to improved student learning, positive learning experiences during adolescence, and a desire and capacity for lifelong learning (Chadbourne & Pendergast, 2005). While this project was not specifically an investigation of the use of netbooks in terms of Middle Schooling, knowledge developed in this project will be used to direct future educational programs of the school and also contribute to informing the wider educational domain concerning 1:1 computing and its impact on student learning. This project focused on a variety of themes including mLearning, digital technology usage by early adolescents, 1:1 computing, alternatives to 1:1 computing, and the impact of mobile
technologies on classroom environments. It also investigated the efficacy of Activity Theory as an appropriate conceptual and methodological framework.

The research site was an Australian Catholic Primary School. Although reasonably well resourced through Federal and State funding, major ICT initiatives in the school are funded via parent levies. As it is a Catholic Primary school, it is ineligible for either the federally funded Digital Education Revolution (DER) Laptop program or funding from any Education Queensland ICT funding. The lack of appropriate funding for computing resources in Catholic primary schools is a key consideration when making decisions regarding the future deployment of 1:1 computing programs in such schools. An overview of the situation with computing and schools in Australia, with particular reference to early adolescents is outlined in the following section.

1.1. **Brief Description of the Current Context**

From my experience of educating early adolescents for the past 20 plus years, and based on data collected from the students in this study, it is suggested that the vast majority of early adolescents are heavily engaged with digital technologies and exhibit digital literacy practices in the form of emailing, instant messaging and text based SMS messages sent to each other via mobile phones, Personal Digital Assistants (PDAs) and computers (Hall & Israel, 2004; Luke et al., 2003; Snyder, Wise, North & Bulfin, 2008). Their engagement with mobile technologies provides an opportunity for educators to harness, for educational purposes, the depth and richness of digital material readily available via mobile computing devices (Mellow, 2005) and to provide opportunities for learning that are individualised, context specific, and mediated by peers and mentors (Peters, 2005).

Much of this early adolescent engagement with digital and computing technology occurs, however, outside of school contexts (Mellow, 2005; Lee & Levins, 2010) and furthermore, on the limited occasions in which ICT is incorporated into classrooms, it is rarely used to engage the students in learning related to critical literacy, digital literacy or multiliteracies (Luke et al., 2003). The limited and highly controlled use of ICT by teachers makes it difficult to cross the ‘critical use border’ (Newhouse, Clarkson & Trinidad, 2005) where ICTs become integral in the provision of digital
learning environments for students. The ‘critical use border’ is a theoretical construct which outlines five stages of teacher use of ICT – Inaction, Investigation, Application, Integration and Transformation. It is only at the final two stages of teacher use that ICT becomes a tool whereby student learning is enhanced by the presence of computers (Finger, Russell, Jamieson-Proctor & Russell, 2007).

Making mobile technologies available to early adolescents at school, and allowing them significant freedom to use these technologies for access to information and collaboration, is an important component of an educational approach seeking to engage these students (Albright, Purohit & Walsh, 2002; Rockman, 2003). The provision of mobile technologies in early adolescent learning environments can result in these devices becoming an integral and almost invisible tool for collaboration and communication (Swan, Hooft, Kratcoski & Unger, 2005) and create opportunities for ‘deep learning’ via, for example, the creation of Electronic Portfolios (Barrett, 2006). Should a move towards mobile computing occur, it can also change perceptions of what a school should be doing and how it should be doing it (Glennan & Melmed, 1996). If schools are to utilise the resources available to them in an increasingly networked world (Finger & Sun, 2010) then the provision of 1:1 computing may be a means to engage early adolescents in their learning. In this thesis, 1:1 computing indicates that devices are available in the classrooms for students to use as required and that there are sufficient devices for each student to use. It does not refer to situations where students have 1:1 access in a computer lab or have borrowed a bank of laptops for a specific task.

In more recent times, the interest in school based ICT has focused on the implementation of 1:1 computing programs (see Franklin, 2007; Penuel, 2006). In this project, 1:1 computing is defined as the availability of a mobile, wireless enabled learning device to each student in a class (see Liang et al., 2005). For this study, netbooks were chosen as the 1:1 learning device. This definition, however, could also be satisfied through the use of laptops, tablet PCs or handheld devices such as PDAs, iPhones or iPod touches. 1:1 computing allows individual student access to learning activities which suit their learning styles, preferences and/or learning needs. This suggests that there no longer needs to be a ‘one size fits all’ approach to learning and that “multi-modal options and device independent access will be the norm”
A diagrammatic representation of the digital components of 1:1 computing in a classroom is provided in Figure 1-1.

![Diagram of a 1:1 digital classroom environment](image)

**Figure 1-1 Common Components of a 1:1 digital classroom environment.**

Figure 1-1 illustrates that a number of components need to be present for a classroom to be considered a 1:1 computing environment (Liang et al., 2005, p. 182). Integral to the concept is that each student has access to a device and that there is a device management system to safely store and recharge the devices when they are not in use. In order to facilitate shared access to resources, and also to demonstrate the outcomes of learning, classroom server space and a data projector are also recommended. It is important to realise that the definition of 1:1 computing only refers to the level of access and says nothing about actual educational practices (Bebell & O’Dwyer, 2010). The intent of this thesis was to further investigate the educational implications implicit in the provision of 1:1 computing access.

This research was situated in Year 7 classrooms in a primary school where the provision of netbooks afforded the opportunity for various patterns of 1:1 computing for students aged from 11-13 years old. This research into a 1:1 computing environment is particularly relevant to the broader Australian educational context. Both Federal and State Governments in Australia have recently emphasised the importance of ICT in education (Department of Education, Employment & Workplace Relations [DEEWR], 2008) and have long required schools to use ICT to improve student learning (Department of Education, Science & Training [DEST], 1999). Schools are held accountable to ensure that students are “confident, creative
and productive users of new technologies” (Curriculum Corporation, 2005, p. 14). In 2008, the heightened Federal Government interest in the 1:1 computing agenda was firmly established with the launch of a federally funded initiative entitled the ‘Digital Education Revolution’ (DEEWR, 2008) which sought to direct the use of computers in schools. A component of this ‘revolution’ was the planned distribution of laptop computers to all Year 9 - 12 students, as a contribution to sustainable and meaningful change to teaching and learning. As a consequence of the national scale of this project, and the broader political and educational interest in 1:1 computing, the need for contemporary Australian research into 1:1 computing to better inform further Federal and State policymakers is necessary. Such research is needed along both logistical lines; for example, powering, storing, maintaining, and connecting the devices provided by the government; and pedagogical lines in relation to the impact of the devices on the classroom environment (Oxley, 2008). This project suggests that research be focussed initially on the pedagogical implications of the revolution as it is the learning and teaching which can be supported by this intervention which requires immediate attention (Lim & Khine, 2006). Secondary to this initial focus, and given the competing demands for resources in schools, research is needed to inform schools regarding the most effective deployment of funds to enable sustainable models of student access to computers, and their most effective use by students for learning.

Chapter 2 provides a comprehensive analysis and synthesis of the literature related to the findings from previous research regarding computer use in schools in general and related to 1:1 computing in an Australian context in particular. A number of themes were identified in the literature that are relevant in addressing the research problems. These include early adolescent use of mobile technologies, the relative functionality and mobility of PDAs, netbooks and laptops, 1:1 and near 1:1 laptop programs, teacher agency, Technological Pedagogical and Content Knowledge (TPACK), and the impact of innovations on schools. As a means of organising the various themes mentioned above, a conceptual model (Figure 2-2) is presented at the conclusion of Chapter 2 which classifies the themes in relation to their impact on student learning and engagement. The three dominant themes identified are: i) student readiness to use ICT; ii) teacher agency and its influence on classroom use of ICT; and iii) Classroom ICT environments. These three themes also emerge in Chapter 3 where a conceptual framework for the thesis is proposed.
In engaging with, and reflecting upon the findings from the literature, particularly in relation to 1:1 computing in Primary schools, it appears that there has been limited credentialed research conducted. Furthermore, the majority of these research projects have occurred in the USA, with a significant proportion of them conducted in wealthy, urban schools where the parents purchased the devices (Penuel, 2006). Although there have been some instances of schools achieving 1:1 student-computer ratios in Australia, often through laptop programs, these examples have not been widely documented or researched (Oxley, 2008). Furthermore, where Australian research studies have been undertaken they have: i) involved high school students (Newhouse, 1997; 1998; Newhouse & Rennie, 2003; Stolarchuk, 1997; Zandvliet, 1999); ii) primarily dealt with the experience of the teachers in the laptop program (Hartnell-Young, 2006; Department of Education and Training [DETA], 2006); iii) were fundamentally theoretical in nature (Lloyd & Cronin, 2002; Romeo & Walker, 2002); iv) involved government primary schools (Newhouse, 2001); or, v) used PDAs as the computing device (Callil, 2006; Fluck & Robertson, 2006). It is suggested here that further research concerning 1:1 computing in Australian Primary schools is necessary to provide an informed and considered response concerning the educational value of 1:1 computing (see also Romeo & Walker, 2002; Weston & Bain, 2010). In particular, research is needed to establish the impact of 1:1 computing on early adolescents in Australian primary schools which do not receive government funding for computing initiatives and which therefore need to be particularly mindful how financial resources are utilised.

1.2. My Personal Interest in this Project

My involvement with Primary education, as a teacher, an administrator and more recently as a researcher, fostered an interest in the learning potential of digital technologies, particularly as they relate to early adolescent learners. This interest led to an investigation of the potency of mobile devices to support early adolescent learning and resulted in a book chapter which details the potential use of PDAs as a mobile learning device appropriate for early adolescents (Larkin, 2007). It explores a range of issues in relation to the use of PDAs in primary school contexts, and suggests a variety of potential impacts in relation to classroom communication, school structures and student learning. It was my intention at the time to utilise PDAs as the
computing device in the research component of the degree as I was particularly interested in the mobility and functionality balance of the PDAs as a mLearning tool. mLearning has been defined as “the intersection of mobile computing and e-learning that includes anytime, anywhere resources; strong search capabilities; rich interaction; powerful support for effective learning; and performance based assessment” (Abernathy, 2001, p. 1). The intention to use PDAs as the mLearning tool was based on an understanding, at that point in time, that PDAs offered the best combination of mobility and functionality. This viewpoint was supported by Keegan’s (2005) positioning of PDAs as the most appropriate tool for mLearning, in terms of a balance between functionality and mobility (see Figure 1-2).

<table>
<thead>
<tr>
<th>FUNCTIONALITY</th>
<th>MOBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td>Laptop Computers</td>
</tr>
<tr>
<td>Laptop</td>
<td>PDA</td>
</tr>
<tr>
<td>Computers</td>
<td>Handhelds Palmtops</td>
</tr>
</tbody>
</table>

Figure 1-2 Functionality and mobility in mobile learning

In the three years since the publication of this book chapter I have continued to engage with the literature, in particular with published research involving 1:1 and mobile computing technologies, early adolescents and their use of digital technologies, and the impact of computers on classroom environments. Based on my analysis of continuing development in mobile technologies, I concluded that netbooks would be the computing device for this project. The rationale for the decision to utilise netbooks in this research is outlined further in Chapter 2 where Keegan’s (2005) notion of a continuum of mobility and functionality is built upon to suggest that netbooks are the most appropriate device for early adolescent students to use to support their learning.

1.3. A Socio-cultural Understanding of Classroom Environments

In researching the environments of the four classrooms in the study, I was deliberate in my attempts to understand holistically these environments. Based on my personal experience in teaching and leading classrooms and schools, it was of paramount
importance that I capture the intricacies of each of these environments and avoid a simplistic account of the impact of the computers solely in terms of quantifiable merely reporting that, for example, the computers were used for 56 minutes per day and the students used them for typing up their projects. If I was to make an informed recommendation to my school principal, and if the information provided in the thesis was to be of any relevance to educators in other schools, a full accounting of the impact of computing devices on classrooms in terms of individual learning, classroom interaction, classroom communication, access to information and teaching styles was required.

A concern in relation to research investigating the use of computers by students is that such research studies have often disregarded a holistic view of education and thus failed to fully consider how the characteristics of students, teachers, and the particular school interact with the characteristics of the technology in determining educational outcomes (McCreary, 2001). Instead, they have proceeded in one of two ways, either at the micro level and only focussed on the impact of a particular technology on a particular element of the learning process; for example, the use of computers to assist in the learning of Algebra (Coupland, 2004); or from a macro approach, where the classroom is conceived as a homogenous entity and where technological innovations are considered to impact on the classroom as a discrete unit.

The danger of approaches such as those mentioned previously is that they conceive of ICT as existing separately from other elements of an educational context, at either the micro or macro level. Classrooms are conceived here as socio-cultural contexts in which elements cannot be considered in isolation. For instance, it is invalid to investigate the use of computers in a classroom without considering the teacher’s educational philosophy, or how the school resources ICT, or whether the school has a designated ICT leader. Consequently, studies in ICT need to reconsider its position as one element, interwoven with other elements of the classroom learning environment such as teaching and learning activities, curriculum, interpersonal relationships, communication, and student-student / student-teacher collaboration.

As classrooms are conceived as sites in which learning occurs as a social and cultural endeavour, Activity Theory is used as a framework which assists in an analysis,
synthesis, and evaluation of such environments. A full articulation as to the efficacy of Activity Theory in understanding school classrooms is provided in Chapter 3. Activity Theory is considered useful in understanding the range of complex factors related to computer use and how this use impacts on student learning. It also provides a focus on the mediating impact of tools in the attainment of a motive by a subject or group of subjects. Activity Theory further recognises that student learning is influenced by current and historical socio-cultural artefacts and that learning proceeds from the external to the internal. In summary, Activity Theory is proposed and justified as a conceptual and methodological framework which can be utilised as a way of examining the complex, interrelated elements of a classroom, including the introduction of a new tool, in a holistic manner.

1.4. Guiding Questions for this Research

The following are the research questions which guided this study:

- What factors influence the relationship between 1:1 access to netbooks and their actual use by students?
- In what ways does varying the ratio of netbook availability – from 1:1 to 1:2 or varying the pattern of availability - 5 days per week for 6 weeks versus 3 days per week for 10 weeks affect student usage in terms of quantum (as a ratio of available time) and modes of use?
- How are the classroom environments affected by the use of the netbooks? In what ways does the deliberate provision of a class set or a half class set of netbooks affect these classroom environments?
- What affordances of the netbooks suggest that they are appropriate or inappropriate computing device for early adolescent students?
- In what ways does the availability of the netbooks impact on student learning?

In essence, the project investigated whether the netbooks were an appropriate technology for the provision of 1:1 computing for early adolescents and whether they were an appropriate use of educational resources. In answering these questions it also investigates whether altering the pattern of access to computing resulted in different educational outcomes and if so, which of these outcomes is considered most
beneficial to the students at the research school. Finally, whilst not specifically a research question, the project also investigated the usefulness of Activity Theory as a framework for answering research questions such as those posed in this project.

1.5. How the Research Questions were Addressed

This study utilised Activity Theory (Engeström, 1987) as the conceptual framework underpinning both the research methodology and also the latter discussion of the findings. It was considered appropriate that a ‘mixed method’ (Onwuegbuzie, 2002) methodology would be most appropriate for this study. Mixed methods research is a pragmatic approach which draws from the strengths and minimises the weaknesses of purely quantitative or qualitative research approaches. The methodology of a mixed method project is intuitive, interactive and open (Punch, 1998) and seeks to arrive at warranted conclusions via the conduct of a range of empirical investigations. In this classroom based study, a mixed methods approach, combining elements of quasi-experimental design (for example, pre and post intervention surveys) and qualitative design (for example, interviews and student forums), was necessary to identify contextual factors which could not be experimentally or statistically controlled (Maxwell, 2004). A mixed methods approach facilitated the investigation, at a deeper level, of the beliefs and values of the teachers and students in this study.

A range of data collection methods or tools were used in this project.

- Classroom Observations – (Prior to, during, and after netbook use)
- Semi – structured interviews, student forums, and surveys (Freebody, 2003)
- The New Classroom Inventory Index (NCEI) (Newhouse, 1987)
- Data Logging Software installed on the netbooks
- A reflexive researcher diary

Data collected were analysed for statistically significance utilising SPSS as a tool for analysis and checked for accuracy by a university statistician. Results from this analysis generated themes for further qualitative investigation using NVivo as a data management tool. As a key focus of the research relates to levels and patterns of access, four different levels of netbook access were provided, as indicated below, to four Year 7 classes.
Class a. Ratio of 1:1 student to netbook access - 5 days per week for 6 weeks;
Class b. Ratio of 1:1 student to netbook access - 3 days per week for 10 weeks;
Class c. Ratio of 1:2 student to netbook access - 5 days per week for 6 weeks; and,
Class d. Ratio of 1:2 student to netbook access - 3 days per week for 10 weeks.

Chapter 4 details further the philosophical and educational reasons behind the choice of methodology and outlines the practical implications of this choice in terms of how data was collected and analysed in order to provide credible answers to the research question.

1.6. Why the research was necessary

1:1 laptop programs, whereby students receive a computer for their individual use, represent an important, contemporary initiative in the field of educational technology (Weston & Bain, 2010). This is in no small part due to their increased popularity and also their perceived potential to bridge the digital and didactic divide that currently exists in schools (Mouza, 2008). This is evidenced in a flurry of 1:1 initiatives and considerable resourcing to enable 1:1 access, very evident in the USA, including State wide deployment to Year Eight and Nine students in Maine (Gravelle, 2003), and widespread use in Florida (Dawson, Cavanaugh & Ritzhaupt, 2008/2009) and Pennsylvania (Zucker & Hug, 2008). Such initiatives are also apparent in Australia, in particular through the Federal Government laptop program in Australian secondary schools. Although becoming more prominent, 1:1 computing programs are not universally popular and there are growing concerns over the effectiveness of such high cost programs with increasing resistance by some parents, school administrators, and educational bureaucracies to their implementation (Cuban, 2006; Lei & Zhao, 2008). At the crux of the issue is the debate as to whether or not 1:1 computer programs, which come at a significant cost, have resulted in improved educational outcomes for students (Romeo & Walker, 2002). Those responsible for determining educational policy are awaiting evidence of the benefits of 1:1 computing programs for learning and teaching (Grimes & Warschauer, 2008).
As indicated earlier in this chapter, despite the apparent need for research in 1:1 computing, research into the educational uses and student outcomes of laptop programs is still in its infancy (Russell, Bebell & Higgins, 2004; Bebell & Kay, 2010) and aside from project evaluations, independent research on 1:1 computing is still scarce (Penuel, 2006). Further hampering effective and informed decision making is the fact that much of the evidence presented to argue one way or the other on the benefits or otherwise of laptop program, has been largely anecdotal in nature (Newhouse, 1997).

In presenting an argument for the need for further 1:1 computing research, it is suggested that what is needed is the continued development of knowledge regarding if, and how, 1:1 computing leads to, for example, improved student outcomes, constructivist pedagogy, positive classroom environments, or increased student collaboration (Lemke & Martin 2003; Penuel, 2006; Zucker, 2004) in a wider variety of contexts than studied thus far (for example, Australian primary schools, schools in regional areas, or non-Government schools). Specifically, there is a need to study how 1:1 access contributes to these potential benefits, in such a way that would not otherwise be possible with higher student to computer ratios (Dunleavy, Dexter & Heinecke, 2007). This project concentrated on the practical benefits of such research both to the research school and also to the broader educational domain. The necessity of utilising a conceptual framework appropriate for the study of ICT rich classroom environments and a methodology which is robust enough to be useful in collecting and analysing data from such classrooms is recognised.

1.7. Specific Contributions of this Project

This research into various patterns of netbook usage in four Year 7 classrooms contributes valuable insights into the use of computing devices in school contexts. In particular, it provides insights into the provision of various modes and densities of computer access, and also addresses whether or not 1:1 access translates to substantial usage of computers in a 1:1 environment. Furthermore, it considers whether access to computers in a 1:2 pattern is advantageous to the students from an educational perspective as this has economic implications for schools and school systems. From my engagement with the literature it appears that research studies completed to date have yet to test specifically the links between hypothesised outcomes for 1:1
initiatives and the impact of different implementation strategies to achieve these outcomes (Penuel, 2006; Zucker, 2004).

Findings from this research project suggest that: i) Ubiquitous access to netbooks did not translate into ubiquitous use of the netbooks with average daily use of the netbooks of approximately 60 minutes; ii) the access pattern affected usage with the netbooks in the 1:2 pattern being used more often than in the 1:1 pattern; iii) notwithstanding the impact of pattern of access, a significant factor in usage was the readiness of the teacher to utilise the technology; iv) netbooks were considered highly appropriate for early adolescent students; v) the use of netbooks affected classroom environments, particularly in relation to Student Involvement, Teacher Control and Productivity; and vi) social activity in classrooms diminished during periods of netbook usage.

These findings contribute to a range of continuing issues surrounding the use of computers in schools in general, and more specifically the early adolescent school based use of computers in a 1:1 context. It suggests that, for these classrooms at this point in time that 1:1 availability did not equate to a significant uptake of the technology in this primary school and that 1:1 netbook usage was not the most beneficial pattern of access in terms of student learning or classroom environments. This project established that the netbooks were highly appropriate for early adolescent students in this study and that the teachers and students preferred netbooks to laptops. Finally, the study demonstrates the usefulness of Activity Theory as a conceptual and methodological framework for analysing complex settings such as school classrooms.

I stated earlier in the chapter that this research was a component of a wider range of activities in the research school around Middle Schooling and that the findings from the research would be used to assist in the establishment of learning goals for the school. The implications of this research for this school, and possibly for other primary schools, are articulated fully in Chapter 7 but include: i) the continued rollout of netbooks as the computing device of choice to our 10 – 13 yr old students; ii) the allocation of the netbooks in a 1:2 pattern; and iii) an expanded program of professional development for the teachers in relation to the use of digital technologies to support the learning of early adolescent students. Chapter 7 also makes a number of
suggestions in terms of conceptual, methodological and practical domains of knowledge and recommends that further research is conducted in other research sites to ascertain whether the default provision of 1:1 computing is the most appropriate utilisation of computing resources.
Chapter 2. Netbooks and Student Learning

Netbooks are a relatively new form of mobile computer and their use in classrooms is a recent phenomenon. Hence, little empirical evidence is available about their use by students and utility for learning. However, a significant body of research exists in regard to the impact of other types of computing devices in education. This chapter engages with relevant literature to identify relations amongst various elements of this research project commencing with a review of relevant literature at a macro level and a consideration of the impact of mobile technologies on the learning of early adolescents. Subsequently, the review interrogates the literature in relation to: i) research on the use of laptops in education; ii) ubiquitous or 1:1 computing using laptops or other computing devices; and iii) the impact of technological innovations in educational contexts. The synthesis conducted in this chapter reveals that: i) research regarding the use of netbooks by early adolescents has yet to be investigated; and ii) that research is yet to be conducted concerning the educational implications associated with varied patterns of access in a 1:1 environment, particularly in relation to the impact of these patterns on classroom environments.

2.1. Early Adolescents and Digital Technology: An Australian Perspective

In order to understand the influence of mobile technologies in the lives of early adolescents, and to contextualise this research, it is necessary to investigate the particular learning needs of early adolescent students. Adolescence was categorised as a distinct phase of life by G. Stanley Hall at the beginning of the 20th Century (Bahr, 2005). As noted in Chapter 1, for the purpose of this project, early adolescence is defined as the period from 10 -14 years of age (Carnegie Corporation, 1995). Two themes concerning early adolescence are elaborated upon here, namely digital culture, including media and ICT, and early adolescent education in the Australian context. These two themes are critical to the later learning experience of the students in the use of mobile technology in the research project.

2.1.1. Digital Culture, Media and ICT

In the first decade of the 21st Century, Australian early adolescent access to electronic media and ICT is commonplace. On average, according to the Australian Bureau of
Statistics [ABS] (2001), early adolescents spend more than six hours a day multi-tasking with an array of media, including television, video games, the Internet, mobile phones and instant messaging, and iPods or MP3 players. The largest single grouping of Australian Internet users is early adolescents (Aisbett, 2001). Snyder et al., (2008) surveyed over 2500 Year 10 students, regarding their use of technology at home and at school. They reported that nearly all students (98.4%) had computers in their homes, and most (93.4%) also had an Internet connection (dial-up 24.6%, broadband 72.1%). The majority of students had mobile phones (92%) and music players (88%). The picture that emerges from the range of data is of modern young people spending long hours at the computer, or using mobile technologies, and thus, limiting their time for human, real face-to-face interactions and, to some extent, discounting these (Donchi & Moore, 2004).

Regardless as to whether or not this increased ICT usage by adolescents is considered as being positive or negative, the reality is that adolescent use of ICT is characterised by increasing levels of mobility and global reach (Australian Communications and Media Authority [ACMA], 2007; Holmes & Russell, 1999). In this interaction with the global world via the Internet, adolescents are engaging with a range of cultural artefacts and establishing a sense of self-identity which is largely beyond the control of traditional institutions such as families and schools. Early adolescent use of technology influences the formation of adolescent identity and has profound implications for current educational practice (Holmes & Russell, 1999; Snyder et al., 2008) especially in relation to behaviour management and pedagogic practice (Carrington, 2006). This is because, in many instances, the students come from a non-school context where they determine where and when technology access occurs and for what purpose, to a school context where the majority of decisions regarding their technology use is made by their teachers.

2.1.2. Early Adolescent Education in the Australian Context

The nature of early adolescent ICT usage, and the widening gap between pre and post ICT generations has resulted in a “usurped information poor and the younger information rich” (Holmes & Russell, 1999, p. 3). This widening gap presents both challenges and opportunities for schools to respond so that school based student learning maintains its relevance to highly ICT literate early adolescents. It would
appear clear that the increasing array of knowledge sources and technologies, such as
the Internet, extensively used by students in the Middle Years (Snyder et al., 2008),
exerts a significant pressure on pedagogy and curriculum because the ways that these
students access and use information has changed (Bennett, Maton, & Kervin, 2008).

As a result of the rapid technological change which has occurred immediately
previous to and during their lives, the current generation of school students are
growing up more technologically literate than students their age were a decade ago.
Comparatively, early adolescents use computers and mobile technologies on average
more frequently, and for more than twice the duration outside of school than they do
in the classroom (Lee & Levins, 2010; Looms, 2002). In qualitative terms they use
ICT for a far broader range of tasks, and in a more creative fashion, outside of school
than they do at school with digital technologies becoming central to the
communicative, social and cultural lives of young people (Goggin, 2005), at least in
terms of their use of such technologies. The increased and often more creative digital
technology use by students at home challenges the relevance of technology use in
schools which is often limited to word processing and Internet searching (Coulter,
2001; Suhr et al., 2010) and limits the potential of the computers to enhance student
learning.

What are ‘new’ technologies to most adults have been largely ‘naturalised’ into the
world of early adolescents. These new technologies have a significant impact on how
young people form identity and cultural allegiances and on the ways they experience
school based learning. The background of these students, their interactions associated
with technology, and their cultural capital increasingly differ from those anticipated
by traditional classroom practice. Even though many students know and use these
technologies as integral parts of their lives, they learned to do so mostly outside of
school, with teachers struggling to integrate technology into the curriculum (Swan et
al., 2005). It is increasingly significant that the new digital technology skills and
knowledge of young people are surpassing those of many adults. This has profound
implications for classroom practices and curriculum design (Carrington, 2006)
including the continued professional development of teachers to integrate digital
technology into early adolescent classrooms and the need to restructure schooling to
better incorporate ‘blended learning’ (Traxler & Kukulska-Hulme, 2005) whereby curriculum content is made available to students both ‘face to face’ and online.

Early adolescent students are facing increasingly sophisticated literacy demands from new technologies, both in schools and in their home use of technology. These demands go well beyond those of the traditional printed page as they interact with information communicated through a range of digital media (Sarker & Wells, 2003). In a social context in which meaning is made through multiple forms of semiosis, understanding how people ‘read’, ‘write’ and ‘communicate’ using multimedia and online technologies is a key challenge for education (Atkinson & Nixon, 2005) which is still primarily structured around pen and paper technologies. Early adolescent students need to be provided with learning opportunities that include immersion / situated practice, overt instruction, critical framing and transformed practice where they create digital texts and use digital texts innovatively and effectively (Wells & Reynolds, 2005).

Schools need to make this ‘changing landscape of communication’ a legitimate context for learning and teaching and commence, or continue, the movement towards an online context for student learning. This requires paying greater attention to the screen as a new space of representation (Atkinson & Nixon, 2005) and to online worlds as an integral part of the communication webs in which early adolescents now participate. The challenges to student learning fostered by early adolescent exposure to digital technologies appear unlikely to be met without significant student access to mobile technologies in schools.

### 2.1.3. Early Adolescent Education: A Summary

In a society which is becoming increasing reliant on digital technology, early adolescents are increasingly comfortable and aware of the ways in which media and ICT attempt to situate and manipulate them. They are embedded in commercial and marketing discourses and practices which seek to construct them in particular ways. They both influence, and are influenced by, these discourses and practices. Many of these students display a strong proclivity for, and competence with, new media, particularly in the pursuit of leisure and cultural consumption (Luke et al., 2003). They are often familiar with digital modes of communication and are increasingly
able to express themselves and frequently make sense of their world through multiple modes: linguistic, visual, and audio (Hartnell–Young & Vetere, 2006).

Although digital technologies clearly have the potential to vastly transform relationships between teachers and students, and perhaps even transform what schools look like, the majority of schools have not yet been able to effectively come to terms with this aspect of early adolescent life and identity (Snyder et al., 2008). The history of education reform provides scant evidence that such a transformation will occur simply because the technology exists. Reforms that are adopted by schools tend to be those that readily fit existing organisational structures and practices (Doherty & Mayer, 2003; Weston & Bain, 2010). As previously noted, social connections with peers and significant adults are critical factors in the successful schooling experience for early adolescent students (Newhouse-Maiden, Bahr, & Pendergast, 2005).

This thesis argues that mobile digital technologies can create a bridge between the home-school experiences of early adolescents and can assist in the fostering of positive teacher–learner relationships (Bateman & Oakley, 2004) with resultant positive outcomes for student learning. Mobile digital devices with communication ability (for example, SMS, email, Bluetooth) are tools which can foster peer relationships and facilitate teacher/student and student/student communication in a non-threatening way (Davis, 2003) and become "cultural tools that help forge students’ identities and give rise not only to new behaviours and cultural experiences but also to new constructions of identity” (Albright et al., 2002, p. 3). The nexus between the needs of early adolescent learners and current mobile technologies is one which can foster positive student–teacher relationships and help diminish the disparity in the use of computing devices between home and school (Finger & Sun, 2010). Consequently, the focus here is to clarify whether the 1:1 availability of netbooks enhanced student learning opportunities and whether the netbooks are an appropriate device for early adolescent learners.

The literature examined thus far has indicated that many early adolescents are immersed in a digital culture outside of school and that there is a disconnection between their use of digital technologies between home and school. The following section investigates how mobile learning might be a way forward in minimising this
difference and also how school learning might take advantage of mobile technologies currently used by early adolescents.

2.2. **mLearning and Schooling**

A search of educational journals and educational databases failed to identify any scholarly research available on the educational uses of netbooks. However, a significant amount on the educational uses of handheld devices such as PDAs is available. That research focuses on the potential of these devices to i) encourage mLearning; ii) enhance student-student communication and collaboration; iii) foster the reshaping of school structures; and iv) their use as a 1:1 computing tool. These focuses are relevant here as they informed the decision to utilise netbooks as the mobile computing tool in this study.

mLearning is defined in the educational literature by, for example, Kinshuk (2005) “any service or facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless of location and time” (p. 1). Vavoula and Sharples (as cited in Kinshuk, 2005) indicated three ways in which learning can be considered mobile - “learning is mobile in terms of space; it is mobile in different areas of life; and it is mobile with respect to time” (p. 1). Scanlon, Jones and Waycott, (2005) suggest that mLearning can be defined as “any educational provision where the sole or dominant technologies are handheld or palmtop devices” (p. 2). Abernathy (2001) defines mLearning as

> the intersection of mobile computing and e-learning that includes anytime, anywhere resources; strong search capabilities; rich interaction; powerful support for effective learning; and performance based assessment (p. 1).

Mobile learning is thus characterised by two factors. Firstly, the learner is considered as mobile, and learning occurs wherever the learner is rather than predefining a specific place for learning as currently happens with school based education. Secondly, as the learning can occur anywhere, the onus is on schools to make available resources which can be accessed from any place at any time. These factors are elaborated upon in the *Emerging Technologies Report* (ACT, 2005) which
recognised that mLearning involves learning in the environment, community and workplace; learning directly in the course of real world engagement and in real world time frames; and requires students to interact with the digital environment through their hand-held devices, portable PCs, mobile phones, or GPS devices (Johnson, Levine, Smith, Smythe, & Stone, 2009; Snyder et al., 2008). From my experience and observations in primary schools, we still have a significant journey to undertake in order to engage students in learning which can be facilitated by their use of mobile technologies.

2.2.1. Handheld Digital Devices and their Educational Impact

A substantial body of research exists which outlines the potency of mobile devices to support student learning. Fung, Hennessy and O’Shea (1998) describe the potential use of handhelds as a ‘paradigm shift’ towards portable computing in education with the devices acting as a catalyst for interactive learning paradigms outside traditional formal learning settings (Schwabe & Go’th, 2005). Alexander (2003) presents two dichotomous educational approaches. One approach is the ‘traditional’ classroom which works largely on a two-step information access schedule (alternating between an isolated classroom and an out-of-class connection to the full world of information via libraries and the Internet). The second approach is a digital classroom with ubiquitous connectivity blurring the two-step modes, with always-on, connected learners accessing the internet on demand and collaborating digitally with peers (and teachers) at any time. Digitally rich classroom environments, such as those described here, also emphasise themes such as “mobility, interoperability, convergence, divergence, integration, richness of content, security, creativity, interactivity and collaboration” (ACT, 2005, p.11).

Whilst not necessarily endorsing the paradigm shift discussed above, other researchers believe that the ubiquitous use of a handheld wireless device has the potential to fundamentally change teaching and learning (Cochrane, 2005; Fung, Hennessy & O’Shea, 1998). Educational research regarding ubiquitous use of handheld devices has documented changes in pedagogy with teaching styles being more student-centred (Norris & Soloway, 2004); project oriented (Norris & Soloway, 2004; Swan et al., 2005) and more inquiry-based (Norris & Soloway, 2004). In each of the previous instances, the student is placed at the centre of the learning experience
rather than as the recipient of the learning. As is the case with ubiquitous laptop use, research into 1:1 use of handheld devices indicates that teachers are seeing the educational benefits of a more flexible organisation of classroom activities (Swan et al., 2005) which allows the students greater control over their learning.

In terms of specific effects on students, research has identified improved motivation by students who participated in activities with mobile tools (Swan et al., 2005; Vahey & Crawford, 2002) and engagement by students in these tasks (Russell et al., 2004; Swan et al., 2005). Students using handheld devices are also more independent in their learning (Swan et al., 2007) and work more collaboratively with other students and with their teachers (Fung et al., 1998; Sharples, 2000; Vahey & Crawford, 2002). However, it remains unclear whether the kinds of students who engage fulsomely with mobile technology would ordinarily be independent learners. A secondary consideration is that this research has yet to be conducted with netbooks which may be considered a hybrid between handheld devices used in the above studies and laptops.

2.2.2. Human / Computer Interaction with Mobile Technologies

The use of mobile computing devices such as netbooks, owing largely to their reduced size and increased portability, has the potential to encourage both collaborative and independent learning. In addition, it enables a “transition from the occasional, supplemental use associated with computer labs, to frequent and integral use of portable computational technology” (Roschelle, 2003, p. 260). This means that rather than irregular and isolated access to computers, the use of mobile devices places computing power and versatility of use into the hands of students. When coupled with access to wireless networks, opportunities for collaboration and communication are expanded (Grimes & Warschauer, 2008). Indeed, the emotional experience of using handheld technologies, due to their size and mobility, is more personal than the experience of using desktop computers and, as a consequence, usage of such devices increases (Alexander, 2004). Fairman (2004), reporting on her experience with the use of portable computing devices with adolescents noted that her students became very attached to their devices. She also reported that they significantly increased both the amount of writing as well as the creativity of this writing. It would seem that these
devices invite student engagement in ways that are not always available in school classrooms.

The particular affordances of mobile devices can change how students perceive the worth and limitations of the technology (Swenson, Young, McGrail, Rozema, & Whitin, 2006). The interaction between humans and tools is a central aspect of Activity Theory (Vygotsky, 1978; Wertsch, 1981) which claims that all human action is mediated by tools which may include technologies and artefacts such as the PDA or desktop computer; semiotic systems such as language including diagrams; social interactions such as those between student and class or student and class teacher and institutional structures such as school ICT policy (Wishart, McFarlane, & Ramsden, 2005, p. 7).

It would seem from the literature that the user of the device is the key determinant of the successful and innovative use of mobile devices. Although the qualities of the tool may encourage certain patterns of use, it is ultimately the user of the device who determines how the tool is used and whether the tool is useful and appropriate to their needs. Technology does not adhere in particular objects but, rather, objects acquire technological essence only when specific people envision, approach, or otherwise act toward those items as a means of accomplishing something (Schlosser, 2002). For instance, the potential mobility of the netbooks was not particularly utilised by the students in this study as the teachers directed that they were to be only used within the classroom on most occasions. The relationship between tool and tool user, and its implications for student interaction with the netbooks, will be further analysed in Chapter 3.

Although the research cited above indicates the potential of PDAs as an educational tool, their applicability in schools was problematic due to factors such as ergonomics, slow processing speeds, lack of educational software, compatibility problems with desktop software, and teacher unfamiliarity with the devices. However, whilst these remain significant obstacles to the use of PDAs, it is unclear as to whether these
factors will be obstacles to the use of netbooks in schools. Potentially, the use of small, mobile, computing devices can be a significant factor in allowing education to truly integrate ICT into teaching practice (BECTA, 2004).

mLearning appears to offer opportunities for learning that are not constrained by time or place. Although research in the use of handheld devices suggests that they can enhance student motivation and student engagement they have yet to be used more broadly in school classrooms. This may be due to the problematic features noted above. This research will contribute knowledge regarding the use of netbooks as an alternative computing tool to support student learning in schools which maximises the benefits of mobile devices but minimises the problematic aspects of their use.

2.3. Computers and Student Learning

Although a small number of laptop projects have been conducted in Australia (See Newhouse, 1997; Newhouse & Rennie, 2001), research regarding ubiquitous laptop use in Australian schools is still in its infancy. Much of the research available is based on the experience of American schools. Since the advent of the use of computers to support student learning in the 1970s, various purposes for implementing computing programs into schools have been proposed. These include: i) narrowing the digital divide (Gravelle, 2003); ii) improving the educational connection between home and school (Lee & Finger, 2010; Russell et al., 2004); iii) encouraging constructivist teaching practices (Fairman, 2004; Hartnell-Young, 2006; Rockman, 2000); and iv) specific improvement in targeted curriculum areas (Dawson, Cavanaugh, & Ritzhaupt, 2008/2009). These goals are still in evidence in 2010.

The most commonly cited outcomes of educational computing programs are increased use and proficiency with these devices (Penuel, 2006); positive effects on student motivation and improved attitude towards, and engagement with, schooling (Silvernail & Lane, 2004; Bebell & Kay, 2010); improved student writing (Gulek & Demirtas, 2005); and improved student organisational and study skills (Warschauer, 2006). Other factors cited as reasons for educational use of computers include: i) improved school attendance (Stevenson, 1998); ii) increased student autonomy (Dwyer, Ringstaff, & Sandholtz (1991); iii) development of independent learning skills (Means & Olson, 1995); iv) improved teacher-student relationships (Dwyer et
al., 1991; Fairman, 2004); v) enhanced interaction between students (Newhouse, 1997); vi) academic, social and emotional benefits for students with special learning needs (Harris & Smith, 2004; Hasselbring & Williams-Glaser, 2000); and vii) a movement towards student centred learning and project based teaching (Fairman, 2004).

In contrast to the studies mentioned above, other studies suggest that there are concerns regarding the use of computers in schools (Selwyn, Potter & Cranmer, 2009). Russell et al. (2004) and Newhouse (1998) argue that, despite the overall increase in the availability and use of computers in education, they are yet to be effectively integrated into the learning and teaching process. Students have been found to report minimal computer use each day (Russell, O’Brien, Bebell, & O’Dwyer, 2003), with teachers reporting that usage as being highly dependent on the curriculum area and specific learning activity (Newhouse & Rennie, 2001). Although the findings noted in the studies cited above suggest that student learning is enhanced by the use of computers in school learning environments, they also suggest that further research is required as to the most appropriate way to utilise these technologies to enhance student learning.

Possible explanations for this relatively slow uptake in usage, when compared to computer usage in many domains outside of education, and despite the significant reduction in student to computer ratios in many schools, are proposed by researchers in this domain. Firstly, the rise in availability of computers has not been accompanied by a comparative rise in teacher professional development (Moursund, 1999). Hennessy and Deaney (2004) report that teachers have only recently started to integrate computers into their own learning and teaching processes and have yet to embrace technology into their pedagogic practice. Secondly, although the ratio of students to computers has decreased, their distribution in many school settings does not afford student usage uptake. Many schools have established banks of computers in labs or in libraries making access to these computers a negotiated experience (Russell et al., 2004) and hence their availability to support student learning is competitive and contested. Under these circumstances, computers may not be available for use as an integral component of the teaching and learning process. This pattern of computer distribution is evident in the school at which the research was conducted. The school
has allocated three or four desktop computers for each classroom and maintains a dedicated lab with 32 desktop computers. Observations suggest that for many teachers at the school, ‘computing’ happens in the lab with the support of the school ICT technician and a number of staff have requested the establishment of a second lab.

Finally, a third explanation for the slow uptake of computer usage in schools is that the ratio of students to computers has not yet reached a critical mass, a level where the computers are pervasive or ubiquitous (Russell et al., 2004). Norris, Sullivan, Poirot, and Soloway, (2003) support a broad deployment of technology and argue that “a teacher’s use of technology for curricular purposes is almost exclusively a function of their immediate access to that technology (p. 25). The potential for computers to be useful in supporting student learning appears to be limited due to the lack of student access. This is the experience of many students at the primary school where the research was conducted where data suggested that access to computers was ad hoc at best and largely dependent on access to the lab. The following section examines whether the limitations of current computer use in school are overcome in a 1:1 computing environment.

2.3.1. Specific 1:1 Laptop Programs and Findings

From theoretical and educational perspectives, researchers have suggested that more widespread access to computers makes it possible for students and teachers in schools to move from occasional, supplemental use of computers for instruction to more frequent, integral use of computers across a multitude of settings (Roschelle & Pea, 2002). This is because teachers and students can begin to conceive of computers as a tool which is as available to use as pens, paper and desks in current school classrooms. Beyond facilitating more frequent use of computers in class, providing students with better access to computers can provide students with more equitable access to resources and learning opportunities (Penuel et al., 2001). Providing students with wireless enabled computing devices gives all students and teachers the ability to use up-to-date learning resources that before were available only to those who lived close to a library or benefited from school budgets that allowed for regular purchases of new textbooks (Penuel et al., 2001). However, the set of ideals noted above are a proposition to be investigated rather than an account of what is occurring in various classrooms operating under a range of different circumstances.
As was the case with non 1:1 computing programs, there are a range of goals for 1:1 laptop programs which are used to attempt to convince school boards, foundations, state legislatures, and others to pay for laptop computers (Lemke & Martin, 2004). These goals for 1:1 laptop initiatives have included improving access to computing resources for all students (Penuel, 2006); encouraging constructivist learning environments (Fairman, 2004); and the transformation of teaching practices through laptop programs and professional development (Dawson et al., 2008/2009). Many of the initiatives focus on “making instruction more ‘student-centred,’” that is, more differentiated problem- or project-based, and demanding of higher-order thinking skills” (Penuel, 2006, p. 335).

Zucker (2004) categorised the goals for 1:1 initiatives into one or more of four outcomes. These are: i) improving academic achievement with the use of computing devices; ii) increasing equity of access to digital resources and thus reducing the ‘digital divide’; iii) increasing the economic competitiveness of the educational region by preparing its students more effectively for today’s technology saturated workplaces; and iv) effecting a transformation in the quality of instruction by introducing ubiquitous access to computers. In short, these initiatives sought to address issues of achievement, equity, economic competitiveness or academic quality by guaranteeing 1:1 access. Advocates of intensive laptop programs have further claimed that 1:1 computing has the potential to transform education as we know it (Stager, 1995), while others see this promise as simply another ‘oversold’ fad that is at best a drain on the perpetually limited education budget and at worst a distraction that is actually detrimental to the students’ education (Cuban, 2006; Oppenheimer cited in Dunleavy et al., 2007; Jaillet, 2004). Whilst 1:1 programs have been introduced to support a variety of political, economic or equity agendas, what does the research suggest in relation to their impact on student learning?

### 2.3.2. Findings from 1:1 Computing Initiatives

As might have been expected, findings from research conducted in 1:1 laptop computing environments mirror many of the findings from non 1:1 computing contexts. These findings suggest that 1:1 computing leads to changes to pedagogy – more student centred approaches (Donovan, Hartley & Strudler, 2007; Swan et al., 2005; Zucker & Hug, 2008), flexible and constructivist teaching styles (Rockman,
2003; Zucker, 2004; Mouza, 2008), and delivery of learning episodes which are more project oriented and inquiry based (Swan et al., 2007). In regards to student learning, research has documented increased media literacy (Hill & Reeves, 2002; Rockman, 2003), improved writing (Gulek & Demirtas, 2005; Mouza, 2008; Ricci, 1999; Rockman, 2003; Russell et al., 2004), and, in some cases, increased scores on standardized tests (Gulek & Demirtas, 2005; Stevenson, 1998; Suhr et al., 2010).

In terms of a broader impact on student performance, other positive effects of ubiquitous laptop computing on students include increased motivation (Mouza, 2008; Ricci, 1999; Russell et al., 2004; Zucker & McGhee, 2005), improved student engagement (Cromwell, 1999; Rockman, 1998; Silvernail & Lane, 2004), decreased disciplinary problems (Silvernail & Lane, 2004), and improved school attendance (Stevenson, 1998). Students utilising 1:1 laptops were better organised (Lowther, Ross & Morrison, 2003) and more independent in their learning (Light, McDermott, & Honey, 2002; Ricci, 1999; Zucker & McGhee, 2005). Harris and Smith (2004) noted social and emotional benefits for special needs students who utilised 1:1 laptops and Hounshell, Hill and Swofford (2002) likewise reported on improved performance from minority students involved in a 1:1 laptop program.

The findings noted above suggest that computers, when accessed in the classrooms at lower student to computer ratios can have positive outcomes for students across a range of domains. What is critical for my context is whether these positive outcomes can be achieved at less than a 1:1 ratio and with netbooks rather than laptops used in the projects noted above.

2.3.3. Alternatives to 1:1 Computing

It is important that educational institutions expend their funds wisely. Budgetary realities often mean that schools have struggled and continue to struggle with the dilemma of providing increased cost effective and educational appropriate access to computing technology. Two alternatives appear to be apparent: i) increasing access to computers to achieve educational outcomes without initiating a full 1:1 program; and ii) using a computing device which is not as expensive as a laptop yet still provides appropriate computing power for, in my instance, early adolescent students. These two alternatives are addressed now.
As a means of increasing such access, without overstraining limited budgets, the sharing of laptop carts among multiple classrooms has become an alternative strategy for creating 1:1 access in classrooms on a temporary basis. Research into the effectiveness of such a strategy is still in its infancy and my research project adds to the body of knowledge in this particular domain. One study which attempted to determine whether varying the pattern of 1:1 usage affected student outcomes was conducted by (Russell et al., 2004). As this study was the first, to my knowledge, which focussed on the experience of the students using the laptops in various patterns of 1-1 access, and due to similarities between this study and my project, it is necessary to discuss the findings from this study in some detail.

Russell et al. (2004) examined how varying computer ratios in elementary classrooms might change the student experience of laptop usage. They studied two classrooms which were permanently equipped with 1 laptop for each student and five other classrooms that shared a cart of laptops to create a 1:1 laptop environment on a temporary basis (that is, these classrooms received the laptops for 1 week in every 5 week period) to determine the extent to which this strategy provided a computer-rich learning environment that was comparable to a setting in which students are provided with their own laptop on a permanent basis.

In brief, their research indicated that increasing the level of access to computers to the point where each student has his or her own laptop in school expectedly led to increased computer use; the magnitude of the difference in computer use was quite dramatic. Whereas students in the shared classrooms reported using computers during class time for between ‘15 minutes or less’ and ‘15 to 60 minutes’ a day, students in the 1:1 classrooms reported using computer between ‘1-2 hours per day’ and ‘over 2 hours per day’ (Russell et al., 2004, p. 318). The permanent 1:1 classrooms provided several advantages over the temporary 1:1 classrooms. In permanent 1:1 classrooms, students used computers more across the curriculum. The authors also noted that in the 1:1 classrooms, instruction was different as well; there was less large-group instruction than in the temporary 1:1 classrooms.
Despite being used in a supportive classroom environment and taking into account a relatively high access setting (that is, three desktop computers permanently in the room plus a cart of laptops brought into the classroom for a 1 week period once every 5 weeks) the quantum of student usage of laptops and other computers in the temporary access classrooms was barely affected (Russell et al., 2004). In contrast, in those classrooms with full access to laptops on a permanent basis, student use increased to a level that was likely to result in increased learning across a variety of curricular areas (Russell et al., 2004). As it is important for schools to understand the link between access and student usage, this research extends on the work of Russell et al. (2004) by establishing different patterns and lengths of access and investigates the impact on classroom environments which results from modified patterns of access. It also differs from the previous study as netbooks, rather than laptops, were used as the computing device for the students.

The second alternative available to schools to ensure the best educational outcomes in relation to available resourcing is the purchase of netbooks rather than laptops as they are less expensive computing devices. As noted in Chapter 1, my initial preference was for the use of PDAs as computing devices for students (Larkin, 2007) as they are also a cost effective alternative. Since then, I have continued to engage with the literature, in particular with published research involving 1:1 and mobile computing technologies, early adolescents and their use of digital technologies, and the impact of computers on classroom environments. Based on my analysis of continuing development in mobile technologies, I conclude that netbooks are the most appropriate computing device for my research project.

2.3.4. Netbooks as the computing device for this study

The following information regarding netbooks supports the above proposition. The term netbook was coined by Psion in 1999 as a generic term for small, portable computers with sufficient processing power for Internet and other core computing functions such as word processing (Montecillo, 2008). A netbook is a very small, light-weight, low-cost, energy-efficient device (Taylor, 2008) which is smaller than a laptop but larger than a handheld computer. On these devices, users are able to
complete tasks such as viewing standard definition video, browsing the Internet, using email, listening to music, editing photos, and using office productivity software (Chester, 2008). The netbook of choice in my research project is the Acer Aspire One. To ensure longer usage periods the basic model was upgraded to include a six cell battery which, when tested, comfortably lasted six hours. Netbooks differ from laptops in a number of ways. They are generally less powerful in terms of processing power and random access memory; they do not have a DVD or CD drives; and they can be purchased with Flash Drives rather than mechanical hard drives.

![Picture 1.1 Acer Aspire netbook utilised in my project](image)

Netbooks are envisaged as an introductory mobile computing device for early adolescent students and as a secondary device for students in senior secondary or tertiary education. As they are ideal devices for connecting to the Internet, students can use a netbook for online research, communication via email, social networking and productivity applications (Merritt, 2008). As a way of illustrating where I suggest netbooks are positioned in terms of educational contexts in general, and mLearning environments in particular, Keegan’s (2005) diagrammatic representation of eLearning and mLearning is adapted to incorporate the affordances of netbook computing devices (see Figure 2-1).
In positioning Functionality /Mobility and eLearning /mLearning on a continuum rather than as discrete constructs, as is the case in Keegan’s (2005) representation, it is argued that the eLearning /mLearning and Functionality /Mobility perspectives should be seen as relational rather than dichotomous. From this viewpoint, a desktop computer has limited mobility and high functionality and a mobile phone has high mobility and limited functionality. However, both devices have aspects of both perspectives. The use of netbooks in my research project still affords the positive aspects of PDA use, for example, mobility, sense of ownership, 1:1 access (Abernathy, 2001; Roschelle, 2003) whilst minimising many of the negative aspects of PDA use, such as small screen, input limitations, and limited functionality (Serif & Ghinea, 2005; Oliver & Barrett, 2004).

Although the potential cost saving was a consideration in deciding on the use of netbooks, it was not the decisive factor. In light of the earlier discussion regarding mobile devices use by early adolescents, my primary concern is the selection of a device which mirrors, as closely as possible, the digital technologies that early adolescents already use, for example, personal Digital Versatile Disk (DVD) players, touch screen phones, and palm sized entertainment devices such as Play Station Portable (PSP) without sacrificing the functionality provided by laptops. A key aim of this research project is to determine whether or not the type of computing device made available to the students, in terms of mobility, functionality, and ease of use, is instrumental in adolescent uptake of these devices. Consequently, it is necessary to
deploy a device which affords some of the qualities of digital devices already used by early adolescents.

In summarising the benefits of the netbooks, and thus accounting for my decision not to use PDAs, the following points are made. Netbooks offer a similar degree of mobility and sense of ‘personal ownership’ (Vahey & Crawford, 2002) as PDAs but significantly greater functionality. Due to high level of Home Computer / Internet Access for students in this project, it is considered unnecessary to purchase a device which needs to go home with the students each day. Consequently, the mobility advantage of PDAs as compared to netbooks is less critical. An initial attraction of PDAs was their cost advantage over laptops. Netbooks are an appropriate compromise and a ‘relative advantage’ (Roblyer, 2006) analysis indicated that for a similar price to PDAs more functional netbooks can be purchased. As noted earlier, research indicates that the use of PDAs in schools is problematic (Norris & Soloway, 2004) due to factors such as ergonomics and processing speed (Serif & Ghinea, 2005); availability of educational software (Norris & Soloway, 2004); and compatibility issues (Oliver & Barrett, 2004). Netbooks are more similar to the desktop and laptop computers that students and teachers already use thus minimising the amount of time teachers need to spend teaching students how to use the computing devices (Bick, 2005).

In 2009, a comprehensive database search for information relating to the use of netbooks in educational contexts was conducted revealing that substantial research determining the impact of netbooks in educational contexts is yet to be published. The initial search noted above was conducted using both ERIC and PROQUEST and the search terms used were ‘netbook’ and ‘netbooks’. This initial search retrieved 144 articles - all of which were business type reviews regarding processing power; cost versus benefit analysis; functionality issues; and how to maximise netbook performance. The same search terms retrieved no articles of a scholarly nature. Likewise, no articles have been published regarding netbooks in major journals such as the British Journal of Educational Technology (BJET), the Journal of Information Technology Education (JITE) or the Australasian Journal of Educational Technology (AJET).
2.3.5. Practical Classroom Considerations of 1:1 Computing

It has been noted that there are generally positive outcomes associated with laptop usage in classrooms, both in 1:1 and none 1:1 patterns of use; however, as yet no reference has been made in this thesis as to the challenges, both technical and organisational, which classroom teachers face in the implementation of 1:1 computing initiatives. The practical appreciation for the complexities and difficulties of implementation of educational technologies tempers some of the excitement about the potential of providing students with wirelessly connected laptops with claims that new technological innovations have proven unusable to a wide variety of teachers (Blumenfeld, Fishman, Krajcik, Marx, & Soloway et al., 2000). This can occur because schools lack the capacity to implement them well, policies are not congruent with technology use, and the culture of the school is not supportive of technology adoption. Problems with 1:1 implementation can be considered along two dimensions, one technical and the other organisational.

Technical issues regarding the use of the laptops can be summarised as those immediately resultant from the affordances of the actual device and then secondarily as a consequence of their deployment in schools. In terms of the laptops themselves, researchers have documented fragile or excessively heavy machines; limited desk space due to size of device; software deficiencies; data loss; unreliable Internet access; and infrastructure inadequacies as concerns accompanying 1:1 laptop programs. One of the most frequently observed challenge relating to laptop implementation is the problem of batteries (Hill & Reeves 2002; Lowther, Ross & Morrison, 2003; Rockman, 1997). Dunleavy et al., (2007) commented that, “invariably one to three students arrive to class without a functional computer because of a lack of charge” (p. 449). In practical terms, this mitigates against the potential benefits to student learning in a 1:1 computing environment much as arriving at what could be described as ‘traditional classrooms’ without a pen or paper would minimise learning in these classrooms.

The perceived negative features mentioned above may lead to an inconsistent approach to their use. Newhouse (1998) found that some students in his study left their laptop at home if they did not think it would be needed. Newhouse also reported
that many students preferred to use the school’s desktop computers because they preferred the colour screens, larger keyboards, access to the network and greater processing power and memory. However, more recent studies (Newhouse, 2008), indicate that the availability of more powerful laptop computers have resolved many of the issues noted above. The provision of the supporting technical infrastructure for a laptop program, including the availability of support for addressing problems as they arise, and the high level of maintenance costs (Newhouse, 1998; Zucker & Hug, 2008), are also significant factors in computer use in the classroom (Zhao, Pugh, Sheldon & Byers, 2002).

As the majority of laptop programs now involve access to the internet and other file sharing processes, such as printing, and blogging, the reliability of the network is frequently an issue and a barrier to widespread use by teachers for instruction (Hill & Reeves, 2002). The issue of extrinsic barriers to computing use, such as hardware, software, technical support and network speed are identified by Ertmer (1999) as First Order barriers. It appears clear that technical issues need to be addressed if 1:1 computing is to deliver on its potential to enhance student learning.

2.3.6. Human Agency and 1:1 Computing

The delivery of a robust technical infrastructure is, of itself, no guarantee that computers will be integrated into the curriculum. Penuel (2006) noted that even the perception among teachers that there may be limited access to timely technical support from school-based or district staff is enough to hinder their computer usage. It appears, therefore, that even when the technological issues accompanying a 1:1 computing program are addressed, significant impediments to a successful laptop implementation relate to teacher concerns in utilising the computers. These perceived concerns are often intrinsic and are referred to in the literature as Second Order barriers (Ertmer, 1999). Second Order barriers relate to the individual ways in which teachers approach the use of technology in their pedagogy.

Research into specific technological innovations seems to suggest that many teachers experience difficulty in implementation (Franklin, 2007), particularly in relation to the implementation of 1:1 computing strategies. Teacher concerns regarding such innovation appear to cluster around the two themes of curriculum and behaviour
management. Significant barriers to computer use in elementary American schools, as perceived by the teachers, include: (i) too much curriculum to cover; (ii) lack of time in daily schedule; and (iii) high stakes, standardised testing. These factors are evident in the comments of the teachers in this research. Other perceived barriers to the successful use of laptops include an anticipated increase in teacher workload (Zucker & McGhee, 2005) and concerns related to how their teaching will need to be adapted to effectively utilise the computers (Penuel, 2006).

Perceptions regarding the usefulness of the laptops in achieving curriculum outcomes was a determining factor in student computer use for some teachers with Sarama, Clements and Henry (1998) suggesting that a misalignment between curriculum and technology resulted in the diminished use of technology. Individual teacher characteristics also impact on the level of implementation and include their pedagogical approach (Watson & Tinsley, cited in Penuel, 2006), their confidence or feelings of preparedness to use computers (NCES, 2000), their subject-matter expertise (Penuel, 2006), their ability to link laptop use to learning outcomes and standards (Newhouse 2001), and their level of Technological, Pedagogical and Content Knowledge (TPACK) (Mishra & Koehler, 2006). It appears that the teachers who most utilised the laptops were those who leant towards constructivist pedagogy (Becker, 2000; Vannatta & Fordham, 2004), and those who were open to change regarding their teaching philosophy and beliefs (Vannatta & Fordham, 2004).

As reported earlier, it might be that the use of laptops in classrooms would have a healthy effect on classroom management because of its positive impact on motivation (Ricci, 1999; Russell et al., 2004; Zucker & McGhee, 2005), and student engagement (Cromwell, 1999; Rockman, 1998; Silvernail & Lane, 2004). However, a number of studies (Newhouse, 2001; Hill & Reeves, 2002) have indicated that, at least from the teachers’ perspective, the advent of 1:1 computing has negatively impacted on the classroom environment in terms of an increase in management problems. Dunleavy et al., (2007), quote one teacher in their study who explained that the presence of laptops “raises the management to a whole other level, if you let it” (p.449). Their study further identified significant examples of teachers unable to successfully manage the 1:1 computing environment “in this environment, if the teacher does not have strong
class management skills, the computers simply add another layer of management complexity that is possibly overwhelming” (p. 449).

This increased teaching complexity is also reflected in a study by Mathiasen (2004) on the impact of student laptop use on teachers in Danish schools, which included the following extract from a teacher in the study

It is a shocking experience to come into a classroom and realise that because of the presence of the laptops, one has lost every fixed point one had as a teacher. There is no eye contact, the students are not all ready to be taught, one is interrupted by technical questions, teaching the subject takes at least twice the time, and one is no longer the students' sole source of communication because it now takes place over the Internet. (p. 284)

The experience of the teachers in the study by Mathiasen (2004) was similar to the experience of the four teachers in this research who all noted significant concerns regarding their position as ‘teacher’ when the students were using the netbooks. Lei & Zhao (2008) reported that 39.3% of the teachers they surveyed “believed that it had become harder for their students to concentrate in class after receiving the laptops, because the students were distracted by the Internet, email, games, music, and so on” (p.116). Interestingly enough, however, the students surveyed in the same study were more optimistic about their ability to deal with potential distractions as “most of the students (83.9%) did not agree that laptops posed distractions to them in class” (p.116). It is apparent from the literature that the extent of human agency exhibited by the teachers is a significant element in the success of 1:1 computing (Lee, Finger & Lewis, 2010).

In recognising the impact of human agency on the success of technological innovations in schools, I am not, however, positioning the individual in a workspace in opposition to the social practice evident in the worksite as “individuals are socially shaped, albeit uniquely through an idiosyncratic set of experiences” (Billett, 2006, p. 14). Rather, the suggestion is, that in order to understand the success or failure of
technological innovations in schools, a relational approach is taken which recognises that the teachers, who are largely responsible for the implementation of the innovation, are shaped both by the institutional ‘social capital’ of the school as well as their own vocational practice. The presence of 1-1 computing may exacerbate the tension between what is expected by the school and what is held to be appropriate teaching by the individuals tasked to deliver the innovation.

The individual vocational practice of teachers largely determining the successful implementation of ICT, of which 1:1 computing is a component, in their classrooms is characterised by Mishra and Koehler (2006) as involving three domains of knowledge – Content, Pedagogical and Technological. A schematic representation of these domains and their interrelationships is shown in Figure 2-1.

In this schema, teachers are identified as autonomous agents with power to significantly influence the appropriate integration of ICT into education and to transform the learning experience of students. Mishra and Koehler (2006) suggest that to successfully integrate ICT into classrooms involves the three domains of teachers’ knowledge: i) knowledge of the curriculum content which the students are required to learn; ii) knowledge of age appropriate ways in which to teach this knowledge; and iii) knowledge as to how technology may be used to facilitate this process. Jamieson-Proctor, Finger and Albion (2010) note that teachers are well equipped to deliver
curriculum content in pedagogically appropriate ways and, thus, demonstrate what Shulman (1987) described as Pedagogical Content Knowledge (PCK) but suggest that the Technological Knowledge (TK) component of TPACK may be less strong. They suggest that this lack of Technological Knowledge is relevant to current teachers as well as pre-service teachers in various teacher education pre-service programs.

A lack of Technological Knowledge was identified by the four teachers in this study as a key limiting factor in the use of the netbooks. The acknowledgement by the teachers that they lack Technological Knowledge has implications for the learning of students, particularly in light of the deployment of significant numbers of computers into these classrooms. These implications include the use of computers to enhance creativity and thinking skills (both required by the National Curriculum), the opportunity to use the computers across a range of Curriculum areas rather than just for word processing, and the use of computers to foster greater home-school links so that students can continue their learning online at home.

2.4. A Diagrammatic Representation of Key Elements from the Literature

This chapter has argued that there are relations amongst a range of elements involved in student learning: between the students' lives outside of school and what they do in school, between the environment and students, between teachers and students, and between students, teachers and mobile ICT. Figure 2-2 is suggested as a way of representing the interplay between students, teachers and the technological environment and answering the question, ‘What does this do to student engagement and their school based learning?’
Figure 2-2 Contextual factors affecting student learning and engagement

Figure 2-2 is a visual representation of the major themes from the Literature which relate to the research problems posed in this research project which seeks to address the issue of 1:1 computing and student learning. The three fundamental elements which emerge from previous research in relation to ICT use in schools are student experience and readiness to engage with ICT, teacher readiness and experience to engage with ICT and the classroom ICT environment. This chapter concludes with a summary of what the research indicates in relation to these three elements and proposes that it is the relations between these elements which impact on the learning and engagement of the students in the classrooms.

Engagement with the literature indicates that 21st century early adolescents are immersed in a rich digital environment at home and that access to computers, mobile devices and the Internet is common. The literature suggests that engagement with ICT is critical to the development of self-identity and that ICT is a fundamental component of the social networks that these early adolescents form. It is also evident in the research that there is a widening disconnect between access to ICT at home and
access at school and that this widening gap is detrimental to the educational
development of these early adolescent students. In short, many early adolescents are
highly equipped for learning supported by ICT.

In contrast, it would appear from the literature that many schools are not well
equipped, either in terms of human or technical terms, to take advantage of the
potential of ICT. As far as human agency is concerned, this thesis has suggested that
the Technological Knowledge component of the teaching practice of many teachers
needs to be enhanced to utilise ICT in classrooms to support learning. In addition, the
philosophical and pedagogic beliefs of teachers regarding the value of, and concerns
around, the integration of ICT largely mitigate against increased ICT usage. The
classroom ICT environment is also critical to the learning experience of the students.

The literature suggests that the use of mobile computing devices and access to these
computers at or near a ratio of 1:1 may minimise current obstacles to minimal
computer usage. This thesis examines the interplay of the three factors mentioned
above, that is student readiness, teacher agency, and classroom ICT environment, to
clarify the potential of 1:1 mobile computing for student learning. As a researcher, a
multitude of theoretical lenses (for example, ethnography, phenomenology, critical
typeology) through which to investigate a problem, are available for me to use to
understand the phenomena under investigation. Chapter 3 proposes a
conceptualisation of how various factors, such as these noted above, can explain the
attainment of a goal or motive – in this case student learning.
Chapter 3. Understanding Mediated Action through Activity Theory

In the previous chapter, it is argued that the enhancement of learning for early adolescent students is premised on a complex of factors comprising: i) students’ home experience with computers and their general readiness to engage with technologies both online and via the use of mobile technologies; ii) the readiness of the teacher to utilise newer technologies and their pedagogic ability to do so; iii) the infrastructure of the school to support newer technologies which includes the frequency and ease of access to computers. This set of factors and the relationships amongst them, need to be understood through conceptual premises that are able to explain these factors, the relation between these factors, and how these factors coalesce to improve student learning.

As indicated in Chapter 1, Activity Theory is the conceptual and methodological framework underpinning this research project. This chapter engages with the academic literature that pertains to the historical and conceptual development of Activity Theory. It explores the principles underpinning Activity Theory, particularly tool use and the place of human agency in a socio-cultural theory and discusses varying perspectives of the theory in terms of three generations (broadly delineated by the work of Vygotsky, Leont’ev and Engeström). The chapter concludes with an evaluation of the utility of Activity Theory as a conceptual framework and methodological tool appropriate for research in educational contexts.

3.1. Activity Theory

Activity Theory is a commonly accepted name for a line of theorising and research initiated by the founders of the cultural-historical school of Russian psychology, Lev Vygotsky and Alexie Leont’ev (also spelt as Leontyev, Leontjew and Leontiev), in the 1920s and 1930s (Engeström, Miettinen & Punamaki, 1999). Activity Theory is an approach that aims to understand individual human beings in their natural, daily circumstances. This understanding occurs through an analysis of the genesis, structure, and processes of their activities. The meaning of the term activity, as it is used in Activity Theory, is derived from the Russian concept of deyatelnost (Leont'ev,
1981) which refers to physical labour, mediated by tools. The notion of activity was later expanded to include mental actions, such as remembering and reflection rather than solely material tools of work (Gordon, 2006).

The central concept and basic unit of analysis of Activity Theory, as expected, is activity (Kaptelinin & Nardi, 2006). An activity is a coherent, stable, relatively long-term enterprise directed towards a specific goal or ‘object’. In this particular case, it refers to how the activity of teaching, the involvement of the students in classroom activity, and the engagement of both teachers and students with netbooks is generative of productive learning. In defining Activity, Vygotsky (1978) emphasises the individual, Leont’ev (1981) emphasises the individual in activity and Engeström (1987) emphasises the individual within an activity system. Regardless of the emphasis, human activity is always oriented to the achievement of goals and motives (Nardi, 1996a) and in this sense activity implies an action done in order to transform some object Engeström (1999).

Activity Theory maintains that no properties of the subject and the object exist before and beyond activities. Activity is understood as a purposeful interaction of the subject with the world, a process in which mutual transformations between the poles of ‘subject – object’ are accomplished (Kaptelinin & Nardi, 2006). Hence, through classroom activity, students and teachers purposefully interact with the computers to accomplish learning. Activity is considered the key source of development of both the subject and the object and, as the unit of analysis, provides a way to understand both subjects and objects. Critically, this understanding cannot be achieved by focusing on the subject or the object separately (Kaptelinin & Nardi, 2006). The relationship between the subject and the object is mediated by a tool, which is at the same time both enabling and limiting “it empowers the subject with the historically collected experience and skills ‘crystallised’ in it, but it also restricts the interaction to be from the perspective of that particular tool or instrument” (Kuutti, 1996, p. 27). Here, the tools are the computers which students use to both enable, and in some instances, limit their learning. The restriction of potential interaction is considered a significant limitation of Activity Theory by Daniels (2008) who argues that the inherent historicity of tools can limit opportunities for growth as current practices are ‘tied’ to historical patterns of activity. This is an important consideration, particularly for ICT
innovations in schools, which may need, in many instances, to overcome traditional models of schooling and historical forms of pedagogy perhaps better suited to older and earlier forms of tools such as pen, paper, textbooks or chalk.

3.2. Activity Theory Principles

An appropriate way of characterising Activity Theory as a meta-theory is via the presentation of a set of principles. These principles will form the framework to understand Activity Theory as it has developed through three generations and might be advanced in the future. This summary of principles is based on the work of theorists such as Cole (1999), Kaptelinin (1996), Kuutti (1996), and Wertsch (1981), as well as the doctoral work of Gordon (2006), Vrazalic (2004) and Young (2005).

The following principles are equally important and cannot be understood in isolation from one another:

• Activity is historically, culturally, and socially mediated.
• Activity is mediated by tools, both physical and psychological.
• Human goals and motives direct all activity / activity systems.
• Knowledge is developmental at both the societal and individual level and its learning proceeds from the external to the internal.
• Activity is the basic unit of human analysis. This activity occurs at different hierarchical levels.
• Human consciousness is inseparable from activity.

These principles, when viewed in their totality, suggest that all activity has a historical, cultural and social genesis, and are engaged with and enacted upon by individuals and groups of individuals for purposes that are both social and personal. Individuals are therefore engaged in a meaningful process of selecting or rejecting activities that are reflective of their particular goals and motives at a particular point in time.

3.3. Conceptualising Activity Theory

Activity Theory has been variously conceptualised as a tool, a framework, or a set of principles. Kuutti (1996) states that activity theory is not actually a theory as such because it is not “a fixed body of accurately defined statements” (p. 25). Waycott,
Jones and Scanlon, (2005) suggest that Activity Theory is a collection of broadly defined concepts that are open to interpretation. Even for Vygotsky (1978), Activity Theory is neither a theory as such, nor a research method, but a way of understanding human conceptions in context. Its central challenge is "understanding the interpenetration of the individual, other people, and artefacts in everyday activity" (Nardi, 1996b, p. 8). Jonassen and Rohrer-Murphy (1999), Kanes (2004), and Kuutti (1996) all view Activity Theory as a well established philosophical and cross-disciplinary framework which is useful for studying different forms of human practices from a cultural historical perspective which links both individual and social elements. Activity Theory integrates multilevel perspectives on human activities within a single conceptual framework. Kanes (2004) goes on to add that Activity Theory further explains the “relations between human individuals” (p. 266). These relations are mediated by cultural artefacts, both physical and psychological, which are themselves the product of previous activities. Hence, by identifying these two kinds of mediating factors, which by their very nature means they form a basis for understanding negotiation of meaning also emphasises their relational processes and legacies. All of this is helpful when seeking to understand how individuals engage in and learn through environments that have a range of socially mediating entities, such as teachers, peers, and artefacts such as computers.

Despite the various ways that Activity Theory is conceptualised, a fundamental consideration in understanding this meta-theory is that it is based on socio-cultural and cultural-historical epistemologies which postulate that humans live in an environment where the objective features of their responses/actions in the environment are culturally and historically shaped. It posits a systemic view of human behaviour in which an individual’s goals and subjective perceptions are interwoven with socio-historical factors (Gordon, 2006). Activity Theory is, therefore, a complex conceptual framework that has evolved historically, and continues to evolve as it is applied in research and in practice. Because it encompasses both human partners and socially derived tools, such as computers, it offers significant promise for understanding the ways in which students in schools engage with and learn through the use of computers.
3.3.1. Historical and Philosophical Underpinnings

Activity Theory owes its genesis to a line of theorising and research initiated by the founders of the cultural-historical school of Russian psychology in the 1920s and 1930s and the work of this school was largely based on Karl Marx's theory of dialectical-materialism (Sharpe, 2003). According to Groves and Dale (2004), Activity Theory evolved from the German philosophy of Kant and Hegel (which emphasised both the historical development of ideas as well as the active and constructive role of humans), the more contemporary philosophy of Marx and Engels, and the cultural-historical psychology of Vygotsky (1978) and Leont'ev (1981). Its heritage therefore emphasises the agentic action of humans actively involved in shaping their environment but at the same time being shaped by such norms, forms and practices that constitutes the physical and environment where that activity is enacted. However, the key essence of an educational interest in activities is that there is a cognitive legacy: learning that arises through these activities. Hence, and because of this, it is important to understand the relationship between human consciousness and activity.

3.3.2. Consciousness and Activity

Activity Theory is held as a social theory of human consciousness, construing consciousness as the product of an individual’s interactions with people and artefacts in the context of everyday practical activity (Kaptelinin & Nardi, 2006) and suggests that conscious learning emerges from activity, not as a precursor to it. For example, it would suggest that, in the action of using computers, specific and context specific learning occurs and that this learning is a consequence of their engagement in this specific activity rather than merely as a consequence of the completed task. It thus provides a way of viewing human thinking and activity (Jonassen & Rohrer-Murphy, 1999) which differs from a Cartesian views of consciousness which, in its early forms, emphasise a separation of mind and body (Thompson, 2004) or a Piagetian perspective which is held by some to view the individual as pre-existing in a context and developing along a linear path in response to the demands of a complex environment (Engeström, 1996). Indeed, it is this relationship between the individual and the social world which makes it potentially useful to understand learning that arises in classroom settings.
The ontological relationship between activity and consciousness is a key quality of Activity Theory and one which has significant implications for understanding learning and teaching. This is because consciousness is held not to be a set of discrete, disembodied acts that are regulated by executive control mechanisms, but rather a phenomenon that unifies attention, intention, memory, reasoning and speech (Vygotsky, 1978). Because consciousness is integrated with the wider activity system that surrounds an individual’s activities, changes in the physical, mental, or social conditions of a person’s situation are internalised and directly reflected in the person’s conscious activities (Jonassen & Rohrer-Murphy, 1999; Nardi, 1996b). Nardi (1996b) extends the concept of consciousness “past an idealistic, mentalistic construct in which only cognitive resources and attention 'inside the head' are at issue, to a situated phenomenon in which one's material and social context are crucial” (p.18). In this understanding, “consciousness doesn’t exist situated inside the head of the individual but in the interaction - mediated by activity - between the individual and the objective forms of culture created by the labour of mankind” (Miettinen, nd, p. 2). It is the degree to which the subject is considered as equivalent to the social that is a source of some tension in determining the appropriateness of Activity Theory, to understand individual student learning in a social environment such as classrooms.

3.3.3. Activity as Mediated by Tool / Artefact Use

As a meta-theory, Activity Theory presupposes that all activity is mediated and all human experience is shaped by the culturally defined tools and artefacts we use (Nardi, 1996b). An activity always contains various artefacts (for example, instruments, signs, procedures, machines, methods, laws, forms of work organisation) through which actions on objects are mediated. So, for example, students use computers to create a digital presentation to demonstrate their understanding of a curriculum concept. These activities are not static or rigid entities but are under continuous change and development. This development is not linear or straightforward but uneven and discontinuous. Artefacts themselves are created, manipulated and transformed during the development of the activity and carry the historical residue of their development (Kuutti, 1996). For instance, a common student task is the production of a report. The use of the computer transforms the completed report (through the availability of digital images and text manipulation) but at the same time the historical structure of the report genre limits the potential of the
computer (for instance, the report must be text-based; no multimedia). These artefacts reflect the experiences of people who have tried to solve similar problems at an earlier time and reflect similar events. Tools in this respect can be seen as artefacts of design, initially invented, and then modified, re-modified, and potentially replaced, to make an activity more efficient (Meloche, 2006). This is clearly the case with computers which have been, and continue to be, modified to make activity more efficient.

Tools (both internal and external), suggest modes of operations; are historically developed; and possess an evolutionary cultural component. In Activity Theory terminology, these instruments of labour, (tools or artefacts), are seen to be both an articulated accumulation of social experience and knowledge, and also a cultural source of transmission of this accumulated knowledge (Meloche, 2006). Tools affect not only our external physical activity, but also our internal mental activity. The crucial nature of tool mediation in Activity Theory is indicated by Wertsch (1981) “It is not that activities could be carried on without them or that they make actions easier, but that they allow and even lead to the creation of types of activities that would not otherwise exist” (p. 26).

All human development is assumed to be enabled and constrained by tools. Their use both mediates and is mediated by our social world and by the cultural history embedded in the tool itself (Wertsch, 1981). Tools import history into person-goal relations, carrying a configuration of resources that both enables a task to proceed, and constrains its possibilities (Roschelle, 1998). For example, teachers may constrain the potential of computers to engage students in learning by limiting their use to the typing up of pre handwritten pieces of student work. The sets of technological tools currently available are ones that have been created for us in response to a previously perceived need or goal (Dourish, 2006). Although all individuals are affected by the historicity inherent in tool use, it is incorrect to assume that this influence is uniform throughout a collection of individuals (such as a classroom). In other words, although computers carry a collective history, each individual within the classroom brings their own history with computers and this affects their usage of computers. In this study a range of perspectives existed regarding computers including their use as productivity tools, or tools for social activity or tools for collaborative work.
3.3.4. Human Agency in a Socio-cultural Context

Whilst clearly a socio-cultural framework, the recognition of human agency remains a key component of Activity Theory. Activity Theory has a strong notion of the individual and theorists within this tradition believe that human beings are not merely at the mercy of extant institutional contexts, but rather that humans are endowed with the power to act (agency), which allows for critique and revision of the contexts in which an individual operates (Roth & Lee, 2007).

Regardless of its relative position, the emphasis on the key role of human agency is a fundamental ontological assumption made when selecting Activity Theory as an appropriate conceptual and methodological framework to understand students and computers. Activity Theory resists the temptation to anthropomorphise artefacts as agents, “People have goals, whereas artefacts merely mediate” (Roschelle, 1998, p. 244). This suggests that it is not sufficient simply to consider a social setting as a social system that is generative of activities, but to consider how individuals elect to engage with those activities, and for what purposes.

In this way, although Activity Theory is premised upon a social / cultural / historical frame, the individual is not reduced to society or culture. This relationship between an individual and their society, in terms of the agency of the individual, can be misunderstood or misinterpreted as providing a deterministic model of individual development that perceives individuals as produced in somewhat of a societal assembly line governed by the current needs of society and the pervasive power of social suggestions and social norms. This understanding is not an accurate reflection of the cultural-historical tradition which, from its genesis, has focused on interactions between persons and between people and their environment. This is evidenced in Vygotsky’s (1978) proposal of the zone of proximal development which accredits individual growth in the presence of a significant adult or peer (Hedegaard, Chaiklin & Jensen, 1999). To summarise, activity is social in nature, mediated by tools and directed via the active agency of humans.

In order to elaborate the potential contribution of Activity Theory to understanding students and computers in schools, it is possible to identify particular contributions
that have arisen across the development of this theory, and further, to discern the particular contributions that have come from each of three generations of Activity Theory. Elaboration of the contributions will be made in relation to the use of computers in classrooms.

3.4. **First Generation Activity Theory**

The following sections examine Activity Theory according to what are broadly considered as three ‘generations’ and which primarily chart the major contributions of Vygotsky, Leont’ev and Engeström (Coupland, 2004). It is necessary to note that the use of the term ‘generations’ is not pejorative and does not imply that the 2nd Generation is better than the first or that the 3rd is better than either the 1st or 2nd. As noted, each of the generations, as they are categorised here, exist in their own right, and can be used to understand various aspects of activity. In this thesis, examples will be provided which illustrate their usefulness in understanding how computer use by students can enhance learning. As each of the generations is discussed, examples will be provided to indicate their potential usefulness in understanding computer mediated activity. The term ‘generations’ does, however, imply that there are conceptual similarities between how different theorists have used activity theory to understand socio-cultural contexts.

The key theorist in 1st Generation Activity Theory, and the theorist perhaps most familiar to Western educationalists, is Lev Vygotsky (Gordon, 2006). The term Activity Theory, although clearly retrospective as it was coined after his death, has come to be understood as encompassing Vygotsky’s earlier work, particularly those conceptualisations which relate to cultural-historical psychology and to his theories about the cultural and historical context of human development and interaction.

Vygotsky was concerned with developing a theory of psychology that would explain “the way natural processes such as physical maturation and sensory mechanisms become intertwined with culturally determined processes to produce the psychological functions of adults” (Vrazalic, 2004, p. 96). This means that as early adolescents use computers in culturally controlled environments such as classrooms, the cultural processes which direct classrooms become entwined with the natural process of maturation. Vygotsky saw natural processes as being socially and
culturally situated and that these processes are achieved by subjects who use a variety of tools (via language, concepts or material artefacts) to construct meaning and ‘ways of knowing’ that are relevant to the society in which they live (Clarkin-Phillips, 2007). Vygotsky extended the concept of tool mediation to include the use of signs as mediating factors. Like other tools used by humans, signs, are historically and culturally bound and change over time. The mechanism of individual developmental change is, therefore, seated in the development of society and culture (Gobbin, 1999).

Two key Activity Theory contributions of Vygotsky relate to mediation by psychological tools and the process of internalisation. These two key contributions are now elaborated.

Vygotsky’s concept of what constitutes a tool extended to cognitive processes, including psychological tools such as speech and semiotic systems (Gordon, 2006). He proposed that the relationship between human agents and the environment is mediated by physical tools (such as computers, calculators or blackboards), symbolic tools (such as language, mnemonic techniques and decision-making procedures) and cultural means (Vygotsky, 1981). Vygotsky viewed language as the most significant of all psychological tools (Suratmethakul, 2005) and both thought and speech were deemed as ‘Meta-tools’ or instruments involved in the carrying out of actions.

Vygotsky’s second key contribution was his theorising of consciousness and internalisation. His important insight into the dynamics of consciousness was that it is essentially subjective and shaped by the history of each individual’s social and cultural experience (Vygotsky, 1978). Consciousness, according to Vygotsky, is constructed through a subject's interactions with the world and is an attribute of the relationship between subject and object. It is neither reducible to behaviour not separate from it, but instead is an attribute of the organisation of practical activity (Coupland, 2004). Consequently, according to this view of Activity Theory, individual development advances through the process of internalisation. Internalisation is defined by Verenikina and Gould (cited in Coupland, 2004) as “the transition in which external processes with external, material objects are transformed into processes that take place at the mental level, the level of consciousness” (p.17).
Vygotsky was concerned primarily with how children internalise certain features of activities that are social and cultural in nature (Coupland, 2004) and believed that higher mental functioning is enabled through interaction between children and adults (Sharpe, 2003) in a socio-historical context. In this way, the contributions of and relations between tools and consciousness are helpful in providing explanatory bases for understanding classroom activity, including tools comprising computers and the legacy of students’ consciousness when engaging with them. As a psychologist, much of Vygotsky's work was oriented towards the individual, and even though he situated the development of the mind in a socio-cultural context, he did not incorporate collaborative aspects of human behaviour.

Consequently, in terms of this research, 1st Generation Activity Theory is particularly useful in investigating the individual experience of students as they engage with the netbooks to support their own learning and how their use contributes to the development of individual mental models. It also assists in determining the influence of the teacher and their peers, again mediated through computer use, and how such computer use supported individual student learning.

3.5. Second Generation Activity Theory

It was Vygotsky’s student, Alexei Leont'ev, who formalised Activity Theory and expanded it by making a distinction between individual actions and collective activity (Vrazalic, 2004). Leont'ev's work is encapsulated in 2nd Generation Activity Theory. Wertsch (1981) identifies Alexei Leont'ev as the figure most responsible for consolidating and integrating the ideas of Vygotsky into what is now known as the theory of activity. Leont’ev made historically evolving, object-practical activity, the fundamental unit for analysis.

3.5.1. Goals and Motives

For Leont’ev, goals and motives are the driving force for activity; they distinguish human activity from non-human activity and result in the transforming of an object into an outcome over an extended period of time (Kuutti, 1996). Leont’ev characterised human motives and consciousness as culturally and historically developed, and thereby qualitatively different from the motives of animals. The object of an activity is its ‘real motive’, whether material or ideal, real or imagined and all
activity is purposeful and goal oriented. Leont'ev proposes that all collective activities are directed towards a single object. In this project, students used the computers to work ‘individually’ on aspects of a design challenge which were then meshed with the work of other students to produce a collaborative outcome. The motive energises the activity, and arises out of a need experienced by an individual or a group of people. Because of the nature of shared work, individuals who are participating in the same activity may be performing actions that are not directly aimed at achieving the object that motivated the activity, for example, the aim of a group of hunters is to capture animals. However, certain members of a group may have the job of chasing animals away from themselves (but towards other members of the group). In an education context, the group task may be to use computers to create a digital movie but certain members of the group may be prevented from using the computer and instead are directed to making the props.

Leont’ev’s understanding of activity is encapsulated in the following model (see Figure 3-1). The primary focus of activity is the production of some object. The tools can be anything used in the transformation process (physical, such as pens or computers or mental, such as models or heuristics). The tools alter the activity and are, in turn, altered by the activity (Jonassen & Rohrer-Murphy, 1999). Although the triangle model presented appears somewhat rigid, activities are not conceived as given or static entities, but dynamic ones; activities are always changing and developing (Kuutti, 1996).

![Figure 3-1 Leont’ev’s Basic Model of Activity (Engeström, 1999, p. 30)](image-url)
What is being proposed in this diagram, and in the proceeding paragraphs, is that in order to understand classroom environments it is necessary to understand the activity in the classroom. In turn, this activity needs to be understood in relation to the motive (extrinsic and intrinsic) that is directing the activity. Furthermore, the activity can be encapsulated in terms of a subject or a group of subjects achieving an object mediated by a tool or artefact. In this thesis, this translates to understanding how students use the netbooks to produce a digital movie to demonstrate their curriculum knowledge.

### 3.5.2. Collective Activity

Another key point of difference between Vygotsky and Leont’ev is the positioning of activity as individual or collective. For Vygotsky, activity was primarily an individual experience situated in a social context. For Leont’ev, activity itself was a collective experience and little, if any, meaningful activity was accomplished individually – “The human individual’s activity is a system of social relations and does not exist without those social relations” (Leont'ev, 1981, p. 47). In activity, humans put their social relationship to the world and to themselves into practice. Leont'ev argued that, although activity could be completed alone, if it was removed from the system of social relationships and social life, it would not exist and would have no structure. Therefore, in Leont’ev’s framework, emphasis is placed on practical activity and social and cultural processes in psychological development and the actions of individuals are elements of a broader sociocultural system which shapes the cognition of its members.

This has obvious implications for cognitive activity in a classroom which can be characterised as the learning of individuals within the context of the classroom, school, and wider community. In particular, it suggests that 2nd Generation Activity Theory is useful in understanding how the computers assisted the students in completing group tasks or how the increased access to the tools modified the learning outcomes for the students as a cohort. In particular, 2nd Generation Activity Theory is useful for the specific analysis of how the computers were used, in terms of three hierarchical levels (activities, actions, and operations) (Roth & Lee, 2007), to achieve outcomes for the cohort or groups of students within the cohort.
A note of caution is necessary here. Leont'ev (1981), by emphasising collective activity, is not arguing for the diminishing of the value of the individual or constructing individuals as tools within a communal activity system. Neither the external world, nor the human organism is solely responsible for developing knowledge about the world. In this way, the second generation of Activity Theory helpfully elaborates the role that both individual agency and the influence of the particular environment contribute to the development of knowledge. In classrooms, the student and the classroom environment determine the learning of the student. This is particularly useful for noting the importance of both individuals and their social partners’ goals and motives, such as those of students, other students and teachers, as well as understanding that these motives are played out within collective activity, such as in classroom settings. Moreover, they play out in particular ways when individuals are either sharing a computer or when students have sole attachment to a computer.

### 3.6. Third Generation Activity Theory

Engeström is the third major theorist in terms of major conceptual developments in Activity Theory. He reconceptualised the primary Activity Theory heuristic from the simple subject-tools-object triangle into a six element model (Figure 3-2) which has become an analytical tool used in a wide range of concrete research (Kaptelinin & Nardi, 2006). Third Generation Activity Theory is also referred to in the literature (Engeström, 1998) as Cultural Historical Activity Theory (CHAT).

![Figure 3-2 An Activity System (Engeström, 1987, p. 37)]
Engeström contributed to the range of theoretical tools that cultural-historical theorists use to understand practical, object-oriented activity (Pietsch, 2005). Engeström’s third-generation articulation of Activity Theory is aimed at transcending both the individualist (Vygotsky) and collectivist (Leont'ev) paradigms, permitting a multiplicity of voices and views. The system of collective activity which relates people to each other, their cultural history, and their realm of action is referred to as an ‘Activity System’ by Engeström (Gordon, 2006). Engeström’s work, and the contributions of other theorists including Nardi (1996b), Kaptelinin (1996) and Daniels (2004) to 3rd Generation Activity Theory, will be considered here.

3.6.1. Activity System Framework

Engeström defined the underlying concept of his framework as that of an “object-oriented, collective, and culturally mediated human activity system” (Engeström, & Miettinen, 1999, p. 9). This framework is potentially helpful for understanding students and computers because it recognises that in order to understand the impact of the netbooks, other factors need consideration including the object of the particular activity in which the netbooks are used and also the cultural influence of the teachers and the school in terms of learning. Minimum elements of this system include the object, subject, mediating artefacts (signs and tools), rules, community, and division of labour (Sharpe, 2003). Engeström's (1987) framework provides a schematic for the structure of activity which describes the relationship between individual and community in social contexts. The most basic relations are a subject (person) oriented to accomplishing some object (outward goal, concrete purpose, or objectified motive) using a historically-constructed tool. To this simple triangular relationship, community was added, generating two more links - People relate to their community via rules (norms, conventions) and the community relates to the object via division of labour (organisation of processes related to the goal) (Roschelle, 1998).

Like Leont’ev, Engeström (1987) positions activity as a social occurrence. Expanding on Leont’ev's original model enabled Engeström to analyse the complex interactions and interrelationships which explain the social and collaborative nature of actions. The ability to analyse contextual interactions and interrelationships, afforded by the 3rd Generation model, suggests that Activity Theory is an appropriate tool for classroom based research. An Activity System is a heterogeneous, disturbance and
innovation-producing entity that is constantly being renegotiated by the subjects as they construct the object and other system elements in conflicting ways (Engeström, 1999). This fluidity provides bases for taking into account both a systemic view of activity, as if from above, and at the same time the subjects' view as they are engaged in and construct the activity (Sharpe, 2003). Yet, the key invigorating quality of activity system is still premised upon perturbations and disruptions within the system. These are referred to as contradictions and transformations.

3.6.2. Contradictions and Transformations

The mechanism for growth and development, for individuals and the community, is the resolution of contradictions or tensions in a system which leads to transformations and expansions of the system. According to Kuutti (1996), a contradiction is a misfit within elements. Contradictions exist when external influences change elements of activities causing imbalances between them. Consequently, Activity Systems are almost always in flux as they work through contradictions which manifest themselves as problems, ruptures, breakdowns, or clashes (Scanlon & Issroff, 2005). For example, in an educational context, a major contradiction is a view of students to be educated versus students as a means of financial profit.

Internal contradictions are the driving force behind disturbances, innovations and change, and are the motive of change and development. In this sense to ‘develop’ means to resolve or transform these contradictions, resulting in a change in the activity system and the construction of a new object or practice (Dobson, LeBlanc, & Burgoyne, 2004). The resolution of these contradictions leads to development of the system via an ‘expansive cycle’. An expansive cycle in Activity Theory “represent(s) the way in which action is embedded within this more complex organizational structure of activity” (Wells, cited in Sharpe, 2003) which leads to the development of new structures within an activity system. From a research point of view, the concept of contradictions is a useful analytical tool, enabling the identification and classification of particular instances of change and development in an activity system (Waycott, et al., 2005). In my research context, each classroom is conceived of as a similar, but separate, Activity System.
Contradictions can also occur at the level of the individual within an activity system and in some sense are conceptually similar to the Vygotskian concept of the Zone of Proximal Development. Individuals can be the driving force of expansions in a system as a result of a desire to change aspects of their ‘personal world’. This becomes an important consideration when assessing the role of individual human agency in an Activity Theory construct as conscious intentions and purposeful actions emerge from contradictions that individuals perceive in their environment (Jonassen & Rohrer-Murphy, 1999). The use of any new technology offers both affordances and constraints. As a consequence of the decision to deploy a powerful ‘tool’ in the classrooms, Engeström’s 3rd Generation conceptualisation of Activity Theory is primarily used in order to gain an understanding of the four classrooms in this study. His elaboration of the basic subject, tool, object triangle to include the impact of the broader community in which these subjects operate and the accompanying realisation of the roles and responsibilities of others in the community suggests that the Activity Systems model provides a powerful analytical tool for educational research.

3.7. Appropriateness of Activity Theory to Conceptualise Computer Use

Activity Theory allows the researcher to examine critically the praxis between individual and society, and between object and subject, and seeks to explain cognitive development via psychological processes driven by the individual but mediated by a variety of tools (physical, psychological and historical) in a particular context. In this understanding the activity of individuals becomes central in the cognitive picture – “knowing is not isolated from the world of activity, it is imminent in it and occurs through the various elements of a human activity system” (Stevenson, 2004, p. 192).

Activity Theory provides a coherent, yet still developing, theoretical framework which provides a range of practical research tools which can be used to investigate multi-faceted sites such as classrooms. Activity Theory was used as the conceptual framework and methodological paradigm to better understand the classroom context prior to, during and after the introduction of a new ‘tool’. As well as gaining a richer understanding of my particular educational context, and with it a greater knowledge of the transformations which can occur, this project also contributes to the continued
development of Activity Theory by clarifying its applicability as a conceptual and methodological framework appropriate for educational research.

This chapter has argued for the appropriateness of Activity Theory, and, in particular, 3rd Generation Activity Systems, as a conceptual premise to understand the complex of factors which coalesce to influence student learning. In the case of this project, a new factor, the netbook computers, was introduced into the environments of four classrooms and the following questions are used to direct the research.

- What factors influence the relationship between 1:1 access to netbooks and their actual use by students?
- In what ways did varying the ratio of netbook availability – from 1:1 to 1:2 or varying the pattern of availability - 5 days per week for 6 weeks versus 3 days per week for 10 weeks affect student usage in terms of quantum (as a ratio of available time) and modes of use?
- How were the classroom environments affected by the use of the netbooks? If so, in what ways did the deliberate provision of a class set or a half class set of netbooks affect these classroom environments?
- What affordances of the netbooks suggest that they are appropriate or inappropriate computing device for early adolescent students?
- In what ways did the availability of the netbooks impact on student learning?

It is suggested here that Activity Theory offers a range of conceptual tools which are utilised to understand the problems which were identified in Chapter 2. These problems included the disconnect between the early adolescent use of mobile digital technologies at home and at school, the readiness level of the individual teachers to incorporate technologies in the classrooms and their ability to incorporate Technological Knowledge into their existing Pedagogical and Content Knowledge. Further problems were identified in relation to access to netbooks and also the allocation of the netbooks and how this translates into actual computer use. Activity Theory is useful in understanding the range of complex factors related to computer use and how this use impacts on student learning as well as providing a focus on the mediating impact of tools in the attainment of a motive by a subject or group of subjects. It recognises that student learning is influenced by current and historical
socio-cultural artefacts and that learning proceeds from the external to the internal. In terms of the Activity System of the classroom, it acknowledges tensions between, for instance, the individual readiness of the classroom teacher and the readiness of the students in terms of digital technologies and suggests that the resolution of such tensions can result in transformations to this system and the resultant outcome of improved student access to, and learning from, digital technologies. Activity Theory also contributes to an understanding of classroom environments as a methodological framework. The affordances of Activity Theory as a tool for investigating classrooms are discussed in Chapter 4 where the methodology and the procedures used to investigate the research questions are presented.
Chapter 4. Understanding the Impact of 1:1 Computing: Method and Procedures

Chapter 3 outlined why Activity Theory was an appropriate conceptual framework for research in an educational context. Chapter 4 provides a theoretical accounting of the methodology employed in this project and commences with an account as to why Activity Theory is also an appropriate methodological framework to support the mixed methods approach which was considered necessary for this project. It then discusses a range of classroom environment indices which have been used to examine classrooms and proposes that a modified form of the New Classroom Environment Index (NCEI) (Newhouse, 1997) was most appropriate for this research. Following this discussion, an outline of the various data collection methods and methods of analysing the collected data is presented. The chapter concludes with a review of the ethical considerations deemed relevant for this research and indicates how these issues were overcome.

4.1. Activity Theory and Educational Research

Activity Theory is an appropriate research methodology for studying complex contexts such as school classrooms. It provides a broad and deep account of the actions of people as an activity unfolds over a period of time, for example, the students and teachers in the classrooms in the study who interact with the computers for a 30 day period. Activity Theory “reaches for a way to incorporate subjective accounts of why people do what they do and how prior knowledge shapes the experience of a given situation” (Nardi, 1996c, p. 94).

Numerous examples of the use of Activity Theory as a conceptual and methodological tool in educational research contexts from the Early Years through to Tertiary Education are found in the literature. Georgeson (2006) conducted research in various pre-school settings in England, Dale (2003) investigated calculator use in a high school classroom, Engeström (1987) explored the inherent contradictions of traditional school-going, Berglund (cited in Coupland, 2004) investigated learning in a computer science classroom, Stevenson (2004) investigated RHD supervision, and

In an Activity Theory construct, it is theoretically unsound to examine the integration and implementation of new technologies in the classroom independently of the social and cultural context of the classroom environment (Salomon, 1992). As this study is primarily concerned with understanding learning and teaching in classrooms where 1:1 computing was available, the focus is directed towards the impact of the netbooks on the classroom system, rather than their impact on individual subjects (Angeli, 2008). In the majority of the research examples cited above, 3rd Generation Activity Theory was used as the framework to understand classroom activity. In order to investigate the more systemic influence of the computers in this study, Engeström’s (1987) Activity System model is used as a methodological framework to investigate and explain the various activities which occurred in the classrooms as a consequence of netbook use. Thus, in studying the classroom as a system, the various ways these particular environments, and the individuals within them affect student learning in classrooms where 1:1 computer access is available, is revealed.

Three features of Engeström’s (1987) Activity Systems render it appropriate to a research context: i) the collective activity system is taken as a unit of analysis, giving context and meaning to seemingly random events; ii) the activity system and its components are understood historically; and iii) inner contradictions of the activity system are analysed as the source of the disruption, innovation, change and development of that system (Young, 2005). Activity Systems are environments which reveal the activity of individuals, and groups of individuals, in a specific setting which often comprises common goals (Yamagata-Lynch, 2003). Although the four classrooms in this study are unique, the research indicates that they often share similar
common goals and motives, such as the planned achievement of Year Level outcomes, production of curriculum artefacts, or a desire for increased productivity. The subjects in these classrooms also indicate significant similarities in their preferred classrooms, as illustrated by their responses on the preferred version of the New Classroom Environment Index (NCEI).

In this research, the Activity System model itself becomes an analytical tool (Sharpe, 2003). It draws upon the Activity Systems concepts of contradictions and transformations to reflect upon the impact of the netbooks on these classrooms and to propose a way forward for their future use in other classrooms in this school. When an external element enters a classroom activity system, contradictions and tensions become evident between nodes of this system. These contradictions cause the system to become imbalanced with heightened emphasis on one particular node in the system. In the case of this research the ‘Tools’ node is modified following the introduction of the computers to the system. This results in the need to restore balance with the other nodes, for example, by renegotiating the Division of Labour (the teacher may need to prepare a greater range of tasks for the students to complete). This in turn results in a transformation in the system (a modified type of student assignments and assessment). Identifying the source of contradictions, such as in the example above, is of crucial importance if one is to understand how change occurs (Engeström, 1987). As in other classroom based research which utilised an Activity Systems model (see Scanlon & Isroff, 2005; Waycott et al., 2005), contradictions, tensions and expansions are also discussed at the systemic rather than at the individual level.

As the introduction of 1:1 computing directly caused a disruption to the classroom system, this study particularly focuses on the notion of the mediating nature of tool use to frame this analysis. The values and beliefs of teachers, and, to a lesser extent, students, as they had limited agency in determining the use of the netbooks, mediate the ways in which the potential of the netbooks is realised. Waycott et al. (2005) suggest that the use of tools exhibits a degree of reciprocity where “the user adapts the tools they use according to their everyday practices and preferences in order to carry out their activities; and, in turn, the tools themselves modify the activities that the users engage in” (p. 107). As a consequence of the ubiquitous access to the netbooks,
they become one of the key elements in the socially constructed practice which is occurring in the classrooms (Romeo & Walker, 2002).

4.2. Mixed Methods Research

Given what has been argued above about the need to better understand the educational processes and consequences of student engagement with computers in a primary school classroom, an approach to enquiry is required that can capture both the subjective qualities that comprise individuals consciousness, interest and motivations as well as the contributions of the physical and social world (Creswell, Shope, Clark & Green, 2006; Maxwell, 2004). The approach selected to meet these requirements is referred to in the literature as ‘mixed methods’ research. Burke & Onwuegbuzie (2004) define mixed methods research as “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (p. 17). De Landersheere (1997) validates this perspective by suggesting that “the scientific approach is now seen to be complementary to the anthropological, historical, phenomenological, or humanistic approach” (p. 9). Certainly, this kind of complementarity is required to understand the relationships and relational outcomes of primary school students’ engagement with computers in their classrooms.

Mixed methods research is, therefore, a pragmatic approach drawing on the strengths and minimising the weaknesses of both research approaches. The methodology of a mixed method project is held to be intuitive, interactive and open (Punch, 1998), which is important here because this research takes place in classrooms which can be characterised as fluid social environments, and seeks to arrive at warranted conclusions via the conduct of a range of empirical investigations. A vital component of arriving at such warranted conclusions is ensuring that both the inquiry process, and the required chains of reasoning, is open to public scrutiny (Eisenhart & De Haan, 2005). The selection of a mixed methods approach is also premised on its potential to reduce biases inherent in various methods or instruments and conversely increases the validity of findings as quantitative and qualitative evidence can be obtained, and then used to support specific propositions.
The necessity of employing a range of empirical investigations in order to reach warranted conclusions is vital in educational contexts where the conditions necessary for experimental or quasi-experimental research are less often met. These conditions include a well developed theory allowing for interpretation of the experimental results, and a research arena relatively free from temporal and contextual variability (Bernard, cited in Maxwell, 2004). In such contexts, a mixed methods approach, combining elements of quasi-experimental design (pre and post intervention surveys) and qualitative design (interviews and forums), is appropriate for identifying those contextual factors which cannot be experimentally or statistically controlled, and for investigating at a deeper level, the beliefs and values of the participants (Maxwell, 2004).

Mixed methods research is a valid approach to employ because “at its core all research is an attempt to provide warranted assertions about human beings (or specific groups of human beings) and the environs in which they live and evolve” (Burke & Onwuegubuzie, 2004, p. 15). Having argued, in theoretical terms, for the value of a mixed methods approach, and being aware that there are pitfalls in this research approach in relation to the potential lack of theoretical and epistemological rigour (Yanchar & Williams, 2006), it is necessary to outline the practical implications of using a mixed methods approach in my project.

4.3. **Mixed Methods Research and School Environments**

The choice of a mixed methods approach, whilst affording the researcher flexibility in terms of method, requires adherence to specific guidelines when used in schooling and environments. It is seen as being appropriate for this purpose for three specific reasons. Firstly, the study should proceed in a natural setting. Secondly, although researchers have some knowledge prior to entry into the field, they should attempt to enter the field as learners. Thirdly, given the emphasis on the context of the project, the researcher becomes a part of the research process rather than merely a dispassionate observer and recorder of events (Creswell, 1998).

This research project was conducted at the school where I am employed as a Deputy Principal and, consequently, my methodological approach needed to accommodate a number of specific situational features and constraints. Firstly, as Deputy Principal
and the ICT Co-ordinator at the school, I had a practical and vested interest in the success of the netbook implementation as outcomes of the research were used to guide future educational decisions regarding the use of 1:1 computing at our school. In this way, as researcher, measures had to be taken to ensure the research was conducted in a way which reflected disinterest. Secondly, the ubiquitous availability of computers added a powerful new component to an already complex context consisting of multiple interrelated elements, such as the teachers, students, curriculum outcomes, and classroom management practices. It follows, therefore that a research approach was required which could accommodate the realities of complex environments (Tondeur, van Braak & Valcke, 2007) and also permit my involvement as a participant in the project. Thirdly, the use of a mixed method approach was congruent with the conceptual framework established in Chapter 3. In arguing for the appropriateness of Activity Theory as a conceptual tool to analyse educational contexts, classrooms are advanced as being complex systems whose contributions afforded an examination of six key elements of such systems, all mediating the attainment of a goal.

Taking this approach recognised that teachers and students were not ‘units of analysis’ (Shaffer & Serlin, 2004) but were, in fact, “a key component in the establishment of social and cultural contexts which explicitly affected the phenomena under study” (Maxwell, 2004, p. 9). A mixed methods approach permitted an investigation of what happened in the four classrooms selected for these purposes while minimising the impact of the researcher on their integrity by affording a range of options in terms of data sources and the subsequent analysis of the data (Coupland, 2004; Ercikan & Roth, 2006; Gordon, 2006). In summary, the research methodology recognises that teachers and students are not primarily units of analysis in research and that classroom based research should examine the rich social interactions that occur between individuals and groups of individuals. Finally, it provides a framework for conducting research in a classroom without significantly disrupting its integrity, as it complements the fluid, dynamic nature of learning and teaching.

4.4. **Researching the Classroom Environment**

It is suggested here that the educational impact of technology is dependent on a number of interconnected facets, not least of all being the human agency of the
individuals involved. In primary schools, because of the significant amount of time spent together in a classroom, a significant component in the success (or otherwise) of 1:1 computing are the students and the teacher in a particular classroom. Consequently, to understand the impact of the netbooks on the classrooms in my project, it is necessary to understand the dynamics of the four individual classroom environments involved in the project. One method of gaining such an understanding is via the use of a classroom inventory. This component of the review will examine the previous use of such inventories in research, particularly in studies involving the use of computers, and will address the theoretical and methodological implications of their use.

4.4.1. History of Classroom Environment Indices

Research into classroom environments began in the 1950s with the development of two environmental measures – the Learning Environment Inventory (LEI) and the Classroom Environment Scale (CES) (Zandvliet, 1999). These questionnaires were designed to quantify the subjective evaluation of the learning environment by gathering information from its participants, primarily the students, but also in some studies, the teachers (Newhouse, 1997). The LEI contained a number of classroom climate dimensions which included concepts which were: identified as good predictors of learning; considered relevant to psychosocial theory; similar to ones found to be useful in educational research; and were deemed relevant to the social psychology of the classroom (Newby 1998). In contrast, the CES was based on a number of social climate scales classified into one of three dimensions namely, relational (interaction between people in the environment); goal orientation (the collective aims of the participants in a particular environment; and systemic (the degree of structure and clarity of expectations of the particular environment) (Newby, 1998).

Both inventories provided a foundation for other researchers to further develop a range of environmental instruments appropriate for the measurement of the perceptions of students and teachers on a range of aspects which constitute educational environments (Zandvliet, 1999). A sample of such inventories includes the - My Class Inventory (MCI); School Level Environment Questionnaire (SLEQ); and the Student Classroom Environment Measure (SCEM) (Zandvliet, 1999). These
instruments have generated findings which have been used to assist scholarship and encourage practical developments in a variety of educational domains and across educational sectors ranging from early childhood through to university (Hine, 2001). Whilst not specifically designed to investigate classroom computing environments, the New Classroom Environment Index (NCEI) (Newhouse, 1987; 1997) has been utilised to investigate the impact of computing – most notably in investigating issues concerning the impact of student-owned, portable computers on the classroom learning environments of students in a variety of Australian schools (Newhouse, 1997; Newhouse & Rennie, 2001).

4.4.2. Findings from Studies of Classroom Environments

Extensive research on learning environments, in a variety of classroom settings, has been conducted to determine whether any association exists between perceptions of classroom environments and student learning outcomes (Fisher & Fraser, 1990; Fraser & McRobbie, 1995). The majority of this research has focussed on variance in cognitive and affective learning outcomes accounted for by class environment beyond that attributable to pre-existing student characteristics (Hine, 2001) and has indicated that such associations between students' perceptions of their classroom environment and attitudinal and cognitive outcomes exist (Newby 1998; Newhouse, 1997). Importantly, these associations are found consistently even in those studies where other variables have been controlled (Fraser & Fisher, 1982; Haertel, Walberg, & Haertel, 1981; Newby 1998).

4.4.3. Actual Environments as Compared to Preferred Environments

The key environmental inventories reviewed for their appropriateness in this project, namely the LEI, MCI, SLEQ, and NCEI are all presented to participants as two components – ‘Actual’ and ‘Preferred’. In doing so, they provide an opportunity for the respondents to evaluate the actual classroom environment as they perceive it (the ‘Actual’ Version) and also to indicate their perception of how their ideal classroom environment would look (the ‘Preferred’ Version). In this project, a classroom environment instrument which used both actual and preferred components has been selected. The use of the actual version of a classroom environment instrument will allow me to determine whether changes occurred in the classrooms in my study, over the period of netbook usage, in terms of the particular dimensions measured by the
classroom inventory. In doing so, it can be tentatively suggested that classroom changes are either positively or negatively correlated to computer usage and these results can be compared to results presented in similar studies.

Whilst useful in a global sense, the limitations of this approach is the determining the relevance of previous studies to the students in the specific classrooms in my study. For instance, it may be that a particular group of students in my study perceive the need for a ‘high level’ of Teacher Control whilst a second group perceives the need for greater student autonomy. Each of these perceived environments is equally valid for the participants in those environments. The use of a preferred version of a classroom environment allows the researcher to investigate changes in a classroom environment and whether such changes result in a movement towards, or away from, the perceived ideal classroom of the participants. Fraser and Fisher (1982) conducted ‘person-environment fit’ research (Stolarchuk, 1997) in the early 1980s, to investigate whether students achieve better outcomes in their preferred environments. The researchers discovered that, across a range of outcomes, student achievement was likely to improve following changes to the classroom environment which resulted in an increased congruence between the actual and preferred classrooms. In their review of studies such as these, Fraser and Walberg (cited in Newhouse, 1997) note that, "one practical implication of these findings for teachers is that class achievement of certain outcomes might be enhanced by attempting to change the actual classroom environment in ways which make it more congruent with that preferred by the class" (p.43).

4.4.4. Using a Classroom Environment Index in this Project

Environmental indexes are considered important and appropriate for my research for a number of reasons. Firstly, this thesis conceptualises classrooms as complex socio-cultural environments which both shape and are shaped by the interplay of elements (Tools, Subject, Object, Rules, Community and Division of Labour) which exist in such contexts. Consequently, a data collection instrument was required that collects information on the perceptions of the participants across a range of classroom dimensions rather than an instrument, such as the Science Learning Environment Inventory (SLEI) which solely collects information on a specific topic such as student attitudes in Science classes. Salomon (cited in Newhouse, 1997) argues for a holistic
approach to a study involving computers and comments that it is neither possible to study "the impact of computer use in the absence of the other factors" nor to assume that "one factor impacts outcomes independently of the others" (p.45). Secondly, environmental indices provide ‘high inference’ information as to the perceptions of the participants in the classroom. This information can be collated and analysed, using quantitative methods, and the inferences drawn from this analysis can be triangulated with information gathered using a variety of qualitative data collection instruments. Finally, as the use of classroom environment indices in research in primary schools is minimal (the MCI is one exception) my research, in using a non-specific classroom index, will not only provide data for my research project but also provide meta-data on the use of such indices which may inform future educational research.

4.4.5. Procedural Matters related to the Administration of the NCEI

The NCEI questionnaire consists of 56 statements pertaining to a classroom environment and has both an Actual and Preferred version. These 56 statements relate to the eight sub-scales mentioned above with each scale represented by seven statements distributed throughout the questionnaire. Student responses were requested on a five point scale (1 = Strongly Disagree, 2 = Disagree, 3 = Unsure, 4 = Agree, 5 = Strongly Agree) for both their actual and preferred classroom. The difference in the two versions relates to the wording of the statements. To illustrate, in the Actual version the students evaluate their actual classroom, and in the Preferred version the students evaluate the statement in light of their ideal classroom. By way of example, Statement 20 on the Actual version reads, ‘Students work together in class on group activities’ while Statement 20 on the Preferred version reads, ‘Students would work together in class on group activities’. Both versions of the questionnaire are attached as Appendix 4.

The students completed each of the versions of the form twice. They completed this immediately before and immediately after their period of netbook access. Each class had the netbooks for 30 school days but, because the pattern of their access varied, two classes (Classes A and C) completed the initial and final questionnaires six weeks apart. For the other two classes (Classes B and D) there was a ten week difference between initial and final completion. Classes also completed the questionnaires at different times of the year. Class A completed the questionnaires in Term 1, Classes B
and C in Term Two, and Class D in Term Three. The impact of the different periods of time use and different times of the year is discussed in the following analysis. However, my project did not involve direct comparisons of the individual classrooms in terms of their physical classroom architecture and environments, as these differences were minimal and not a focus of this study.

The potential did exist for the students to discuss with students in other classes their use of the netbooks, and this might have affected how the students completed the questionnaire. To determine the extent of this happening, if at all, students were asked during the initial interview whether or not they had spoken with other students in other classes about their experiences of using the netbooks. The most common response was that they were aware that the students in the other classes had enjoyed the experience without really knowing much more about how the netbooks were used or what activities were completed on them. To enhance the consistency in the approach to the completion of questionnaire, I facilitated the distribution, explanation, supervision and collection of all of the questionnaires for all of the classes. Consequently, students were provided with the same scripted set of instructions, and similar clarification if needed, was provided for each class. Strategies for completing the questionnaire were also suggested to the students, for example, use a ruler to ensure that you are circling the correct response on the correct line and after ten questions stop and check your answers. The statements were arranged in five groups of ten and one group of six to facilitate accuracy in recording answers.

4.4.6. Background Explanation – Quantitative Analysis of NCEI Data

The data from the questionnaires were manually entered into Excel and then exported to SPSS. A copy of the ‘raw Excel data’ was kept as a means of ensuring the accuracy of any data analysis conducted using SPSS. As the questionnaire involved ‘negative’ statements, these were recoded (1=5, 2=4, 3=3, 4=2, 5=1) so that all data ‘pointed in the one direction’. As the Actual and Preferred versions were completed twice, 224 variables were created, for example, Statement 12 on the Initial Actual version became IAS12 and the same statement on the Final Actual version became FAS12. A variable of class was also created.
Subscales scores were then computed by collating the scores of the seven statements related to that sub-scale, for instance, Compute IA_GW = IAS4 + IAS12 + IAS20 + IAS28 + IAS36 + IAS44 + IAS52 collated data related to the Group Work sub-scale. Once these sub-scale scores were computed for each of the four versions, they became variables to be used in the quantitative analysis of the data. Using this process, 32 variables were generated, namely eight Initial Actual, eight Initial Preferred, eight Final Actual and eight Final Preferred. In order to conduct correlational analysis, 16 further variables were created; that is Actual Innovation = Final Actual Innovation minus Initial Actual Innovation and Preferred Innovation = Final Preferred Innovation minus Initial Preferred Innovation).

Subsequently, the following comparisons were conducted using SPSS

- Final Actual Classroom Environment to Initial Actual Classroom Environment using dependent t-tests (for example, FA_GW minus IA_GW) on the mean scores (for both individual classes and the whole cohort).
- Final Preferred Classroom Environment to Initial Preferred Classroom Environment using dependent t-tests (for example, FP_GW minus IP_GW) on the mean scores (for both individual classes and the whole cohort).
- Final Preferred Classroom Environment to Final Actual Classroom Environment using dependent t-tests (for example, FP_GW minus FA_GW) on the mean scores (for both individual classes and the whole cohort).
- Initial Preferred Classroom Environments for the four classroom using ANOVA to suggest a baseline in terms of Preferred classrooms for this cohort.
- Actual Classroom Environment at the conclusion of netbook access (for example, FA_GW minus IA_GW) against Preferred Classroom Environment at the conclusion of netbook access (for example, FP_GW minus IP_GW) using correlation coefficients to see if any relationship existed between the two measures (for both individual classes and the whole cohort).
### 4.4.7. Validity and Reliability of the NCEI Subscales

To ensure validity and reliability of the NCEI subscales, two reliability and consistency tests were completed prior to analysing the comparisons noted above. Firstly, to test the internal validity and reliability of the NCEI subscales, a Cronbach Alpha score, as displayed in Table 4-1, was generated for each subscale. The Cronbach alpha coefficient, a commonly used indicator of the internal consistency of questionnaires, indicates the extent to which items in each of the sub-scales ‘agree’ with each other (Field, 2005). Secondly, to determine the relative homogeneity of the Year 7 cohort, an ANOVA comparison was conducted. This comparison was based on the data related to the students’ perception of their Preferred Classroom Environment prior to the use of the netbooks, and is presented in Table 4-2. These data are also charted graphically in Figure 4-1

<table>
<thead>
<tr>
<th>NCEI Sub-scale Indicator</th>
<th>Actual Classroom Environment</th>
<th>Preferred Classroom Environment</th>
<th>Mean Score for both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement</td>
<td>0.693</td>
<td>0.733</td>
<td>0.713</td>
</tr>
<tr>
<td>Affiliation</td>
<td>0.779</td>
<td>0.722</td>
<td>0.751</td>
</tr>
<tr>
<td>Teacher Support</td>
<td>0.769</td>
<td>0.716</td>
<td>0.743</td>
</tr>
<tr>
<td>Group Work</td>
<td>0.818</td>
<td>0.841</td>
<td>0.830</td>
</tr>
<tr>
<td>Competition</td>
<td>0.402</td>
<td>0.597</td>
<td>0.500</td>
</tr>
<tr>
<td>Order and Organisation</td>
<td>0.781</td>
<td>0.668</td>
<td>0.725</td>
</tr>
<tr>
<td>Teacher Control</td>
<td>0.700</td>
<td>0.771</td>
<td>0.736</td>
</tr>
<tr>
<td>Innovation</td>
<td>0.669</td>
<td>0.648</td>
<td>0.659</td>
</tr>
</tbody>
</table>

Table 4-1 indicates that the majority of the subscales scored highly in terms of reliability using Cronbach Alpha suggesting that the seven questions which comprised each of the subscales were internally coherent. The Competition Sub-scale was the least reliable, particularly on the Actual Classroom subscale. I referred to Newhouse’s (1997) study which reported scores on the Competition subscale in the range of ($\alpha = \ldots$
0.25-0.65. Discussion relating to Competition, particularly in relation to the NCEI data, will be cognisant of this slightly lower reliability rating.

This project is not an investigation concerned with how classroom environments might differ between the classes but rather an investigation into how the four individual classroom environments might have changed during the netbook usage period. I have also indicated that, as far as possible, the student make up of the classes are similar. That is, no attempt was made to stream the classes in terms of ability or behaviour. As a way of testing the homogeneity of the classes, at least in relation to the type of classroom environment they prefer, an ANOVA analysis of how the students perceived their ideal classroom prior to the use of the netbooks was conducted. The results of this analysis are shown in Table 4-2.

Table 4-2
F and Alpha scores for the Initial Preferred Environments

<table>
<thead>
<tr>
<th>ANOVA - Initial Preferred Environment</th>
<th>(n = 117)</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEI (Sub-Scales)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involvement</td>
<td></td>
<td>.148</td>
<td>.964</td>
</tr>
<tr>
<td>Affiliation</td>
<td></td>
<td>.799</td>
<td>.528</td>
</tr>
<tr>
<td>Teacher Support</td>
<td></td>
<td>.263</td>
<td>.901</td>
</tr>
<tr>
<td>Group Work</td>
<td></td>
<td>.084</td>
<td>.987</td>
</tr>
<tr>
<td>Competition</td>
<td></td>
<td>4.735</td>
<td>.001</td>
</tr>
<tr>
<td>Order and Organisation</td>
<td></td>
<td>.582</td>
<td>.676</td>
</tr>
<tr>
<td>Teacher Control</td>
<td></td>
<td>.861</td>
<td>.489</td>
</tr>
<tr>
<td>Innovation</td>
<td></td>
<td>.506</td>
<td>.731</td>
</tr>
</tbody>
</table>

In relation to the results presented in Table 4-2, the data indicate a statistically significant difference on only 1 of the eight sub-scales, namely the Competition subscale. To further investigate this difference a post hoc test was conducted using Benferroni’s measure. Statistical significance was established at 0.004 between Class D and Class A, and at 0.002 between Class D and Class B. In all instances, Class D reported a preference for a much lower level of classroom competition than the other classrooms which reported similar preferences for competition. As there was only one
subscale where any statistical differences were recorded, and that this only involved one of the four classes, it suggests that the students in this Year 7 cohort share similar beliefs regarding an ideal classroom. This observation becomes important in relation to a discussion on the potential impacts of netbooks on classroom environments as, although unique, each classroom is statistically similar in their judgement regarding the relative importance of the eight NCEI sub-scales.

These similarities can be seen in Figure 4-1 which is a graphical representation of the similarity between the classes in terms of their Initial Preferred Environment. In this figure the mean scores of the students in the four classes are indicated. Although there are minor differences in these scores (only statistically significant in the competition subscale) the students in the four classes share similar beliefs about their preferred classrooms. The implications of this similarity become apparent in Chapter 5 when findings are presented which identify whether actual classroom environments changed, and whether these changes made the classrooms more or less preferable for the students.

![Figure 4-1 Class Means from the NCEI Initial Preferred Environment](image)

**4.5. Data Collection**

Data collection does not occur in a vacuum as there are both theoretical and practical implications which accompany the choice of data collection tools. The data collection tools used in my project were both ‘quantitative’ and ‘qualitative’ in nature. As
suggested by Bogdan and Biklen (2007), the collection of various types of data provided information that enabled research questions to be addressed and yet be open to further questions that arose as the project proceeded. This approach has been described as being ‘empirically omnivorous’ (Freebody, 2003) and allows for the collection of a range of potentially relevant artefacts including surveys, classroom observations, questionnaires, field notes, email correspondence, interviews, student forums, data logging and a personal reflexive diary in which the researcher noted both observational data and also data regarding the experience of the research process.

4.5.1. Participant Sampling

Students and teachers in four, Year 7 classrooms were selected as the sample for this project and data was collected from these classrooms during the 2009 school year. The detailed study of a relatively small sample allowed for the generation of what Geertz (cited in Shaffer & Serlin, 2004) described as ‘thick descriptions’. The use of thick descriptions permitted the gathering of the comprehensive kinds of data required for researching interactions between students and computers and among students and teachers in classroom settings. Consequently, the credibility of my research will largely be determined by the transferability of my findings rather than their generalisability. Generalisability refers to the extent to which the findings of one study can be applied to another situation (Merriam, cited in Young, 2005). Generalisability was not a high priority for my research project which was primarily concerned with providing a coherent and illuminating description of a phenomenon. An alternative to the concept of generalisability is the notion of transferability.

Transferability relates to the degree to which the research context, and the context of the reader of the research, is similar (Shaffer & Serlin, 2004). The responsibility to determine the level of transferability resides with the reader as it is not possible for the initial researcher to determine the extent to which the research is transferable to unknown contexts. What is required of the researcher, in terms of future transferability, is to provide sufficient contextual and situational information so that a ‘baseline understanding’ of the problem is provided and upon which other studies can be compared (Guba & Lincoln, 1989; Young, 2005). Stake (1994) suggests that
Researchers do not avoid generalisation…they cannot. They expect their readers to comprehend their interpretations but to arrive at their own as well. Methods actually used…are not only to encapsulate complex meanings into a finite report but to describe the case in sufficient descriptive narrative so that readers can vicariously experience these happenings, and draw their own conclusions. (p.243)

From this perspective, the research attempts to present findings that can be scrutinised and viewed by other researchers and be considered as a thorough and transparent account of the context. The study did not undertake a “quest for conventional generalisability” (Huberman & Miles, cited in Bateman & Oakley, 2009, p. 18), but rather sought to display a thorough understanding of the conditions under which particular findings appear and operate.

Data was collected from both the whole cohort using the New Classroom Environment Index (NCEI), data logging software on the netbooks, and anonymous student surveys. It was also collected from interview participants selected using a random sampling technique. Three pairs of students were chosen at random from each class. Each student who had agreed to be part of the study was assigned a number from 1-32. A random number generator (www.random.org/quick-pick) was used to provide eight numbers for each class and matched these numbers to student’s names. The class teacher was given the eight names and asked to establish four pairs from the eight names. One pair of names was allocated as a backup to be used if any of the selected students felt uncomfortable with the prospect of being interviewed. One student, who participated in an initial interview, left the school during the course of the study and was replaced by one of the backup students. The selection of the teachers involved in the study contained both random and non-random elements. The decision to conduct the project with Year 7 classrooms, and, therefore, the Year 7 teachers, was non-random. However, the particular teachers involved in the project have been teaching Year 7 for a number of years and were therefore, randomly chosen by virtue of their year level and not their expertise or otherwise with technology.
The allocation of the classes to the four different patterns of usage was agreed to by the four teachers at a meeting facilitated by the researcher at the end of 2008. Although present at the meeting, the researcher had no input in the allocation of the classes to a particular pattern of usage. The teachers discussed the four patterns of use available and then decided which teacher would work with which pattern. As noted, each of the four teachers had previously taught Year 7 and had, based on anecdotal knowledge of their technological skills, similar levels of ICT competency.

The class groupings for Year 7, 2009 (and all other Year levels) were compiled by the school Deputy Principals, school support staff (for example, Learning Support Teacher and Guidance Counsellor), and by their teachers from the previous year. The intent of this process is to ensure a heterogeneous mix of gender, academic skills, and social competency across each of the classes. Thus, in relation to the above criteria, the four Year 7 classes were similar. In terms of computing resources, each classroom had a teacher’s desktop computer and four student computers. Each of the computers was connected to the Internet / Intranet /school server and students were able to print documents to both a local classroom printer as well as a range of network printers. All students had access to files stored on the server, from any computer in the school (including the netbooks) via a specific username and password. In this way the selection of participants was undertaken to remove concerns about bias, enhance reliability and validity of the data and engage the teacher participants as informed and engaged co-participants.

4.6. Data Collection Procedures

A range of data collection procedures were selected to realise the particular purposes of the investigation. These comprise: Classroom Observations, Semi – structured interviews, student forums and student surveys (Freebody, 2003), The New Classroom Inventory Index (NCEI) (Newhouse, 1997), Data Logging Software installed on the netbooks, and a reflexive researcher diary. Table 4-3 identifies the range of problems which are answered in this project and the conceptual issues which arose from them. It also indicates the range of data collected and the procedures which were used to gather this data.
Table 4.3  
**Nexus of research problems, conceptual issues an data collection**

<table>
<thead>
<tr>
<th>Problem to be addressed (Chapter 2)</th>
<th>Conceptual issues (Chapter 3)</th>
<th>Data to be gathered (Chapter 4)</th>
<th>Means of data gathering (Chapter 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to computers</td>
<td>Did 1:1 access equate to ubiquitous use of the devices?</td>
<td>Usage Times Patterns of usage</td>
<td>Log on/off script, Spy KeyLogger and Student Computer Use Form Student /Teacher Interviews</td>
</tr>
<tr>
<td>Patterns of access to computers</td>
<td>Were there other factors, other than pattern of access, which affected netbook usage?</td>
<td>Usage Times Patterns of Usage Software used by students</td>
<td>Log on/off script, Spy KeyLogger and Student Computer Use Form Student /Teacher Interviews</td>
</tr>
<tr>
<td>Classroom Environmental factors</td>
<td>Were classroom environments changed as a consequence of the use of computers? Was this a preferred change for the students?</td>
<td>Information relating to classroom environments according to the eight NCEI sub themes</td>
<td>Modified New Classroom Environment Index questionnaire Student /Teacher Interviews</td>
</tr>
<tr>
<td>Appropriateness of netbooks for early adolescents</td>
<td>Was the particular functionality and mobility of netbooks relevant to their use with early adolescent students?</td>
<td>Technical issues with the devices. Student use of netbooks. Functionality of netbooks.</td>
<td>Student Forum Student /Teacher Interviews Classroom Observation Anonymous Survey</td>
</tr>
<tr>
<td>Student engagement and learning</td>
<td>In what ways was student learning and engagement affected by netbook usage?</td>
<td>Impact of netbooks on Productivity, Teacher Agency, Social Activity and Individual Learning</td>
<td>Student Forum Student /Teacher Interviews Classroom Observation Anonymous Survey</td>
</tr>
</tbody>
</table>
4.6.1. Classroom Observation

Observations of students and teachers provides much of the raw data for this study as they provide the “richest vein of information” (Eisner, cited in Sewell, 2006, p. 57) and guides the progress of the research. Key considerations, regarding classroom observation in my context relate to my presence in the classrooms and a determination of the appropriate level of my involvement. In determining the level of researcher involvement, reference is made to the participant-observation continuum, suggested by Glesne and Peshkin (cited in Scribner, Cockrell, Cockrell & Valentine, 1999). Glesne and Peshkin conceive of participation in the following ways. At the ‘observer’ end of the continuum, the researcher has little or no interaction with the participants in the setting, such as observing a classroom through a one-way mirror. Next on the continuum, the ‘observer-as-participant’ is still mainly an observer but has some interaction, such as taking notes at the back of the classroom. Further along the continuum the ‘participant-as-observer’ interacts extensively with others, such as engaging in a range of classroom activities and also taking notes. At the ‘participant end’ of the continuum the teacher is the researcher and is a full participant in the classroom (see Sewell, 2006).

Although the researcher’s positioning changed throughout the project, it primarily operated as ‘participant-as-observer’ as the researcher was involved in the activities with the teacher and students whilst at the same time kept some distance to observe what happened in the various classrooms. In reflecting on this experience as researcher, post data collection, it was a rewarding experience to be able to spend time in the various classrooms, getting to know the students more thoroughly and becoming more aware of the intricacies of each of the different classrooms. This was certainly the position which the students, teachers, and the researcher were most comfortable with as the ‘participant-as-observer’ best recognised the prior (and continuing) role of the researcher as deputy of the school.

Classroom observations occurred prior to the period of netbook usage. To gain an understanding of the functioning of the classrooms without the presence of the netbooks, the researcher completed twenty observations in each of the classrooms prior to the period of netbook usage. Each period of observation lasted 15 minutes. In
order to gain an accurate picture of pre netbook usage, these observation periods were conducted at random times during the school day and the teachers were not told when these observations would occur. To aid in the data collection of computer usage information, prior to and after the netbooks, a modified version of the *Survey of Computer Use (SCU) Instrument* (Dawson et al., 2008/2009) was used. This instrument is specifically designed to conduct classroom observations in relation to computer usage. A record of the classroom observations made during non-netbook periods is attached as (Appendix A).

It had been the intention, prior to the commencement of the research, to also collect netbook usage data using the SCU. An attempt to use the SCU during the first week of the 1:1 netbook usage in Class A was found to be very difficult in relation to making observations and judgements about the quality of computer usage when over 30 students were working individually on computers. Attempting to complete the SCU form was distracting the researcher from observing what was happening in the classroom. Consequently, the decision was made not to use the SCU when the netbooks were in the classroom.

Classroom observation data, during netbook usage periods, were collected via observation records in the researcher diary and records were kept which detail any direct interactions with students and teachers during these observation periods. Over the course of the project, six, one week long periods of leave were taken by the researcher so that substantial amounts of time could be spent observing the classroom use of the netbooks. These structured observations were in addition to regular visits to the classrooms, during non-leave periods, in my roles as deputy and ICT co-ordinator. The purposes of the classroom observations are two-fold. Firstly, observing the classrooms prior to the netbook usage periods generated a range of data about the impact of the netbooks on computer usage in these classrooms and meant that comparisons could be made regarding, for instance, student to student communication via ICTs in the classrooms pre-and-post intervention. Secondly, the observations were triangulated with quantitative data collected via the NCEI.
4.6.2. Semi-Structured Interviews

Semi-structured interviews (Garthwait & Weller, 2005) were used as a data collection and data generation tool in this research. Interviews are an opportunity to collaboratively create new knowledge with both interviewer and respondent active in this process (Ellis & Berger, 2002; Freebody, 2003). In this sense, the interview act mediates this experience for both parties in the achievement of a purpose, namely the generation of knowledge (Gubrium & Holstein, 2002). The interview act, described using Activity Theory meta-language, envisages ‘subjects’ (interviewer and respondent) working towards the attainment of an ‘object’ (information) mediated by a particular ‘tool’ (the interview act) in a specific ‘community’ (the particular classroom with its rules and division of labour) to achieve a ‘goal’ (co-generation of knowledge). In this research interviews are viewed as interactional sites for the joint creation of knowledge and social worlds; as encounters with active subjects who choose from a variety of subjective positions; and, as sites where both interviewer and interviewer provide accounts of their individual and societal experiences. This approach is consistent with the conceptual underpinnings of Activity Theory and recognises that any social act is a mediated interaction between two or more subjects in a particular socio-cultural context, shaped both by the history of that particular context and by the rules which govern the current context, towards the attainment of a particular goal or goals.

The interviews consisted of a mixture of pre-determined questions regarding specific aspects of the project such as the impact of netbooks on specific curriculum areas or the effects of netbook use on access to information, as well as questions which arose from the nature of the discussion. The semi-structured nature of the interviews thus allowed for deeper probing of participant responses, as the need arose, and also allowed the participants the opportunity to contribute additional reflections, comments or opinions and to ask me questions about the project if they so desired. The initial, interim, and final interviews also contained a set of specific questions related to the classroom environment and curriculum use of the netbooks which required a Likert scale answer. Quantitative analysis of this component of the interviews was conducted on these responses.
Each of the teachers was interviewed four times - prior to their class using the netbooks, during their use, at the immediate conclusion of their use and then again a period of time (between four to six weeks) later. The student interviews were conducted as paired interviews. Each pair was interviewed three times - prior to their class using the netbooks, during their use, and at the conclusion of their use. The six students from each class also participated in a discussion forum, conducted approximately 6 weeks after the completion of their netbook usage period. Post-usage information about the classroom environment and patterns of post-netbook computer usage was gathered. The interviews were recorded (with the consent of the participants) and interview notes taken. The interviews were transcribed as soon as possible after the interviews and the transcripts were shown to the participants to ensure the accuracy of the transcription. An example of a final teacher and student interview, which is indicative of the initial and interim interviews, is attached as Appendix B.

Towards the end of the first 6 week period of access it was apparent that qualitative data was only being collected from six students (and their teacher) and that it would be beneficial to collect further qualitative data from all of the students. This data would serve both as a means of verifying what the randomly selected interviewees were reporting, and also as a tool to ensure significant ‘student voice’. Consequently a survey to be completed by all students in the study was created. The survey questions largely replicated the questions which had been used throughout the student interviews. The data collected from these surveys was triangulated with interview data, observations, and the qualitative data collected throughout the project to construct a picture of the four classrooms. The responses to the survey regarding the use of the netbooks supported and re-enforced the perspectives that were offered by the interviewed students. A copy of the end of usage student survey is attached as Appendix C.

4.6.3. New Classroom Environment Index (NCEI)

A key research question investigates the impact of the netbooks on the classroom environment and whether this impact varies according to the pattern of this access. It is therefore necessary to gather data which provides insight into these classroom environments prior to, during, and after their usage. The methodological validity of
classroom indices to collect and interpret data concerning classroom environments has previously been established. Supporting the actual, physical observations of the various classrooms is the use of the New Classroom Environment Index (NCEI) (Newhouse, 1997). The NCEI provides information, directly from all of the students, which is to be triangulated with the classroom observations noted previously.

The findings from the NCEI may also suggest further avenues for investigation. The NCEI is based on the Classroom Environment Survey (CES) but also includes elements from the Classroom Interaction Patterns Questionnaire (CIPQ) Group Work sub-scale. Newhouse (1997) notes that “all items for the NCEI were either directly from one of these two parent instruments or were reworded items from those instruments” (p.93). The NCEI Index has eight sub-scales (Involvement, Affiliation, Teacher Support, Group Work, Competition, Order and Organisation, Teacher Control and Innovation), which are used to evaluate a classroom environment. Each sub-scale is represented by seven items (56 items in total) distributed throughout the questionnaire. Respondents indicate their perceptions of the classroom environment using a three-point frequency response format, Almost Never, Sometimes and Often.

The NCEI has a number of features considered necessary for investigations into classroom environments. Firstly, it is non-specific in design; in other words it is not designed to measure a specific classroom dimension as is the case with the Classroom Learning Environment Index (CLEI) or the Middle School Classroom Environment Indicator (MSCEI). Newhouse (1997) suggests that the NCEI is a generic instrument that can be used to provide data on everyday classroom environments. The generic nature of the instrument is congruent with the researcher’s belief that classrooms need to be understood holistically. Secondly, the NCEI has been used in a number of similar mixed methods research project concerning computer usage (Newhouse, 1997; Newhouse & Rennie, 2001). Finally, the NCEI has been previously used in projects involving Year Eight students. A review of the literacy level of the NCEI questions indicates that it is also appropriate for Year 7 students. A secondary consideration in deeming the NCEI appropriate is the fact that it only contains 56 statements. These twin factors distinguish the NCEI from other classroom environment instruments designed for secondary students, such as the SLEQ or which contain as many as 90 statements, for instance the CES.
Although the NCEI was used in this project, the initial three-point response scale was changed to the more common five point scale, used in the SLEI, SLEQ, and MSCEI classroom environment instruments (Hofstein & Lunetta, 2003). Each of these instruments used five-point descriptors - Strongly Disagree, Disagree, Neither Agree nor Disagree or unsure, Agree, and Strongly Agree - to evaluate the dimensions of a classroom environment. The decision to utilise a five point scale was made for two reasons. Firstly, the wording in the five point scale is more appropriate and easily understood by Year 7 students. Secondly, as the NCEI will be used pre and post netbook implementation, the broader scale will more readily reflect changes in the environment than the three point scale. To ensure that sub-scale reliability was not affected a Cronbach Alpha was conducted on the modified five point scale questionnaire. These figures are reported in Table 5-1. A copy of the modified NCEI is attached as Appendix D. The 117 students involved in the project completed the NCEI questionnaire twice, before and after the netbooks the netbook usage period. Unlike the case in the study by Russell et al. (2004), where the researchers were unable to complete a pre-test / post-test questionnaire “since the laptops were already in the hands of the students” (p. 316), data is to be collected in relation to the classroom environment, via this questionnaire before and after the use of the netbooks. In this way a quantitative ‘measure’ of changes in the classroom environments during the period of netbook usage can be obtained.

In evaluating the data provided by the NCEI, a key consideration is that the NCEI measures changes to the total classroom environment, rather than just measuring changes directly related to computer use. To elaborate, the questionnaire statements do not ask, for instance, ‘this is a well organised class when we are using the netbooks’. The fact that the NCEI measures the overall classroom environment is both a strength and a limitation of the instrument. It is a strength because it provides a holistic account of the classroom environment rather than reporting only on changes to specific contexts, such as Computer Labs, or Science classrooms, or constructivist classrooms, as is the case with other environmental scales. At the same time, this is a potential limitation as changes to the classroom which might have been detected using a specific computer environment instrument are missed and a Type 2 error occurs (Muijs, 2004): that is, changes occurred in the classroom environments which were
too small to be measured using the more holistic NCEI instrument. This limitation might be present in this study where the netbooks were only used on average for 1 hour per day and the usage for two of the four classes covered a shorter period of six weeks.

4.6.4. Data Logging Software

Although anecdotal information on computer usage, in terms of both duration and purposes for usage, was gathered via observations and interviews, it is necessary to collect actual usage data directly from the netbooks. Data usage software has been effectively utilised in a previous studies involving computing devices (Swan et al., 2005). Computer data regarding usage is particularly important in answering Research Questions One and Two which specifically seek to determine the overall quantum of netbook usage as well as usage according to the different modes of access. Consequently, software was required which could collect this data directly from the devices without the need for the user to record this information. This is considered a more reliable method of collecting usage data rather than, as was the case in other computer studies (Dawson et al., 2008/2009; Dunleavy et al., 2007; Zucker & McGhee, 2005) relying on self-reports of usage and is a valuable contribution of this project. Two tools are used to collect usage data. The primary data tool is a logon script on each netbook which records start-up, logon, logoff, and shutdown events. An example of the data collected is presented in Appendix E. The students were encouraged, both by the researcher and by their teachers, to always logoff at the conclusion of an activity and logon again when the computers were needed. The logging on and off proved somewhat onerous for some students:

It is a problem if other students have not logged off properly as then you have to waste time shutting it down and then restarting it.

(Ambrose, Student, Class A, April 2009)

The need for students to logon and logoff was a necessary evil if accurate data was to be collected. At the end of the day the usage data was collated and recorded in an Excel Spreadsheet. An example of this data is shown in Appendix F.
Despite the anticipated diligence of the students to log off at the conclusion of each netbook activity, it is still conceivable that students will logon and then not logoff at the end of an activity. This would result in the recording of inaccurate usage times as the logon / logoff data will not record times of inactivity, merely the times between logon and logoff. In order to minimise this potential measurement error, and also to collect data on what the students were doing on the netbooks, a second technical data collection tool, Spy Keylogger, is installed on each of the netbooks. This tool collects information on every keystroke (Appendix G) and provides a range of information indicating precisely how the netbooks are used in terms of software and the types of learning activities completed. It also records student activity completed online. Spy Keylogger also functions as a pro-active research tool in that it provides entry points into the experiences of the students. Each evening the Spy Keylogger data is reviewed and often evidence of student usage is uncovered which requires further investigation. These instances are noted in the research diary and they form the basis of the following days’ discussion with either students or the teacher. This follow up is crucial as the Spy Keylogger data can be misunderstood if the context of the activity which generated the data is not investigated fully. Finally, the Spy Keylogger data provides a crucial triangulation and data verification function. The use of Spy Keylogger is considered a particular strength of this research as it is difficult to observe accurately the computer usage of 15-30 students working simultaneously.

In daily checks of the logon and the logoff data, on occasions, ‘outliers’ in terms of netbook usage were identified: for example, the average daily use of the netbooks was 58 minutes, however, one of the netbooks reported a usage of 128 minutes, with a large time differential between logon and logoff events. In instances such as these, a cross check was made to the Spy Keylogger data to determine the keystroke activity for this netbook. If there was no keystroke activity on the netbook over the course of the extended time, the time usage in the Excel logon / logoff recording sheet was adjusted (and noted that it had been adjusted in the event further investigation was required). It is the researcher’s view that, via the use of two data logging software tools, a very accurate record of actual netbook usage, across the four classrooms was collected, without needing to depend on the less reliable, self reporting technique.
For ethical reasons, the students and teachers were aware, via the Participant Information Sheet (Appendix H), the Informed Consent Forms (Appendix I), and by a physical demonstration by the researcher at the commencement of netbook usage, that the software outlined above was used. To further protect identity, no individuals were identified by the data collected as the data was aggregated for analysis. Information gathered from the devices during the project was sent to, and stored on, a server that was only accessible to the researcher.

4.6.5. Participant Diary

The final data collection device was a research diary. As part of the research project, it was appropriate for me to collate, and later report my reflections of the process of the research (Sewell, 2006). Such a diary was a means to maintain reflexivity where the effects of my values, feelings and actions could be identified and reported on (Newbury, 2001). Research diaries have been used in other research projects to explore responses to issues that arise in the research and to the feelings associated with these (Silverman, 1997), thus assisting the researcher to better understand both their part of the research process and the conduct of the overall project.

4.7. Data Analysis

As was the case with data collection methods, the type of analysis appropriate for this project was governed by the conceptual and methodological stance adopted and, similarly, had both theoretical and practical elements. Internal coherence between theory, methodology and analysis is critical if validity of interpretation is to be later established (Freebody, 2003). A key concern throughout the data analysis phase was the provision of sufficient information for a reader of this project to judge the credibility and astuteness of analysis of these classrooms (Lancy, 1993).

Thorough analysis is particularly important in this particular case where the researcher is very familiar with the research contexts as the researcher may feel that they already know what is important and what is peripheral. A methodological contribution of this project is the manner in which the tension between familiarity and academic distance is reconciled. Comprehensive analytical work is a way of testing this knowledge, of looking at the familiar, the comfortable, through new lenses (Freebody, 2003). Outlined below is an account of how two technical analysis tools,
NVivo and SPSS were used to assist in the analysis of data. It is important to note that although the tools were used to assist with the analysis, they did not do the analysis.

4.7.1. Qualitative Analysis Methods

Rather than leaving any analysis until the conclusion of the data collection phase of the project, initial data analysis commenced soon after the start of the project. This early analysis shaped subsequent data collection procedures. Initial analysis involved transcribing interview data and the processing of classroom observations and other artefacts (Garthwait & Weller, 2005). The data collected were coded into emerging categories of interest, initially based on the six Activity Theory nodes and the eight NCEI sub-scales. This early analysis primarily related to the data collected from Class A. At later stages throughout the research, as other teachers and classes became involved and other themes arose, these initial transcripts were revisited and, if necessary, this early data was recoded into the emerging themes. After considering the advantages and disadvantages of a range of qualitative analysis tools which facilitate the digital management of data, NVivo was chosen for this project. NVivo has been utilised as the data analysis tool of choice in a range of ICT related educational projects (see Dunleavy et al., 2007; Sewell, 2006; Thompson, 2005). While NVivo did not analyse the data, it was a powerful tool to assist in the sorting, coding, storing and retrieving of a range of data sources including spreadsheets, pdfs, and audio files.

As a range of quantitative data was collected via the use of the NCEI, SCU, Logon / Logoff Scripts and Spy Keylogger, a tool was also required to assist in the analysis of this data. The software tool chosen for this task was the Statistical Package for the Social Sciences (SPSS). SPSS has been successfully used in a variety of educational research projects (Gordon, 2006; Mouza, 2008; Newhouse, 1997). SPSS was particularly critical in analysis of the data collected by the NCEI and its use as a data analysis tool is outlined Chapter 5.

4.7.2. Maximising Reliability and Validity

To ensure the selection, and implementation, of appropriate quantitative analysis methods for my data, the advice and expertise of a university statistician was utilised. This statistician was able to assist in determining the statistical significance of a range of data collected. As the domain expert, however, it was the responsibility of the
researcher to complete the data entry, analysis and interpretation of results, and to determine any practical significance of the statistical results. This is an appropriate delineation as interpretation of results should be made by those with expertise in the researched domain (Wainer & Robinson, 2003). The assistance of the university statistician is again acknowledged. The combination of ‘qualitative’ and ‘quantitative’ data collection instruments, and the subsequent analysis of this data using methods from both these perspectives, enhanced the potential transferability of the findings from this project.

The use of a Mixed Methods approach generates a different understanding of the terms reliability and validity as compared to their use in quasi-experimental design. Various authors (Denzin & Lincoln, 1994; Silverman, 1997) suggest that these terms be replaced with criteria such as credibility, transferability, dependability and confirmability. In this project, the terms credibility and transferability are used as guiding concepts in determining the integrity of this research. Credibility and transferability are reflected in the authentic representation, to the reader of the research, of the how the data were collected and the type of analysis that was conducted (Holstein & Gubrium, 1997). Transferability is not concerned with the question of whether the findings are valid for all other contexts, but rather with the question of whether the research findings and analysis are helpful in understanding the reader’s context (Bogdan & Biklen, 2007). Credibility is viewed as the fit between what is recorded and presented as data and what actually occurred in the setting under study.

Transferability and credibility were enhanced via the employment of a number of strategies recommended by Creswell (1998). These strategies included triangulation of the data; an appropriate length of time spent observing and interviewing; the clarifying and declaring of personal bias; and entering the research site as a participant rather than an observer. Member checking (Eisenhart & De Haan, 2005) was also a research strategy, whereby, after completing data analysis, the researcher returned to the students and teachers in the research and asked them “Is this right?” Where necessary, conclusions were reconsidered to accommodate the follow up information provided by the participants.
4.8. Ethical Considerations

The description and examination of how ethical issues were dealt with in this project is the final piece of the methodological puzzle. Due to the specific research context, it is contended that the ethical procedures utilised in this project are a potential methodological contribution to be used by future researchers. Consequently, ethical information provided here relates only to procedural matters and to generic ethical issues in relation to working with students. In terms of these ethical procedures, ethical approval from Griffith University (EPS/08/08/HREC), approval from Brisbane Catholic Education (BCE) to conduct research in one of their schools, and approval from the Principal of the specific school site being researched to complete this project were received prior to the commencement of the project. These approvals are provided as Appendix J.

As the project unfolded, it became increasingly apparent to me that the opportunity to speak to students about what was happening in their classroom was a privilege for me. They were amazingly astute in their observations and their reflections. What was also clear was that ‘discussions with an adult’ (in the true sense of the word where their opinions were sought and respected) is not a normal part of their daily school routine. Despite continued attempts to convince the students that any discussions we had were because of a genuine interest in their opinions and thoughts, it is unclear that the students initially perceived of them in this way (see Sewell, 2006). An initial impression is that the students thought that, if they were asked a question, they had either done something wrong or that their knowledge was being tested in a traditional ‘teacher-student’ dynamic. Bogdan and Biklen (2007) noted in their research that school students “have developed particular strategies in dealing with the full grown; they may seek their approval, withdraw, or even conspire to deceive” (p. 95). The response of the students in this project may indicate a socialisation into a particular ‘experience of school’ where adults direct and children follow. Graue and Walsh (cited in Sewell, 2006) note that children expect that the answers to questions posed by an adult are known by that adult: “few children have had the experience of being approached by an adult who wants them, the kids, to teach her, the adult, about their lives” (p. 60).
Having identified above, some methodological and conceptual concerns which particular relate to research involving school students, a number of compensatory strategies were employed to enhance the accuracy of my observations and reflections. Firstly, students were always interviewed in pairs. A key learning from this project is that the students preferred the paired interviews and the presence of a peer helped the students feel comfortable and also minimised the power differential that can exist between researcher and student participant. Paired interviews are also useful as a means of better understanding the students as they construct their meanings collectively with their peers. Mayall’s (cited in Sewell, 2006) analysis of research conversations with pairs or groups of children revealed their social competence to listen, respond, add points, and to support each other to speak; talking with children showcased their collaborative abilities. This was certainly the case in the paired interviews conducted in this project where it was a common occurrence for students to build on the ideas of each other. Secondly, all interviews were conducted in the students’ normal daily context which increased the comfort level of the students involved. Finally, on a few occasions, the spelling and grammar in any student comments used in this project are corrected. This is not to change the meaning of what the students say but to prevent the readers of this thesis from feeling pejorative towards the abilities of the students (and vicariously their teachers). It was also possible that spelling or grammatical errors could potentially distract the reader from the intent of what the students say.

4.8.1. Limitations of Research Design and Approach

All research studies comprise ambitious approaches with the pragmatic realities of conducting research. While the following modifications to the research design used might have strengthened the conduct of this project, several constraints limited the extent to which these could be undertaken.

Firstly, given a more extensive budget, it would have been possible to have the four classrooms using the netbooks in the four different patterns, at the same time of the year. This might have minimised some of the external factors which impacted on the use of the netbooks such as differing pedagogical approaches used at different times of the year: such as, student management techniques or use of group work, or the effect of different curriculum content to be covered.
Secondly, the project could have been conducted over a longer period of time. Although the project itself covered a substantial amount of time through being conducted over 30 weeks, some of the individual classes only used the netbooks for a short period of 6 weeks. Lengthening the amount of time each class had with the netbooks, without causing the project to span more than one school year would have generated its own set of limitations, such as different students, and the students having potentially different teachers. This would only have been possible if the school had been in the financial position to purchase more than one class set of netbooks.

Thirdly, the length of time that the students used the netbooks was also a possible limiting factor in the appropriateness of the NCEI to measure changes in the classroom environment. Because some of the classes only used the netbooks for limited amounts of time in a shortened period of 6 weeks, changes to the classroom environment which were evident in the qualitative data, may have been too small for a holistic classroom environment index, such as the NCEI, to measure.

Fourthly, although it has been stated previously that the project did not intend to argue for the generalisability of the findings, but rather their transferability, the project was relatively small in scale. Finally, although measures were taken to diminish the impact of the researcher’s role as deputy in the school, it is reasonable to infer that this role may have influenced both the level of involvement of the teachers in the program and also their thoughts and opinions, as well as those of the students who were interviewed.

4.9. Coherence of Methodology, Procedures and Theoretical Construct

This chapter outlined the design of my research project and argued that its success depended on a high level of internal coherence between the research questions established and the theoretical and methodological perspectives adopted to answer these questions. Also crucial to its success is the choice of an appropriate range of procedures (for example, data collection and data analysis tools) which are congruent with these perspectives. It has also argued that the credibility and transferability of
any findings relate to the ethical manner in which the study was conducted. Any educational research project involves a series of practical activities in the ‘real’ world: observation, analysis and reporting and then a reduction and distillation of these moments into written form. The challenge for this research (and any other research) is to ensure that this distillation does not unhinge the findings from the original question and in so doing render the conclusions unwarrantable (Freebody, 2003). Chapters 2, 3 and 4 have therefore established the theoretical framework of this project. The remainder of this thesis will present and explain the meaning of the findings and then conclude with its conceptual, methodological and practical contributions.
Chapter 5. Quantitative Findings and Discussion

This chapter presents quantitative data which are used to answer the following research questions:

- What factors influence the relationship between 1:1 access to netbooks and their actual use by students?
- In what ways did varying the ratio of netbook availability - from 1:1 to 1:2 or varying the pattern of availability - 5 days per week for 6 weeks versus 3 days per week for 10 weeks affect student usage in terms of quantum (as a ratio of available time) and modes of use?
- How were the classroom environments affected by the use of the netbooks? If so, in what ways did the deliberate provision of a class set or a half class set of netbooks affect these classroom environments?

For each of the questions listed above, data will be presented and findings will be identified. Deductions will then be drawn from these findings in light of my conceptual and methodological position, to answer the particular research question.

5.1. The Computing Environment before and after the Netbook Project

In order to understand the relationship between 1:1 netbook access and their usage, it is first necessary to understand computer usage in the classrooms prior to the deployment of the netbooks. To determine the extent of computer usage, each of the four classrooms was visited on numerous occasions both prior to, and after their respective netbook usage periods. Whilst the overall classroom environment was observed, the primary intention was to assess the usage of computers in these classrooms.

5.1.1. Computer Usage Prior to Netbook Usage

Each classroom had one computer situated on the teacher’s desk and designated as the teacher’s computer. Students were occasionally allowed to access this computer in three of the four classrooms and were not allowed to use the computer in the fourth. Each classroom also had three or four desktop computers positioned against the wall.
at the back of the room which were designated as student use computers. Observations of these classroom visits, outside of the netbook usage period, include details of number of computers available and used, the number of students using the computers and how the computers were used (see Appendix A). The data collected from the eighty, random observation periods indicate that computer usage, across the four classrooms, is minimal. Similar low levels of computer usage in classrooms with limited access to computing resources are reported in studies by O’Dwyer, Russell and Bebell (2004), Bebell and Kay (2010) and Selwyn et al. (2009). Only 15 of the 80 observation periods showed any evidence of any computer use. Expressed as a percentage, computer usage was evident on only 18.75% of the visits.

Prior to the netbook usage period, when classroom computer usage occurred, it involved only three or four students at a time. Observation of student usage indicated that these students were primarily typing out previously handwritten and teacher corrected pieces of work. On two occasions, students were involved in searching the Internet to support a project they were completing. Based on these observation periods, and also on my observations of these and other classrooms outside of this study in my role as ICT co-ordinator and Deputy Principal at this school, it was clear that classroom computer access was infrequent; when it did occur access only involved three or four students at a time; and that this usage primarily related to word processing activities or basic internet searches. As either of the computer tasks could be more easily completed at home, it is apparent that the mediated value of the computers in relation to the teachers and the curriculum is not great.

These observations and reflections were confirmed when I spoke to students in the project about classroom computer access. Furthermore, it became clear that the classroom computers are used so infrequently by individual students that they do not consider their use in their overall computer usage schema. The following comments were made by students regarding classroom computer usage prior to this project:

If we want to type things up to hand in we just use the computers at home. (Bob, Student, Class D, July, 2009)

I use them once every two weeks. (Jim, Student, Class D, July 2009)
I get to use them probably once a week to once a fortnight. (Joe, Student, Class C, August, 2009).

In the event that more computer usage was required, the teachers would try to book the school computer lab. More commonly, the students would be sent to other classrooms throughout the school to complete their work on the computers in these rooms. For example, a student commented that:

We don’t have enough time for everyone to get on the four computers in the classroom unless we are sent to different classrooms to finish on their computers. (Bob, Student, Class D, August 2009)

In my visits to classrooms through my role as Deputy Principal, I have often observed students from other classrooms working on computers and this reinforces the point previously made: which is that much of the computer work done at school by students could be more efficiently completed at home (see Finger & Sun, 2010; Selwyn et al., 2009).

5.1.2. Observation of Computer Usage Post-Netbook Usage

The observed pattern of usage in the four classrooms after the conclusion of the netbook usage period was largely the same as that prior to their use. The students were observed typing previously written and checked work or were using the Internet to do research. Once again, only three or four students at a time were using the computers. There were, however, two significant differences observed in the usage. Firstly, both the teachers and students were keen to use the netbooks on the days when the designated netbook classes, due to the access restrictions in the project, were not allowed to use the devices. Vernon (Teacher, Class A, September 2009) was particularly keen to access the netbooks as much as possible, particularly towards the end of each term when the students were completing a variety of assessment tasks. He stated that:

When I need the students to complete work quickly for their folios I send them down to Ursula and ask if we can use the netbooks.
The emphasis here was clearly on the completion of the task rather than on the potential educative advantages of computer use for collaborative or creative endeavours (see Selwyn et al., 2009).

My classroom observations, pre- and post- the netbook usage period, confirmed what I have observed over many years as a Deputy Principal, namely that computer usage in classrooms with only three or four computers is largely ad hoc. Furthermore, the computers were primarily used as a tool to improve the presentation of already written and edited texts. This point was clarified by comments from teachers and students in the research:

   I have only used the computers at the back of the room once so far this year to finish my story. Paige (Student, Class C, April 2009)

Similarly, Neville (Teacher, Class C, April 2009) said:

   If we need to do anything else we normally go to the lab, but most of the time it is in here for those two things, good copies of work and research. (see Coulter, 2001)

If the primary purpose of computers in schools is the improved presentation of work, then it is perhaps a better use of valuable student and teacher time that this work is completed at home. This is an appropriate strategy to consider as home computer access for these students is approximately 95%. The pre and post test observations indicate that computer usage is minimal in terms of time and low in terms of educative value. A key interest in this research, therefore, is to observe whether the availability of 1:1 or 1:2 access results in computer usage moving from marginal to mainstream both in terms of computer usage and also in terms of how the students use the devices.

5.1.3. First and Second Order Barriers.

A final consideration in the analysis of the existing conditions before the use of the netbooks, and also throughout the period of their usage, is a brief comment in relation to the schools overall ICT Infrastructure as the failure of technology programs in
schools is often a result of First Order Barriers (Ertmer, 1999) including lack of access, inferior equipment, or the unreliability of the network infrastructure network (Hill & Reeves, 2002; Yamagata-Lynch, 2003). Although there were minor issues at the research site which require attention, the school has established a robust infrastructure to support a movement towards wireless, mobile technologies. Consequently, for the teachers in this project, First Order barriers were either eliminated, or at least kept at a minimal level. This point is noted by Vernon who was the first teacher to receive the netbooks:

So far the introduction of the netbooks has been reasonably easy from a technical point of view. (Vernon, Teacher, Class A, March 2009)

As a consequence of this strong technical infrastructure provided to the classes studied, the factors affecting usage in this study were primarily Second Order barriers (Ertmer, 1999) that are intrinsic to teachers and encompass their underlying beliefs about how students learn and how teachers teach. Second Order barriers include, as noted in the study by Franklin (2007), curriculum demands, assessment pressures, and lack of time. These barriers were also identified as issues by teachers in a study of Primary school use of ICT in English schools (Selwyn et al., 2009). In addition, the general disposition of the teachers involved to incorporate ICT into their pedagogical practice is a Second Order barrier (Garthwait & Weller, 2005). Second Order barriers, as they are generated at the level of individual subject, are identified in this chapter as a key contradiction in the dialectic between teacher control and student netbook use. These contradictions between the individual subject and the broader classroom environment are explored through the conceptual and methodological lens of Activity Systems.

5.1.4. Activity Systems Prior to and Post Netbook Usage

Whilst each of the classrooms were unique learning environments, they shared enough similarity in their use of computers for them to be characterised using a Generic Activity System, as shown in Figure 5-1, which depicts the classrooms prior to and after the use of the netbooks. In describing the classrooms in this study, the six activity systems nodes are utilised; Object, Subject, Tools, Community, Rules and Division of Labour. The discussion relating to these classrooms, and how they
changed as a consequence of the use of netbooks, will be articulated in relation to the contradictions, tensions and expansions (Engeström, 1987) evident within the six interrelated elements of the Activity System. Tensions between Activity System nodes are indicated by the bi-directional red arrows.

The object of the four classroom environments primarily involves the completion of a range of tasks to achieve the attainment of curriculum outcomes as prescribed by the Queensland Studies Authority (QSA) and also the social, emotional, physical and spiritual development of students in a Catholic context. The subjects in the setting were the teachers and the students. The teachers brought differing levels of Technological, Pedagogical and Content Knowledge (TPACK) (Mishra & Koehler, 2006) and each of the subjects had individual beliefs about learning and teaching. Tools in the environment included the structuring of the physical environment to achieve learning outcomes, textbooks, workbooks and four desktop computers. The community context is a Queensland Catholic primary, registered as an educational entity. Rules include specific procedures for each classroom and generic policies and procedures across the cohort and the school. It also includes Queensland College of Teachers (QCT) rules governing curriculum, assessment, teacher registration and
professional standards. Division of Labour is exercised by the allocation of roles and responsibilities to classroom teachers, specialist teachers, administration and other support staff.

In terms of tensions and contradictions in this model, the concern here is with those tensions which relate to computer use, and primarily access to computers. The lack of access means that computers were seen as an addition to ‘normal’ schooling and their use tends to be limited to rotational activities where students type up pre-written stories. The majority of students in the study, prior to netbook usage, reported access of about 30 minutes per week and were resigned to completing most of their computing requirements at home. As far as the teachers were concerned, the lack of access meant that curriculum and assessment tasks did not require the integral use of technology other than as a tool to improve the presentation of work. These historical uses of computers, and the general attitude that computer use at school is not critical to learning (Weston & Bain, 2010), were carried over by the teachers and students into how the netbooks were used.

By way of clarification, the activity systems represented pictorially as models in this thesis reflect my understanding and my experience of the contexts under study. These models are used in an attempt to represent and communicate these varied understandings. These models became the conceptual tools with which, and by which, I explore and explain my findings (see Angeli, 2008). In the remainder of this chapter, a number of specific Activity System models are used to focus on the contradictions and tensions which resulted from the use of the netbooks in the classrooms as a means of addressing my research questions.

5.2. 1:1 Access to Netbooks and their Actual Use by Students

This research question is concerned with establishing what factors influenced whether or not ubiquitous or near ubiquitous access to the netbooks equated to ubiquitous use of the netbooks. Two of the four classes had ubiquitous access - 1:1 availability of the netbooks. The other two classes had 1:2 availability - one netbook per two students. The second question sought to determine whether varying the pattern of usage or
varying the ratio of netbooks to students affected the quantum of their use. Each of the four Year 7 classrooms had access to the netbooks for 30 school days – Class A and Class D had 1 netbook per student to use and Class B and Class C had 16 netbooks to use. Therefore, the usage times displayed in Tables 5-1 to 5-4 indicate netbook usage times, and not necessarily individual student usage times. In some instances, two or more students worked collaboratively on the one netbook. On other occasions, the students worked individually on the netbooks. The predominate mode of use in the classes with 1:1 access, when the netbooks were used, was one student per netbook, that is, there were very few occasions that some netbooks were left in the trolley and students shared devices to work collaboratively on a task.

Before examining the data about the quantum of usage across the overall cohort, it is necessary to contextualise the findings. When compared with the level of computer use prior to the introduction of the netbooks, computer usage for the students in each class increased significantly as a result of the availability of the netbooks. The usage increased from an average of 30 minutes per student per week without the netbooks to between 60 - 90 minutes average usage per student per day with the netbooks. This represented an increase in computer usage of the order of 500%. The availability of access to computers clearly resulted in a substantial increase in computer usage for these students. The students and teachers spoke positively of the increased access to computers:

Absolutely, the netbooks have been a massive boost to the kids and to computer usage by the kids. (Vernon, Teacher, Class A, June 2009)

When we have the net books we can research easily without having to wait for a computer lab time or going to other classes to use the computers. (Student, Class A, April 2009)

It’s useful having the netbooks, because they allow us to do our assignment work in the classroom without having to fight for the computers that we have if we are unable to go to the computer lab. (Student, Class D, October 2009)
These comments indicate that whilst usage has increased, the focus of this usage mirrors computer use prior to the netbooks, that is, research and productivity. In this sense the use of the computers does not transform learning patterns to be, for instance, more individualised or less structured but rather reinforces the patterns of learning which existed prior to their use (Selwyn et al., 2009).

This increase in usage was relatively consistent across all four classrooms regardless of their pattern of access and hence it is not an effect of teacher preference. The data did, however, indicate that regardless of 1:1 or 1:2 access, the two classrooms with three days per week access over ten weeks recorded higher levels of netbook use. What was also evident from the data, and supported by comments from the respective teachers, was that there were still significant increases in computer usage in the two classrooms which only had access to 16 netbooks. To illustrate, Neville commented that:

Even just having the sixteen is a massive increase in computing access and it changed the way I did things. (Teacher, Class C, May 2009)

I discussed this point further with Neville and he indicated that having the access to the computers meant that if an opportunity arose to support student learning via the use of ICT, then the netbooks were available and the activity could continue without the disruption of moving to the lab or sending students to other classrooms. This perspective was common to all four teachers. Although the availability of the netbooks resulted in a significant increase in usage, in relation to the overall availability of the netbooks, usage was low across the cohort.

![Mean Daily Use Per Netbook in minutes and as a percentage of available time](chart_image)
Figure 5-2 illustrates daily netbook usage per class in terms of time used and also as a percentage of available time. Whilst the netbooks were potentially available for 5 hours (300 minutes) per day, the average usage per netbook per day were as follows: Class A (Average daily usage was 54.54 minutes per day or 18.18% of the school day; Class B (Average daily usage was 90.44 minutes per day or 30.15%); Class C (Average daily usage was 56.10 minutes per day or 18.7%); and Class D (Average daily usage was 63.97 minutes per day or 22%).

From these figures it is clear that full time or near full time access to computers did not result in ubiquitous computing use of the netbooks for these students. Despite the substantial increase in computing access available to students, actual computer usage was very limited. As illustrated in figure 5-2, the range of usage, as a percentage of available time, was 19% – 31% with 22.5% being the mean daily usage across the four classes. What this indicates is that the devices were only utilised for approximately 20% of the available time in three of the four classrooms, and approximately 33% of the time in the fourth classroom, during the 30 day trial. These findings are comparable with the findings of Russell et al. (2004) who reported usage of 15-60 minutes per day in classrooms which shared computer access and usage of between one - two hours in the 1:1 classrooms. They are at the lower end of usage time when compared to those reported by Bateman and Oakley (2009). The primary reasons for the non ubiquitous usage in this project relate to three themes: i) lack of time due to a crowded curriculum; ii) the TPACK level of the teachers; and iii) the historicity of tool use.

5.2.1. The Crowded Curriculum

The experience of teaching in Year 7 classrooms is that significant amounts of direct contact with a class of students is lost due to reasons including Non-Contact Release Time, Planning Days, School and Year Level Assemblies, Inter and Intra School Sport Commitments, and Extra-curricula or School Leadership activities. These interruptions are exacerbated in this particular research context due to the decision of the teachers to implement mathematics groups, as students were organised into ability groups for mathematics for four, 1 hour lessons per week, and by rotational Key
Learning Area (KLA) activities whereby, every Wednesday, each teacher teaches the same KLA based lesson, for one hour, to the other three classes. Vernon calculated that each teacher only has face to face contact, with their ‘home’ class for just over three days per week. The other teachers agreed with this assessment:

> The timetable does not allow full time use of the computers because Wednesday is out due to rotations and Friday is out because of sport so even getting three days is hard enough. (Wendy, Teacher, Class B, June 2009)

> Today we had Library, Maths, French, emptied and returned the paper bins, Music. After lunch we have to do the rubbish bins! (Jasmine, Teacher, Class D, February)

In visiting the classrooms during the project it was a common occurrence to witness these interruptions or discover that smaller groups of students were absent from the classroom completing individual or small group elective activities such as Piano, Band, or Speech and Drama.

Whilst the option existed for the teachers to use the netbooks in the KLA rotations and Maths groups, this option was not exercised to any significant extent by any of the teachers (see Bebell & Kay, 2010). Reasons cited for this lack of use include the size of the mathematics group in relation to availability of netbooks, lack of knowledge as to how to use the netbooks in specific content areas such as Science or SOSE, too much curriculum to cover in the hour dedicated to the specific KLA, and assessment requirements for the KLA not conducive to the netbooks. These reasons coincide with the factors suggested by (Franklin, 2007) for low computer usage in American schools. It is the case in this context, that the teachers perceived the computers as an additional disruption to the daily activity in the classroom and that to facilitate their use would require a change to their pedagogic practice and also the broader pedagogic practices of the school. This barrier to greater use in the classroom is conceptualised in terms of TPACK.
5.2.2. TPACK Capabilities and their Impact on Netbook Usage

The Technological, Pedagogical and Content Knowledge (TPACK) model attempts to capture some of the essential qualities of knowledge required by teachers which enables them to integrate technology into their practice. Central to this framework, is the complex interplay of three primary forms of knowledge, namely Content Knowledge, Pedagogical Knowledge, and Technological Knowledge (see Figure 2-1).

A common theme in any discussions with the teachers is that they would have liked to have completed a greater range of activities with the students, but were restricted in doing so by the time constraints noted above and also by the self-reported lack of knowledge of what could be done with the netbooks to enhance the learning experience of the students:

I guess I was limited in what I could do and I would like to learn more.
I need to know more as to how to use IT for teaching using different programs which is why I have signed up for that in-service later in the year. (Vernon, Teacher, Class A, April 2009)

There was also a lack of urgency by Vernon and Neville to improve their technological knowledge. The reason cited, and understandably so, was that they only had the netbooks for six weeks and therefore it was not a productive use of their time to develop their skills. Both Wendy and Jasmine, who had the netbooks for 10 weeks, more willingly invested time into the exploration of new ways to use the netbooks. Whilst all four teachers recognised the benefits of the netbooks to engage students, and also in making many teaching tasks more efficient, they also acknowledged that it takes time to learn how to teach well when every student has a computer (Zucker & King, 2009).

The lower levels of Technological Knowledge, and the short period of netbook use also contributed to the lack of innovative use of the netbooks. The netbooks were primarily used in productivity tasks and data logs indicate almost daily use of Microsoft Word, with some use of PowerPoint and Publisher but minimal use of any
other software such as Excel, Moviemaker or PhotoStory. In terms of research, the students primarily ‘Googled it’, or used Wikipedia for their information sources. This usage is not dissimilar to usage reported in the literature regarding ICT use in classrooms which suggests that teachers predominantly focus on Internet and word processing functions (Coulter, 2001).

Comments from the teachers included:

They have mainly been using them to research their Victoria Cross Winner, and researching for their Alien exposition. They have also used them to research internet sites for political cartoons as part of the government unit. (Wendy, Teacher, Class B, June 2009)

The Internet early on when we are collecting information for the project and then later on the productivity type tools at the end to present their information. (Neville, Teacher, Class C, June 2009)

Student reaction to this lack of innovation was mixed:

I think the netbooks were really fun and good to use and there would be nothing I would change about them because I like to use them the way I use them now. (Student, Class B, July 2009)

I would have liked to take them to French and done more creative things with them, for example, creating pictures on paint and other programs. (Student, Class D, October 2009)

The limited innovation in terms of netbooks usage reflects both the crowded and increasingly limited nature of the curriculum and also the low level of Technological Knowledge as compared to Pedagogical and Content Knowledge dimensions of TPACK (Selwyn et al., 2009). The tensions and contradictions caused by the availability of the netbooks, and which are representative of all four classrooms in this project, are represented in Figure 5-2.
5.2.3. Generic Activity System for Netbook Usage

As indicated earlier, the netbooks are not considered integral to the educational practice of these teachers, consequently a tension results as they became an additional element to be slotted into what the teachers were already doing (rather than being a given component of the system such as desks or pens of textbooks). This observation complements findings from other research (Bateman & Oakley, 2009; Penuel, 2006) which suggest that computer usage in 1:1 computing environments is strongly correlated with how closely that usage can be aligned with curriculum requirements.

For Jasmine and Neville, the netbooks were not critical for learning and they could largely operate equally well without them:

I think I am lucky with the timing of them as we are almost at the end of the year and the tasks that they still have to complete do not really need a lot of computer access. So in that sense I don’t need them.

(Jasmine, Teacher, Class D, October 2009)
If the kids need access we go to the lab or we borrow some of the netbooks from Jasmine but it is early in the term so we don’t have a lot of use for them so I haven’t been chasing them so hard. (Neville, Teacher, Class C, October 2009)

This approach to computer usage can minimise improvements in student outcomes as their potential for any widespread effect on teaching and learning is co-opted, diluted and ultimately diminished (Weston & Bain, 2010).

This certainly reflects that, for these teachers, the Technological Knowledge component of the TPACK model is the least important element in their teaching practice. TPACK largely involves the top triangle of an Activity System – namely Subject, Tool and Object. The primary relationship appears to be that of how the subject, in this case the teacher, uses TPACK in an interrelated way to utilise the tool to achieve the object. In this study, because the new tool was a digital device rather than, for instance, a new curriculum initiative, the particular focus was on Technological Knowledge. For the majority of the netbook usage period, the object was largely student productivity. Productivity was a recurrent theme in the data and was clearly articulated by both students and teachers. Almost all of the students interviewed commented first and foremost that they were more motivated to complete the work with the netbooks (see Silvernail & Lane, 2004), and that the netbooks helped them complete more work, and to a higher standard:

It has helped us to do our work faster and better. The netbooks have been a privilege for us and an advantage. We have been ahead of everyone with the netbooks. (John, Student, Class A, April 2009)

It was really fun and nearly 100% of us were consistently working on what we needed to finish. (Student, Class C, June 2009)

When they have a task that they can be self-directed with, and that they are into they do tend to focus pretty well and increase the amount of work they produce. (Neville, Teacher, Class C, May 2009)
The use of netbooks resulted in improved presentation of student work and also an increase in the amount of work which was completed. As discussed further in Chapter 6 there was also evidence of increased student motivation to work and also improvements in student behaviour and student motivation. Just as clear, however, was that the netbooks were used to reinforce existing work practices rather than generate new ones.

Whilst the top triangle in an Activity System (Subject, Tool, and Object) is critical, Groves and Dale (2004) warn that an overemphasis on this triad can partially explain why technological innovations sometimes fail in schools. They suggest that focussing on the top triangle of the model diminishes the impact of Community, Rules and Division of Labour. In this case, the low netbook usage is also explained by tensions between Rules and Subject (for example Guidelines stating curriculum and assessment requirements) and Division of Labour and Tool Use (such as the role of the teacher in a 1:1 netbook classroom). These notions become particularly critical once the pattern and level of access are manipulated and are discussed in relation to research question two later in this chapter.

5.2.4. Historicity of tool use

A third significant tension, which existed regardless of how the netbooks were accessed, pertained to the historicity inherent in the computer as an educational ‘tool’. In Activity Theory, both the physical tools, such as the netbooks, and mental tools, such as the strategy employed by the teacher to direct their deployment, are critical components. Because of their physical and mental attributes, tools shape both the external behaviour of subjects as well as their internal mental processes. Any tool is, at the same time, both enabling and limiting, as it empowers the subject in the transformation process with the historically collected experience and skill ‘crystallized’ to it, but it also restricts the interaction to be only from the perspective of that particular tool or instrument (Kuutti, 1996).

This historicity of tool use is evident in the ways that teachers have traditionally used computers in their classrooms (Buell, 2003). These historical factors include the pedagogical preference of the teachers, their prior experience with computers as a productivity tool, and the structure of curriculum and assessment tasks. Whilst there
have often been tensions in relation to computer use in classrooms (for example access or how to incorporate there use into the curriculum), the past experience of computer use by these teachers has largely been of computer use being supplementary to their practice. The introduction of 1:1 computing therefore caused significant tension.

The initial response of the teachers was to attempt to use the netbooks in the same manner as they had historically used the classroom computers which was in the production of a range of artefacts to demonstrate student learning. This resulted in a tension for the teachers as they determined how to achieve their previously established educational goals whilst incorporating netbook usage. In some cases, rather than creating a new activity in light of the availability of the netbooks, an existing activity was selected and the use of the netbooks imposed over the top of this activity. Alternatively, activities were deliberately chosen only because the netbooks were available:

> I would use them when the circumstances arose if they were there all year. Now I am planning circumstances just to more often use them. (Neville, Teacher, Class C, May 2009)

In other cases, the advantages of the netbooks, primarily the increased productivity of the students, shaped the decision making of the teacher:

> They are probably using the netbooks now as a tool to achieve an end so there is not much discussion happening at the moment. They are at the productivity end of the program. (Jasmine, Teacher, Class D, October 2009)

> They got these projects done in an hour. You don’t get that without the netbooks. (Vernon, Teacher, Class A, October 2009)

The potential of the netbooks to influence the classroom environment was also limited by historicity of practice as in the case of curriculum and assessment rules which prescribe what is to be taught and how it is to be reported (Selwyn et al, 2009).
During the netbook usage period, Vernon (Teacher, Class A) wanted the students to submit their work electronically rather than in hard copy. He was effectively prevented from doing so by a school requirement that the students prepare a portfolio of their work for the parents to view during Parent Teacher interviews. As a consequence of this historically constructed ‘rule’ the students were required to print out work for these folios which in turn limited the types of activities which could be completed on the netbooks. This aspect of historicity of tool use reappears again in the discussion of productivity and social activity.

5.3. **Netbook Usage in Relation to Patterns of Access**

It may be the situation in some primary schools that, due to financial constraints, netbooks have to be shared between two or more classrooms resulting in either a 1:2 access ratio, or a 1:1 ratio for 2 or 3 days per week. The second research questions investigates the impact of varying the ratio of netbook availability – from 1:1 to 1:2 or varying the pattern of availability - 5 days per week for 6 weeks versus 3 days per week for 10 weeks on student usage in terms of quantum (as a ratio of available time) and modes of use? The answer to this question will assist schools in determining an educational viable level of computer access to support student learning.

Over the course of the study there were three distinct periods of usage for the one class set of netbooks purchased by the school. In the first 6 week period of usage, Class A had all of the netbooks all of the time. In the second period of usage, Classes B and C shared the netbooks using 16 netbooks each (Class B for 3 days a week for 10 weeks and Class C for 5 days per week for 5 weeks. In the third period of usage, Class D used all of the netbooks for 3 days per week for 10 weeks. The use of the 32 netbooks over the three, 30 day periods is represented in Figure 5.4.
The information presented in Figure 5-4 illustrates that the set of 32 netbooks shared between two classrooms was used, on average, for 10 hours more per day than Class A and 13 hours more per day than Class D. This suggests that from a quantum of usage perspective, the devices were used for longer periods of time in the classrooms which shared the devices than in either of the classrooms which had access to the whole set. Based on this information it could be argued that schools get increased value for their money in only providing a ratio of 1:2 as this minimises the amount of time the devices remain unused in the trolleys. The economic rationale for provision of computers is only a component of determining the overall ‘relative advantage’ (Roblyer, 2006) of the computers and that the educational efficacy of the various models is also critical. The impact of the shared netbooks on student productivity, teacher control and individual learning is discussed further when the findings from the qualitative data is presented and implications considered.

Whilst overall use of the netbooks was relatively low, each class used the netbooks for varying amounts of time. There were also variations across the four classes in how these varying amounts of time were used. For example, Class A used the netbooks for an average of just under 1 hour per day but on some days used the netbooks for 3 hours and on other days for 15 minutes. On some occasions, Class B used the netbooks for one session of two hours and then not at all for the rest of the day and on other occasions used the netbooks three or four times on one day for periods of 30 minutes at a time. This variance is partially accounted for in terms of the crowded curriculum but also reflects the particular period of time the netbooks were used. For
example, towards the end of units of work the netbooks were used heavily for productivity tasks. The following analysis presents data in relation to the total usage and pattern of use and is expressed in terms of the minimum, maximum and mean usage for each class.

![Max, Min, Mean Daily Use Chart]

Although a large range of usage was evident across all four classes, Class B and Class D which had three days per week access, were most consistent in their usage and there were no days in which the netbooks were not used, as opposed to Class A and Class C which had 5 days a week access, which both recorded days where the netbooks were available but not used at all. The primary reason for this consistency might be that Classes B and D were better able to avoid the external interruptions to classroom teaching time which occur as they could plan which three days each week they would use the netbooks. For instance, they could check the school calendar and establish when external class events were held; for example, sports carnivals, NAPLAN testing and school retreats and then elect not to use the netbooks on those days. This was not an option in the two classes with access 5 days a week and so there were days when...
the netbooks were not used due to the types of disruptions noted above. As Neville commented:

The timetable does not allow full time use of the computers because Wednesday is out due to rotations and Friday is out because of sport. (Teacher, Class C, May 2009)

If a school is fortunate enough to be in the situation where each classroom has a set of netbooks then none use due to external classroom events is not a particular problem, other than the problem of having a valuable resource effectively unused for up to 40% of the time. In this school context, which is likely indicative of many schools, the netbooks will be used as a shared resource between classes. It is therefore necessary to establish the best pattern of access to minimise the amount of time the netbooks were unused.

The data collected from the logon scripts also indicated that some of the netbooks remained unused during periods of netbook usage. Over the 30 day period, on average, 2 netbooks remained unused daily in Class D and 3 unused in Class A. In contrast, Classes B and Class C with their allocation of 16 netbooks, never had individual netbooks unused used if a netbook related activity occurred. These data highlight a potential problem regarding the allocation of a class set of netbooks. That is, there are very few school days where all of the students are present at school, or even if they are all present at school, that they are all present in the classroom during the periods of netbook use. This is due to other commitments at school, such as extra curricula activities, and attendance at learning support. Consequently, there will often be instances where netbooks are not utilised. Once again, in schools where technology budgets are tight, it is important that devices deployed to classes are used to the best of their potential and are not left sitting unused in the storage trolleys.

Data presented thus far indicate that the average use of the netbooks was approximately 60 per day for three classes and just over 90 minutes per day for a fourth class. Over the course of the 30 days, usage fluctuated. On some days, the netbooks were not used and on other days they were used significantly. Table 5-4 presents data which indicates the variety of daily usage across all four classrooms. For
example, netbooks were used for less than 30 minutes a day for 15% of the time they were used.

The data presented in Figure 5.6 indicates that the predominant daily use of netbooks was between 30 minutes and 90 minutes (61%) and that the devices were used between ½ hour to 1 hour, 33% of the time. On many occasions, the netbooks were only used once per day. In these instances the percentages depicted in Figure 5.6 represent a single session of usage for that day. There were minimal occasions when the devices were used for more than 2 hours in a day, but a significant number of occasions when they were used for less than 30 minutes per day. The rare occasions of more than 2 hours use often occurred on days where sport or other scheduled events were cancelled and the teachers had time to catch up on ‘missed’ classroom time.

It has already been suggested that disruptions to the school week in terms of whole school events, such as Athletics carnivals, impact on overall netbook usage. There were two additional factors which contributed to the use of netbooks for between 30
minutes to 90 minutes per day. Firstly, school organisational matters, namely School Assemblies, Maths Rotations, and Non-Contact Release, which interrupted class teaching time in all four classrooms. Secondly, it was noted by both the teachers and the students that 60 – 90 minutes in one session was the most that the students could concentrate using the netbooks:

You get a headache if you use them too much and you cannot concentrate after you have used them for an hour or so. (Lance, Student, Class D, October 2009)

Teachers were therefore conscious not to use the netbooks for sustained periods of use. Students were keen to use the netbooks for shorter periods in each session (before Morning Tea, between Morning Tea and Lunch, and after lunch), rather than a sustained use only in one session, but this was often not possible due to the timetabling issues noted previously.

Collectively, the findings presented in Figures 5-2, 5-4, 5-5, and 5-6 indicate that the netbooks were used for different amount of times by the four classrooms and that the manner in which this time was utilised also varied. The following sections discuss why this might have been the case and establishes whether or not the varied patterns of access might explain the discrepancies in their use or whether there were other factors at play. What is suggested from these figures, despite some differences in the amount of their use, with only Class B being substantially different, is that 1:1 computing, when defined as being each student using a learning device to support their learning, is present in terms of access, but clearly not being realised in practice. The following reflections explore this incongruence between intention and implementation and, through the use of Activity Theory, offer possible explanations as to why such limited use occurred. In discussing these findings, further reference to the findings of other studies which investigated 1:1 computing is made, such as that of Russell et al., (2004) which examined the impact of varying levels of computing access.
5.4. Availability affects Usage Patterns – an Activity Theory Perspective

The data presented above suggests that the pattern of access influenced different levels and modes of use. The focus here is to further analyse why there were differing levels and modes of use to clarify whether these differing levels of use were mainly a consequence of the level of access or whether specific factors operating in each of the classrooms were the primary cause of variations in usage. (Figures 5-7, and 5-8) will be used to discuss these factors. Although there were similar tensions and contradictions evident in each of the classrooms, as indicated in Figure 5-3, there were also very specific tensions which resulted from the differing levels of access. Consequently, the classrooms with access to 32 netbooks experienced a different range of tensions and contradictions (Figure 5-7) than the classrooms which had access to 16 netbooks (Figure 5-8).

In analysing the data, three models of netbook usage were evident. For consistency in referring to these three models, they are referred to as 1:1, 1:2 and 1:1-1/2. Reference to 1:1, indicates that each student in the class used a netbook individually; 1:2 indicates that two students worked in a pair using one netbook; and 1:1-1/2 indicates situations where half the class were using the netbooks on an individual basis whilst the other half of the class was completing a non netbook activity. Apart from very rare occurrences, these were the three modes of netbook usage in the study.

5.4.1. Netbook Usage in the 1:1 Classrooms

The contradictions evident in the two classrooms with access to 32 netbooks are largely a result of the teachers’ decision to use the netbooks as ‘digital textbooks’ whereby the students all use the computers at the same time, for the same task and often from the same, or narrow, range of webpage(s). This is confirmed in the data logs for these classrooms which indicate that either all of the netbooks were used, or none were used. The teachers would decide which activities required the netbooks and usage would only occur for a specified time, to directly support these activities. The decision to use the devices in this manner is shaped by the historical factors mentioned previously; that is, computers have historically been used as productivity tools for typing or research, and also by the pattern of access to the computers in these
two classrooms. Figure 5-7 provides a representation of the contradictions which occurred in the two classrooms with 1:1 access.

![Figure 5-7 Activity System – (1-1) computing access](image)

The availability of 32 netbooks was very influential in how the netbooks were used and the unlimited access to the devices was a significant determinant of the pattern of use. The unlimited availability of the tool shaped the behaviour of the subject(s). To summarise the attitude of the teachers to 1:1 computing, the thought processes seemed to suggest the following pattern: (I have access to enough computers so that each student can use one simultaneously, therefore, regardless as to whether an activity might be better conducted in pairs or in groups, it will be completed individually by the students). The trajectory of netbook usage in Class D is a clear example of the substantial influence of the tool on the relationship between the subject and the object.

Despite having access to 32 netbooks, Jasmine initially used the netbooks to support her normal pedagogic practice which is largely based on group activities. The netbooks were used by the students, at different times during the day, and for specific group rotational tasks. This pattern of usage lasted for just under four weeks. For the last six weeks of her usage, she reverted to the pattern of usage noted in Class A; that
is, each student used a netbook individually, at the same time and for the same task, for an hour or so a day. I discussed this change in usage with Jasmine (Teacher, Class D, September 2009) during an interview and her reply was very illustrative of the influence tool availability has on pedagogy:

I have the 32, the kids want to use them and they get a lot done with them, open them up and let’s go.

This point was restated in the final interview:

As I said before, if I had 32 I would use them, but value wise and effects in the classroom wise, I think 16 is the best. (Jasmine, Teacher, Class D, October 2009)

This pervasive influence of the 32 netbooks was also noticed by Neville and Wendy who each received 16 netbooks. In an interview with Neville the likely impact of 32 netbooks in his classroom was discussed:

I think having access to 32 computers may lead to a deterioration of my teaching as I might spend 5 minutes speaking to the kids in the morning and then getting them to research a project… it would be very tempting to use the 32 as it frees up my time and also the kids are very keen to use them and are productive and on-task when they do so. (Teacher, Class C, October 2009)

Likewise, in relation to ubiquitous access, Wendy noted:

The students would not have worked together in pairs – I would have felt that I had to use the 32 computers because I would not have wanted to waste them. (Teacher, Class B, October 2009)

It appears that for these teachers, the availability of the netbooks meant that activities would be planned where all students could use the netbooks and other activities where no one used the netbooks. Student autonomy in deciding whether or not to use the
netbooks was largely non-existent. The impact of this lack of autonomy is discussed at a later date in this thesis.

Social interaction between students in Class A and Class D during netbook usage, perhaps as a consequence of the availability of 32 netbooks and their use in the productivity oriented manner noted earlier, was almost non-existent. This was not seen as a significant drawback by the students or by Vernon, but was considered as a negative by Jasmine. Again, historicity comes into play; computers have been used at school as a tool for work rather than as a tool for creativity of collaborative work. As the netbooks were only used for about an hour a day, the students wanted to get ‘stuck in’ and complete the work which otherwise would have become a homework computing task. The 1:1 students did not experience the advantages of paired work on the netbooks, as reported by students in the 1:2 classroom, and so were perhaps unaware of the benefits of other forms of access. The use of computers in a 1:1 pattern has, therefore, implications on social aspects of classroom life and must be considered in any decision making regarding computers and student learning.

5.4.2. Netbook usage in the 1:2 Classrooms

It has already been noted that the presence of the netbooks in the classrooms was a major contributory cause of the contradictions which developed in the activity system. The contradictions which were directly related to the reduced availability of the netbooks were particularly felt in the two, 16 netbook classrooms and are represented in Figure 5-8.
Although contradictions regarding netbook usage were also identified in the 1:1 classrooms, for example, relevance to the curriculum; needing to complete assessment tasks, they were more easily reconciled by teachers of Class A and Class D as the 1:1 netbook usage did not require a fundamental change to their pedagogy, particularly as they were used in this study (see Bateman & Oakley, 2009). However, in Classes B and C, the limited presence of the tool necessitated a fundamental change to the dynamics of the classroom. Both teachers were cognisant of this disruption to their teaching:

A critical factor of the 16 computers was that it ‘forced’ me to at least plan two different activities for the students to complete and in the ideal situation ‘forced’ me to teach the 16 students whilst the other 16 students worked on the computers. I am doubtful this would have happened if we had 32 computers. (Neville, Teacher, Class C, June 2009)
The limited availability of 16 netbooks meant that Neville and Wendy were not as 
easily able to integrate the technology into existing classroom pattern as had been the 
case with Vernon and Jasmine. In these classrooms a clear disruption had been caused 
which required a pedagogic response.

5.4.3. New Pedagogical Approach Required

How the teachers in Class B and Class C responded to the presence of 16 netbooks 
has implications for the future use of netbooks at the research school. Their pedagogic 
decisions in response to the device allocation had significant effects on Teacher 
Control, Teacher Support, Student Involvement, Student Affiliation, Rules, and 
Division of Labour. Both Wendy and Neville used the 16 netbooks in either a 1:2 or 
in a 1:1-1/2 pattern. If they wanted the students to work on a productivity type task, 
for example, typing an assignment or writing a letter to the Principal, then the 1:1-1/2 
model was deployed with the teacher working with one half of the class whilst the 
other half worked individually. The students would then swap over and the teacher 
would repeat the activity. If the teacher wanted the students to search for information, 
or begin the brainstorming for a new task, the students would work with a partner on 
the netbooks in a 1:2 model of usage.

The 1:1-1/2 model of use was considered very successful by both students and 
teachers. Student comments included:

I like working with partners on the netbooks. I just feel comfortable 
using them this way. (Paige, Student, Class C, June 2009)

We know each other a little better. We made a lot of friendships with 
the netbooks because we were with people we did not know. Term 
Two with the computers helped change how we are with our teacher 
and with each other. (Kirstene, Student, Class B, May 2009)

Likewise the teachers noted:

I think the partner motivated them…. some kids could lose their 
motivation without the pairs. (Wendy, Teacher, Class B, June 2009)
I have found with the netbooks that the kids are, within the pair especially, sharing ideas and learning together and talking a bit more and discussing what they are researching. (Neville, Teacher, Class C, April 2009)

The sharing of ideas and collaborative learning mentioned in these comments from the classes with 1:2 access was absent in the 1:1 computing scenarios.

The netbooks appeared to motivate Neville to move towards a new form of pedagogy and helped Kerry move her class towards a pattern of teaching and learning which she felt most comfortable with. Ironically, although the netbooks caused a contradiction which needed resolution, they were also instrumental in being a part of the solution. Both Wendy and Neville indicated that the netbooks were critical in the students being able to work independently, and remain on task, whilst they taught the second half of the class. In the case of Class B, the positive transformation in the classroom environment continued after the use of the netbooks had ceased:

They have come a long way since the beginning of the year in terms of them being able to work independently. I could not do this at the start of the year and I think that the netbooks were very important in putting them into that mode. I have a feeling that the netbooks got them used to working in that model. (Wendy, Teacher, Class D, October 2009)

In this classroom in particular, the presence of the netbooks was a catalyst in the transformation of the classroom from a largely static, teacher directed classroom to one where the students were more involved in their learning.

In summary, the impact of the tools was felt across all the classrooms; in a minimal way in Class A, somewhat more so in Class C and Class D, and quite substantially in Class B. The contradictions to the four classroom systems were largely a result of the patterns of access and availability of the netbooks. Class B received 16 netbooks and had them for 10 weeks. This combination, that is the 10 week period of use and the observation that the netbooks were used primarily in the 1:1-1/2 model, was perhaps a
key as the transformative effects noted above did not occur as markedly in Class C (16 netbooks for 6 weeks) or in Class D (32 netbooks used for 10 weeks). The access pattern for Class A was the most limiting in terms of creating potential contradictions as this classroom had all of the netbooks for a 6 week period. It was previously suggested that a concern with Activity Theory, is that the agency of individuals is potentially diminished (Billett, 2006; Daniels, 2008). If this discussion of netbooks usage ceased at this point, the impression could be that it is solely the pattern of allocation (16 or 32 / 6 weeks or 10 weeks) which determined how the netbooks were used. This was definitely not the case, and it will later be explained that the teachers, and also the students, had significant influence in how the netbooks were used in their classrooms. I explore further the human agency of the teachers and the students in Chapter 6 when more qualitative data is presented and analysed.

5.5. The Impact of the Netbooks on the Classroom Environment

The third research question seeks to determine the impact of the netbooks on the four different classroom environments and also their impact on the overall cohort. Data collected from the NCEI is presented. The appropriateness of the NCEI to examine classroom environments has already been established in Chapter 4.

By way of summary, the NCEI was used for two purposes. Firstly, it was a means to gather information directly from all of the students involved in the study and it provided a form of data which could be analysed for statistical significance to the broader population. Secondly, it provided a reference point for subsequent qualitative data collection and suggested initial research themes for further investigation which are presented and discussed in Chapter 4. The eight NCEI sub-scales (Involvement, Affiliation, Teacher Support, Group Work, Competition, Order and Organisation, Teacher Control and Innovation) formed the basis of a number of standard discussion points used in the interviews and forums, helped shape the structure of the student surveys and provided an entrance point into qualitative data analysis becoming nodes in initial NVivo organisation of the data collection. The discussion on the impact of netbooks on classroom environments, commences with an examination of the
correlations found in the NCEI data between the environments the students experience and the environments which they would prefer.

5.5.1. NCEI - Actual and Preferred Environments

In terms of comparing the Final Preferred Environment (the classroom environment the students preferred at the end of the period of netbook usage) with the Final Actual Environment (the actual classroom environment at the end of the period of netbook usage), there were significant differences in all of the subscales indicating that the students’ perceptions of their actual environment were significantly different to what they would prefer. The subscale scores ranged from \( p < .019, r = 0.2 \) to \( p < .000, r = 0.9 \). Whilst the implications of the disparity between preferred and actual environments may be significant, the reasons why this occurred and the impact this had on student learning were not relevant to the answering of the research questions in this thesis and, therefore, are confined to being noted here.

The focus of this study is the investigation of whether or not there was any change in the relationship between what the students preferred and what they perceived was the actual environment during the period of netbook usage. To measure the relationship between the classroom environment which the students preferred and what they perceived was their actual classroom environment, and to determine whether or not this relationship changed over the period of the study, a correlational analysis was performed. Statistical significance is reported using Alpha scores and Spearman’s rho. As the data was ordinal rather than scale, it was not appropriate to use a parametric test such as Pearson's \( r \). Subsequently a non parametric correlation (Spearman’s rho) was employed, which is appropriate for the non-scale data collected in this study (Field, 2005), to test the significance of the relationship between Actual and Preferred environments.

The data from these tests are reported in Tables 5-1 and 5-2. The analysis of the correlational data is presented with the analysis of the dependent \( t \)-tests conducted for the whole cohort and the individual classes. The following tables organise information in the following way. The first column identifies the eight subscales of the NCEI. The columns to the right of the eight indicators display information from the four classrooms and also from the total cohort of students. Each of these columns
compares NCEI data collected from the students at the conclusion of netbook usage with data collected prior to their use. Statistical differences are reported using p-values and effect sizes.
Table 5.1: Measures of Actual and Preferred Environments for cohort and individual classes

<table>
<thead>
<tr>
<th>NCEI Class A (n = 32)</th>
<th>Class B (n = 27)</th>
<th>Class C (n = 31)</th>
<th>Class D (n = 27)</th>
<th>Cohort (n = 117)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p) Value</td>
<td>(r) Value</td>
<td>(p) Value</td>
<td>(r) Value</td>
<td>(p) Value</td>
</tr>
<tr>
<td><strong>Sub-Scales</strong></td>
<td>Involvement</td>
<td>Affiliation</td>
<td>Teacher Support</td>
<td>Competition</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
<td>.383</td>
<td>.888</td>
<td>.406</td>
<td>.026*</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.0</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.114</td>
<td>.133</td>
<td>.196</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.469</td>
<td>.197</td>
<td>.753</td>
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<tr>
<td><strong>r</strong> Value</td>
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<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.807</td>
<td>.818</td>
<td>.227</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Sub-Scales</strong></td>
<td>Involvement</td>
<td>Affiliation</td>
<td>Teacher Support</td>
<td>Competition</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.117</td>
<td>.158</td>
<td>.089</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.4</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.158</td>
<td>.729</td>
<td>.798</td>
</tr>
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<td><strong>r</strong> Value</td>
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<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.200</td>
<td>.629</td>
<td>.126</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.3</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.295</td>
<td>1.000</td>
<td>.970</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-Scales</strong></td>
<td>Involvement</td>
<td>Affiliation</td>
<td>Teacher Support</td>
<td>Competition</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.891</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.009**</td>
<td>.607</td>
<td>.743</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
<td>0.2</td>
<td>0.4</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.905</td>
<td>.905</td>
<td>.601</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>p</strong> Value</td>
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<td>.354</td>
<td>.354</td>
<td>.601</td>
</tr>
<tr>
<td><strong>r</strong> Value</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>

* indicates difference is significant at the 0.05 level (2-tailed); ** indicates difference is significant at the 0.01 level (2-tailed); *** indicates difference is significant at the 0.001 level (2-tailed).
Table 5-2

Measures of Correlations between Final Actual and Final Preferred Environments for cohort and individual classes

<table>
<thead>
<tr>
<th>Sub-Scales</th>
<th>NCEI Class A (n = 32)</th>
<th>Class B (n = 27)</th>
<th>Class C (n = 31)</th>
<th>Class D (n = 27)</th>
<th>Cohort (n = 117)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( p ) Value</td>
<td>( \rho ) Value</td>
<td>( p ) Value</td>
<td>( \rho ) Value</td>
<td>( p ) Value</td>
</tr>
<tr>
<td>Involvement</td>
<td>.436</td>
<td>.104</td>
<td>.002</td>
<td>.568( ^* )</td>
<td>.003</td>
</tr>
<tr>
<td>Affiliation</td>
<td>.184</td>
<td>-.174</td>
<td>.540</td>
<td>.089</td>
<td>.580</td>
</tr>
<tr>
<td>Teacher Support</td>
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<td>.044</td>
<td>.563</td>
<td>.086</td>
<td>.876</td>
</tr>
<tr>
<td>Group Work</td>
<td>.882</td>
<td>-.020</td>
<td>.750</td>
<td>.046</td>
<td>.783</td>
</tr>
<tr>
<td>Competition</td>
<td>.437</td>
<td>.104</td>
<td>.248</td>
<td>.171</td>
<td>.000</td>
</tr>
<tr>
<td>Order and Organisation</td>
<td>.171</td>
<td>.183</td>
<td>.226</td>
<td>.177</td>
<td>.178</td>
</tr>
<tr>
<td>Teacher Control</td>
<td>.365</td>
<td>.120</td>
<td>.003</td>
<td>.495( ^* )</td>
<td>.569</td>
</tr>
<tr>
<td>Innovation</td>
<td>.161</td>
<td>-.186</td>
<td>.149</td>
<td>-.261</td>
<td>.126</td>
</tr>
</tbody>
</table>

\( ^* \) Correlation is significant at the 0.01 level (2-tailed).
5.5.2. Actual and Preferred Environments – $t$-tests and Correlations

The following sections report on findings from the NCEI data comparisons based on dependent $t$-tests and correlational analysis for the whole cohort and for the four individual classrooms. Measures of the Actual and Preferred Environments for the computer cohort and the individual classes, and associated effect sizes, were presented in Table 5-1, with levels of significance between initial and final measures indicated. In terms of the data presented in Figures 5-5 to 5-9, only statistically significant findings are specifically noted.

As indicated in Chapter 4, each of the eight NCEI subscales is represented by seven statements on the questionnaire. Each statement is scored between 1 (strongly disagree) and 5 (strongly agree). Scores for each statement are added for each class and for the cohort and the mean is determined. This mean is between 1 and 5. The means for each of the seven questions are summed giving an overall mean for the subscale with scores possibly ranging from 7 to 35. The higher the score the more positively this sub scale is seen by the students. Two questionnaires (Initial and Preferred Environments) were given twice (Initial and Final). The results from the four questionnaires are depicted in Figures 5-5 to 5-9 using different colours. For consistency sake, the same colour represents the same questionnaire throughout the figures (for example, blue always illustrates the initial actual questionnaire). In Figure 5-5, for example, the students felt that the level of teacher support was less than they preferred and the level of Teacher Control was greater than they preferred. Figures for the computer cohort and the four classes will be displayed and statistically significant differences noted prior to a discussion of the results.
5.5.3. Computer Cohort - Actual and Preferred Environments

Graphical data for the cohort (n = 117) is displayed in Figure 5-9

![Figure 5-9 Mean scores for Computer Cohort using NCEI Questionnaire](image)

As illustrated in Figure 5-9, means for the Initial and Final Actual Environment and Initial and Final Preferred Environment across the computer cohort largely mirror each other with differences between Initial and Final Preferred Affiliation and Initial and Final Preferred Group Work noted at a statistically significant level. In examining these differences the following is noted;

- Students reported a preference for less Affiliation at the conclusion of the use of netbooks (M = 27.96, SD = 4.4) than they reported prior to their use (M = 28.99, SD = 4.0, \( t(116) = -2.707, p<.008, r = .30 \))
- Students reported a preference for less Group Work at the conclusion of the use of netbooks (M = 27.67, SD = 4.4) than they reported prior to their use (M = 28.32, SD = 4.0, \( t(116) = -1.736, p<.085, r = .20 \))
- There was a statistically significant positive relationship between the cohort’s preference for Involvement and their actual experience of Involvement \( p<.000, r = .40 \) with the students indicating a preference for increased Involvement and reporting an increase in their perception of Involvement.
- There was a statistically significant negative relationship between the cohort’s preference for Competition and their actual experience of Competition \( p<.002, \)
$r = .30$ with the students indicating a preference for decreased Competition but reporting an increase in their perception of Competition.

- There was a statistically significant positive relationship between the cohort’s preference for Teacher Control and their actual experience of Teacher Control $p < .033$, $r = .20$ with the students indicating a preference for increased Teacher Control and reporting an increase in their perception of Teacher Control.

### 5.5.4. Class A – Actual and Preferred Environments

Graphical data for Class A ($n = 32$) is displayed in Figure 5-10

![Figure 5-10 Mean scores for Class A using NCEI Questionnaire](image)

Initial and Final actual means and Initial and Final Preferred means largely mirror each other with changes in Affiliation and Group Work noted at a statistically significant level. In examining these differences the following is noted:

- Students reported an increase in Group Work at the conclusion of the use of netbooks ($M = 27.22$, $SD = 3.1$) than prior to their use ($M = 25.91$, $SD = 2.7$, $t$ (31) = 2.337, $p < .026$, $r = .4$)
- Students reported an increase in Order and Organisation at the conclusion of the use of netbooks ($M = 22.84$, $SD = 3.4$) than prior to their use ($M = 25.28$, $SD = 3.5$, $t$ (31) = -2.43, $p < .000$, $r = .70$)
5.5.5. Class B – Actual and Preferred Environments

Graphical data for Class B (n = 27) is displayed in Figure 5-11

![Figure 5-11 Mean scores for Class B using NCEI Questionnaire](image)

Initial and Final actual means and Initial and Final Preferred means largely mirror each other with changes in the actual level of competition noted at a statistically significant level. In examining these differences the following is noted:

- Students reported a decrease in Competition at the conclusion of the use of netbooks (M = 22.07, SD = 3.2) than existed prior to their use (M = 23.19, SD = 3.1, $t(26) = -2.813, p<.009, r = .40$).

- There was a significant positive relationship between Class B’s preference for Involvement and their actual experience of Involvement $p<.002, r = .57$ with the students indicating a preference for increased Involvement, and reporting an increase in their perception of Involvement.

- There was a significant positive relationship between Class B’s preference for Teacher Control and their actual experience of Teacher Control $p<.003, r = .50$ with the students indicating a preference for increased Teacher Control, and reporting an increase in their perception of Teacher Control.
5.5.6. Class C – Actual and Preferred Environments

Graphical data for Class C (n = 31) is displayed in Figure 5-12

![Figure 5-12 Mean scores for Class C using NCEI Questionnaire](image)

Whilst there were apparent differences between Initial and Final Actual, particularly on the competition sub-scale, and also between the Initial and Final Preferred (Affiliation and Group Work) there were no statistically significant findings in terms of dependent t-tests on these subscales. In examining these differences the following is noted:

- There was a significant positive relationship between Class C’s preference for Involvement and their actual experience of Involvement \( p<.003, r = .52 \) with the students indicating a preference for increased Involvement and reporting an increase in their perception of Involvement.

- There was a significant negative relationship between Class C’s preference for Competition and their actual experience of Competition \( p<.000, r = .60 \) with the students indicating a preference for decreased Competition, but reporting an increase in their perception of Competition.
5.5.7. Class D – Actual and Preferred Environments

Graphical data for Class D (n = 27) is displayed in Figure 5-13

![Graphical data for Class D](image)

Initial and Final actual means and Initial and Final Preferred means largely mirror each other. For this Class, there were no significant statistical differences recorded in any of the comparisons between Actual and Preferred Environments and no significant correlations were evident. As noted earlier, the ANOVA on Initial Preferred classroom environment evidenced that this Class preferred lower levels of competition than their peers in other classrooms.

5.6. NCEI Results suggest Changes in Classroom Environments

The results from the NCEI indicate that there were statistically significant changes to the classroom environments throughout the period of netbook usage in some of the NCEI sub-scales. Class A student questionnaire responses indicated statistically significant changes in both the Order and Organisation and Group Work sub-scales over the period of netbook usage. These changes perhaps reflect that this class used the netbooks very early in the school year, during Weeks Three to Eight in Term One, where the teacher was still establishing their classroom environment. Conversely, Class D which recorded no significant changes on any of the sub-scales, used the
Classes B and C, which used the netbooks in Term 2 were also well settled environments. The teachers had already established their classroom environments; however, it was these two classrooms which exhibited greatest changes to the Actual and Preferred Environments. Changes to the environments in these classrooms, related to Teacher Support and Student Involvement with positive relationships established between Actual and Preferred Environments. These changes were due in part to the allocation of only 16 netbooks. In a sense, these classrooms were ‘forced’ to make accommodations to existing classroom practices. These classes demonstrated both statistically significant changes in the actual classroom environment and also significant correlational relationships between Actual and Preferred environments.

The suggestion is that the allocation of one netbook per student has little effect on the classroom environment as the teachers in Class A and Class D could use the netbooks as a form of ‘digital workbook’. When the teachers decided that the students needed a ‘digital workbook’ there was one available for each student and little modification was required to existing classroom practices. The teachers of Class B and Class C did not have this luxury. They could not say to the students go and get a netbook as there were not enough for each student. Consequently, teachers in these rooms had to change their classroom practices to accommodate the pattern of availability. They became more supportive of the students learning needs, scaffolding activities for the students to complete on the netbooks and working more closely with smaller groups of students. This meant an increased workload for the teachers as they often had to teach the same lesson more than once. This effort was appreciated by the students as is evidenced in the following comment:

Yes, I think he has to work harder as he has to teach it twice but then it is a benefit for us. (Louise, Student, Class C, Date)
As a result of the more limited access, the students in these classrooms also worked more regularly in a 1:2 model of access where they would complete various tasks with a partner and this may account for the reported increase in perceptions of involvement in the classroom.

The findings revealed from the use of the NCEI instrument provide a focal point for further discussion regarding the classroom environments of the four classes involved in the project. The use of NCEI indicated ‘flags’ or points of interest for further investigation. The eight NCEI subscales, alongside the six AT elements, were pivotal elements in the more substantive analysis of the data collected via interviews, surveys, classroom observations and reflective diaries throughout this research project. The analysis of the NCEI data has indicated that changes to the classroom environments were evident in relation to the sub-scales of Group Work and Order and Organisation for Class A and in relation to the sub-scales of Teacher Support and Involvement in Class B and C which used only 16 netbooks. A more extensive discussion on the findings from the NCEI questionnaire will occur in the following chapter where significant changes in the various sub-scales are triangulated with data collected from interviews, classroom observations and student surveys. It will provide inferences about why the use of the netbooks might have affected some aspects of the classroom environment in some of the classrooms to the statistically significant levels reported above, and consider why similar aspects in different classrooms were not affected to the same degree. An Activity Systems approach will be used to underpin this discussion.

5.7. Conclusion

This chapter presented a variety of data which represent the outcomes of this project. In order to contextualise the impact of the netbooks, the chapter commenced with an examination of the use of computers in the classrooms prior to the commencement of the project. A range of quantitative data, collected directly from the netbooks and from the NCEI questionnaire, was then analysed to determine what occurred to the quantum of computer usage following the introduction of the netbooks and how the various patterns of access affected this usage. The findings from the NCEI data suggest that there were statistically significant changes to the classroom environments
of three of the four classrooms during the period of netbook usage. Findings from the analysis of the NCEI data suggested a number of initial themes which were then explored further. This exploration utilised a range of qualitative data collected from classroom observation, researcher diary, student and teacher interviews, student forums and anonymous surveys.

From this analysis the following key themes emerged - student productivity, social activity, teacher control, individual learning, appropriateness of the netbooks as a computing device, and TPACK. Findings from the qualitative data were then presented according to the above themes. The following chapter presents a deep synthesis and evaluation of the findings presented in this chapter and addressed the research questions which directed this project.
Chapter 6. Qualitative Findings and Discussion

This chapter presents a variety of qualitative data which relates to the following Research Questions:

- What affordances of the netbooks suggest that they are appropriate or inappropriate computing devices for early adolescent students?
- In what ways did the availability of the netbooks impact on student learning?

For each of the questions listed above, data will be presented, findings will be identified and then deductions will be drawn from these findings, in light of my conceptual and methodological position, to answer the particular research question. The discussion in this chapter is largely based around key themes which emerged from the data analysis. Whilst some of these themes were more evident in some of the classrooms than others, or manifest themselves in different ways in different classrooms, they were applicable to all of the classrooms. Key Activity Theory nodes (Subject, Object, Tools, Community, Division of Labour and Rules) and the eight sub-scales of the New Classroom Environment Index (Affiliation, Innovation, Involvement, Teacher Control, Teacher Support, Competition, Order and Organisation, Group Work) were used as initial themes to guide this discussion.

The use of Activity Theory nodes, as the starting point for the coding of qualitative data, occurs in a number of Australian research projects (see Lloyd & Cronin, 2002; Romeo & Walker, 2002; Zevenbergen & Lerman, 2007; Sweeney, 2010). As data analysis continued, other themes including productivity, social activity, individualised learning, student behaviour and access to information also emerged. As was the case in Chapter 5, Activity Systems will be used to examine the tensions and contradictions were emerged from the data.
6.1. Appropriateness of Netbooks for Early Adolescent Students

The following findings relate to the specific affordances provided by the netbooks, which will assist schools in establishing whether or not the netbooks provide an appropriate solution to identified problems with laptops, such as size, weight, battery life and cost (Rockman, 1997; Hill & Reeves, 2002) and whether they meet the particular learning requirements of early adolescent learners including mobility, access to online resources, and the ability to create digital artefacts.

6.1.1. Learning Mobility and Functionality of the Netbooks

Netbooks were considered an appropriate tool, by both students and teachers, for the completion of tasks as required in this project. Vernon indicated the following in relation to the functionality of the netbooks:

No, the netbook has been spot on. We have not wanted for anything. They have been great. (Teacher, Class A, April 2009)

In a similar vein, Neville reported:

We have been able to do everything I have wanted to do with them from a technical perspective. They have been fine. (Teacher, Class C, June 2009)

The following software was successfully loaded and used on the netbooks – Microsoft Office Suite (Word, PowerPoint, Publisher, and Excel), as well as Internet Explorer, Microsoft Media Player and Microsoft PhotoStory. The devices were also able to successfully load Google Earth, Gimp, Java, Shockwave and QuickTime and there were no issues in watching embedded videos from various educational websites.
Students also commented on the netbooks:

I think they are fine for Year 7 to use. We did PowerPoint, watched videos on the Internet and made brochures. (Belinda, Student, Class C, July 2009)

The preference of a significant majority of students was for netbooks rather than laptops due to their mobility, size, and impact on desk space. For example, a student commented that:

I like the netbooks because you can take it, you can walk back to your desk and the netbooks are really fast and easy to carry around. I will be a bit sad that we don’t have the computers to use every day. (Student, Class A, April 2009)

The size and portability of the netbooks were considered a significant advantage by the students and teachers in this study:

The netbooks have been able to do everything that I have wanted them to do but plus it gives me much more space in the classroom to do things. Space becomes critical in Year 7 as they take up much more space as they grow through the year. (Jasmine, Teacher, Class D, October 2009)

There was strong student preference by the majority of students for typing in their notebooks, rather than writing using pen, pencil and paper. The students were much more willing to edit their work when it was typed rather than when handwritten:

When they have done something on the netbooks they are much more willing to go and edit their work. (Wendy, Teacher, Class B, June 2009)
When we had the netbooks you could make mistakes but fix them up easily but with the writing it is not easy to fix things up. (Paris, Student, Class A, April, 2009)

This was a factor in the increased productivity of the students which is discussed in relation to the final research question which concerns availability and student learning. The teachers established a sharing space on the server that each student could access and where they could place assignments for the students to complete or web sites for the students to access. The option also existed for this space to operate as a collaborative space for the students to use. Although, there was limited evidence of students digitally sharing their work, the netbooks were appropriate for this contingency.

There were minor issues with the 85% keyboard for students who were fluent typists as they were used to the location of the keys on a full size keyboard. Approximately 20% of students preferred to bring a mouse from home rather than use the track pad on the devices. The netbooks have some ornamental elements, such as rubber stoppers and silver caps on the hinges, which many of the students removed. The switch to turn the wireless on and off is at the front of the machines and situated near where hands are positioned to type. On occasions, the students accidentally turned off the wireless by fiddling with the switch. These were minor issues which were easily resolved by the teachers.

6.1.2. Were the Devices Appropriate for Upper Primary School Use?

1:1, or near 1:1 access to netbooks was clearly a contradiction causing event and their introduction into the classroom system as a new tool resulted in number of tensions. However, these contradictions were not a consequence of the particular affordances of the netbooks but rather were a consequence of computer usage in general. In other words, many of the contradictions in evidence would still have been present if the computing device was a laptop, a PDA, or a tablet computer. Cognisant of this fact, in discussing the appropriateness of the netbooks for school use the focus of this section of the discussion on the appropriateness of the netbooks as a computing device for Upper Primary / Middle School students. The discussion on their appropriateness will
be framed in terms of the Mobility / Functionality – eLearning / mLearning continuum, based on Keegan (2005) which was suggested in Chapter 1. Of particular interest is whether or not the mobility and functionality of the netbooks was a critical factor in their appropriateness for Early Adolescents. Discussion on the numerous contradictions caused by the netbooks, as indicative of the contradictions possibly caused by a range of computing device, will occur later in this chapter.

The netbooks were considered appropriate for the goals and motives of the teachers, and the majority of students, in this study. The presence of the netbooks was valued by the teachers because they afforded, as was the case in Bateman and Oakley (2009) and Sarker and Wells (2003), the potential for changes to classroom practices to enhance student learning and teacher pedagogic practices which were not possible prior to their use. By way of example improvements were noted in the depth of their ideas:

Absolutely, the increased depth of the ideas has been very noticeable. (Wendy, Teacher, Class B, June 2009)

And also in the quality of student work:

I think the quality of their work has improved. (Jasmine, Teacher, Class D, October 2009)

Thus, for these teachers and students, the netbooks could perform, from a technical perspective, all that was required of them. This ranged from basic word processing to some limited use of more advanced software such as Google Earth, Gimp and Microsoft Photostory. From a functionality perspective, the devices were the equal of the laptops and there were no reports of technical problems. This is a dissimilar finding to that reported in projects with laptops such as battery life and mobility of devices (see Dunleavy et al., 2007; Hill & Reeves, 2002), or reported in projects using PDAs; such as available and compatible software and input limitations (Oliver & Barrett, 2004; Serif & Ghinea, 2005). One student was very impressed with the netbooks and commented:
These computers have been great to use so it’s going to be hard without them. I feel like buying one myself! (Tenille, Student, Class B, June 2009)

In terms of mobility, the devices were highly mobile and were often used in a variety of learning spaces, for instance, in the Languages Other Than English (LOTE) classroom, the covered area, or in the students’ ‘buddy’ classrooms. The preference of a significant majority of students was for netbooks rather than laptops due to their mobility, size, and lessened impact on desk space. Teachers preferred the size of the netbooks for the students as they left space on the desk for student exercise books, and also because the students were comfortable carrying the devices around the room:

With the netbooks a good thing is that you can stash them somewhere when you are not using them. It would be really hard to fit 32 laptops in a classroom. Already with the netbooks you only just have enough room for your exercise books. (Joe, Student, Class D, October, 2009)

As identified in Figure 1-3, netbooks were considered more mobile, but less functional, than laptops. This project has confirmed this positioning. A second observation is that the netbooks were almost as functional as the laptops in relation to the task requirements of these teachers and students. When combined with the enhanced mobility of the netbooks it is clear, for the participants in this project, that the netbooks were the preferred computing device.

The overall positive perspective on the netbooks is tempered by two issues which were noted by a small percentage of students in the study. The first issue is the size of the keyboard, which is 85% of the size of a normal keyboard, and the second issue is the screen size. In relation to keyboard size, the following was noted:

When you try and touch type the keys are not the same as on a normal computer. (Christina, Student, Class B, June 2009)

The problem of the smaller keyboard was only an initial issue for the few students who knew how to touch type and they quickly adjusted to the netbook keyboard size.
In contrast, many students who did not previously know how to type reported a preference for the smaller keyboard due to the size of their hands and the relative closeness of the keys:

I like typing on the netbooks because the keys are a little smaller and it suits our hands, the keys are a lot closer and you can reach all the letters easily. I can type more quickly on the netbook and you get used to the keys very quickly. (Bob, Student, Class D, October 2009)

The size of the screen was the second concern reported by the students. This was only an issue when the students were researching web pages. Because many web pages are not formatted for viewing on smaller screens, there were occasions when the students had to scroll side to side to read the text:

With the netbooks you have to scroll a lot because of the smaller screen. (Mitch, Student, Class B, August 2009)

As the netbooks were not used for more technically difficult purposes (‘higher end’ digital publishing or video editing) it is not possible to comment on the technical abilities of the netbooks to complete tasks which might require greater processing power. This may have implications for the success of netbooks in schools where the usage of the netbooks demands greater processing power. The suggestion here is not that the netbooks are incapable of this function, only that they were not extensively used in this manner in this study.

6.2. Student Learning in 1:1 Environments

The findings from the NCEI (Newhouse, 1997) suggested that the netbooks made an impact on a number of aspects of the classroom environment. The remainder of this chapter will focus on two paired themes which were evident in the data collected by the NCEI, in the conversations with students and teachers, and also in the feedback from the students in the end of usage survey. The two themes are the relationship between productivity and its effect on social activity, (reflected in the NCEI subscales of Group Work, Involvement, Competition and Affiliation); and Teacher
Agency in relation to ICT and the effect this had on student access and use of the netbooks, (reflected in the NCEI sub-scales of Teacher Control, Teacher Support, Order and Organisation and Innovation).

6.2.1. Productivity and Social Activity – key findings

It is apparent that the teachers and students largely perceived the netbooks as a tool for productivity which affected the level of social interaction in the classrooms. As a consequence of the productivity agenda, the netbooks were primarily used in the direct production of work for assessment, rather than, for instance, as a tool for student to student communication. The findings below relate directly to the goal of productivity, how it was achieved, and the impact of this on the social environment of the classrooms.

Across the four classrooms, teachers and students invariably commented that a key benefit of the netbooks was increased productivity. The amount and quality of work, particularly in terms of presentation, increased and less student work was required at home. A student commented:

We don’t get much done with the computers at the back of the room so it is good to have the netbooks. (Kirstene, Student, Class B, June 2009)

Likewise it was noted that:

It certainly means less work at home when they have the computers here. (Wendy, Teacher, Class B, October 2009)

In the classrooms with 16 netbooks, the 1:2 model was largely used when research / information gathering was the object of the activity with the 1:1-1/2 model used primarily for ‘work productivity’ tasks. In the classrooms with 32 netbooks, the 1:1 model was used for both productivity and research tasks. Student to student and student to teacher communication diminished when netbooks were used and many classroom discussions became largely teacher focussed and directed. At the same time the quantity of ‘teacher talk’ (instructions and explanations from the teacher) also
diminished when the netbooks were used as students were given greater responsibility to self-manage the task. The students preferred less ‘teacher talk’ as they felt able to solve problems for themselves and were keen to commence the activity quickly:

He (the teacher) will say what we have to do – just look up this on the computer and then let us go off and do it. If we didn’t have the computers he would have to go on and explain step by step and tell you what to write down and it would take a lot longer. (Louise, Student, Class C, June 2009)

However, a consequence of the desire for students to work on their own was increased difficulty for the teacher to re-engage the class once a netbook based activity had commenced. This study found that the use of the netbooks reduced the amount of group work completed by the students during netbook based activities:

We don’t do any group work with the netbooks but we have done more paired work with the netbooks than we normally do. (Joe, Student, Class C, May 2009)

This was particularly evident in Class A, where netbooks were only used in a 1:1 pattern and also in Class D once the teacher stopped using the netbooks in rotations and switched to a full 1:1 access model:

I think we do less work in groups now because everyone has their own computer to use. (Poppy, Student, Class D, July 2009)

I am doing a lot less group work because we have the computers and once the computers are gone we will go back to doing groups and I need to do groups. (Jasmine, Teacher, Class D, October 2009)

Although not statistically significant, the level of Group Work in this classroom was noticeably less than the students preferred and noted in this student comment.
Using the netbooks has made it much more unlikely that we will do group work. (Joe, Student, Class D, October 2009).

Collaboration increased in classrooms with 16 netbooks as students were working in pairs on a regular basis. This was seen positively by students in these classrooms. Student preference in these classrooms was initially for 32 netbooks yet, by the end of the project, 16 netbooks was the preferred option for all of the students interviewed in Class B and C. For example:

I now would like the 16 because I want to work with my friends.  
(Billie, Student, Class C, August 2009)

I enjoyed how we learnt to share as we only had the 16 computers. This was a good thing for me from the experience. (Tenille, Student, Class C, June 2009)

Behaviour management issues were found to diminish across all four classrooms during periods of netbook use and this confirms findings from the literature (see Carrington, 2006; Silvernail & Lane, 2004). This was noted by the four teachers and also by the students:

People liked using the computers but when we are writing in our books kids are going off task more easily. (Student, Class A, July 2009)

Behaviour is better when we are on the Netbooks it is our own independent thing. (Student, Class C, July 2009)

In terms of ‘online’ behaviour, students were highly responsible in their netbook usage and there was little evidence of off task / inappropriate usage of the netbooks. The teachers felt that students remained on task due to their interest in using the netbooks:
They are pretty focussed and better focussed than a similar task without the computers. They are less distracted. (Jasmine, Teacher, Class D, September 2009)

This finding has important implications for the ‘freedom of access to versus tight control of digital technologies’ debate which is being played out in schools. It suggests that students in this school, which has a ‘digital citizenship’ approach to ICT use and teaches students about appropriate use of ICT (Larkin, Finger & Thompson, 2010), were therefore more responsible in their use of the netbooks.

6.2.2. Discussion - Productivity and social activity

The findings noted in the section above suggest that the use of netbooks for specific and highly content production based tasks affected the social activity of the four classrooms and also that the pattern of access to netbooks was a factor in the degree to which this occurred. This section discusses these implications further and makes use of Activity Systems, and also Pietsch’s (2005) categorisation of classroom activity. Pietsch conceives of classroom activity in three ways:

1. ‘Educational’ activity - largely the pedagogic approach of the teacher;
2. ‘School Going’ activity - the activity that the students complete as a consequence of the pedagogic decisions of the teacher; and
3. ‘Social’ activity - the interpersonal relationships which exist in the classroom.
He suggests that, whilst there is significant overlap between these activities, the different motivations of the participants in these activities in terms of goals and associated actions, would suggest distinct forms of activity. A depiction of the three distinct types of classroom activity is provided in Appendix K. As a principal concept in Activity Theory is the understanding of human behaviour in Activity (Kaptelinin & Nardi, 2006), Pietsch’s (2005) categorisations complement an Activity System examination (Figure 6-1) of activity in the classroom in relation to the primarily educational and school going concerns of the teachers in their use of the netbooks and the impact of these decisions on the desire of the students for learning within social activity.

Primarily, the netbooks were used by the students, as instructed by their teachers, for one of two types of activities; either to directly complete a set task, such as typing a narrative, or to use the World Wide Web to gather information (Suhr et al. 2010). It was evident that, although the teacher had a collective goal for the students, for example productivity or research, there was little evidence that the students as a class were working towards a collective goal. Rather the students were working individually towards fulfilling the teacher’s goal for them. In contrast, an example of
a collective goal, in an Activity Theory sense, is where the students are working collaboratively towards the achievement of a collective enterprise such as the creation of a class movie where individual students work on different aspects of the movie, such as scriptwriting, digital editing, the sound track or animation.

The absence of a collective goal, and its substitution with the individual pursuit of a similar goal was almost always the case in the classes where 1:1 netbook access was available. There were very few examples where the students had the opportunity to set their own goals or even to work in a scenario where they shared a goal with a fellow classmate. This did not mean that shared activities did not occur in the classes that had 1:1 access, only that shared activity was not a component of the classrooms during computer usage. The use of the netbooks minimised the social or collaborative aspects of learning. In the classrooms with 16 netbooks, the attainment of shared goals happened more regularly in the 1:2 pattern of access where two students worked collaboratively on one netbook. These collaborative instances primarily occurred when the teacher determined that the focus of the activity was research or where the teacher established a joint task involving the netbooks which required a level of student discussion.

The increased availability of computers through 1:1 or 1:2 access overcame the historically significant barrier of limited access which previously prevented substantial use of the computers, and resulted in improved student usage of computers in these classrooms. The historically limited access to computers resulted in a model of use where the primary use of the computers was for typing and research. It appears that, despite the unlimited access to netbooks, that both the teachers and students were caught in historical model of use; namely, that we have access to computers, so we had better use them as we have done in the past - for productivity (see Kuutti, 1996). This desire for individual productivity was not problematic in the 1:1 classrooms as every student could access a netbook, and therefore, was able to be productive. However, it was a significant issue for the two classrooms which had 1:2 access as not every student could be productive on the netbooks at the same time, with productivity being understood here in terms of content output. This caused significant contradictions in the system of use, causing tension and leading to a transformation in the use of the devices in the 1:2 classrooms, for instance the 1:1-1/2 pattern of use.
The teacher and student focus on productivity, which the increased availability of netbooks appears to encourage, has a detrimental effect on social aspects of the classroom. Student feedback suggests that the preference for most of the students was for a computer based activity which facilitates ‘School Going’ and ‘Social’ activity:

I like working on the netbooks in pairs, we talk about the work we are doing more with netbooks but we still talk about what we are doing on the weekend. (Krista, Student, Class B, June 2009)

In other words, the students enjoy, and felt they were most productive, in activities which allow for both productivity and social interaction. Activities such as these require the planning of a specific educational activity from the teachers. Overall, the two teachers using the netbooks in a 1:1 situation were less concerned in facilitating Social Activity in their use of the devices:

I like the kids to go straight to the computer then at least everyone produces something at the end of the lesson. (Vernon, Teacher, Class A, April 2009)

The difficulty in facilitating ‘Social’ activity whilst using the netbooks was a clear contradiction for Jasmine who recognised that group work was an important social component of a positive classroom, but at the same time acknowledged, as noted earlier, that she had ceased doing group work with the students:

I am doing a lot less group work because we have the computers and once the computers are gone we will go back to doing groups and I need to do groups. (Jasmine, Teacher, Class D, October 2009)

Once the period of netbook access finished, the class returned to a more group based approach to learning.
In activities which focussed on productivity, the students are depicted as producers rather than consumers, with an emphasis on what the students produce rather than on catering for different student learning styles. In this scenario, the students are fulfilling the demands of the teacher, rather than making decisions about their own learning. A greater opportunity exists, in the classrooms which utilised the netbooks 1:2, to move beyond working individually on the netbooks and become teams of inquiry, working collaboratively rather than competitively. Instead of the focus being on the production of an artefact, the emphasis shifts to the interaction with other individuals to produce a shared outcome. The key difference in the completion of activities involving netbook usage in 1:2 classrooms, as opposed to 1:1 classrooms, was the more central, decision making role of the students. This increased capacity for decision making, with the support of a peer or a group of peers is theorised in Vygotsky’s (1978) Zone of Proximal Development.

In the 1:2 classrooms, students can more easily appropriate the ideas of other students (and the teacher) which fall within their individual zone of development. The opportunity for greater student dialogue and peer support whilst using the netbooks increases the likelihood that students receive assistance in the understanding of a new concept or skill and then individually come to master this skill or concept. The synergy of netbook usage and student collaboration is evidenced in the following comment:

We need to have the netbooks and also a friend to work with otherwise you could have the information but no one to share the ideas with or you might not understand the information. (Billie, Student, Class C, June 2009)

The increased level of involvement in the setting of goals, the opportunity for greater dialogue during periods of computer use, and the improved access to peer and teacher support in Class B and Class C triangulates with the NCEI data for these classes. Class B showed statistically significant changes in two correlations (Involvement and Teacher Control). The positive correlations in terms of Involvement and Teacher Control reflect the modified teaching approach adopted by this teacher as a result of the availability of only 16 netbooks. As a consequence of limited availability, the
teacher set specific tasks for half the class to complete whilst teaching the non-netbook students. As was the case with Class B, Class C also demonstrated a significant correlation in the levels of Involvement; however, they did not show a similar correlation in terms of Teacher Control. This reflects a shortened period of usage (6 weeks full time rather than 10 weeks part time) and also the observation that Neville operates the classroom at an overall lower level of Teacher Control than Wendy.

In this discussion, it has been noted that the students in Class A and Class D used the netbooks for productivity purposes and that these students did not see any use for paired work on the netbooks. Thus, their object was primarily the individual completion of set tasks. For these students, the best usage of the devices was 1:1 and in these classrooms, in the completion of ‘School Going’ activities, there was a sense of ‘leave me alone – I have work to complete’:

I noticed that one of the boys who was working on the netbook made a snappy remark to someone beside him because he wanted to get on and do his work. He had already started and another student asked him what he had to do and he snapped ‘it is on the board, read it’.

(Jasmine, Teacher, Class D, July 2009)

Students in Class A did not experience any other usage pattern than 1:1 and did not consider that netbook usage, other than in a 1:1 scenario, would be adequate to meet their computing needs.

A more interesting scenario arose, in relation to the tension between what was perceived by the teachers and some of the students as a productivity-social activity dichotomy, with students in Classes B and C which had 16 devices and where the students had to share the netbooks. The reflections of the students in both classrooms, in terms of ‘Social’ and ‘School Going’ activity demonstrate significant personal agency. The exertion of agency in the relationship between individual subjects (in the same class and with the same access), their object, and thus their preference for netbook use is clearly indicated in the following student comments:
I would still like the 32 because I really like getting my work done.
(Kirstene, Student, Class B, July 2009)

I now would like the 16 because I want to work with my friends.
(Belinda, Student, Class B, July 2009)

Other students indicated that they liked the opportunity for both individual work (productivity) and shared work (social activity), and the choice of 1:1 or 1:2 use depended on the task at hand:

I like using one between two because if you need help your partner might be able to help you. I also like using one each because if you need to get something done you would be able to get it done but if it was one between two it might not have been my turn. (Student, Class B, July 2009)

Finally, some students changed their perspective as a consequence of their usage experience:

I wanted the 32 at the start but now like the 16 because I want to work with my friends. (Billie, Student, Class C, June 2009)

The comments noted above suggest that the access to computers affected usage; however, the personal agency of the teacher to a significant extent, and the agency of the students to a lesser extent, also affects computer usage. Findings in relation to agency and computer usage, and the implications of this for student learning are presented below.

6.2.3. Teacher Agency in a 1:1 Environment

Important findings to emerge regarding changes in the classroom environment related to the impact of the netbooks on the manner in which the teachers exercised control of the learning environment in response to the presence of the netbooks. The influence of the teacher in the success or otherwise of 1:1 computing programs cannot be understated as “teachers nearly always control how and when students access and use
technology during the school day” (Bebell & Kay, 2010, p. 47). As was the case in the study mentioned above, teacher decisions regarding netbook use had direct implications on the subsequent learning activities completed by the students.

Teaching and learning patterns changed noticeably in the two classrooms with 16 netbooks. These changes included increased 1:2 and 1:1-1/2 activities. The 1:1-1:2 usage regularly involved the teacher working on an activity, including direct teaching activities, with half the class whilst the other half of the class used the netbooks. The students would then swap and the teacher would complete the activity with the other half of the class:

The way I did it worked better where 16 of them worked individually for a short period – 40 minutes while I worked with the others. (Wendy, Teacher, Class B, October 2009)

The management of these changes required an additional commitment by the teacher to prepare significant scaffolding for activities to be completed on the netbooks as well as a willingness to potentially teach the same lesson twice.

Students demonstrated increased engagement in learning activities when using the netbooks (see Cromwell, 1999; Rockman, 1998; Silvernail & Lane, 2004). Parents reported to the teachers that their children were more enthusiastic about attending school:

The feedback I have had through the interviews is that the parents have been really happy with how happy their kids are to come to school at the moment and I think the netbooks contribute enormously to that. (Vernon, Teacher, Class A, April 2009)

Continual, positive feedback about the netbooks was given by the students throughout the study:

Well the motivation was up when we were working with the netbooks. (Ambrose, Student, Class A, June 2009)
This motivation remained consistent across the four classrooms for the length of the project. Whilst the study was only for a short period, the impression of the teachers was that the students would continue to be motivated to use the netbooks over longer periods of use.

There was a marked increase in student access to information and such access facilitated an increase in depth of content knowledge, less direct teacher talk and the opportunity for more individualised learning experiences. There was also anecdotal evidence of improvement in quality of student ideas as a consequence of this access:

\[
\text{The increased depth of the ideas has been very noticeable. This is a key point - using them gave them much more depth. (Wendy, Teacher, Class B, June 2009)}
\]

However, despite the access to information noted above, there was no substantial evidence of any change towards more individualised opportunities for learning. There was also little scope for students to decide whether or not to use the netbooks. In all four classrooms the netbooks were primarily used in the form of a ‘digital workbook’ – all of the available netbooks were used at one time or none were used.

The use of the netbooks substantially increased the literacy demands on students who were required to engage with an increase use of digital texts (see Hill & Reeves, 2002; Rockman, 2003). Concern was expressed by three of the teachers regarding the ability of the students to cope with these increased literary demands:

\[
\text{Yeah, just the sheer volume of the information available is a problem for them. It was too daunting for them to look at all the available information and work out where they were going to start. (Neville, Teacher, Class C, June 2009)}
\]

This problem was exacerbated by the fact that students, whilst using the netbooks at the same time for the same task, were often accessing information from a range of sites, not all of which were matched to their individual levels of literacy.
Although there was little evidence of inappropriate usage of the netbooks, there was significant teacher concern that students would access inappropriate images whilst using the netbooks; that the students would not be on task when using the netbooks; or that they would not be able to monitor student learning on the devices:

> Having more computers increases the risk of inappropriate use of the computers. (Neville, Teacher, Class C, May 2009)

> I could not be sure that the kids were doing what I wanted them to do and I knew from a glance that sometimes they weren’t. (Jasmine, Teacher, Class D, May 2009)

Jasmine’s solution to this problem was to tightly control the range of web sites that the students could use and to work through the various web pages as a whole class group.

The following findings expand on how teachers controlled the range of netbook usage and how this affected the way the students used the netbooks to support their learning. At the start of their period of netbook use the teachers were busy managing technical aspects of the technology, however, as they became more comfortable with the devices towards the end of the trial, they commenced limited experimentation with how the netbooks could be more widely used in the classrooms. Despite this experimentation towards the end of the trial, overall there was limited innovation by the teachers in the use of the netbooks. As indicated, they were largely used as a productivity tool (word processing and information gathering) – rather than as a tool for more creative pursuits, for example digital manipulation, creation of podcasts or student blogs. (Poppy, Student, Class D, October 2009) said in her final interview:

> I enjoyed the use of the netbooks but I would have liked to have done something creative with them.

These findings reinforce those found in Coulter’s (2001) study and suggest that teachers significantly direct, and limit, student use of computers. There was little
evidence of more creative uses of the devices although one teacher used Scootle, (a Web 2.0 website application), with the students.

The requirements of meeting curriculum and assessment outcomes, and presenting these outcomes in student portfolios were mentioned by all the teachers in the study as a limiting factor in both the quantum of netbook use and also in the range of activities the students could complete using the netbooks (Bebell & O’Dwyer, 2010). Teachers also identified a lack of technology knowledge of what might be possible with the netbooks and this also limited what the students could do with them:

I am efficient in terms of what I do with computers but I need to know more as to how to use IT for teaching. (Vernon, Teacher, Class A, April 2009)

Although students indicated that using the netbooks was enjoyable and educational they also indicated that they would have liked greater freedom in determining when and how to use the devices and also increased opportunities to use the netbooks for a greater range of activities:

I would have liked to use the netbooks more for Maths. (Belinda, Student, Class B, July 2009)

The lack of netbook usage in subjects other than English and Studies of Societies and the Environment was a finding from this project. Teachers were not able to widely use the netbooks across other curriculum areas and there was only minimal use of the netbooks to support student learning in Maths, Science, or the Arts. Further investigation is required into why this was the case but early indications are that lack of Technological Knowledge and the crowded curriculum are two contributory factors for this minimal use.

6.2.4. Implications of Teacher Agency for Student Learning
The remainder of this chapter discusses the findings in relation to teacher agency and the impact of this agency on the use of the netbooks. Displayed in Figure 6-2, were the key sources of contradiction and tension in this particular aspect of the system. They relate to teacher uncertainty regarding student use of computers, both in relation to student learning, and also in relation to the potential access to inappropriate sites; and the lack of innovation and creative use of the devices. These contradictions reflect the level of TPACK of the teacher (Mishra & Koehler, 2006); the use of a tool which can potentially support a higher degree of individualised learning (Bateman & Oakley, 2009; Means & Olson, 1995); and the accompanying challenges such a move brings in relation to Division of Labour, Rules, and the overall motive of the system.

Figure 6-2 Activity System – teacher agency and individual learning

How the netbooks were used is clearly related to the level of access but also strongly contextual as the subjects’ philosophy regarding learning and teaching affected tool use in each classrooms. By way of example, both Vernon and Jasmine used the computers in a 1:1 pattern for about one hour per day. Whilst their time usage was similar, how they used the computers was quite different. Vernon used the computers as a way of providing some level of individual freedom for the students in their selection of websites, with the overarching goal of high levels of student productivity.
In contrast, Jasmine used the netbooks in a more teacher directed manner with the students working on a specific web page or word processing activity with the clear focus on the completion of a specific learning task.

Likewise, the two teachers with access to 16 computers approached their usage in a different manner. Neville used the devices only when they complemented the activities he had previously planned, whereas Wendy remodelled the activities she had planned to accommodate the potential of the devices to assist with a collaborative approach to learning. Clearly, the different subjects had different motives when engaged in a similar activity or when exposed to the same tool (Leont’ev, 1981; Engeström, 1998). Furthermore, such is the centrality of motive in understanding activity that “when a motive is frustrated, people are upset, and their behaviour becomes unpredictable” (Kaptelinin, 1996, p.108). This was clearly evidenced in the case of Jasmine who wanted to use the netbooks to support a group work approach to learning but felt that the ubiquitous access to computers mitigated directly against the attainment of her underlying motive (see Sheridan & Pramling Samuelsson, 2004).

A significant limitation in regards to netbook usage was a two-fold concern of the teachers in relation to the types of activities completed by the students on the netbooks. The first concern related to inappropriate access and the second to gaining and maintaining student attention once netbook activities had commenced. The availability of inappropriate images on the Internet, and the potential for students to either accidentally or deliberately access these images, was a major and consistent concern for the teachers. This concern was both for the potential harm to the students in accessing this material and also a professional concern as to how this would reflect on themselves as teachers. This concern might go some way in explaining the teachers’ use of the devices primarily as a productivity tool, and the accompanying tight control over student access to the Internet. Neville used a direct reward system to manage this potential problem. If there were no issues of inappropriate use, including playing games, during the designated netbook usage periods, the students in his class were rewarded with free time when they could use the netbooks to play games or listen to music. The inherent difficulty of supervising 16 or 32 computers being operated simultaneously by highly tech savvy, upper primary school students, appears a significant barrier to increased ubiquitous use of computers in schools. The fear of
inappropriate access can be minimised, but not eliminated, by net filtering programs, student education in terms of ‘digital citizenship’ (Larkin et al., 2010), and Acceptable Use Policies.

The second concern related to gaining or maintaining student attention once the students were using the netbooks. Although teacher and student feedback throughout the project consistently reported greater on task behaviour during periods of netbook usage (see Silvernail & Lane, 2004), this engagement with the tool, and the students desire to be using the tool, caused frustration for all of the teachers. As Mathiasen (2004) noted, the 1:1 use of computers is a significant challenge to the pedagogical practice of a teacher in relation to the level of attention which they receive from the students during their use. All four teachers tried a number of strategies to gain and keep student attention using, for example, directions such as stand up, sit on your hands, turn the netbook away from you, during netbook usage:

We have to sit on our hands or put our hands behind our chairs so we don’t continue typing. (Chantelle, Student, Class D, September 2009)

From my observation, and from conversations with students and teachers, the students are not deliberately being non-attentive, but, rather, they are engaged in the activity and ‘tune out’ to teacher directions. Alternatively, they know that they can more easily solve their own problems or direct their own learning with the netbooks and therefore feel less need for teacher instruction. One of the positives of the experience for many of the students was the reduction in ‘teacher talk’, for example, the giving of instructions and the explanations which precede activities:
Our teacher is doing a whole lot more talking. We don’t get to our work straight away any more. When we had the netbooks we would just open them up and get to work straight away but now she has to explain everything to us. (Student, Class B, August 2009)

When we had the netbooks she would just say here is what I want you to do and maybe write some sites on the board and then we would start. We would not have to listen as much. (Poppy, Student, Class D, September 2009)

Although a minor change, the reduction of teacher talk, and the increased opportunity for students to direct their own activities, is a move towards greater student control of their own learning.

The final tension to be discussed in terms of the teacher agency and access to computers relates to opportunities for individualised learning and the use of netbooks for creative activity. Although the netbooks offered the potential to assist in the delivery of a differentiated curriculum experience (Zucker & King, 2009) this potential for individualised learning was rarely utilised in these classrooms. Whilst there was a high level of individual use of the netbooks this did not indicate individual learning as, by and large, students were completing the same task at the same time with the same collective goal. There was little space for students to negotiate their own goals for learning or to develop a timeline to achieve these goals (see Bateman and Oakley, 2009; Dwyer, 2007). The key Activity System nodes involved in individual learning are Tools and Division of Labour. Although the tool lends itself to individual use, individual activity, individual learning (Light et al., 2002; Ricci, 1999; Zucker & McGhee, 2005) the responsibility of the teacher to control the learning environment, the pressures of a set curriculum and increasingly external assessment, and the historical ways in which classrooms have traditionally been managed, directly mitigate against the affordances of the tool.

The lack of individual learning opportunities noted in this 1:1 computing study complement the findings of other research (Bateman & Oakley, 2009; Newhouse & Rennie, 2001; Dwyer, 2007; Lim & Khine, 2006). These studies suggest a lack of
individual learning may be due to the new understandings and changes to pedagogy which teachers need to develop in their utilisation of computers. In this thesis these changes have been framed in terms of levels of TPACK. It is further suggested that the tensions around individualised learning relate more broadly to the associated challenges of managing curriculum expectations and the blurring of traditional learning and teaching roles. It appears that a curriculum related shift from teacher-led instruction to more participative and responsible student-led learning means the dissolution of traditional boundaries of control and responsibility and the need to negotiate new ways of student-teacher interaction (Jedesog & Nissen, 2004). Although the teachers were generally confident that the students would use the netbooks appropriately, they were not always confident that students have the capacity for self-responsibility in regards to their own learning (see Sheridan & Pramling Samuelsson, 2004).

The contention here is that individualised learning is both enabled and disabled by the access to 1:1 computing. It is enabled because the students have access to information; they see advantages in the technology in terms of productivity; and they feel confident in their ability to direct their own learning. It is simultaneously disabled because of the potential for misuse of the devices, with serious consequences; the current lack of Technological Knowledge of many teachers; and the current school curriculum which increasingly emphasises a narrowing of student outcomes to those which can easily be reported on a five point assessment scale. In a discussion related to individual and independent student access to the netbooks, the following observation:
It would be good to do that in an ideal world if you could trust kids to do what they were supposed to be doing and if you could trust kids to be on task when they are supposed to be. I think the other problem with that is if there is certain content you have to cover, and if the kids have that much freedom you find that the kids have done a different curriculum and different activities and it is hard to assess that at the end of the term. In smaller groups that may work but with the larger group I think that it would be very hard to monitor. It also increases the risk of inappropriate use of the computers. (Neville Teacher, Class C, May 2009)

It appears that before computers can be used ubiquitously in school classrooms that fundamental changes need to be made to the structure of schooling (for example, flexible timetables, student decision making) including changes to the current contentious issues of curriculum, assessment and reporting and inappropriate use of computers (Bebell & O’Dwyer, 2010; Selwyn et al., 2009).

6.3. Summary

I noted earlier in this chapter that the pattern of allocation is a significant factor in how they were used. Although the particular combination of access and length of use partially explain the success of Class B, the impact of teacher agency was also critical. Wendy made deliberate decisions regarding the Division of Labour in this classroom. These decisions meant that the use of the netbooks afforded opportunities for collaborative activity, individual productivity work, enhanced access to the teacher, and access to peers for netbook support. These decisions resulted in the attainment of a variety of objects – productivity, social activity, collaborative research with the resultant outcomes including enhanced relationships with peers and teachers, student productivity and a perceived increase in the level of student involvement and teacher support (as indicated by the NCEI results for this classroom). The same results were not evident in the other classes. The 1:1 access pattern largely over-rode pedagogic decisions in Class A and Class D and resulted in were very few episodes of collaborative student activity.
Although Class C also had 16 netbooks, Neville initially went for a ‘Cinderella’s Glass Slipper’ approach and tried to force the netbook usage into a pre-existing classroom structure. He had witnessed how Vernon had used the devices 1:1 for increased productivity and presumed that he could do the same with 16 netbooks. He set productivity tasks and had two students working on one netbook but soon discovered that student behaviour deteriorated as there were always students who weren’t directly using the netbooks and thus off task. It was only after a few weeks that Neville switched to using the netbooks in a 1:1-1/2 or 1:2 pattern. As he only had the netbooks for six weeks, the usage period was over very quickly and so the students had little opportunity to experience the enhanced collaboration and ‘Social’ activity which occurred in Class B. Class B thus became the exemplar of the positive effects 16 netbooks can have on a classroom environment and many of the recommendations made in Chapter 7 are based on the positive outcomes of the pattern and level of access experienced by this class.
Chapter 7. 1:1 Computing: Conceptual, Methodological and Practical Considerations

In the introductory chapter to this thesis, it was established that access to ICT by students for learning has been acknowledged as being important in the 21st Century. Governments, education systems and schools have been moving to greater levels of access, including students having 1:1 computing access, referred to as ubiquitous or uLearning when the 1:1 access involves students using technologies which are mobile, such as netbooks used in this study. As schools move to 1:1 computing, research is required to inform the design and provision of access and usage by students and to understand how school computer usage can progress effectively.

This chapter restates the aim and the significance of the study, summarises the research methodology employed and notes the conceptual, procedural and methodological contributions of this research project. Subsequently, a summary or the key findings are presented in relation to the research questions, and recommendations are proposed for informing future netbook usage for the school in which the study was located, and, while caution is needed in relation to the generalisability of the findings, possible transferability of the findings generated by this site specific study are suggested for consideration by the wider educational community.

7.1. Restatement of the Aim and Significance of this Study

This study sought to determine whether or not ubiquitous access to netbooks equated to ubiquitous usage of the devices and whether varying the pattern and ratio of access affected the uptake and impact of netbook usage and also the impact of the devices on classroom environments. Specifically, it examined the impact of the netbooks on student productivity, classroom activity, teacher agency, and individualised learning. It also sought to further establish whether Activity Theory was an appropriate methodological and conceptual framework for classroom based research. Four classrooms received the netbooks in one of the following four patterns:

- 1:1 student to netbook access - 5 days per week for 6 weeks;
• 1:1 student to netbook access - 3 days per week for 10 weeks;
• 1:2 student to netbook access - 5 days per week for 6 weeks; and,
• 1:2 student to netbook access - 3 days per week for 10 weeks.

The study is significant for a number of reasons. Firstly, it contributes to the educational discourse surrounding 1:1 computing initiatives and specifically the current Australian context in relation to the deployment of 1:1 laptops for Years 9-12 students as part of the Digital Education Revolution. Secondly, it addresses a key question in the deployment of laptops; that is whether 1:1 computing is the best utilisation of limited computing resources or whether there are more appropriate ways to use computers in classrooms that is 1:2 or 1:1-1/2 and questions whether ubiquitous computing access translated to ubiquitous computing use for students in this study. Thirdly, it assists schools in determining whether netbooks are an appropriate device for early adolescents to use in terms of functionality, mobility and cost and seeks to establish the ‘relative advantage’ of the technology. Finally, it contributes to the continued refinement of Activity Theory as a conceptual and methodological framework for analysing complex settings such as school classrooms.

7.2. Summary of the Major Findings of the Study

The study generated a range of findings related to netbook usage patterns and the influence that varying how the netbooks were accessed had on such usage. It was found that, rather than 1:1 access, the use of the netbooks in a pattern of 1:2 offered a greater range of educational advantages for the students studied, to support their learning. Impacts on classroom environments were also affected by such patterns of access. The summary will also demonstrate the influence which human agency, significantly that of the teacher in these classrooms, had on the quality and quantum of netbook usage. From a technical and user oriented perspective, the suitability of the netbooks is discussed and the findings component of this chapter conclude with an evaluation of the appropriateness of Activity Theory as a framework for researching classroom environments.
7.3. **Ubiquitous Netbook Access but non-ubiquitous Use of the Netbooks**

The study found that, despite the provision of netbooks to enable ubiquitous access, the usage of the netbooks was not ubiquitous in terms of the definition used in this study, namely, the ‘weaving of the technology until it is indistinguishable’, neither in terms of the quantum of computer usage nor in relation to how the netbooks were used. The average daily use of each netbook was 65 minutes per day or 22.5% of the daily available time. These figures need to be considered noting that, for significant periods of time, the netbooks were ‘unavailable’ for usage. This unavailability is due in large part to the current structural organisation of schools with continual interruptions to classroom learning due to non-contact time, school assemblies and rotational and extra-curricula activities. The net result of these disruptions is that the teachers have approximately 12 hours per week with their ‘home class’. Adjusting for this, the computers were used about 40% of the available ‘home class’ time in Classes A, C and D and over 60% of this time in Class B.

In regards to the four specific patterns of access, usage was found to be greatest in the classrooms which had the option of using the netbooks 3 days per week for 10 weeks, irrespective of whether or not 16 or 32 netbooks were available. The teachers in those two classrooms with these provisions of netbooks had the opportunity to plan their netbook usage to avoid many of the external interruptions mentioned previously. Consequently, they were able to determine which 3 days per week were best to maximize their usage. The greatest usage, by far, was Class B which had 16 netbooks, and had the option to choose which 3 days per week they would be used. The daily netbook usage in this classroom was 50% higher than the other classrooms. This study found that 16 netbooks, used 3 days per week is the model which could maximise the use of the netbooks in terms of quantum of usage. The key finding here is that, although computer usage is not ubiquitous, the ubiquitous availability of the netbooks permitted the teachers great flexibility and opportunity to utilise the netbooks in ways which supported student engagement.
7.4. **Patterns of Access and Availability directly affected Use**

A clear conclusion from this project was that the pattern of access not only significantly affected the quantum of netbook usage, but also influenced the manner in which this usage was distributed, which in turn contributed to a range of learning and teaching patterns in these classrooms.

7.4.1. **Tool Allocation - a Significant Determinant of Object and Motive**

The impact of a new tool became influential in the attainment of specific goals in all four classrooms, yet this impact was felt most noticeably in the classrooms which only had access to 16 computers. This ‘limited availability’ at best ‘facilitated’ and, at worst, ‘forced’ a 1:1-1/2 model of use, whereby students alternated between two types of activities while the netbooks were used. One activity consisted of largely individual work on the netbooks while the other involved the students working in a half class group with their teacher. Although it required the commitment of the teacher to prepare scaffolded activities for the students to complete on the netbooks, and also a willingness to potentially teach the same activities twice, this pattern of usage was seen as a positive experience for both students and teachers.

These models of usage had a range of potential advantages and disadvantages for the teachers. The advantages for the teachers were an increase in student engagement and also the opportunity to teach a smaller and more responsive group of students, whilst half of the class were productively engaged in a largely self-managed, netbook activity. The disadvantages were an increased workload for teachers, and also a reduced opportunity to conference with students individually or in small groups as they were more likely to be busy in direct teaching activities with one half of the students. Overall, there are greater benefits in terms of interaction amongst students, and with their teacher, when student collaboration increases in a 1:2 pattern of access than when the students use the netbooks individually in the 1:1 pattern.


7.4.2. Individual Teacher Agency

Whilst the pattern of ‘tool allocation’ was a critical factor in determining the amount and quality of netbook usage, this only partially accounted for the variety of ways in which they were used. As has been the case in other classroom based research, the pedagogical decisions of the teacher were also a key factor in the computer usage in the various classrooms (Donovan, Hartley, & Strudler, 2007; Zucker, 2004). In this study, both Vernon and Jasmine had unlimited access to one netbook for each student in their class. Vernon consistently used the netbooks in a 1:1 pattern and preferred this pattern of access as it gave him ultimate flexibility when and whether to use the netbooks. Likewise, despite early attempts to use the 1:1 availability to support collaborative group work, Jasmine also completed here period of usage using the computers in a highly controlled, 1:1 pattern of usage which mirrored Vernon’s use, that is, either all students used a netbook or no students used a netbook. Neville and Wendy, who had access to 16 netbooks, used a variety of pedagogic practices in their classrooms. Neville used the 1:2 model for paired research tasks and the 1:1-1/2 model when productivity was the desired outcome. In contrast, from the very early outset of netbooks use, Wendy primarily used the 16 netbooks available to her in a 1:1-1/2 scenario with the 1:2 model being used for both productivity and research tasks. It is clear that the pedagogic practice of the four teachers is central to how and when the netbooks were used and, consequently, netbook usage in classrooms goes beyond the simple factor of their availability.

7.4.3. Differing Forms of Activity in the Classroom

Classroom activity can be understood in three forms: i) Educational (largely initiated by the teacher); ii) School-going (the completion of teacher set activities by the students); and iii) Social (the social relationships established by students and teachers in curriculum and non-curriculum discourses (Pietsch, 2005). During the periods of their use, the netbooks substantively affected the social activity in three of the classrooms, and in a less significant way affected the social activity in the fourth classroom. The level of social activity in Class A diminished markedly during netbook usage. When the students were using the netbooks, and, perhaps as a consequence of only using the netbooks in a 1:1 model, they preferred to work individually and were almost singularly focussed on completing set tasks. They
preferred, and required, less instruction from the teacher whose role was largely to support individuals in the completion of the task. 1:1 computer access worked against the establishment of high levels of social activity in the classrooms and therefore diminished the opportunities for student collaboration and the shared development of ideas and concepts important for student learning.

In contrast, levels of student activity increased markedly in both the classrooms which used 16 netbooks. The access to ‘only’ 16 netbooks required a restructuring of student work patterns and resulted in an increase in the amount of paired work. The teachers generally were found to use the 1:2 model for initial brainstorming, research and joint presentations and switched to the 1-1:1/2 usage for the completion of writing based activities. The motive of the activity, involving paired research or productivity was critical in determining whether or not a 1:2 or a 1:1-1/2 model was used. Students noted that they enjoyed paired work on both a social and academic level and that prior to using the netbooks they had not worked very often in pairs. A key finding was that, whilst three of the four teachers thought that 16 netbooks were, from both a pedagogic and economic perspective, the best model of use, all of the teachers, given the choice, would opt for the use of 32 netbooks. It appears from the reaction of these teachers that the only way to guarantee a balanced approach between educational, school going and social activity, in regards to the use of the netbooks, would be to only allocate 16 netbooks to each classroom.

**7.5. Appropriateness of the Netbooks**

The netbooks were found to be highly appropriate, when supported by a strong school based ICT infrastructure, and are recommended for use with early adolescents. The netbooks were also found to be robust, practical, cost effective devices for the completion of computing tasks. The students efficiently completed word processing, presentations, publications and research tasks on the netbooks and incorporated sound and images into the work they presented. There are two caveats on this recommendation. Firstly, the netbooks were viewed in a positive light by the students and the teachers because of their reliability. This reliability is only deliverable in a school context such as occurred in this project, if there is a strong technical infrastructure structure in terms of wireless connectivity, bandwidth, data management and noting that no data needed to be stored directly on the netbooks,
wireless printing and on-site technical support. Such a strong infrastructure is critical in overcoming First Order barriers (Ertmer, 1999) which often derail computer based activities (Bateman & Oakley, 2009). Secondly, although the netbooks performed all of the computing tasks demanded, this group of teachers did not ‘push the envelope’ in terms of higher end computing such as the creation of digital movies, music clips or high end digital image manipulation. I am not suggesting that the netbooks could not successfully manage tasks such as these, but only that further research is required as to the appropriateness of the netbooks for ‘higher end’ computing tasks.

7.6. Impacts on Classroom Environments

The classroom environments of the four classrooms changed during the period of netbook usage, particularly in relation to productivity, student involvement, teacher support and social interaction. Classroom impacts included: i) greater student engagement in learning; ii) increased motivation to complete set tasks on the netbooks; iii) changes to levels of collaboration between students dependent on access; and iv) changes to patterns of interaction between teacher and students. As was the case with changes to teaching and learning patterns, the impact of the netbooks on the classroom environment was more evident in the two classrooms with access to 16 netbooks.

A substantial change occurred in the level of student involvement during periods of netbook usage and this was commented on regularly by both teachers and students. This student involvement was reflected in the reporting of improved ‘on task’ behaviour whilst the students were using the netbooks. This improvement might be explained for two reasons.

Firstly, the students were able to produce work of a high presentation quality and were proud of their efforts. They believed that they were doing more work than they would have done without the netbooks but also felt that, as a consequence, they were required to do less computing work at home. There was also some anecdotal evidence from the teachers that the quality of ideas had improved as a result of the netbook use.

Secondly, a majority of students were proficient at typing and, almost without exception, preferred typing to writing. The students primarily learnt to type through
the use of MSN or other social networking sites, and were more willing to edit computer work as compared to their handwritten work. The increased willingness by the students to conference with their teachers regarding their work, and then edit their computer based work appropriately, is a positive outcome of netbook usage. The teachers spent less time entertaining and controlling the students and were able to spend more time either conferencing or small group teaching. The impact of the netbooks on student involvement was particularly apparent in relation to students who had historically demonstrated low levels of engagement in classroom activities (Harris & Smith, 2004). These students were better able to remain on task during periods of netbook usage and thus were more productive in terms of work output. Unfortunately, at the end of the netbook period, many of these students again disengaged from classroom activities.

Whilst the students were more actively involved in their learning, and highly productive in terms of output, there was no change to either the provision of more individualised student learning experiences or in the evidence that students could choose when to use a netbook. Typically, the study found that the teachers used the netbooks as ‘electronic textbooks’ with the students working more or less on the same task, and at the same time, with little scope for individuality. Despite not being able to decide when to use the netbooks, the students reported and demonstrated a high degree of enthusiasm throughout the project.

7.7. Contribution to theory

This thesis has as its focus, an investigation into the impact of 1:1 or near 1:1 computing on student learning. Chapter 2 identified a range of factors in the literature which had been identified in previous research. These factors included, for example, early adolescent use of ICT, functionality of PDAs, First and Second Order Barriers, School Infrastructure, Curriculum Demands and Teacher Agency.
A contribution of this thesis is the creation of a pictorial representation of the interplay of these factors in 1:1 learning environments, as displayed in Figure 2-2. This figure was used in Chapter 2 to conceptualise the range of factors, which emerged from previous research in relation to ICT use in schools, that impact on the classroom use of ICT. It suggests that these factors can be organised into three domains, namely student experience and readiness to engage with ICT, teacher readiness and experience to engage with ICT and the classroom ICT environment.

Although the model was initially devised as a means of summarising the literature in relation to ICT use, it has been utilised in this thesis to underpin its conceptual framework and research methodology and also as a means to identify contributions to improved practice in schools.

The decision of the Federal government in Australia to supply 1:1 computer access for students in Years 9 – 12 has demanded a response from schools as to how such access is to be managed. Based on the Australian experience, and the experience of school systems overseas, particularly the United States, it is reasonable to assume that primary schools may soon also be under pressure to implement 1:1 programs. The model presented above may be useful for school leaders considering the implementation of 1:1 computing. Reference to a model such as this may encourage school leaders to consider the use of ICT in classrooms more broadly than simply the provision of infrastructure and technical support, which has been identified in the
literature as a concern with 1:1 computing programs (Oxley, 2008; Selwyn et al., 2009). The implications on the professional practice of schools are noted later in this chapter.

7.8. **Contributions to Research Methodology**

This project makes three contributions to knowledge in relation to methods and procedures appropriate for school based research. The three contributions concern: i) Activity Theory as a methodological framework for research; ii) the use of data logging software; and iii) specific ethical considerations for researching one’s own workplace.

7.8.1. **Activity Theory an Appropriate Methodological Tool**

Activity Theory, in particular, 3rd Generation Activity Systems, was found to be an appropriate conceptual and methodological tool in this study. It enabled a systematic analysis the different elements in the research context, and an examination of the relationships between these elements to arrive at a holistic understanding from which future action was planned. In suggesting the appropriateness of Activity Theory, the reflections of Sharpe (2003), and Buell (2003) who likewise used Activity Theory to analyse classroom based activities, are considered.

The use of an Activity Systems framework allowed for both a theoretical and practical examination of the use of netbooks in four distinct classrooms. It did this by providing a structure for the examination of the activities occurring in the classrooms which were supported or distorted by the use of the netbooks (Subject, Community and Object), and how the conduct of these activities was mediated by contextual elements in these environments (Rules, Tool Use and Division of Labour). Its conceptualisation of individual activity occurring in social contexts appeared an appropriate way for investigating, understanding and finally reporting the impact of a new technological tool on a classroom activity system. It was particularly appropriate in its ability to explore and explain the mediation which occurred between various elements in the activity system following the deployment of a significant learning tool.
In this particular project, the deliberate introduction of the netbooks into a classroom activity system was inevitably going to result in contradictions and tensions. In this sense, a component of Action Research was occurring. As Activity Theory provides a strong theoretical account as to the mediating power of tools in human activity, it was an obvious tool to use, at a meta-cognitive level, to examine and understand the resultant changes in the classroom activity systems. At a more subtle level, the delivery of the tool was varied to determine whether the pattern of availability of the tool altered the extent of the impact on the classroom environments, particularly in relation to Division of Labour and Rules. In this way, the manner in which deliberate variations in specific nodes in the system affected the Subject - Object - Motive of individuals in these classroom communities, is investigated.

Using Activity Theory as a lens to examine the impact of technology on educational practices led to understandings which might be valuable in improving student outcomes, pedagogical practice, the deployment of technology at a school and systemic level, and the development of school based curriculum which can accommodate the potential of 1:1 computing. At a personal, meta-cognitive level, the opportunity to examine four classrooms in some detail, using a socio-cultural lens, and focussing on the praxis between theory and practice, resulted in a deepened understanding of digitally enriched classroom environments as sites of learning and teaching.

7.8.2. Use of Data Logging Software

A limitation of many projects which attempt to determine computer usage in classrooms is that they do not collect data directly from the computing devices, and instead rely on self-reporting of participants to determine levels of usage (Bateman & Oakley, 2009; Dawson, et al., 2008/2009; Dunleavy, et al., 2007; Zucker & McGhee, 2005). The use of two computer based tools to accurately record usage was an important strength of this study. Based on a thorough review of the literature, only one study (Swan et al., 2005) was located which used data logging software to record computer usage data directly from the computer. The use of data logging software has a number of research advantages: i) the use of such software reduces the amount of time the researcher needs to spend in manually recording usage times, thus allowing greater flexibility in observing, more holistically, the classroom context; ii) the
information is collected whenever the students use the netbooks and does not rely on self-reporting; iii) as the researcher does not need to be physically present to collect the data, the potential of the researcher to influence the amount and type of computer usage, by their presence in the room, is minimised; iv) it is difficult to manually record netbook usage from 32 netbooks over a period of 120 days; and v) the data collected by the software enables triangulation with data collected via other means and provides data which can suggest themes, concepts, or classroom events requiring further investigation.

7.8.3. Ethical Considerations

A key consideration in any research project is the well being of the students and teachers in the study. This was especially true in my research context where I am a member of the school community and where my relationship with both students and teachers continues beyond the completion of this research project. As a consequence of my role in the research school, strategies were designed and implemented throughout the project, to provide scholarly distance from my role as Deputy Principal. The strategies employed here may be useful for others who are likewise researching their own context. The following points summarise how I attempted to minimise my influence.

Before the project commenced, I met with the teachers likely to be involved in the project, to clarify the intent of the project and my role as researcher in the project. At this initial meeting in late 2008, at subsequent meetings at the commencement of the 2009 school year, and then again at individual meetings with the teachers prior to the period of netbook usage, I articulated explicitly four key points: i) there was no obligation for the teachers to take part; ii) I reminded them of the strong ethical position assumed by the university regarding this project; iii) there was no evaluation of their teaching performance; and iv) it was made explicit that there were no pre-determined outcomes as to how the netbooks were to be used, and that the manner in which the netbooks were used was solely at their discretion. Although confident that the teachers did not view me as a threat to their professionalism, my presence in their classroom may have been problematic. Therefore, a consistent theme of my interactions with them was the clarification of the ethical points made above.
In a deliberate attempt to separate the roles of researcher and deputy, particularly for the students, I assumed the role of ‘Researcher Rex’ whenever classroom observations or interviews occurred. When Rex, casual clothing was worn, as opposed to the generic ‘business clothes’ I wear in my role as deputy. Students were also encouraged to refer to me as Rex. This did cause some amusement to both the students and myself because, as Rex, I was not visiting their classroom to control their behaviour but rather to learn about their behaviour. I impressed on the students and the teachers that I was completing the project to learn from them. Although initially a little awkward, I believe that the students soon became accustomed to Rex being in their classroom and understood that I was not there to control or direct them. Whilst cognisant of the fact that I was never fully divorced from my role as deputy, it is considered that the steps taken to diminish this influence were necessary and appropriate.

7.9. Contributions for School Based Practice

Based on the finding of this research study, the following recommendations are offered: i) computers be made available in the ratio of 1:2; ii) if resources are limited that 16 netbooks be shared between classrooms; iii) that netbooks rather than laptops are to be used by early adolescents; and iv) that further research be conducted in the use of 1:2 computing.

7.9.1. Provide Netbooks to Classes in the Ratio of 1:2

The most appropriate deployment strategy for future netbook usage in the research school is the 1:2 model of access. This pattern of usage had substantial pedagogical advantages over the 1:1 model and appeared to afford the best balance between individual student productivity, student collaboration, direct teacher instruction, and flexibility to respond to other curriculum and extra-curriculum events. It was also the pattern of access which resulted in the greatest use of the devices, in terms of quantum of usage, with the netbooks used between 30 – 35% more in the 1:2 model than in 1:1 model. Furthermore, the 1:2 provision of netbooks was sufficient to provide a ‘critical mass’ of computers which resulted in significant use by teachers and students (Norris et al., 2003).
In addition, without compromising the educational advantages of the netbooks to the students and teachers, there are significant economic benefits to schools in the decision to deploy netbooks in the 1:2 model. These considerations are particularly relevant in non-government primary schools as there is currently no direct government funding for the purchase of computers in these schools. In the case of the research school, the difference in purchasing one netbook for each student, as opposed to one between two, is in the order of $325 000. Even if the devices are purchased only for students in Years 5-7 the difference between the provision of 1:1 computing and 1:2 computing would be over $100 000. This also has implications for the Australian Government’s Digital Education Revolution which plans to provide 1:1 computing access for all students in Years 9-12.

In recommending the 1:2 model, a deliberate attempt to inform and shape a particular pedagogical approach to netbook usage. The appropriateness of this recommendation is based upon the viewpoints of the teachers and students in the study, particularly those who used the netbooks in a variety of patterns. Based on the experiences gleaned from this project, supplying teachers with 32 netbooks meant that primarily one pattern of usage was deployed, namely that every student obtains a netbook and work individually on the tasks set by the teachers. As the students each had their own netbook, teachers seemed to be strongly influenced by this and seemed compelled to use all of the computers at the same time. Whilst this pattern of usage had advantages in terms of productivity, and also in terms of allowing teachers to spend time conferencing with students, it had a negative impact on the level of social activity in the classroom, made it more difficult to promote individual and self-directed learning, and was not viable from an economic point of view with the netbooks unused for large periods of the school week.

In contrast, the classrooms which used the 16 netbooks were characterised by increased levels of student involvement, teacher support and social activity, which resulted in an improvement of the quality of student ideas. The students valued highly both the opportunity to work with a peer with the netbooks and also the opportunity to work individually on the devices. In addition, and of significant value to the students, were the increased opportunities to interact with their teacher, at a lower student
teacher ratio, which the 1:1-1/2 model encouraged. In one of the classrooms which used 16 netbooks, these effects carried on after the end of the netbook usage period, much to the delight of both the students and the teacher. Although the availability of 16 netbooks might limit productivity, the options exists, in future netbook deployment, for the teachers to co-ordinate their use and, if considered necessary, make all the netbooks available for one classroom to use in a 1:1 model if time pressures require high levels of productivity.

**7.9.2. Consider Providing 16 Netbooks between two Classrooms**

If funding is limited, it is suggested that it is more educationally appropriate to purchase half sets (16) of netbooks for their use between two classrooms rather than the current practice in many schools of deploying three or four computers in each classroom. This would be relatively cost neutral for schools as eight desktop computers would cost approximately $8000 and 16 netbooks approximately $10 500. The following proposal, ‘would you prefer to share 16 netbooks between two classrooms or keep the current model of four desktop computers at the back of each classroom?’ was put to the teachers and students at the end of the netbook period. The universal response was to opt for the netbooks. Teacher replies to this question indicated that this would result in a significant increase in student use of computers, that it would free up existing computer resources for the students in younger grades, and that this pattern of access would be most productive in terms of actual use of the netbooks. The opinions of the teachers and students noted above support one of the findings of the project which suggested that the availability of only four computers was not sufficient to generate anything other than superficial computing use. For most of the students in this study, the three to four classroom computers were considered largely redundant to their needs, with the majority of their computing work completed at home.

**7.9.3. Schools to Consider the Use of Netbooks, rather than Laptops**

Although the recommendations mentioned thus far could also be achieved with the purchase of wireless enabled laptops, the third recommendation from this project is that schools should consider the use of netbooks rather than laptops, as the computing device for use by primary and middle school students. The netbooks were clearly a
robust, appropriate device for the computing needs of the students and teachers. While the study found that there were minor technical issues with the netbooks, those issues were related more to the existing school infrastructure rather than limitations in the actual netbooks. When considered in conjunction with the cost advantages, in the order of approximately $350 per device when selecting netbooks instead of laptops, this would translate to a saving of approximately $70,000 in the supply of netbooks, rather than laptops, in the 1:2 ratio.

Moreover, it should be noted that, in recommending the netbooks, there are a number of supporting sub-recommendations, some of which are also applicable if schools decide to purchase laptops. Firstly, it is highly recommended to purchase a number of spare netbooks which are charged and available to be used in the event of a failure in one of the class set netbooks. The availability of a spare netbook means that students can quickly hot swap a netbook, and thus minimise student downtime whilst using the devices. This would be much like swapping a pen that doesn’t work for one that does. Secondly, this ‘hot swap’ option is dependent on a strong infrastructure, and also the ability to save files onto a server rather than onto each netbook. As part of the ‘hot swap’ scenario, a procedure needs to be established which can quickly and efficiently rebuild the machines if required. In saying this, there were very few problems with the netbooks during this study, and, over the course of the year, only two needed to be rebuilt.

Thirdly, as part of the install and rebuild procedure, a Standard Operating Environment (SOE) is installed on all of the netbooks. This SOE includes all the software and additional plug-ins which might be required by the users. Correctly installing an SOE means that students and teachers become confident in working in the same environment each time they use a device and also means a more efficient and reliable computing environment in terms of technical support. Fourthly, secure trolleys should be purchased to store and charge the devices. These trolleys can be secured to the classroom floor which reduces the need to return the devices to a central point, such as the library each evening, thus saving time and the potential device damage with daily movement back and forth. The purchase of 16 rather than 32 bay trolleys is also suggested. The 16 bay option is most preferred because it both facilitates a 1:2 usage pattern and because it is lighter to move.
Finally, due to the minor issues of screen size noted in the study, a slightly larger screen netbook should be purchased. Due to developments in the market place, the newer version of the Acer Aspire retains the same overall size and weight dimensions as the model used in the trial but makes better use of these dimensions to deliver a slightly larger screen. The basic requirements of the device, size, weight, and mobility are still the fundamental requirements in a device to be used with primary and middle school students.

### 7.9.4. Further Research Should Be Undertaken Using a 1:2 Model

The final recommendation of this project is that further research be undertaken in 1:2 netbook deployment and its subsequent effect on classroom environments. The rapid movement towards a digital 1:1 future for our students needs to be made problematic, as it appears that too much has been assumed that 1:1 computing is the most desirable goal for classroom computing. This is reflected in terms of the assumptions conveyed in much research, policy and practice regarding the use of computers with students. As a consequence, the default position of a 1:1 allocation of computers might well become an expensive, but poorly utilised classroom resource. The research presented in this thesis was a substantial exploratory study in one site, and it effectively sought to establish guidelines for the further deployment of netbooks at that school site. What is required is a more extensive study in classrooms utilising the 1:2 pattern of access which this study has suggested holds the most promise for their use in classrooms.

Consequently, it is recommended that further research is undertaken which might involve a yearlong study of one or more classrooms or school sites utilising a 1:2 deployment of netbooks. Those studies would also further investigate whether or not the teachers’ level of TPACK capabilities developed over a longer period of. Improved levels of technological and pedagogical knowledge might result in different patterns of usage which could build on the findings reported in this research study.
7.10. Reflections on the study

The opportunity to conduct research has been both personally and professionally rewarding and challenging. As a Deputy Principal, it was a timely reminder of the modern realities and challenges which teachers face on a daily basis. It was also a significant professional learning experience for me to be able to take the time to speak to students about their classroom environments and to use this information to help shape school based policy. As a researcher, it has been an opportunity to witness and investigate more deeply through scholarly research, what happens in classrooms, and to attempt to draw deductions from these events, based on the literature and on what I have come to understand from my own context through employing the conceptual framework of Activity Theory.

Prior to their use, I asked a number of students what they thought they would be doing with the netbooks. Typical responses were that:

We will mainly use them for typing up projects and for researching. (Bill, Student, Class A, March 2009)

They would be doing similar things that they would have done on the classroom computers anyway except they now have their own one to use. (George, Student, Class B, April 2009)

Predictions such as these turned out to be remarkably accurate and perhaps reflect strongly the notion of historicity of tool use noted previously. The netbooks were largely used to do the same things as before – with better access and therefore increased productivity, but rarely used in any creative or group endeavours. Although the netbooks were used effectively as a tool to better complete existing tasks (typing and research), there was little evidence of the crossing of the Critical Use Border (Finger et al., 2007) to integration and transformation (problem solving or creative endeavours). The teachers primarily used the netbooks in a manner which complemented their existing classroom practices (Doherty & Mayer, 2003; Weston & Bain, 2010). Based on the data collected in the study, ubiquitous access did not mean ubiquitous use. The crowding of the curriculum, the teachers’ TPACK level, the
current demand for significant levels of increasingly standardised measures of student performance, and the specific components of this particular research context; that is the decision to stream for Maths and KLA all contributed to the low levels of netbook usage.

Despite their relatively low use, the teachers and students spoke positively of the experience of using the netbooks and were very enthusiastic about the opportunity to use them again. The use of the netbooks resulted in a 500% increase in student computing when compared to computer usage prior to their deployment. Their use as a tool appeared to be a catalyst in the facilitation of what might be considered desirable events in classrooms. From a teachers’ perspective, there was greater collaboration between students, improved access to information which resulted in a deepened knowledge of the content covered, and some evidence of increased peer tutoring and peer learning.

The perceived main benefits of the project, as reported by the students, were that they could type instead of write, they could present work of a high quality and the netbooks were a good size for them to work on. In addition, they could find information more easily, and thus have to listen to teachers less, and the shared use of the netbooks helped them make new friends and get to know people better. During the project, there was a consistently high level of pride, expressed by the students, in the amount of work they had completed. They were pleased that computer resources had been made available to them at school, as they now had less computer work to complete at home. The knowledge and understanding gained throughout this project will be instrumental in shaping the future course of ICT deployment at my current school. It may also be of some benefit to other schools as both teachers and students come to grips with the impact these technologies can have on classroom environments and patterns of learning and teaching.

7.11. Conclusion

This chapter has restated the aims and significance of this research project. Subsequent to the summary of the significance of this research, key findings based on the data collected were presented. These findings indicated that ubiquitous access did
not equate to ubiquitous use and that the pattern of access was instrumental in
determining the quantum and quality of use. The findings also indicated that the
TPACK level of the teacher was a large determinant of how the students used the
devices in their learning. Netbooks were considered an appropriate technology for the
students and teachers in this study. The chapter concluded with a number of
recommendations based upon those findings including the allocation of computers at
a ratio of 1:2 and the deployment of netbooks as an appropriate tool for early
adolescent students.
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Appendix A (Sample of 1 class)
Computer Usage in Non Netbook Usage Periods

Class A
All classroom visits were unscheduled and were of 15 minute duration

Computers Available – Four (Includes teaching computer)

Status of Computers – Aging but appropriate for use

Internet Connectivity – All computers are able to connect to the Internet

<table>
<thead>
<tr>
<th>Observation Date</th>
<th>Computers Used (Y?N)</th>
<th>Number of students using computers</th>
<th>Classroom Activity</th>
<th>Software Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 18, 2009</td>
<td>N</td>
<td>0</td>
<td>Reading Activity - Students had written descriptive accounts and were reading them aloud to the class</td>
<td>Nil</td>
</tr>
<tr>
<td>February 19, 2009</td>
<td>N</td>
<td>0</td>
<td>Writing Activity - students working individually and completing a writing task in their exercise books</td>
<td>Nil</td>
</tr>
<tr>
<td>February 20, 2009</td>
<td>N</td>
<td>0</td>
<td>Writing Activity - students were creating a leadership poster as part of the introductory unit</td>
<td>Nil</td>
</tr>
<tr>
<td>February 20, 2009</td>
<td>N</td>
<td>0</td>
<td>Maths Activity - students were completing a worksheet on Number Facts</td>
<td>Nil</td>
</tr>
<tr>
<td>April 28, 2009</td>
<td>N</td>
<td>0</td>
<td>SOSE Activity - students were completing a sheet about Government</td>
<td>Nil</td>
</tr>
<tr>
<td>April 30, 2009</td>
<td>N</td>
<td>0</td>
<td>English Activity - students were completing a sheet from their English Text Book</td>
<td>Nil</td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td>Number of Students</td>
<td>Description</td>
<td>Software Use</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------</td>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>April 30, 2009</td>
<td>Writing Activity</td>
<td>0</td>
<td>students were competing a writing task in preparation for NAPLAN</td>
<td>Nil</td>
</tr>
<tr>
<td>May 7, 2009</td>
<td>Religion</td>
<td>4</td>
<td>4 students were preparing a prayer liturgy using text and digital images</td>
<td>Microsoft Publisher / Internet Explorer</td>
</tr>
<tr>
<td>May 25, 2009</td>
<td>Vocabulary Activity</td>
<td>0</td>
<td>students were required to use a list of words in a sentence to demonstrate meaning</td>
<td>Nil</td>
</tr>
<tr>
<td>June 3, 2009</td>
<td>H&amp;PE</td>
<td>0</td>
<td>students were completing a test on the previous unit of work on fitness</td>
<td>Nil</td>
</tr>
<tr>
<td>June 4, 2009</td>
<td>Maths Activity</td>
<td>0</td>
<td>students were completing a task on percentages - teacher was working with small groups of students</td>
<td>Nil</td>
</tr>
<tr>
<td>September 8, 2009</td>
<td>Science</td>
<td>1</td>
<td>1 student was using the teaching computer to finish and then print his Religion Assignment</td>
<td>Microsoft Word</td>
</tr>
<tr>
<td>September 10, 2009</td>
<td>Reading Activity</td>
<td>0</td>
<td>Students were listening to one of their classmates read their story</td>
<td>Nil</td>
</tr>
<tr>
<td>October 6, 2009</td>
<td>Health and PE</td>
<td>0</td>
<td>students were working individually on their H&amp;PE brochures</td>
<td>Nil</td>
</tr>
<tr>
<td>October 13, 2009</td>
<td>Maths</td>
<td>4</td>
<td>the 4 students were working on a Science Assignment</td>
<td>Microsoft Word / Internet Explorer</td>
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<tr>
<td>October 15, 2009</td>
<td>H&amp;PE</td>
<td>0</td>
<td>students were completing a worksheet regarding the Respiratory System</td>
<td>Nil</td>
</tr>
<tr>
<td>October 20, 2009</td>
<td>Maths</td>
<td>0</td>
<td>the students were working individually with the teacher's support</td>
<td>Nil</td>
</tr>
</tbody>
</table>
Appendix B
Teacher Interview 3 (Final)

Research conducted by Kevin Larkin (Griffith University)

Teacher’s Name: Vernon
Date: April 9, 2009    Class 7A

You have had the netbooks for 6 weeks now – what are your thoughts.
It has been a fantastic experience – great. As we discussed earlier it has been such a
positive way to engage students in their learning. Having 32 at my disposal has been
fantastic – it has been a wonderful experience and I am sad to see them go.

If you had the option to use the Netbooks again in the future would you do so?
I think as a teacher I need more skills in terms of IT. I have learnt a lot from this. I am
efficient in terms of what I do but I need to know more as to how to use IT for
teaching using different programs which is why I have signed up for that in-service
later in the year. Because I realise I have so much to offer but they are a great
resource and I would like to know more about how to deliver better quality lessons so
I guess I was limited in what I could do and I would like to learn more.

Did using the Netbooks in First term affect how you used them to any significant
degree?
No, it’s not but we have just been going through the parent teacher interviews and you
do not know as much about the students literacy because they haven’t been writing in
their books and the computer picks up so much for them in terms of editing so I don’t
have so much to refer to and this is my own fault because I used them so much for
English and I wanted to use them for English and so did they and I guess I don’t know
so much as to where they are in terms of Literacy as I possibly could have and I think
my class doesn’t know what it is going to be like without them and so behaviourally
and just the dynamics of the room its going to be just different for them coming into
school in Term Two. They are going to forget what school is like without a computer
in the class so it is going to be interesting to see how that goes. I have started to do a
little more writing in the last week or so and they are all pretty soft with their hand
muscles. They are all starting to do the hand shake (Jacko shook his hand to mimic
the handshaking that students do when their hands get tired).

It has been almost universal from the students I have spoken to that they much
prefer the typing to writing.
Yeah – unbelievable. That is how it works in the world. You and I don’t write things
we type things and then use spellchecker. I have been explaining this to the parents
and they can see that this is beneficial. It is just surprising when the kids are typing
how much you don’t see because it is corrected so quickly but with writing when you
walk around the room and see what kids are writing because it even auto-corrects if
you leave a letter out it just fixes it up straight away so you just cannot tell where kids
are up to with their literacy whereas when they have it in their books you can see oh
there is a spelling mistake or a punctuation error and you can go through things
quickly with them and give them tips.
Have you been over the 6 weeks less and less getting the kids to do work in their books first and more just letting them type directly into the computers?

Yeah – they like it better. It just became almost too cluttered and it was too staged and the kids that would work well would get all their work done in their books and on the computer and you end up with too big a gap between the first person and the last person if you had too many stages whereas if you go straight to the computer at least everyone produces something at the end of the lesson. The kids also said it was a waste of time writing it in the books first. They said why are we doing it in our books when we can do it straight into the computer. That is a fair point and it probably was a waste of time.

So from your point of view it has been a positive experience. How do you think your students feel about the netbooks?

They have loved it – I just said say goodbye to the netbooks guys they are going into the trolley and they were all pretty sad to see them go. It has been really, really good to have them – it has been fantastic.

Is it your feeling that behaviour has been affected by the netbooks?

Umm – no I don’t think so. I think I have struggled to get their attention. It is really difficult to get their attention when they are using the netbooks. So I think it has just been challenging to set up the behavioural cues you use with students – I have had to muck around with them more than I normally would to get the kids attention. They are not as responsive to your voice when they are working on the netbooks which I suppose in a way is a good thing because they are engaged in what they are trying to do on the computer. I feel I am almost disrupting them and annoying them when they are working because I want to talk to them because they are so much more engaged in what they are doing whereas when they are working in their books it is quite easy to get their attention and this is quite hard to do when they have the netbooks but overall behaviour wise I have been very happy with how they have used the netbooks in general with behaviour. They have been really good in solving their own problems with them, they have been really good with staying on task with them, there have been no breakages with them in terms of movement around the room. I didn’t think their would be but I was a bit concerned with the logistics of putting them away and they have been fairly respectful with the way they have used them and this has been very good.

Did you find that the attitude towards using the computers was consistent across the six weeks of using the computers?

Yeah it has been fairly consistent across the 6 weeks – at the end of the term things get a little looser but no. There has been no drop in enthusiasm with the computers. There has been the odd joke about lets break them because they are going next door and the odd gee up but overall they have taken really good care of them and they have reported things that are not working and we try and fix it.

What technical issues have there been with using them?

The most frustrating thing has been the printing. That has been a real pain to get their response to what they are printing out and what they are not printing out and when they are printing out. They just don’t care and they just keep hitting print and if it is not coming through and that is the one thing that I wish they would be better at. The
problem is when you get 32 jobs at once they are not patient enough and they keep hitting print. So what I have started to do because it is an issue is stage it so that I say ok – group one you can print, group two you can print otherwise it just loads it up too much and they are impatient but if you forget to stage the printing it is not much fun. The wireless access has been no problem at all and the kids have worked out how to troubleshoot the wireless issues.

How often do your students use the Netbooks in different subject areas?

<table>
<thead>
<tr>
<th></th>
<th>Often (4)</th>
<th>Sometimes (3)</th>
<th>Rarely (2)</th>
<th>Never (1)</th>
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<tr>
<td>English</td>
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<td>Maths</td>
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<td>SOSE</td>
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<tr>
<td>Science</td>
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<td>X</td>
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<tr>
<td>Religion</td>
<td></td>
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</table>

How often do you think you will use your Netbook with specialist teachers?

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<tr>
<th></th>
<th>Often (4)</th>
<th>Sometimes (3)</th>
<th>Rarely (2)</th>
<th>Never (1)</th>
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<tbody>
<tr>
<td>Library</td>
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<td>Music</td>
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<td>LOTE</td>
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There are four patterns (Researcher Describes). Which model of usage do you think would be the best? You indicated that you thought the 32 was the best model. Are you still thinking that?

Yes, I am still thinking that and I am now stronger with my opinion. I would almost go so far as to say I don’t know how I would use them if I only had half of them. It is so important for everyone to have one. We did group work with them yesterday and we still had one computer each. So they broke up and had a task each and they came together to create posters on Anzac Day and so they were able to break up and still do group work and it was awesome but if you did it between two you just don’t get the productivity, they fight over whose go it is to type, who wants to use the computer, and one person sits there and does nothing. It is really hard to share a computer. Good luck to the teachers who are having one between two. They got these projects done in an hour. You don’t get that without the netbooks.

How about everyone on the netbooks for three days a week?

I think that would be good. That would be fine. I just think it is important to have one each. You would just structure your weekly plan around having them for the three days a week because as you know there were some days I had different activities and only used them for 30 - 40 minutes.

Do you think it is now easier for students to share ideas / projects now that they have the Netbooks?

Yeah – it is something I have encouraged but with this group of kids it doesn’t seem to be that they want to share their work – it is just the group I have got. I think the kids last year would have been more interested in sharing their work but even just to
get kids to read their work they are not as confident, not as open with sharing so I think it is just the group. They love it when I put work in the shared folder for them to complete but they don’t put their work in there but it is something I want to work on and I don’t know why they are like that.

**Have you structured your lessons so that now the kids have to almost 100% get their information from the Internet?**
Yep. Definitely – you usually do anyway so that the kids get the information from the Internet but its limited with what I can give them but now, and I might go to the library and get three or four books but there is a limit, but now with having the netbooks to research it is up to them to find the information. Like with the ANZAC task I did not give them the websites to choose from, I gave them the questions and then said go for it and they are able to research it. We have looked at different ways to research websites over the past 3 weeks and this was sort of the last activity to see how they went with it and it was good to see how they went with it.

**What do you think the students have learnt from using the Netbooks?**
They have learnt so much. They have learnt research skills, so much about how internet sites are set up and how the different layouts of sites affect where you go and what you are looking for and how to navigate your way around them. They already had fairly good skills with working with the programs on the computers but that has come now that it is broader and everyone has come up to the same skill. When you go to the computer lab once a week often you have three or four students who are awesome and the rest are catching up but with the netbooks I feel that all of them are on the same page with only one or two being your experts but everyone is on a better level in terms of working with different programs. What it has meant is that the slowies have had a chance to catch up and learn and I haven’t done a lot of lessons on programs because they honestly know a lot of the basic ones such as PowerPoint and Word and they are really happy to piggyback each other and it works really well and so that is how I have gone with it. It is so boring for them if they know what they are doing the most boring thing would be for them to sit there and tell them what to do. I hate doing that so go for it and we will pick up the problems as we go along sort of thing.

**Think about your class**

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<thead>
<tr>
<th></th>
<th>Often (4)</th>
<th>Sometimes (3)</th>
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<tbody>
<tr>
<td>Teacher talks to groups of students</td>
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<tr>
<td>Students work from a textbook</td>
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<td>X</td>
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<tr>
<td>Students work on activities on their own</td>
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<td>Students work on activities in pairs</td>
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<td>X</td>
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<tr>
<td>Students work on activities in groups</td>
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<td>X</td>
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<tr>
<td>Students use the netbooks</td>
<td>X</td>
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</tbody>
</table>
Students use netbooks in pairs X
Students use the netbooks in groups X
Students are free to choose when and whether to use netbooks X

Do you see that the flexibility of use would change if you had them for a longer period?
Yeah I think that would. You have to really have your class trained up well and I think by Term Three or Four you would have the ability, if you had the right sort of kids, to have the flexibility to say to the kids use the netbooks if you think they will help you complete the task - then go and get one. I told Jackson that this wasn’t a big issue with the kids. I think at this stage of the year the kids are used to being told what to do and when to do it whereas you would give a bit more freedom later on in the year. The hard thing with the netbooks is the catch up – having some kids on them – and then the misuse of them – when the kids are bored the kids are going to do something silly or be off task – so you just have to keep the activities rolling through.

The kids have all commented that they have been pretty busy.
I wish I could give them more time and there are some many things that are interesting to do using a computer and it is not all misuse but I guess I try to keep them on task as much as possible.

Questions here about the eight elements of the classroom environment

Involvement
What have you noticed about student engagement, participation, and involvement?
Oh – it has been awesome. It has been really good. Even the feedback I have had through the interviews – all the parents have been really happy with how happy their kids are to come to school at the moment and I think the netbooks contribute enormously to that.

The feedback from the kids has been that they have not done much extra work because they have been very busy completing the work you have set and that it upgrades their work. Any comments?
Yeah, yeah, it certainly makes their work look better. Interestingly I have had a number of parents commenting that the kids do not seem to be bringing much homework home and also they were not completing the projects which they expected for year 7. I said to them that there will be but there hasn’t been because I have been able to complete all of the things they would normally do at home at school. It has been good like that.

Affiliation
Has the use of the netbooks affected any student friendships in the class?
No I don’t think so. I actually did think at the start that it might make kids not as cooperative and not talk to each other as much but I don’t think that has happened. I don’t think the netbooks has harmed any friendships.

Do they help each other more now than they did previously or might have done without the netbooks?
Ohh, I don’t know. I have definitely noticed them helping each other which has been very pleasing but I don’t know whether that is more than normal for this class or not. Kids are normally helpful and they like to show their knowledge about the netbooks so I think that has been good. I suppose it is easy to help someone who is using a computer than a book. There has been more of an opportunity to help.

Teacher Support

You mentioned a few weeks ago that the netbooks had affected how you interact with the class. Has that been more noticeable these last few weeks?
Ahh – actually since that chat it was quite reflective and since then I have tried to be more energetic and get around and see more and talk to small groups of kids a bit more and I think that it is striking a balance as you can become quite busy at your own computer looking at kids work and setting up kids activities from my teaching computer but I don’t think that helps interaction and it took me a bit of time to find the right balance. So it has slightly changes how I was communicating as I needed to be around and seeing what they were doing rather than being pre-occupied at my computer.

So it allows you to get to more small groups?
Well that the thing – well normally you are teaching from the front and then when the kids were first on the netbooks I was mainly at the back so I just wanted to change it because it had the potential for me just to sit at the back more and more and you could be quite happy just doing that but I felt that I needed to more and more see what the kids were up to so I just changed it in that way. Because the kids are on task it makes it really easy to conference with two or three students at a time rather than if they didn’t have the netbooks.

Do you think your job is easier with the netbooks than without? The feedback from the interviews was that the kids thought your job would be easier with them.
Mm, mm, the fact that the kids are doing a lot of the editing on the netbooks allows me to spend more time helping them with their work. I think they may have got the my job is easier idea for me because before when I was preparing lessons I would have to find the information on the internet and then go down and print it out and distribute it. I have halved that and I think that is what they were referring to as well as the fact that they do the spellchecking and stuff.

You mentioned a couple of weeks ago that even though the quality of the presentation was better with the netbooks you didn’t think that the quality of the ideas was any better. Do you still think that?
Yeah, yeah I would. I guess when I said that we had not finished a lot of the work – it was mid-term so now that I have got all the work in and assessed it I would say that the quality of the work is really good. I am really impressed with the difference in
what I have seen. The depth of the work, in certain cases, is really, really good. I
guess when I made the initial statement it reflected where they were in the middle of
the term.

**Group Work**

Do you think that the use of the netbooks has made it less likely that you will do

group work?

I have just changed it and I have changed how I do group work to suit the presence of

the netbooks. I have tried a few different strategies and the one I picked this week has

been far and away the best one is to give each student a task or even give them the

choice of which of the tasks to choose and then contribute to a final collaborative

piece of work. A few of the other structures I attempted with netbooks and group

work have not been too successful. If you minimise the amount of computers you use

to attempt group work is the biggest mistake. If you have got them – use them. I tried

the one computer with four kids earlier in the term and that did not work at all. They

always want to be inputting stuff into the netbooks so you have to use them. They

have all got to have them and then contribute to the project. If you have got the

netbook you can keep working until you have finished your part of the task. That

worked really well this week and the kids even decided who was to do what task to

solve the whole problem so you are still getting the dynamics of group work but only

with a different structure. The kids I spoke to aren’t really interested in group work. In

saying that we haven’t done a lot of group work and I don’t really do a lot of group

work at the start of the year.

**Competition**

Do you feel that the students compete much against each other?

No – I don’t think so. *You don’t encourage a culture of competition?* I think it works

well a little bit of competition to lift the standard of work and for behaviour but I
don’t really encourage it. I don’t see that the netbooks have affected that at all.

**Order and Organisation**

Has the use of the netbooks affected the class rules?

No – just logistics and management things but the same themes run through the class

with the netbooks or not.

**Teacher Control**

Are you any different in terms of being more or less strict when they are using

the netbooks to when you are not?

No – I think I have stayed the same. I think I started a bit tight with them out of

respect for the product but since they have been so good in using them I have been

able to relax. If there were any issues with them I would have had to tighten up again.

**Innovation**

Has the amount of input that they have in terms of what the class does changed

much since the use of the netbooks?
No – I don’t think so. I still decide pretty much what is going to happen and then they just decide what they are going to do within the range I set them. However, I have had the opportunity to allow them to have a choice as I have been able to say ok – choose your options and I like to teach that way because that is the way I would like to learn and the netbooks have been really helpful in doing this. It doesn’t work well for everyone but I have noticed the girls in particular have been very productive when we have worked this way. So with the netbooks I have been able to say you have one hour, here are your options and then I can go around and help small groups.

So using the netbooks in first term in effect brought forward stuff you would normally do later in the year?

Yeah – quite possibly but I think towards the end of most terms you generally have a lot of assignment work to be handed in and everyone is at a different stage and a different level – it’s just that having the netbooks has allowed the kids to be on task – your hassle is always that 80% of the kids haven’t handed stuff in and what do you do with the 20% who have handed it in. Having the netbooks means you can easily make an activity; there is more learning or more editing can go on with a piece of work when it is on a netbook than when it is in a book. The document is still in a file so they can open it up and continue working on it and I guess that reflects the quality of the work we have been seeing – the fine tuning that the good kids can do to their work.

Would you say they are more willing to do that fine tuning because of the netbooks?

Yeah, yeah, it is. I would be interested to see what it would be like after 12 months to see if the novelty is still there. It is still a fun thing for the kids to be at my desk working on a computer. It still has that novelty after 6 weeks, they still feel pretty cool, I don’t think actually that they would lose that enthusiasm. I think would feel like that after a long time.

What do you think your class will be like after they have gone?

I think apart from the teething issue of the sore hands or negative attitude of not having them – the sore hands was full on – after a short time of writing a narrative they were all doing the full shake out of their hands. They literally haven’t written, because of the netbooks, for more than 20 minutes a day nearly all term. That will be the big thing and with the few negative attitudes I will have to have a few more transitional activities for them to complete I guess that will keep them on task to start with.

Do you think you will have to work harder getting them up to complete the tasks?

Umm, no – the next unit we do is pretty interesting. I don’t know how it would go if it wasn’t an interesting unit.

Was there anything else you wanted to talk about?

Thank you for the opportunity to work with the netbooks. It has been a really good experience for me as a teacher and definitely for this class and this is reflected in the comments from all partnerships, myself, the kids, the parents so it has been really good.
Instead of having a couple of computers at the back of your room would you rather share 16 netbooks with the teacher next door?
Yes. Because if you have 16 between two that is still eight each which is better than just having four at the back of the room - the more the better.

Is there anything you have wanted to do technology wise that you have been unable to do on the netbooks?
No, the netbook has been spot on. We have not wanted for anything. They have been great.

The final interviews were conducted in Week 6 of the project. The students in this class have had ‘unlimited’ access 1-1 for over 3 full weeks.
Appendix C

DATE: ______________ NAME (Optional) ______________

Write a couple of sentences explaining the benefits of using the netbooks over the past 10 weeks. (As you type the next question will move down so you can type as much as you want).

Have there been any difficulties using the netbooks over the past 10 weeks?

Write a couple of sentences describing how you have mainly used the netbooks. Also include a comment about whether you have used them as much as you would have liked to.

Is there anything you would have liked to have done with the netbooks (or done more of) that you did not get a chance to do? Write a couple of sentences about these things.

You used the computers 3 days per week for 10 weeks (30 days). Do you think this is better than still using them for 30 days but having them for 5 days per week for 6 weeks? Do you think having one each is better than sharing one between two? Write a couple of sentences explaining your answers.

Is there anything you want to say about using the netbooks that I have not already asked? If so, write it here.

Was there anything that you wanted to do that the Netbook could not do? (For example, make a CD of songs or watch a DVD) why would you do it at school any way.

Last thing – in one or two sentences write how you feel now that you won’t have the netbooks to use every day.
Appendix D

New Classroom Environment Instrument
(ACTUAL VERSION)

Research on Models of Netbook Deployment in Year 7 Classrooms.

This questionnaire will give us valuable information which will help to improve schools for future students. Your answers will be strictly confidential, only I will see your particular answers. I will collect together all the information (without your name included) which may be used by other teachers and schools throughout Australia. Once this has been done these sheets will be torn up and thrown away.

Thanks for your help.

Researcher Rex

DIRECTIONS

• This questionnaire asks questions about your particular class. There are no right and wrong answers. This is not a test. Your opinion is what is wanted.
• There are 56 statements. For each statement decide whether you agree with the statement or not.
• Indicate your answer to each question by circling:
  1. If you strongly disagree with the statement;
  2. If you disagree with the statement;
  3. If you neither agree nor disagree with the statement or are not sure
  4. If you agree with the statement;
  5. If you strongly agree with the statement

  If the statement in the questionnaire was WE EXERCISE DAILY and you Agree with the statement you would circle number 4

  e.g. 1 2 3 4 5

  3. If you want to change your answer, cross it out and circle a new number.

ANSWER FOR HOW YOU THINK IT IS IN YOUR CLASS NOW.

PLEASE TURN TO THE NEXT PAGE
New Classroom Environment Instrument  
(ACTUAL VERSION)

Circle a number from 1 to 5 for each statement.  
1. STRONGLY DISAGREE  
2. DISAGREE  
3. NEITHER DISAGREE / AGREE  
4. AGREE  
5. STRONGLY AGREE

Please put your response to each statement on the separate answer sheet by using the first response you think of for your particular class.

ANSWER FOR HOW YOU THINK IT IS IN YOUR CLASS NOW

1. Students put a lot of energy into what they do here  
2. This class is very noisy  
3. The teacher is not very strict  
4. New and different ways of teaching are not tried very often in this class  
5. Students don’t take part in class discussions or activities  
6. Students enjoy working together on projects in this class  
7. The teacher goes out of his/her way to help students  
8. Students get into groups for small activities  
9. Grades are very important in this class  
10. The teacher has to tell students to calm down and behave

11. Students don’t compete with each other here  
12. This class is very noisy  
13. The teacher is not very strict  
14. New and different ways of teaching are not tried very often in this class  
15. Students don’t take part in class discussions or activities  
16. Students enjoy working together on projects in this class  
17. The teacher goes out of his/her way to help students  
18. Students get into groups for small activities  
19. Grades are very important in this class  
20. The teacher has to tell students to calm down and behave

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17. The teacher goes out of his/her way to help students  
18. Students get into groups for small activities  
19. Grades are very important in this class  
20. The teacher has to tell students to calm down and behave

YOU HAVE FINISHED THE QUESTIONS – THANK YOU!
NEW CLASSROOM ENVIRONMENT INSTRUMENT  
(ACTUAL VERSION)

Name: (Optional) ______________________________ Male / Female (Circle One)

Class: ______________________________   Date: ________________________

Circle a number from 1 to 5 for each statement.
1.  STONGLY DISAGREE
2.  DISAGREE
3.  NEITHER DISAGREE / AGREE
4.  AGREE
5.  STRONGLY AGREE

REMEMBER YOU ARE RATING YOUR ACTUAL CLASSROOM

If you want to change your answer, cross it out and circle a new letter.

Thank you once again for helping me.

Researcher Rex.
This questionnaire will give us valuable information which will help to improve schools for future students. Your answers will be strictly confidential, only I will see your particular answers. I will collect together all the information (without your name included) which may be used by other teachers and schools throughout Australia. Once this has been done these sheets will be torn up and thrown away.

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**DIRECTIONS**

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- There are 56 statements. For each statement decide whether you agree with the statement or not.
- Indicate your answer to each question by circling:
  1. If you *strongly disagree* with the statement;
  2. If you *disagree* with the statement;
  3. If you *neither agree nor disagree* with the statement or are not *sure*;
  4. If you *agree* with the statement;
  5. If you *strongly agree* with the statement.

If the statement in the questionnaire was

**WE WOULD EXERCISE DAILY**

and you *agree* with the statement you would circle number 4

```
e.g. 1 2 3 4 5
```

3. If you want to change your answer, cross it out and circle a new number.

**ANSWER FOR HOW YOU WOULD LIKE YOUR CLASS TO BE.**

**PLEASE TURN TO THE NEXT PAGE**
Imagine Your Ideal Class

1. Students would put a lot of energy into what they do here
2. Students in my class would get to know each other well
3. The teacher would remain at the front of the class rather than moving about and talking with students
4. Students would work by themselves rather than working together on projects in this class
5. Students would feel pressured to compete
6. The class would be well-organised
7. There would be very few rules to follow
8. New ideas would be tried out in this class
9. Students would daydream in this class
10. Students in the class would not be very interested in getting to know other students

11. The teacher would care about how the students feel
12. Time would be set aside during the lesson for small group activities
13. Students would try hard to get the best grades
14. Students would be quiet in the class
15. If students break a rule in the class, they would be disciplined
16. Students would do very different things on different days in class
17. Most students in the class would not pay attention to what the teacher is saying
18. It would be easy to get a group together for a project
19. The teacher would be more like a friend than an authority
20. Students would work together in class on group activities

21. Students would not compete with each other
22. The class would be very noisy
23. The teacher would not be very strict
24. New and different ways of teaching would not be tried very often in the class
25. Students would not take part in class discussions or activities
26. Students would enjoy working together on projects in the class
27. The teacher would go out of his/her way to help students
28. Students would get into groups for small activities
29. Grades would be very important in this class
30. The teacher would have to tell students to calm down and behave

31. Students would get into trouble with the teacher for talking when not supposed to
32. The teacher would encourage students to try unusual projects
33. Students would sometimes present something they’ve worked on to the class
34. Friendships would be made in this class
35. The teacher would embarrass students for not knowing the right answers
36. Students would work in groups to solve questions raised in class
37. Students here would take notice about what grades the other students are getting
38. Assignments would be clear so everyone knows what to do
39. It would be easier to get into trouble here than in a lot of other classes

40. Students would have very little say about how class time is spent
41. Students would do extra work on their own in this class
42. Groups of students would not get along in this class
43. The teacher would try to find out what students want to learn about
44. Students would work in groups to complete group projects
45. Students would have to work for a good grade in this class
46. Activities in this class would be clearly and carefully planned
47. The teacher would be prepared to put up with quite a lot of problems in the class
48. The teacher would think up unusual projects for the students to do
49. Students would really enjoy the class
50. Some students in this class would not like each other

51. The teacher would not trust students
52. Students would share resources and work together in class
53. Sometimes the class would break up into groups to compete with each other
54. Students would interrupt the teacher when he/she is talking
55. The teacher would send a student out of class if he/she doesn’t behave
56. Students would do the same type of activities every day

YOU HAVE FINISHED THE QUESTIONS – THANK YOU!
# NEW CLASSROOM ENVIRONMENT INSTRUMENT
*(PREFERRED VERSION)*

Name: (Optional) ______________________________ Male / Female (Circle One)  
Class: ______________________________   Date: ________________________

|   | 1 | 2 | 3 | 4 | 5 |   | 1 | 2 | 3 | 4 | 5 |   | 1 | 2 | 3 | 4 | 5 |   | 1 | 2 | 3 | 4 | 5 |   | 1 | 2 | 3 | 4 | 5 |   | 1 | 2 | 3 | 4 | 5 |   |
| 1 | 1 | 2 | 3 | 4 | 5 | 11 | 1 | 2 | 3 | 4 | 5 | 21 | 1 | 2 | 3 | 4 | 5 | 31 | 1 | 2 | 3 | 4 | 5 | 41 | 1 | 2 | 3 | 4 | 5 | 51 | 1 | 2 | 3 | 4 | 5 |
| 2 | 1 | 2 | 3 | 4 | 5 | 12 | 1 | 2 | 3 | 4 | 5 | 22 | 1 | 2 | 3 | 4 | 5 | 32 | 1 | 2 | 3 | 4 | 5 | 42 | 1 | 2 | 3 | 4 | 5 | 52 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 2 | 3 | 4 | 5 | 13 | 1 | 2 | 3 | 4 | 5 | 23 | 1 | 2 | 3 | 4 | 5 | 33 | 1 | 2 | 3 | 4 | 5 | 43 | 1 | 2 | 3 | 4 | 5 | 53 | 1 | 2 | 3 | 4 | 5 |
| 4 | 1 | 2 | 3 | 4 | 5 | 14 | 1 | 2 | 3 | 4 | 5 | 24 | 1 | 2 | 3 | 4 | 5 | 34 | 1 | 2 | 3 | 4 | 5 | 44 | 1 | 2 | 3 | 4 | 5 | 54 | 1 | 2 | 3 | 4 | 5 |
| 5 | 1 | 2 | 3 | 4 | 5 | 15 | 1 | 2 | 3 | 4 | 5 | 25 | 1 | 2 | 3 | 4 | 5 | 35 | 1 | 2 | 3 | 4 | 5 | 45 | 1 | 2 | 3 | 4 | 5 | 55 | 1 | 2 | 3 | 4 | 5 |
| 6 | 1 | 2 | 3 | 4 | 5 | 16 | 1 | 2 | 3 | 4 | 5 | 26 | 1 | 2 | 3 | 4 | 5 | 36 | 1 | 2 | 3 | 4 | 5 | 46 | 1 | 2 | 3 | 4 | 5 | 56 | 1 | 2 | 3 | 4 | 5 |
| 7 | 1 | 2 | 3 | 4 | 5 | 17 | 1 | 2 | 3 | 4 | 5 | 27 | 1 | 2 | 3 | 4 | 5 | 37 | 1 | 2 | 3 | 4 | 5 | 47 | 1 | 2 | 3 | 4 | 5 | 57 | 1 | 2 | 3 | 4 | 5 |
| 8 | 1 | 2 | 3 | 4 | 5 | 18 | 1 | 2 | 3 | 4 | 5 | 28 | 1 | 2 | 3 | 4 | 5 | 38 | 1 | 2 | 3 | 4 | 5 | 48 | 1 | 2 | 3 | 4 | 5 | 58 | 1 | 2 | 3 | 4 | 5 |
| 9 | 1 | 2 | 3 | 4 | 5 | 19 | 1 | 2 | 3 | 4 | 5 | 29 | 1 | 2 | 3 | 4 | 5 | 39 | 1 | 2 | 3 | 4 | 5 | 49 | 1 | 2 | 3 | 4 | 5 | 59 | 1 | 2 | 3 | 4 | 5 |
| 10| 1 | 2 | 3 | 4 | 5| 20| 1 | 2 | 3 | 4 | 5 | 30| 1 | 2 | 3 | 4 | 5 | 40| 1 | 2 | 3 | 4 | 5 | 50| 1 | 2 | 3 | 4 | 5 |

**REMEMBER YOU ARE RATING YOUR IDEAL CLASSROOM**

If you want to change your answer, cross it out and circle a new letter.

Thank you once again for helping me.

Researcher Rex
### Logon and Logoff data collected daily from each netbook (Sample)

<table>
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<th>Time</th>
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<th>Activity</th>
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## Appendix F

### Class A - Collated Daily Use of Netbooks (Sample)

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<th>Netbook</th>
<th>Day 1</th>
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<th>Day 4</th>
<th>Day 5</th>
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<td>135</td>
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<td>86</td>
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<td>Acer 32</td>
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<td>154</td>
<td>52</td>
<td>71</td>
<td>15</td>
<td>0</td>
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</tbody>
</table>

**Total Time On** 942 4418 1458 3239 952 0
**Average Time On** 29.44 138.06 45.56 101.22 29.75 0.00
**Total Potential Time** 9600 9600 9600 9600 9600 9600
**Percentage Use** 9.81 46.02 15.19 33.74 9.92 0.00
**Before school use** 0 0 0 5 6 0
APPENDIX G

Data collected daily from each netbook using Spy Keylogger (Sample)

**Program Run**
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Windows Internet Explorer
Time: 04/23/2009 08:19:05
User: STUDENT NAME WITHHELD

**Keystrokes**
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Customize Your Settings - Windows Internet Explorer
Time: 04/23/2009 08:20:17
User: STUDENT NAME WITHHELD
Google home page

**Program Run**
Module Path: C:\Program Files\Microsoft Office\Office12\WINWORD.EXE
Window Title: Microsoft Word
User: STUDENT NAME WITHHELD
the [BACK][BACK][BACK][BACK]The Government

**Keystrokes**
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Google - Windows Internet Explorer
User: STUDENT NAME WITHHELD
what is govern[CTRL]

**Keystrokes**
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Google - Windows Internet Explorer
User: STUDENT NAME WITHHELD
our french vacation

**Program Run**
Module Path: C:\WINDOWS\Explorer.EXE
Window Title: My Documents
User: STUDENT NAME WITHHELD

**Program Exit**
Module Path: C:\WINDOWS\Explorer.EXE
Window Title: My Documents
Time: 04/23/2009 08:27:36
User: STUDENT NAME WITHHELD

**Keystrokes**
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Our Vacation to France! - Windows Internet Explorer
Time: 04/23/2009 08:29:06
User: STUDENT NAME WITHHELD
monna [CTRL][DOWN]
in the musuem

Keystrokes
Module Path: C:\Program Files\Microsoft Office\Office12\WINWORD.EXE
Window Title: Document1 - Microsoft Word
Time: 04/23/2009 08:32:33
User: STUDENT NAME WITHHELD

bows

Keystrokes
Module Path: C:\Program Files\Microsoft Office\Office12\WINWORD.EXE
Window Title: Document1 - Microsoft Word
Time: 04/23/2009 08:34:21
User: STUDENT NAME WITHHELD

ribbons

Program Exit
Module Path: C:\Program Files\Microsoft Office\Office12\WINWORD.EXE
Window Title: Microsoft Word
Time: 04/23/2009 08:34:40
User: STUDENT NAME WITHHELD

Program Exit
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: http://davinci-code.info/imgs/data/mona-lisa-1.jpg - Windows Internet Explorer
Time: 04/23/2009 08:34:43
User: STUDENT NAME WITHHELD

Program Run
Module Path: C:\WINDOWS\Explorer.EXE
Window Title:
Time: 04/23/2009 08:34:47
User: STUDENT NAME WITHHELD

Program Exit
Module Path: C:\WINDOWS\Explorer.EXE
Window Title:
Time: 04/23/2009 08:34:49
User: STUDENT NAME WITHHELD

Program Run
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Windows Internet Explorer
User: DIFFERENT STUDENT BUT NAME WITHHELD

Keystrokes
Module Path: C:\Program Files\Internet Explorer\iexplore.exe
Window Title: Welcome to the Intranet Zone - Windows Internet Explorer
Time: 04/23/2009 09:47:46
User: DIFFERENT STUDENT BUT NAME WITHHELD

.awn.gov.au
/people/index/
Appendix H: Wireless Netbook Project
INFORMATION SHEET

Who is conducting the research?
Kevin Larkin
School of Education and Professional Studies
(Griffith University - Gold Coast Campus)
0755 351 803
k.larkin@griffith.edu.au

Why is the research being conducted?
This research seeks to investigate the impact on classroom environment, student communication and pedagogy when a mobile bank of wireless Netbooks is used in a variety of usage patterns. The researcher is completing this research project as a component of a Doctor of Education degree from Griffith University, Gold Coast Campus.

What you will be asked to do
As a participant in this study you will be asked to complete a questionnaire at the beginning and end of the project. Selected students will also be interviewed in pairs. Teachers will also complete an online survey. All students and teachers are encouraged to keep a diary of their experience of using the Netbooks.

The basis by which participants will be selected or screened
Appropriate teachers have been nominated by the school Leadership Team. The researcher invited them to become part of the project. If they agree their students are also invited to participate in the project.

The expected benefits of the research
The benefits of this study are threefold. At an individual level students gain access to a new Netbook for either their exclusive or semi-exclusive use. Teachers gain access to a personal Netbook and also professional development in their use. At a school level, the Leadership Team will receive information regarding the best deployment of the Netbook resource. At a broad educational level, Brisbane Catholic Education receives information which can be utilised across the other 140 schools in the system. Griffith University and the wider academic community will also gather further knowledge concerning various theoretical models which will be used to explain the results of the project.
Risks to you

The project is, to all practical purposes, risk free for participants. Training will be provided in the use of the Netbooks and will include information regarding care of the Netbooks and also the correct ergonomic procedures for their use.

Your confidentiality

No identifiable information will be collected. Questionnaires will be anonymous. Participating students will be randomly assigned a Letter/Number identified for example, A1, B7, C23, D30. Teachers will be assigned a pseudonym. The school is only identified as a Catholic School in South-East Queensland. Students and teachers interviews will be digitally recorded but will not be played in public. Transcripts will be used as data but pseudonyms and number identifiers will be used. Data activity statistics collected from the Netbooks will not be used to identify individual students or students and will be collated to provide an overall picture of Netbook usage for each class.

Your participation is voluntary

The participation of teachers and students is voluntary. In terms of the questionnaire / online survey, participants do not need to answer every question unless they wish to do so. Students may refuse the invitation to be interviewed. Participation by staff in the project will in no way impact upon your relationship with the school Leadership Team. As a participant, you are free to withdraw from the study at any time.

Mechanism for distribution of findings

Data collected during this project will be used to better inform the future deployment of the bank of Netbooks which the school has purchased. It will also inform further purchases as well as decisions relating to the professional development of teachers. All participants in the study will receive an information summary of the findings of the study.

Questions / further information

Should you require any further information regarding this project, please feel free to contact the researcher, Kevin Larkin on 07 55 351803 or via email k.larkin@griffith.edu.au. Alternatively, contact can be made with Dr Glenn Finger (Deputy Dean, Learning and Teaching, Griffith Uni) on 07 55 528618 or g.finger@griffith.edu.au

The ethical conduct of this research

If you need further clarification of any of the issues addressed above, or if you have any other questions, please do not hesitate to contact Mr Kevin Larkin (contact details above). Should you have any complaints concerning the manner in which the research is conducted, you can contact the Manager, Research Ethics, Office for Research, Bray Centre, Griffith University, Kessels Road, Nathan, QLD 4111, phone (07) 37355585 or email research-ethics@griffith.edu.au
APPENDIX I: Models of Classroom Wireless Netbook Deployment

CONSENT FORM FOR STUDENTS

Dear Students:

Griffith University is currently conducting research in Year 6 and 7 at Marymount Primary School. I am helping them with this research. We are looking at the educational effects of using Netbooks in classrooms such as yours. What we learn will result in a better understanding of the most effective use of Netbooks in Year 6 and 7 classrooms such as yours.

The research will occur in Terms 1 - 3 of the 2009 school year and will involve four teachers and their classes. 7MQ will be allocated the full class set of Netbooks for six weeks and each student will have their own Netbook. 7DM will be allocated a half class set of Netbooks for six weeks with each pair of students sharing a Netbook. 6DH or (7JE) will be allocated the full class set of Netbooks for three days per week for ten weeks and each student will have their own Netbook. 6CB or (7DC) will be allocated a half class set of Netbooks for three days per week for ten weeks with each pair of students sharing a Netbook.

I will collect some information from you, and from the teachers, before you start to use the Netbooks. You will fill in a Classroom Environment Survey and some of you, if you agree, will also be interviewed by me (you will have another student with you). I will also spend a period of time observing your classroom prior to the study. I will take some notes about what happens in your room.

At the end of the first week of Netbook use your teacher, and some of you, will complete a taped interview with me. If you come for an interview you will have another student with you. I will spend time in your classroom observing classroom activities and I will write down notes about what I see. I will do this again at the end of the period of computer usage. At the conclusion of the computer use you will re-do the Classroom Environment Survey. A diary will be completed by me about what I have seen. Hopefully you will also keep a diary of your experiences with the computers which I can read, if you want me to, to learn more about the best way to use Netbooks in a classroom. I will also collect information from the Netbook you are
using. This will include how long the Netbook is used, which programs you use and which internet sites you visit. This information will be collected as a class and not as individuals. I am interested in the pattern of use for your class. Please remember when you are using the Netbooks that the rules for there use are the same as for when you are using the other computers in the school.

What you will experience may be slightly different to what another class’ experience as some of you will use the computers individually whilst others will share, and some of you will use the computers every day for six weeks whilst others will use them for three days a week for a longer period of time. Regardless of the usage patterns you will experience the following:

- Significant use of a new, wireless and Bluetooth equipped Netbook computer
- Lessons delivered by me as to how to best utilise the device
- Surveys regarding your classroom environment (before and after the research)
- Classroom observation by me
- Some of you will have interviews (always with another student) prior to, during and after the research with me.
- Information about what I have learnt about using computers with school students will be shared with you at the end.
- I won’t use your name, or your teacher’s name, when I write about your class – I will use a letter and number for example, Class A- Student One will be A1, Class A- Student Two will be A2, Class b- Student Three will be B3 and so on.

If you want any more information about my project just speak to your teacher or come and speak to me at school. If you have any other things that you want to talk about, or if something happens which you are worried about, just let your parents know and they can contact someone from the University who can help them. Once I have finished writing about this project I will come and tell you what we have learnt.

Thank you for taking time to read this letter. It would help me to understand how to best use computers if you agree to join in with the project. I ask that you please complete the form with this letter and return it, with the signed form from your parents, to your teacher as soon as you can. Remember to talk to your parents, or your teacher, or me, if you are unsure about what is involved.

Yours truly,

Mr. Larkin
STUDENT CONSENT FORM

Models of Classroom Wireless Netbook Deployment

By signing below, I agree that I have read and understood the information given to me and
know that:

1. My taking part in this research will include the completion of a survey and may also
include a taped interview (always with another student), by Mr Larkin.

2. If I don’t want to take part in the research project I will still participate in activities
with the Netbooks but will not complete the survey, or an interview, and no
information will be collected from the Netbook you are using.

3. I understand that at no time throughout this project will I be identified by name.

4. I have had any questions I have answered clearly.

5. I understand that my participation in this research is voluntary.

6. I understand that if I have any additional questions I can contact my teacher or Mr.
Larkin.

7. I understand that I am free to stop taking part in the project at any time.

8. I understand that I can speak to my parents, who can contact the university, if I have
any concerns about the project.

Please tick one of the following statements:

□ YES, I wish to participate in the Netbooks Program.

□ NO, I do not want to participate in the Netbooks Program.

Signature: ...........................................  .....................  .....................

Your Name       Date       Class
Chief Investigator:
Dr Glenn Finger PhD - (Deputy Dean, Learning and Teaching) School of Education and Professional Studies Griffith University, Gold Coast. Phone: (07) 5552 8618 Email: g.finger@griffith.edu.au

Student Researcher:
Mr Kevin Larkin - (M. Ed Leadership; M. Ed Studies). School of Education and Professional Studies Griffith University, Gold Coast. Phone: (07) 5535 1803 Email: k.larkin@griffith.edu.au

Dear Parent/Guardian:

Griffith University is currently conducting research in Year 6 & 7 at Marymount Primary School. This project forms a part of the student researcher’s Doctor of Education degree and examines the educational implications of various usage patterns regarding wireless Netbooks in Middle School classrooms. Four different models of their use will be researched. Findings of the research will contribute to a better understanding of the most effective use of Netbooks in Middle School classrooms in terms of positive classroom environment, student communication, teaching styles and attainment of curriculum goals.

The research will occur in Terms 1 - 3 of the 2009 school year and will involve four middle school teachers and their students. 7MQ will be allocated the full class set of Netbooks for their exclusive use for a six week period and each student will have their own Netbook. 7DM will be allocated a half class set of Netbooks for their exclusive use for a six week period with each pair of students sharing a Netbook. 6DH or (7JE) will be allocated the full class set of Netbooks for their exclusive use for three days per week for ten weeks and each student will have their own Netbook. 6CB or (7DC) will be allocated a half class set of Netbooks for their exclusive use for three days per week for ten weeks with each pair of students sharing a Netbook.
The following data collection will occur prior to the study. The teachers will complete two surveys, an online ICT Integration Survey and a Classroom Environment Questionnaire and will also participate in a semi-structured, taped interview. The approximately 125 students involved in the study will also complete the Classroom Environment Questionnaire and randomly selected pairs of students (16 students - Two pairs of students from each class) will also be interviewed. The same pairs of students will be interviewed on two more occasions throughout the study. The researcher will also spend a period of time observing each classroom prior to the study. Observation notes will be compiled and an observation checklist completed.

At the end of the first week of Netbook use the teachers and selected students will complete a semi-structured, taped interview. The researcher will spend time in each classroom observing student-teacher and student-student interaction and observation notes will be compiled. This pattern repeats itself at the end of the period of computer usage. At the conclusion of the computer use period all participants will re-complete the Classroom Environment Index and the teachers will re-complete the online ICT Integration survey. A reflexive diary will be completed by the researcher. Teachers and students will be encouraged to complete a reflexive diary. These diaries will form part of the data collection. Computer data will be collected via activity logging software on each Netbook. This data will include length of usage, programs used and internet sites accessed. No individual data will be identified or reported and all data will be conglomerated to provide an overall picture of Netbook usage for that particular class. Participants will be informed of the use of this software in the Participation Information Sheet. Students and teachers already sign a school network usage agreement and are aware that the school utilises software across the network which logs internet usage.

The experience of the participants will vary slightly according to the type of access they receive that is some students will use the computers individually whilst others will share and some students will use the computers intensively for six weeks whilst others will use them three days a week for a longer period of time. Regardless of the usage patterns all students and teachers will experience the following
• Significant availability of a new, wireless and Bluetooth equipped Netbook computer
• Workshops delivered by the researcher as to how to best utilise the device
• Surveys regarding their classroom environment (before and after the research)
• Classroom observation by researcher
• Interviews prior to, during and after the research (all teachers and randomly selected students)
• Access to the research findings (teachers – full access; students – access to information appropriate to their developmental level)
• Anonymity. No students will be identified by name in the research and will be assigned a reference code eg. Student A1, A12, B23, C31 etc.

If you need further clarification of any of the issues addressed above, or if you have any other questions, please do not hesitate to contact Mr Kevin Larkin (contact details above). Should you have any complaints concerning the manner in which the research is conducted, you can contact the Manager, Research Ethics, Office for Research, Bray Centre, Griffith University, Kessels Road, Nathan, QLD 4111, phone (07) 37355585 or email research-ethics@griffith.edu.au

A summary of the overall outcomes of the research will be made available on completion of the project. Parents and guardians of the participating children may obtain this from the investigator. I would like to thank you for taking time to read this request. It would assist my research greatly if you would allow your child to participate. I ask that you please complete the consent form provided and return it to your child’s class teacher at your next opportunity.

Yours truly,

Kevin M Larkin
PARENT/GUARDIAN CONSENT FORM

Models of Classroom Wireless Netbook Deployment

By signing below, I confirm that I have read and understood the information sheet and have noted that:

1. I understand that my child’s involvement in this research will include the completion of a questionnaire and may also include a taped interview with another child by the researcher. It may also include the completion of a diary of their experience in the project.

2. In the event that parental consent is not given to participate in the research project, your child will still participate in activities with the Netbooks but will not complete the questionnaire or be randomly chosen for a paired-student interview and no information will be collected from the Netbook they are using.

3. I understand that at no time throughout this project will my child be identified by name.

4. I have had any questions answered to my satisfaction.

5. I understand that my child’s participation in this research is voluntary.

6. I understand that if I have any additional questions I can contact the researcher.

7. I understand that my child is free to withdraw at any time, without comment or penalty.

8. I understand that I can contact the Manager, Research Ethics, Griffith University Human Research Ethics Committee on (07) 3735 5585 research-ethics@griffith.edu.au if I have any concerns about the ethical conduct of the project.

Please tick one of the following statements:

☐ YES, I give permission for my child to participate in the Models of Classroom Wireless Netbook Deployment research and give my consent freely.

☐ NO, I do not give permission for my child to participate in the Models of Classroom Wireless Netbook Deployment research.

Signature: ........................................  .................

Parent/Legal Guardian  Date

........................................  .................

Child’s Name  Child’s Class
APPENDIX J:
Griffith University Ethical Approval

GRIFFITH UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE

16-Sep-2008

Dear Mr Larkin

I write further to the additional information provided in relation to the provisional approval granted to your application for ethical clearance for your project "Using Laptops to Access Information, Create Communication Patterns, and Transform Learning: An Activity Theory Perspective" (GU Ref No: EPS/08/08/HREC).

The additional information was considered by Office for Research. This is to confirm that this response has addressed the comments and concerns of the HREC.

Please provide us with copies of the approval from Cath Ed and the participating schools, once these are received.

Please also provide us with a copy of the updated informed consent materials for our records.

Consequently, you are authorised to immediately commence this research on this basis.

The standard conditions of approval attached to our previous correspondence about this protocol continue to apply.

Regards

Dr Gary Allen
Manager, Research Ethics
Office for Research
Bray Centre, Nathan Campus
Griffith University
ph: 3735 5585
fax: 3735 7994
email: g.allen@griffith.edu.au
web:

Cc:

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This email and any files transmitted with it are intended solely for the use of the addressee(s) and may contain information which is confidential or privileged. If you receive this email and you are not the addressee(s) [or responsible for delivery of the email to the addressee(s)], please disregard the contents of the email, delete the email and notify the author immediately.
Brisbane Catholic Education Approval

A11.071 LE:em ref:490
28 October 2008

Mr Kevin Larkin
PO Box 2506
XXXXXXXX BC QLD 4XXXX

Dear Mr Larkin

Thank you for your application regarding permission to approach a Brisbane Catholic Education school to conduct your research on ‘Using laptops to access information, create communication patterns and transform learning: An activity theory perspective’ Permission is granted to approach XXXXXXX Primary School, XXXXXXX.

I would ask you to contact the principal of the school seeking his involvement in the project.

Please note that participation in your study is at the discretion of the principal.

If you have any further queries, please contact me on (07) 3033 7427

Mrs Lisa Eastment
Research Coordinator
Catholic Education
Archdiocese of Brisbane
APPENDIX K

Three General Forms of Classroom Activity - *(Adapted from Pietsch, 2005, p. 177)*

<table>
<thead>
<tr>
<th>Educational Activity</th>
<th>School-going Activity</th>
<th>Social Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Actions</td>
<td>Instantiated in the classroom in the following components</td>
<td>Curriculum or non-curriculum discourse</td>
</tr>
<tr>
<td>Student Understanding</td>
<td>Practising KLA's</td>
<td>Social relationships</td>
</tr>
<tr>
<td></td>
<td>which have the following objects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completing set learning tasks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>transformed to achieve following outcomes</td>
<td></td>
</tr>
<tr>
<td>Students prepared to participate in classroom activities</td>
<td>Students fulfil teachers’ expectations</td>
<td>Closer social relationships</td>
</tr>
<tr>
<td>Individual teachers</td>
<td>Individual students who achieve this outcome by</td>
<td>Pairs and groups of students</td>
</tr>
<tr>
<td>Providing monologues focussed on Curriculum content</td>
<td>Working through set learning activities individually</td>
<td>Discussing topics of common interest</td>
</tr>
</tbody>
</table>

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