Chapter 1

The Problem
THE PROBLEM

1.1. Introduction

Computers have the potential to revolutionise teaching and learning. This potential has already been experienced in many other aspects of modern life. For the moment, the potential has bypassed most schools. Why is this so?

Luehrmann (1994) illustrated the point by suggesting that if one's great-grandmother could come back to visit she would find little that had changed in our classrooms. Dyrli and Kinnaman (1994) agreed, declaring that "technology has transformed almost every segment of society - except education" (p.92). Reflecting on the impact of computing at all levels of education Ely (1993) stated:

On a national scale, one would have to conclude that computer-based instruction in schools and universities has had minimal impact. By any measure of learning achievement, of significant changes in styles of teaching and learning, or of curriculum reform, the conclusion is "little or no effect." (p.55)

Why have teachers been unable to integrate information technology? The literature abounds with case studies and reports of teachers doing just that! Could it be that the successful examples cited in the literature are characteristic only of early adopters? If indeed that is the case, then is what is being witnessed in our schools a classic example of cultural lag? As a phenomenon, cultural lag refers to the tendency for some elements of our society to change more rapidly than others do. In this case, changes in technology have occurred more rapidly than changes in teachers' values and attitudes towards computers as tools for learning and discovery.

This is the context for the study. In the study, the underlying values and attitudes of a sample of teachers towards computers are examined to ascertain their form and structure. The study also seeks to build an explanatory model to provide insight into how to better align those elements within our secondary schools.
1.2 Background to the Study

The growth and acceptance of computers in our schools has been nothing short of spectacular, or has it? There is certainly evidence worldwide (Pelgrum & Plomp, 1991) describing the phenomenal infusion of information technology in schools. Similarly, research findings have made it clear that computer applications have undeniable value and an important instructional role to play in classrooms (Roblyer, Castine & King, 1988). However, the acceptance, or more precisely the role of information technology in the classroom remains problematic.

The question of how schools can best use their computing resources to bring about positive and lasting effects upon student’s learning has resulted in the development of two broad sets of curriculum practices (Bigum, 1990; Hodson, 1990; Wellington, 1990). These are:

i. Learning about the computer and its impact upon society - ie. Computing Studies.

ii. Learning with, through and from computers - ie. Computers integrated Across the Curriculum.

Today, both sets of curriculum practices command a significant proportion of schools’ resources (Bigum, 1990). During the 1980s though, curriculum practice emphasising learning about computers gained dominance. Hodson (1990) stated that specific subjects were developed to teach about computers because they represented a highly visible, traditional secondary school response to the problem of resource scarcity.

The popularity of this approach to computer education was not without critics. Bigum (1990) questioned the legitimacy of this approach, suggesting that the conspicuous position of Computing Studies had arisen without real debate. In Great Britain, Wellington (1990) argued that significant economic pressures were behind the push for students to learn about computers. Critical concern was also expressed over subject matter. For Adams (1992), the reality was that such courses often did little more than teach computer programming concepts.

In the early 1990s, the pendulum began to swing in favour of learning with, through and from computers across the curriculum. That shift reflected a growing consciousness of the disadvantages of specialised computer education courses - fragmentation, mystification and academicisation (Hodson, 1990) - and an increasing awareness of the interactive nature of computers as tools for learning and discovery.
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Despite growing support for computers as tools for learning and discovery within school education bureaucracies, teachers generally remain unwilling to integrate computer use across the curriculum. According to Veen (1995) whether or not teachers decide to use computers depends upon two basic categories of factors: factors at a school level and factors at the teacher level.

If teachers' belief systems are paramount, then it is unlikely that efforts to improve teachers' computing knowledge and skills in isolation of those beliefs will have any impact upon teachers' intentions to use computers as tools for teaching and learning.

1.3. Purpose of the Study

The purpose of the study is twofold:

i. Identify those characteristics and dispositions of teachers that impact upon their intended use of information technologies;

ii. Map relationships between teacher characteristics and dispositions into an explanatory model that clarifies how teachers become accomplished educational computer users.

A relevant issue in classrooms today is the incorporation of technology, specifically computers, into teaching and learning. The computer is almost ubiquitous and among informed educators there is a belief that computers are not another passing fad. However, their pervasiveness does not necessarily correlate with classroom use. Research has shown there is a wide variation in the amount different teachers use computers in their classrooms.

Variation in the uptake of computers in classrooms is said to be a function of teacher expertise and comfort. Researchers suspect teachers with superior computer knowledge and skills will emerge provided the school climate is conducive and there is access to sufficient resources. Promoting teacher comfort with classroom computer usage within that context is more problematic, since teacher intentions to use computers is a function of their belief system.

If teacher beliefs about information technology in teaching and learning underpins the uptake of classroom computing, then it is reasonable to expect that an understanding of the components of teacher beliefs about information technology – attitudes - can further enlighten the processes by which teachers become accomplished educational computer users.
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From this perspective, it is plausible to suggest that a specific array of teacher dispositions may be contributing to the variation in the use of computers by teachers as tools for teaching and learning, or more precisely the intended use of computers by teachers. It is important however to go beyond an identification exercise, in which the various elements of the array are named and described, to a point where a conceptual understanding of the array is defined.

1.4. Major Study Questions

The following questions are addressed:

i. What are the teacher characteristics and dispositions that impact upon teacher intentions to use computers in teaching and learning?

ii. How do teacher characteristics and dispositions impact upon teacher intentions to use computers in teaching and learning?

iii. How do teacher characteristics and dispositions that impact upon teacher intentions to use computers in teaching and learning relate to each other?

iv. Can the pattern of relationship between teacher characteristics and dispositions explain the processes by which teachers’ uptake computers into teaching and learning situations?

1.5. Context of the Study

There is a long held belief that the rate of diffusion of information technologies within secondary schools is dependent upon:

i. The range and quality of available software alternatives,

ii. Establishment costs of information technologies, relative to other teaching / learning tools, and

iii. Teacher familiarity with information technologies.

(Bramble, Mason & Berg, 1985).
It would be difficult to argue that a critical mass of educational software and generic tools for learning does not exist in the market place. Over the past two decades, software developers have recognised the potential for present and future profits and have actively developed or reshaped products for the education market. Geisert and Futrell (1995) estimated that in 1995 there were more than 32 000 educational titles available and that this figure was growing by 10 percent per annum. Maddux, Johnson and Willis (1997) consider that the point has been reached where estimates of available titles are no longer meaningful.

Similarly, it would be difficult to argue that hardware shortages hamper school efforts to integrate information technologies across the curriculum. State governments across Australia have actively supported the infusion of computers into their schools for more than 15 years. The recently completed phased rollout of computers to all government schools in N.S.W. (NSW Dept of Education and Training, 1998b) has placed some seventy seven thousand computers into primary and secondary schools at a capital cost of $186.4 million. This massive infusion of computers has achieved a uniform ratio in N.S.W. government schools of one microcomputer to 11 students.

Promoting teacher familiarity with information technologies, however, remains problematic. Pelgrum and Plomp (1991), in a survey of 19 secondary education systems, found that after excluding the U.S.A, where nearly half the teachers used computers in the classroom, only a small proportion of teachers used computers. Roberts and Albion (1993) in a sample of 226 Australian schools found that only one in five teachers were both regular and effective users of computers.

Lack of teacher familiarity with information technologies was initially equated with a need to promote teacher computer literacy (Hodson 1990). Improving teacher computer literacy was believed to be the mechanism for a generational change in teachers’ use of computers, from a sparing use of computers or none at all, to using computers as personal productivity tools, and beyond this to using computers as tools for teaching and learning. Unfortunately computer literacy is not a single concept, it regularly metamorphoses taking on new and varied approaches with time (Lockard, Abrams & Many, 1994). A common thread however remains, and that is each variant of computer literacy continues to treat the computer as subject matter, and hence an end in itself.

Despite growing concern over the legitimacy of training teachers for computer literacy, both the Commonwealth and the N.S.W. Governments continued to provide funds for this purpose. By the mid-1990s, those funds were supporting teams of computer consultants, among whose functions was the development of one-off hands-on workshops, focusing on the acquisition of software and
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hardware knowledge and skills. Walker (1993), studying the effectiveness of this support found expenditure on consultants had no significant impact on teachers’ computer confidence.

Recent efforts to up-skill government teachers (K-12) in New South Wales have been incorporated in the aptly titled Technology in Learning and Teaching (TILT) initiative (NSW Dept of School Education, 1996). In an attempt to refocus training, a centrally written, yet locally delivered training strategy was developed that purported to match training in current software with pedagogic understanding of what computer mediated learning applications were trying to do.

Little evidence, outside of Department of Education and Training documentation, as to the full impact of the TILT has surfaced. Critics argued strongly prior to its implementation that the TILT training strategy would not go far enough in supporting teacher change (Raethel, 1995a). A personal examination of TILT training strategy documentation suggested that it would be difficult to reconcile how participants, many of whom were complete computer novices, could be expected to satisfactory attain fourteen separate outcomes with as little as twelve hours practical computing within the prescribed thirty hours of training.

Systemic solutions alone rarely achieve more than to make teachers feel ‘warm and fuzzy’ about information technologies and so fail to sustain the wider implementation of computers across the curriculum. Ridgway and Passey (1995) believe that when systemic solutions fail it is because:

i. Fundamental values and practices are challenged,

ii. Over ambitious claims are presented,

iii. The practical constraints of resources such as time and support are underestimated,

iv. Exemplary practice and not typical practice is stressed,

v. Individual progress is not monitored, and / or

vi. Programs are not appropriately adapted.

Increasingly, those involved in promoting educational computing in schools are discovering that human factors are the most important variables in the acceptance and diffusion of information technology (Scott & Robinson 1996). Schofield (1995) says it is peoples’ attitudes that shape the extent to which technology is used as well as the way it is used in schools. To span the gap between intention and outcome requires efforts to shape attitudes alongside strategies that focus on the conceptual and procedural knowledge necessary to use computers effectively in classrooms.
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The recognition that teachers' attitudes towards information technology together with hardware and software familiarity influences their intentions to use computers in classrooms, represents a shift away from a technocentric view of technological innovation (Scott & Robinson 1996). Nonetheless, new questions arise, some of which form the contextual foundation of this study:

i. What attitude dimensions are relevant influences upon teachers' intentions to use information technology?

ii. How do those dimensions influence teachers' intentions to use computers as tools for teaching and learning?

iii. Do specific factors distort the dimensions?

iv. What mechanisms given the existence of other factors, promote change in teachers' intentions to use computers as tools for teaching and learning?

1.6. Conceptual Framework

A starting point for this inquiry was an action research project undertaken by Yakub (1994). Yakub employed a single site observational case study methodology to explore whether or not teachers were integrating computers across the curriculum in one comprehensive government secondary school located in Western Sydney. Data were collected from 51 participant teachers (62 percent response rate) about their use or non-use of computers. Data were also collected with respect to teacher attitudes. An analysis of these data revealed the following:

i. Two out of three teachers possessed little, if any experience in using computers.

ii. Sixty-three percent of respondents were unaware of any school-based initiatives to integrate computers across the curriculum. Of those who were aware, awareness was based on the implementation of the mandatory-computing component within the (new) Year 7-10 subject, Design and Technology.

iii. Eighty-seven percent of teachers believed there was a role for computers within their classroom, however 75 percent of those teachers recognised that they would require additional help to achieve this goal.
iv. In the absence of any formalised school-based support a majority of teachers simply did not use computers in teaching and learning.

v. Overall, teachers lacked confidence in their ability to use computers within their subject area asking specifically for help to understand more about relevant issues associated with using computers in classrooms.

vi. When teachers did use computers in their classrooms they did so because of a strong personal belief in the capacity of computers to cater for different styles of learning and therefore, individual differences.

vii. More than 70 percent of teachers believed there were school-based barriers to computer use and that there was a need for organisational change to increase access to computers across the curriculum.

viii. Teachers generally agreed that they needed training and support to use computers more effectively. Ninety percent of respondent teachers wanted access to beginner’s courses, 85 percent wanted to know more about using software within their subject area while 76 percent expressed a desire to know about classroom management issues.

In summary, Yakub believed there were five sets of factors influencing teachers’ intentions to use information technology in their teaching operating within that school. Those factors were:

i. Teacher experiences, motivation, and perceptions of information technology;

ii. Teachers’ current pedagogical practices;

iii. Training, support and collegiality;

iv. The centralisation of facilities, and

v. The formulation of policy from an administrative rather than an educative perspective.

This list of factors was adopted as a reference point from which to begin this wider study of secondary teachers’ intentions to use information technology in Western Sydney. The reference points from Yakub’s study plus personal understandings were combined to develop a framework that would conceptualise for the researcher the factors influencing teachers’ intentions to use information technology. The conceptualisation is presented as Fig 1.1.
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Fig 1.1 Factors Influencing Teachers' Intentions to Use Information Technology

In Figure 1.1 two sets of inter-related teacher factors pertaining to teachers' educational and professional backgrounds and teachers' dispositions toward computers are identified as the major influences upon teachers' use of information technology. A variety of external factors are shown as impinging upon teacher factors rather than as a direct influence upon teachers' use of computers. Since there is no direct link between teachers' use of computers and external factors, external factors must first influence teacher factors if there is to be an impact upon teachers' use of computers.
1.7. Importance of Study

Successive waves of information technology infusion over the past decade and a half have lowered benchmark student to computer ratios in NSW Government Schools. More and more, efforts to inform teachers of the potential benefits of information technologies for student learning are being incorporated into the professional development programs of qualified teachers and into the preservice programs of those in training. As schools begin to plan for increased use of their information technology resources an essential feature of that process must involve deliberations about how to influence teachers' intentions to use information technology.

Past waves of information technology infusion have focused on putting technology within student reach. However, before students can gain access to the hardware and software their teachers must create learning environments within which the information technology is embedded. Unfortunately, efforts to provide teachers with appropriate knowledge and skills to perform that task have at best been slow to emerge. Consequently, teacher understanding of how to use information technology in learning contexts remains limited.

Presently, significant commitments have been made by education authorities to provide teachers with training and curriculum resources to effectively utilise the hardware placed in schools. What is not clear is whether or not teachers will be in a position to make effective use of the hardware, training and curriculum resources provided. To this end studies such as this one are required to assess if teachers are indeed ready and, if not, what additional barriers remain.

1.8. Description of Setting

The teachers selected to participate in the study were drawn initially from six N.S.W. Government Secondary schools located in Western Sydney. A seventh school was surveyed to improve the overall response rate. The sampled schools were representative of secondary schools from Western Sydney in that they were drawn from pools of Comprehensive, Selective and Technology High Schools exhibiting a full range of geographic and socio-economic indicators.

The teacher sample was administered a quantitative survey. The teachers who responded to the survey were, by and large, characteristic of the teaching force at the time the instrument was
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applied. Data collected were compared with known information about the gender, age, experience, teaching position and Key Learning Areas of N.S.W. government teachers. It was found that teachers in the sample were representative across all aspects although the number of teachers from the Technological and Applied Studies Key Learning Area was higher than expected.

A detailed description of the processes involved defining the sample along with an analysis of the sample representativeness is contained in Chapter 3.

1.9. Outline of Remaining Chapters

The thesis is organised in the following manner.

Chapter Two reviews the Research Literature. The review covers salient issues, beginning with a chronological examination of educational computing policy, then exploring the relevance of computers in learning and how teachers use computers. Of particular relevance are the barriers to teachers’ use of computers and ways those barriers can be overcome.

Chapter Three focuses on design and instrumentation issues and details the methodologies used to answer the questions pertinent to this study. The chapter opens with an explanation of how the study was conceived before specifying the particulars of the research design in detail. The chapter concludes with a discussion of the impact of the response rate upon the representativeness of the sample.

Chapter Four provides a detailed account of the processes used to construct the attitudes scales that were a central component of the research. From the original seven constructs that were grounded in the literature and operationalised for the study into a questionnaire, thirteen scales were identified.

Chapters Five and Six present the outcomes of the study. Chapter Five contains an analysis of the data exploring relationships between teachers’ use of computers, self-rated computing skill, formalised computing knowledge base and the interplay of those factors with the attitudinal scales. Chapter Six presents a predictive model based on the analysis undertaken in Chapter Five.
Chapter 2

Literature Review
LITERATURE REVIEW

2.1 Introduction to the Literature Review

Research relevant to the ideas and issues developed in Chapter 1 was identified and reviewed. For clarity, the review is divided into five sections, each of which informs the current study.

Section 2.2 explores the development of educational computing policy within the Commonwealth and New South Wales government educational bureaucracies between 1972 and the present. The documents reviewed place policy development within a chronological perspective. Key issues relate to technology infusion and teachers’ capacity to utilise the available technology within classrooms.

Section 2.3 outlines the literature on student use of computers where two major research directions have dominated a search for the advantages of classroom computer use. This section contextualises the benefits to the educational community of incorporating computers into classrooms as tools for learning and discovery.

Section 2.4 examines the use of computers by teachers. Central to this section is the discussion of teacher access to resources. The key themes to permeate this discussion are the relevance of computers, competent use of computers by teachers and the confluence of those issues with pedagogical practices.

Section 2.5 details teacher attitudes toward the use of computers in classrooms. The section begins with a brief examination of the nature of attitudes and teacher attitudes towards technology before examining in greater detail teacher anxiety with information technology and the variability of technology related attitudes associated with teacher gender.

Section 2.6 is the final section. The purpose of this section is to introduce some potential solutions to the barriers to the integration of computers across the secondary school curriculum. In particular, the promotion of positive attitudes and relevant pedagogies are explored, along with the modification of staff development practices and the refinement of the school information technology environment.
2.2 Australian Educational Computing Policy: A Review

For more than a quarter of a century Commonwealth and state government educational bureaucracies have been developing policy for the use of computers in Australian schools. Those policies have been directed at information technology infrastructure, curriculum development and teacher training. When government initiatives are viewed chronologically it is evident that the direction of educational computing policy has been far more evolutionary than revolutionary.

2.2.1 National Policy: A False Start!

National interest in educational computing began in 1972 when the Australian Advisory Committee on Research and Development in Education (AACDRE) conducted a study into the educational use of computers (Wearing, Carrs & Fitzgerald, 1976). The AACDRE report found the task of describing the educational use of computers problematic. “[I]t ranged from those that reflected planned and systematic development to those that depended on one or two enthusiasts doing their best with very little resources” (Wearing, et. al., 1976, p.36). Specific barriers – deficiencies in facilities, trained personnel, curriculum materials, information and consultative advice – were identified in the report as contributing to the diversity of uses. The barriers were intentionally stated in terms of deficits to suggest potential solutions.

AACDRE proposed less rather than more central control over the management of computer education, believing “responsibility will be most effectively discharged where the people entrusted with making decisions are also the people responsible for carrying them out” (Wearing, et. al., 1976, p.40). AACDRE recognised such a policy would continue to produce ‘ad hoc’ responses, but argued local systems required flexibility to implement goals reflecting overall capacity to pay, believing this would produce the most cost effective solutions in the long run. It was from this perspective that AACDRE envisioned the Commonwealth’s role to be an indirect one, supplementing state activities rather than usurping them, given that constitutional responsibility for planning and resource distribution in education resides with the states. Unfortunately, AACDRE’s vision to increase educational interest in computers did not happen, the report merely reinforced the status quo (Australian Information Industry Association, 1992). It was a decade before the Commonwealth again articulated a policy position on educational computing.
2.2.2 National Policy: Coordinated Responsibility!

In the 1980's government thinking on computers in schools shifted from 'ad hoc' policy response towards 'coordinated responsibility'. The shift was not triggered by any single mechanism, but a complex interplay of social, economic, political and educational forces (Woodrow, 1987). Those forces were propelling Australia towards a new type of society, with an altered economic base in which knowledge and skill rather than raw materials and muscle were the essential ingredients for success (Jones, 1990). As a consequence, the Commonwealth began commissioning studies to generate data to substantiate a national educational computing policy.

In 1982 the Educational Research and Development Committee (ERDC) reviewed the use of computers in Australian schools noting crucial differences between states in the priority each assigned to computer education, resources allocated and the formulation and implementation of policy (Brownell, Sale, Hoffman & Sandery, 1982). In many ways, this report reiterated the diversity mapped in the AACRDE report. Shears and Dale (1983) responding to the ERDC study cited called for strong national and state financial support to realise the benefits spoken of in a growing body of literature supporting computer use across the curriculum.

The Commonwealth Schools Commission announced the National Computer Education Program (NCEP) in February 1983. Under the title Recommendations for 1984 the Commission argued for a five year funding commitment, in addition to that provided by the states, of $125 million to overcome serious deficiencies in the provision of educational computing. When the NCEP guidelines were announced in July 1983, only $18 million was committed for the triennium 1984-86. The guidelines indicated there should be regard to the following objectives:

i. The need for students to have an understanding of the uses of new technologies and their social, environmental, industrial and economic effects,

ii. Planning for use of computers in teaching and across the whole curriculum,

iii. Professional development of teachers,

iv. Access to the program by girls and disadvantaged groups,

v. The economic use of resources including, where appropriate, support for the sharing of services between schools and sectors, and across States, and the standardisation of equipment and materials.

Commonwealth Schools Commission, 1984 (p.2).
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The National Advisory Council on Computers in Schools (NACCS) was formed in March 1983 to provide to the Commonwealth Schools Commission with detail to support the NCEP guidelines (Australian Information Industry Association, 1992). In August 1983 NACCS released a report that argued strongly for information technology to be integrated across the curriculum; to develop student inquiry and problem solving skills rather than have information technology as another academic subject (Australian Information Industry Association, 1992). Even so, the report recognised there was a need for basic awareness understandings, and noted that academic courses in computer studies would be appropriate in the later years of secondary schooling.

If curriculum strategies were to be successful, a strong commitment to promoting teachers’ skill level and understanding of computers, including those from non-mathematics and science backgrounds and especially women, was also necessary. Without professional development any gains from the introduction of computers into schools would be at best limited and at worst, counterproductive (Australian Information Industry Association, 1992).

In 1985 the Australian Education Council’s Task Force on Education and Technology commissioned the next major study on computer education in schools. The report, Computer Applications in Australian Classrooms (Fitzgerald, Hattie & Hughes, 1985) acknowledged the positive reactions of stakeholders to the use of computers to support learning in classrooms. However, those positive attitudes did not necessarily carry over into practice, resulting in distinct differences in the level of computer usage between primary and secondary schools. Not only were computers being used more in primary schools, in secondary schools there were significant differences in usage patterns between boys and girls.

Computer Applications in Australian Classrooms cited a lack of teacher training as the greatest limitation to the use of computers in classrooms. The remedy was seen as more trained teachers with specialist qualifications in both education and information science within the system. Compounding the problem was a lack of evidence that investments in computer hardware were benefiting learning. This was despite the report identifying a growing literature base supporting Computer Assisted Learning. The report concluded by calling for prolonged monitoring to establish if there were any long-term benefits to be gained from educational computing.

The National Computer Education Program (NCEP) ceased in 1986. Outcomes were varied. At the school level NCEP had minimal impact, at best impinging on the activities of only a small number of students and teachers. At a systems level however, NCEP provided a shot in the arm for
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those states already active in educational computing, while acting as a catalyst for the others. By
the end of 1986, all states had formal policy documents and some form of support unit in place.
The major thrust of the states since has been the continuation and refinement of policy based on
the principles espoused in NCEP (Australian Information Association, 1992).

In 1987, the Commonwealth commissioned the last major examination of educational computing
in schools. A House of Representatives Standing Committee was set up to inquire into how new
technologies could improve educational access and outcomes. The committee report, An Apple for
the Teacher - Choice and Technology in Learning (Brumby, 1989) argued that it was the
responsibility of school systems to make students comfortable with new technology by increasing
opportunities for ‘hands-on’ computer experiences. Without a positive adoption of technology by
school systems, major opportunities in the education of our children would be missed.

Calls for government funds to meet the challenge were made. The pragmatic goal was the OECD
benchmark of one computer for every 10 students across Australia by 1992. Substantial variations
in hardware penetration of schools were reported, with ratios as low as 1:22 in Tasmania to around
1:47 in New South Wales secondary schools. While some success in this area was attributed to
NCEP, it was felt more was needed. Similar in-service funding to improve teachers’ understanding
and effective use of the new technology was suggested. Finally, there was a necessity for better
liaison between the states to create a sense of national direction, something that was necessary if
other government goals, such as raising school retention rates were to be achieved.

During the early to mid 1980s the Commonwealth government prescribed the direction of
educational computing through funding arrangements with the states. Unfortunately that funding
was unable to remove all the barriers (Brumby, 1989; Fitzgerald, et al., 1985). Despite
Commonwealth efforts, by the end of the 1980s three obstacles were still perceived as the major
barriers to wider implementation of computers in schools. Those barriers were:

- A lack of clear needs and objectives and a coordinated commitment by all governments and
  educational sectors to use technology to achieve them,

- A lack of knowledge among administrators and teachers of the potential of new
  technological developments to improve education, and

- A lack of incentive for teachers to innovate.

2.2.3 National Policy: National Frameworks

In the latter half of the 1980's changing technological, social and economic circumstances were demanding new policy responses (Wesley, 1993). One principle came to dominate the policy agenda, the restructuring of education. To simplify debate claims were made that education was not as efficient as other sectors of the economy. Of greater importance was the view that the education system lacked a sense of national unity, identity and continuity and for nationally based economic imperatives to gain ascendency it was necessary to restructure (Dempster 1992 in Wesley, 1993). Fragmentation of the education system (Australian Information Industry Association, 1992) into sub-sectors operating either autonomously or semi-autonomously within state boundaries was seen as a major impediment to Australia meeting future challenges. Indeed, this issue had already been identified as a principal factor promoting variability in computer education outcomes across Australia (Brumby, 1989; Fitzgerald, et al., 1985).

In 1987, the Commonwealth responded to changing circumstances by restructuring the bureaucracy establishing closer links between employment, education and training thereby broadening the policy base. For the schools sector the most significant changes were the absorption of the Commonwealth Schools Commission into the super Department of Employment, Education and Training (DEET) and the transference of control over the development of projects of national significance to the Australian Education Council (AEC) (Wesley, 1993).

In many ways the AEC had already assumed a greater role within national policy development, initiating in June 1986 a process that was to culminate in April 1989 with the determination of a common and agreed set of National Guidelines for Schooling in Australia (1989). In total, ten goals were developed to provide a framework for schools and systems to derive specific objectives and strategies in the areas of curriculum and assessment. Of particular interest to educational computing was goal six, which stressed the development in students of:

- The skills of numeracy and other mathematical skills,
- The skills of analysis and problem solving,
- The skills of information processing and computing, and
- An understanding of the role of science and technology in society, and technological and scientific skills.

Curriculum Corporation, 1994a, (p43).
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National Guidelines became the catalyst for further collaborative efforts aimed at generating a national framework for curriculum development and the assessment of learning by education systems and schools (Curriculum Corporation, 1993). Typical of those projects was the National Technology Project, culminating in the publication of Technology - A Curriculum Profile for Australian Schools (1994a) and A Statement on Technology for Australian Schools (1994b). Both publications placed computing and other information technologies within an integrative context, casting computing and information technologies as tools for students to use in the attainment of outcomes rather than as artefacts deserving of study at most achievement levels, at least nationally.

The centrality of information technology within the economy prompted other efforts at refining national policy frameworks. In the National Board of Employment, Education and Training (NBEET) report titled Education and Technology Convergence, the Tinkler, Lepani and Mitchell consortium referred to some sixty government research documents, issued between 1991 and 1994 as representative of that effort. Unfortunately, few policy initiatives involving information technology use as a communication medium or to enhance learning in the classroom, emanated from within state education bureaucracies. No doubt the capacity of state education bureaucracies to plan for appropriate use of information technology was hampered by the rapidity of change and in particular, the impact of technology convergence (NBEET, 1996). Technology convergence describes the coming together of information and communications technologies:

Technologies that previously stood out as separate items, such as telephones, facsimile machines, video and radio, are now becoming components of a technological convergence that is likely to see a time when the telephone will perform as a computer, a video and a facsimile machine, and provide access to the global knowledge network.

NBEET, 1996, (p.5).

Technology convergence brings infrastructure redundancy (NBEET, 1996). In analysing this effect on school infrastructure consortium data revealed that at the end of 1991 schools held approximately 177 000 computers, or one computer to 19.5 students. By late 1994 computer numbers had grown to around 270 000, or one computer for every 15.5 students. Given some schools had or were approaching ratios of one to one, by corollary others had to be at levels significantly above one to 15.5. When infrastructure age was taken into account, estimates of machine to student ratios increased. For access to industry standard machines capable of running generic software the ratio exceeded 1:20, while for multimedia capable machines the ratio
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exceeded 1:50. Tinkler, Lepani and Mitchell then asked the question, what would be the ‘ideal’ student to computer ratio to provide equitable access if computers were to become truly integral parts of the curriculum of Australian schools? The consultants answered that the optimum ratio seemed to be one computer to every three students.

It is a truism that access alone is insufficient to attain the educational goals associated with the integration of information technologies (NBEET, 1996; Zammitt, 1992; Zhao, 1998). It is also the case that greater access has the potential to create more technologically intensive work environments and so create other support needs; among them, the professional development of teachers. Two factors were identified as impinging upon schools’ capacity to take full advantage of technology convergence, a teaching force predominantly over 40 years of age and a short time frame in which to prepare them (NBEET, 1996).

To accommodate new work designs and new skills for teachers, innovative approaches to professional development were essential (NBEET, 1996). Tinkler, Lepani and Mitchell proposed a range of programs involving individualised learning, contextualised learning and just-in-time learning to enable teachers to gain competency. Depending upon need, teachers should access activities that raise awareness, promote familiarity, build confidence and generate competency. Tinkler, Lepani and Mitchell stressed the importance of quality within the awareness phase as people needed to be motivated enough to engage in further training.

Fundamental to this process however, would be the adoption by teachers of a lifelong learning perspective. Of concern to the consortium was how much of the retraining should be provided by the system and how much should be provided by the individual to maintain professional standing. While no definitive answer was given, Tinkler, Lepani and Mitchell did indicate that a systemic approach like a registration board should be charged with the responsibility of providing the detail.

As the 1990s draw to a close, great effort has been expended on re-shaping the Australian education system. Debate has centred upon reforming curriculum and assessment practice with the need for a competency rather than a content-based approach highlighted. It is apparent that further changes will happen as a new paradigm emerges within the ‘education industry’, based on learning rather than teaching (NBEET, 1996). The speed with which this paradigm will unfold will depend upon the ability of systems to remove bottlenecks. Teachers and teaching practice remain at the heart of those bottlenecks.
2.2.4 NSW Policy: Early Directions!

Efforts to promote educational computing in N.S.W. government schools prior to 1980 were at best, sporadic. Computer education activities were dependent upon the interest and enthusiasm of individual teachers and principals (Shears & Dale, 1983; Wearing, et. al., 1976). The process of developing a centralised management system for the implementation of computer education in NSW began in 1979 with the creation of the Computer Education Unit (CEU) and the formation of the Computers in Schools Policy Committee. The first computer education consultant was appointed in 1980 (Munro & Sharpe, 1984).

Formal policy formulation though, dates from early in 1982 (Commonwealth Schools Commission, 1983), when the Computers in Schools Policy Committee began drafting a set of principles and general priorities for K-12 computer education. In October 1982, a consultative document the General Guideline Statement on Computers and Computing in Education, was released. In it, the Department of Education outlined computer priorities appropriate for primary and secondary education, as well as various uses for computers and ways of teaching about computers across the curriculum. Comment was received from interested individuals and organisations. A draft policy was released in April 1983 (Shears & Dale, 1983).

In August 1983, the formal policy Computers in Schools: A General Statement was sent to all government schools. The formal policy confirmed the priorities identified in the consultative document and implemented guidelines announced by the Schools Commission, enabling NSW to participate in the National Computer Education Program (NCEP). Computers in Schools: A General Statement outlined three principles for the development of computer use in N.S.W. government schools.

The first principle, ‘learning about computers and computing’, acknowledged that the most efficient way to provide a broad understanding of the uses and consequences of computers to all students was through formal subjects. The second principle, ‘using computers for learning’, endorsed more fully the belief that computers could enhance teaching and learning across the curriculum. The third principle, ‘the use of computers for administrative purposes within schools’, acknowledged the value of computers as a means to improve communication and the handling of resources, within all levels of school administration.

To support the acquisition of computers by schools following the release of the General Statement, the Wran Government in 1984 initiated the State Government Hardware Program (Walker, 1992).
Funds were administered within the CEU and allocated to schools in units of $1300, based on school population. Prior to the scheme's closure in June 1988, $5 million was spent purchasing some 5625 computers, representing a sixfold increase in hardware numbers between 1983 and 1986 (Pirie, 1986). Even so, by 1987 the ratio of computers to students in NSW was still 1:53 (Winship, 1988).

In December 1987, the Department of Education published the first comprehensive census of educational computing in NSW. The Report on Computer Education in NSW Government Schools noted hardware levels averaged slightly more than five computers per school, with the majority of them located in high schools (about fifteen computers each). The most commonly reported software applications in high schools were Word Processing, (28.5%), Graphics (14.3%), Databases (10.8%), LOGO (9.8%), Mathematics (5.2%) and Simulations (5.0%). Interpretation of the data and its consequences for educational computing in NSW government schools, however, was minimal (Walker, 1992).

2.2.5 NSW Policy: The Impact of Educational Reform!

With the election of the Greiner government in 1988 came major reforms in the direction of educational computing within N.S.W. After taking office, the Minister (Dr Metherell) instigated reviews of educational administration and curriculum in NSW government schools. Those reviews culminated in the release in June 1989 of Schools Renewal: A Strategy to Revitalise Schools within the New South Wales State Education System and in November 1989 of Excellence and Equity: NSW Curriculum Reform.

Schools Renewal or the Scott Review formalised the policy of devolution in which centralised decision making was replaced with greater autonomy for schools. Operational groups like the CEU were dissolved with functions transferred to administrative regions and schools. Devolution however, was not an indication of a lessening of support for computer education in schools; rather it refocused priorities.

Excellence and Equity outlined major reforms to the NSW school curriculum and government support of it. The reforms contained in the White Paper aimed to generate a new focus and structure for study in schools within eight Key Learning Areas (six in primary schools). It was
envisaged that every student from Kindergarten through to Year 12 would receive a balanced education with opportunities to develop a range of skills within the context of a broad education.

As part of the transformation of the NSW school curriculum *Excellence and Equity* proposed a system in which Technology education would become an integral part of every child's education and a number of reforms were implemented in Secondary schools. First, existing Technology education subjects were aggregated within the Technological and Applied Studies (TAS) Key Learning Area. Second, Design and Technology, a 200-hour subject was introduced with the overall objective of integrating the various strands of technology education into one compulsory subject. Furthermore, mandated within those 200 hours of study was a 50-hour component in which learning about and using computers was to be integrated through appropriate design projects. To achieve this goal, the existing 50-hour *Computer Awareness Syllabus Years 7 - 10* was to be phased out by 1994.

The Greiner government also broadened and strengthened support for computer education through the establishment of a State Computer Education Program (SCEP) (Walker 1992). Some $54 million was earmarked for expenditure over four years. SCEP contained eight components, seven related to education, the other to administration; Teacher Professional Development, Computer Education Coordinator training, Purchase of hardware for educational use, Purchase of software for educational use, Computer Classrooms, Electronic Communication, Increased consultancy support and Administrative Computing in schools.

Walker (1992) questioned the capacity of SCEP to meet government objectives within the announced budget. Walker calculated that those funds alone would be insufficient to fund the desired hardware levels for high schools and primary schools, suggesting that either those levels were illusory or that other goals would not be met. Walker did note that changes to school-based budgeting gave schools the freedom to re-prioritise financial decision-making and so re-direct funds to hardware and software purchases. It was not uncommon for schools to redirect funding of the Computer Coordinator position into hardware and software purchases.

Educational computing policy and curriculum directions developed in the first term of the Greiner government continued into its second term. SCEP, which was due to finish in June 1992 remained. As a result of government policy and school initiative the computer to student ratio had fallen to one computer for every 22 students by the end of 1994 (Carr, 1995). However, this figure also included computers used for administrative purposes.
2.2.6 NSW Policy: A New Beginning - Transformation?

1995 was a watershed year for educational computing in NSW government schools. Leading up to the March election the major parties made significant commitments to improve teaching and learning through the application of information technologies. Of the two, Labor’s twelve-point plan was by far the more ambitious. The Labor Party priorities in computer education were:

- Every student should learn to touch type on a keyboard by Year seven (16 500 computers),
- Banks of laptop computers in each school for senior students to borrow for home study,
- Every teacher will receive an initial 30 hours training in the educational use of computers, designed for their subject (250 teacher positions or equivalent),
- Every syllabus will state how computers can enhance teaching and learning in that subject,
- Computers will not take over the classrooms. Teachers will remain in charge and use computers as a teaching tool for the whole class (14 800 teaching computers fitted with classroom projection equipment),
- Funding for computers will be made available for the most disadvantaged non-government schools (11 600 computers included in above categories),
- The computer / pupil ratio in primary schools will be reduced to 1:14 (36 000 computers),
- Every school will be connected to the super-highway - to link schools to the information of the world (under supervision),
- All new teachers in government schools will be computer literate and have the proven ability to use computers in the classroom,
- Appoint a teacher as a coordinator of the use of computers within each high school,
- Establish after-hours computer classes for students, teachers and parents who want to increase their access to technology,
- Encourage community access to schools’ computer resources including software rental libraries, and renting out of computer time not required by the school,

“We will achieve these goals within one term of government, not next century.”

(Carr, 1995, pp.9-10)
Upon gaining office the Carr Labor Government set about transforming its educational computing election platform into achievable policy. In October 1995 the Department of School Education released *Computers and Technology in Schools*, which outlined teacher training and development opportunities, support structures for the integration of computer education to all Key Learning Areas and the provision of computer resources. Commitments were significantly different to previous efforts, even down to the order in which targets were presented. This was done to emphasise ‘learning with’ computers rather than ‘learning about’ them.

Teacher training and development and the provision of support to teachers for integrating computers across the curriculum were accorded high priority (NSW Dept of School Education - Technology Directorate, 1996). However, rather than training for all, the least computer-skilled (about 15,000 teachers) were to be targeted for training in the integration of technology over a three year period. This training was formalised into a thirty-hour program and delivered as the *Technology in Learning and Teaching (TILT)* strategy (NSW Dept of School Education - Training and Development Directorate, 1995). *TILT* comprised six components, Internet, Teaching and Classroom management practices, Computers and related technologies, Hardware to enhance teaching and learning, Software to enhance teaching and learning and Future directions, each presented through audio and videotape, documentation and a hands-on workshop.

To assist teachers to use computers within each KLA, 40 technology advisers were appointed to district offices in 1996 following the dissolution of the regional bureaucracies in 1995. District Technology Advisers were to work in collaboration with departmental curriculum advisers to consult with teachers on how to enhance their teaching programs through technology use. District Technology Advisers were also to consult with schools regarding the management of technology such as the development of local area networks.

Curriculum materials, outlining the integration of information technology within secondary KLA and K-6 Primary, were developed (NSW Dept of Education and Training - Curriculum Support Directorate, 1997a, b, c, d, e, f, g, h). The documents were designed to provide teachers with models to enhance their classroom integration of computers. Each booklet provided:

- A learning-based rationale for using computer technologies,
- A detailed (though incomplete) staged based list of technology capabilities across five related areas,
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- Approaches and strategies about how to choose teaching and learning experiences, select software and manage classrooms,
- Snapshots of specific computer-based technologies, which explained how to use the tool in the classroom,
- Information on access and equity issues and
- Information on a range of issues associated with managing computer use in classrooms.

NSW Dept of Education and Training - Curriculum Support Directorate, 1997a

Two projects to modernise schools’ computing resources were implemented. The first, placed over 77 000 computers into schools (Mawson, 1999). Unlike past schemes, funds were not allocated to schools to purchase computers outright. Instead, a single arrangement between the government and a leasing agency was negotiated to enable the system to roll over its computer stock on a three-year cycle (NSW Dept of School Education Technology Directorate, 1996). The first distribution of computers in late 1995 and early 1996 was based on need to enhance the access of all students to computers.

The second project linked all government schools to the Internet. This decision was driven by two concerns, one educational, the other administrative. The educational aim was satisfied first, at least initially, by the December 1996 deadline (NSW Dept of School Education, 1997). All schools were issued with one computer, appropriate software and a modem to connect to the Department’s Internet Service Provider and asked to appoint an Internet Contact Person to support teacher and student use of that connection. In 1998 the ‘Country On-Line’ initiative (Aquilina, 1998) provided 25 rural high schools and ultimately 200 rural schools (School Education Information Technology Initiatives, 1998) with ISDN lines and routers to facilitate community Internet access. As part of ‘SchoolNet’, the Department of Education and Training educational and administrative wide area network, all remaining government schools received an ISDN Internet connection in 1999.

Computers and Technology in Schools was arguably the most concise and coherent strategy for the implementation of information technology in schools since the release of the General Statement. However, the strategy was not without weakness and much criticism in the area of teacher training was reported. In many ways that criticism was to be expected as the research base has over time highlighted the important role of teachers in educational change.
Leading academics were questioned by the media about the potential effectiveness of the Computers and Technology in Schools strategy (Raethal, 1995a). Professor Ken Sinclair from the University of Sydney regarded the infusion of computers as teaching and learning tools to be critical to the future of education in NSW. Sinclair however, questioned the capacity of TILT to adequately prepare teachers. He suggested that access and equity issues would arise as a consequence of ill-prepared teachers, more computers will simply mean students who were familiar and confident with them would have more access (Raethal, 1995a).

In the same report Dr. Chris Bigum from Deakin University expressed the view that systems concentrated too much on student access and not enough on teacher support. Bigum argued that people made the difference in the learning process, not technology, and that the validity of increasing access without providing adequate teacher support structures should be challenged.

In a subsequent report on the value of computers as learning tools, Raethal (1995b) noted significant scepticism, especially when the introduction of those tools was not supported by a strong teacher professional development component. In support Raethal quoted a study by a former Director-General of Education in Victoria Dr. Laurie Shears, in which he noted teachers' lack of computer knowledge and skill as major barriers to the wider use of computers in schools.

An analysis of TILT materials suggests that academic's concerns may have been warranted. TILT 'Expected Outcomes' were overly ambitious for the targeted audience. Each participant was expected to achieve 14 outcomes within the 30-hour time frame. Indeed after reading course materials and listening to and viewing coursework audio and videotapes, as little as 12 hours remained to gain practical computing experience. For example, what would be the likelihood of novice computer-using teachers developing the confidence to encourage student use of technology to solve problems, present ideas and explore the possibilities of technology as a tool in a variety of ways, e.g. slide shows, animations, hypertext and video (NSW Dept of School Education - Training and Development Directorate, 1995)?

Despite the criticisms internal evaluation of TILT training outcomes indicated that the majority of respondents reported that their confidence in using computers had increased as a result of TILT and that they felt more confident about using computers with their students. These respondents described their own gains in self-esteem and enjoyment when using computers and a subsequent reduction in fear and anxiety.
Furthermore,

Just over forty percent of respondents felt more knowledgeable about using a computer and various software applications and were more aware of the applications for computer technology in the classroom.

NSW Dept of School Education, 1997b, p43.

In defense of TILT, it should be noted that it was designed to ‘kick start’ teachers’ computer learning (Carr, 1995), and continued development was dependent upon individuals practicing what they had learnt. As well, the Department of Education and Training has provided teachers with resources to consolidate their training. Furthermore, TILT remains one component of a longer term process and no doubt subsequent training initiatives will be prepared to improve the computing knowledge and skills of teachers in NSW government schools. The process will continue, especially in-house as the Department of Education and Training maintains a heavy investment in human capital within the Training and Development, Curriculum and Technology Directorates for this purpose.

In summary, for over a decade and a half the NSW government education bureaucracy has supported the use of information technologies in schools. Initial policy directions provided broad scope for the application of computers to teaching and learning. Past top-down models to policy implementation accommodated schools’ acceptances of the technology infusion without them having to alter approaches to teaching and learning. As a consequence educational computing policy appeared as if it were being implemented from a technocentric perspective rather than a pedagogic one.

A top-down approach to policy implementation remains at the heart of educational computing policy in NSW. However, within the current approach there is support for a paradigm shift. A momentum has been generated, focusing upon awareness raising as the first step in altering approaches to teaching and learning in schools. If successful, this approach will see teachers better prepared for using information technologies in classrooms.

What is exciting about current policy and others related to initial teacher preparation is that efforts are finally being directed at removing bottlenecks to the acceptance of information technology. For too long teachers and teaching practice have been at the centre of those bottlenecks.
2.3 Computers as Tools for Learning

2.3.1 The Benefits of Computer-Based Learning

Since the 1960s a body of research has been accumulating on the effects of computer-based learning (Mandell & Mandell, 1989; Roblyer, Castine & King, 1988). Initially, the research scrutinised the place of mainframe computers but by the early 1970s interest in this form of instructional computing had begun to fade. The coming of microcomputers saw research surge seeking to establish the value of microcomputer use as opposed to traditional modes of teaching (Lockard, Abrams & Many, 1994). Driving much of that research were desires by educators and legislators to legitimise the place of computer-based learning given the considerable monetary investment involved (Cotton, 1992).

The results of multifarious comparison studies, though mixed, still suggested a place for computer-based learning (Lockard, et. al., 1994; Cotton 1992; Roblyer, et. al., 1988). However, that place was more circumspect than inflated claims presented in the 1980s would have suggested (Maddux, Johnson & Willis, 1996). Nonetheless, it is possible to identify a range of benefits associated with classroom computing, including increases in student achievement, problem solving capacity, rate of learning, retention of learning and attitudes towards learning.

Numerous studies have compared student achievement scores using computers with scores using traditional teacher-directed tuition (Lockard, et. al., 1994; Cotton, 1992). Typically, those studies have shown computer instruction to be as effective as traditional instruction or to produce greater gains for students. Gains were highest when computer use was supplemental to traditional modes. The findings generally hold true for students of different ages and abilities across all subjects.

Research has shown that effective computer use enhances students' rate of learning. Studies indicate that students using computers can achieve the same level of mastery in less time than traditionally instructed students. Studies cited by Lockard, Abrams and Many, (1994) have reported time saving varying from 10% to an incredible 88%. Similarly, comparative studies using delayed test scores as the indicator of retention (Cotton, 1992; Kulik, 1985) have shown students using computers retained their learning longer than do students who do not use computers.

Research findings on computer-based problem solving are less than conclusive. Duffield (1990 cited in Lockard, et. al., 1994) concluded that problem-solving software was of limited value in developing problem solving skills. Funkhouser and Dennis (1992, cited in Lockard, et. al., 1994)
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on the other hand, found that using computer-based problem solving tools enhanced student performance because students actually spent time solving problems. Liao and Bright (1992) in a meta-analysis reporting on the impact of computers on student cognitive performance detected 23 studies (out of total of 31) in favour of computer enhanced cognitive performance by students. A major conclusion from the study was that the use of simulation and problem solving software impacted beyond specific content knowledge, affecting students' planning skills, reasoning, logical thinking and ability to transfer.

Research is neither conclusive for or against improved student attitudes toward learning. Cotton (1992) in a review of the Computer Assisted Learning literature identified a range of studies in which the use of computers was said to have an affect on attitude towards, course content / subject matter, the quality of instruction, school in general and the student as a learner. Roblyer, Castine and King (1988) however, argued that attitudinal impact was greatest towards the computer itself than toward any other variable.

2.3.2 New Directions

With the advent of new and distinctive computer tools in the 1990s, the focus of computer-based learning research has shifted from comparison studies to examining the potential of 'the computer as a tool' (Grégoire, Bracewell & Laferrière, 1996). Fundamental to this view is that computer use can bring about new and improved kinds of learning, but as with all tools, effective use of computers has to be embedded within practices and activities that realise their functionality for specific purposes and situations. In particular, research efforts have given increasing attention to the use of computers as tools within new educational paradigms, especially constructivism (Forcier, 1999; Maddux, et. al., 1996).

To illustrate the point, Lifelong Learning Associates (1999) provide an enlightening illustration of a science class studying motion using information and communication technologies:

[M]otion is traditionally recorded using devices such as ticker timers with paper tape, attached to objects such as a trolley on a ramp. At the end of a . . . lab class . . . all students will have a series of paper tapes with dots on them. Next lesson, . . . the teacher will use the blackboard to explain how the tapes are to be analysed . . . Analysis . . . may take
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several lessons . . . The result will be a series of figures and graphs representing the motion of a cart that may have been back in the science storeroom for almost a week. Such approaches alienate some students, reinforcing the notion that science is outside their everyday experiences and is irrelevant to them.

[Several alternative approaches using [computers] . . . enable students to obtain immediate readings of velocity and acceleration, and which allow students to investigate more meaningful movement. A computer and datalogger . . . provide a real-time graphical representation of an object's motion, or give direct readings of variables such as velocity and acceleration.

[Groups of students learning graphs of motion will be shown how to use sonic motion sensors linked to dataloggers and computers . . . [Groups use] a worksheet containing several distance/time graphs and velocity/time graphs. The students' task is to recreate the graphs by walking in front of the sonic motion sensor, which displays a graph of their motion on the computer screen. Such an approach allows students to develop an understanding of abstract concepts (graphs of motion) using concrete experiences (movement of their own body). It eliminates the drudgery of repeated measurements and calculations, and saves time – providing time for students to investigate a range of motion phenomena that relate to their interests. The technology used is inherently engaging for many students and portrays an image of science as a modern discipline that uses up to date technology to investigate real-world phenomena. It enables ways of learning that cater for the preferred learning styles of students, which are not possible without [computers].

More students develop a valid understanding of graphs of motion in less time. This is information age learning, using information age tools.

Lifelong Learning Associates, 1999 (p.11).

Approaches like those identified by Lifelong Learning Associates use technology to place the student at the centre of the learning process. Such approaches increase opportunities for student interaction and decision making thereby presenting learning as active and meaningful (NSW Dept of Education and Training - Curriculum Support Directorate, 1997a). As for the task, the technology transforms the complexity of it making it easier for the learner to control and investigate the phenomena.

Using technology this way underscores the paradigm shift in teaching that is at the centre of reforms in educational computing policy. In particular, it will see the teacher move to a new position - one of mentor, facilitator, coach, guide and architect of the learning environment - that will focus less on teaching and more on learning, with a commensurate shift in emphasis from whole class to small groups or individual learners.
2.4 The Use of Computers in Teaching

2.4.1 Introduction

Research on computer integration in the schools has concentrated primarily on use by students in the classroom. Although student-centred issues are critical, research on teachers’ use is also consequential, not only for productivity implications, but also because teachers who are comfortable using computers might model positive uses of technology for their students.


Three conceptualisations of computer use in teaching have been identified in the literature (Mitra, 1998). The first is temporality, which associates use of computers with an individual’s engagement with a computer. Temporality studies report significant attitude differences between low and high users, with low users having a more negative attitude toward computers. Unfortunately, those studies present computer use as uni-dimensional.

A second iteration concerned instruction in computer use (Mitra, 1998). Here too the literature was dominated by anxiety constructs and upon personal interest towards computers. Again, there was no elaboration on the dimensions of use.

The final predilection considered specific software and applications being used, such as a particular operating system or one type of word processor (Mitra, 1998). A number of studies concentrated upon specific applications, but while there was some elaboration computer use was restricted to an area of computer-centric use.

Mitra (1998) defined computer use as “an act where the user engages in applications that are often centred around the computer, which becomes the end rather than the means to an end” (p.283). Under those conditions, computer use relates to specific tasks, each driven by a definite and unique motivation, rather than related to a certain tool. Such discourse recognises computer use to be multi-dimensional rather than uni-dimensional. With growing computer ubiquity, multi-dimensionality has become an issue especially as computer use shifts from studying computers as artefacts to computer use that is both task-related and non-task-related, which is indicative of computers being used as tools.
2.4.2 Access to Computer Resources

It is crucial for teachers to be able to use what they have gained, to practice what they have learned (Chin & Horton, 1993). Teachers' ability to access computer resources, both physical and human, is the critical factor in the successful adoption of information technology (Persichitte & Bauer, 1996).

Access to resources is one of the most important variables impacting upon teachers' use of computers (Becker, 1992). Resources include money, hardware, software, and space. In fact, over two thirds of teachers say that it is a lack of resources that keeps them from using computers more often than they do. In a study of exemplary computer teachers, resources allocated to computer coordination, promoting smaller class sizes and better student to computer ratios were seen as critical (Becker, 1992).

In the early stages of classroom computer use teachers tend to look for software specifically fitting the curriculum, to complement and extend the work done in class (Zammitt, 1992). Teachers commonly report this process to be time consuming, while assessing the quality and appropriateness of software was found to be frustrating because the software was all too often pedagogically weak or inappropriate. Invariably, generic computing tools like word processors, databases, spreadsheets and graphics programs were overlooked even though teachers could have used them in a variety of activities. When teachers did use generic computing tools, they reported that integrating those tools - learning how to use them and preparing for class use - took longer than traditional pedagogic approaches.

Technical problems with hardware can also preclude classroom use (Newhouse, 1995). In particular, access to peripherals like printers can impact upon technology adoption. In the case of portable computers, having students’ computers away with the technician is indicative of the high support needs associated with such initiatives.

Problems don't go away if schools opt for desktop computers, they simply re-appear in alternate form. The major issue surrounding desktop computers are location and scheduling of classes (Zammitt, 1992). Coordinators consistently acknowledge that computer rooms were as a matter of course booked permanently for 90% or more of the time by Computer Studies classes. Consequently, many teachers were reluctant even to think of using computers because they were
aware of the difficulties of access. Those who wanted to become involved needed to negotiate room changes and they often spoke of frustration and of wasted time and effort.

Despite the problems associated with scheduling, secondary schools maintain lab-based configurations as this setting fits more easily in with school organisation (Zammitt, 1992). This was similar to Becker's (1986) finding that middle and high school students used computers in laboratory settings.

2.4.3 Access to Computers by Teachers

A theme consistently permeating the literature on the successful integration of computers as tools for learning is the centrality of teachers (Christensen, 1998; Blease, 1986). If successful integration is teacher dependent then by corollary teachers have to be suitably resourced to effectively carry out their role as computer educators (Woodrow, 1992). In many schools teachers will have to have better access to the technology before the computer can be successfully utilised as a tool for learning.

Research by Okinaka (1992) shows that when teachers have ready access to computers their computer experience increases. In fact, owning a computer is an important influence upon a person's computer competence level (Mahmood & Hirt, 1992). Teachers who own a computer show more positive attitudes towards computers in the classroom (Bassler, Almeida, & Van Voorst, 1984; Gattiker & Hlavka, 1992; Harvey & Wilson, 1985). Furthermore, teachers who own a computer and use it at home are more inclined to use it at work (McCarthy, 1988).

In an era of ever-increasing computer ubiquity, intensity of computer use may become a major differentiating factor (Nash & Moroz, 1997). In a sample of 289 graduate educators, Nash and Moroz found high intensity computer users - whether that be use at school or at home - to be less anxious, like computers more, be more confident users and to find use more rewarding than teachers who were low intensity users. Intensity of use was measured as the frequency of use of computers for programming, accessing the Internet, word processing, electronic mail, graphics construction and spreadsheet/numerical/statistical analysis.
Despite a link between access and confidence, the literature consistently reports discrepancies between teachers’ expected and actual computer use (Marcinkiewicz, 1993). The existence of a discrepancy means that computers in schools may be under-utilised - supply of computers is high, but teacher demand is low. The consequence of under-utilisation is that there may never be an opportunity to realise the expectations of educational computing.

In a study of elementary teachers’ access to computers Winnans & Sardo-Brown (1992) reported that all of the teachers could access a computer at school. When asked how often the computer was used, 81% reported less than 2 hours usage at school per week. Of those reporting home ownership (about 26% of teachers), 72% reported using computers for less than 2 hours per week at school. While teachers understood the importance of implementing computers in schools, it appears that even though the computers are available, the teachers are not using them.

Even in studies of exemplary computer using teachers (Sheingold & Hadley, 1990) those teachers expended their own extra time and effort to integrate computers into teaching. Furthermore, those teachers taught in schools with more than double the then national average of computers, yet rarely was more than one teacher amongst them able to integrate computers into teaching. Exceptional availability was not matched by exceptional use.

Newhouse (1995) in a study of a laptop program in a Perth private secondary school found low levels of computer use by teachers. Nearly 70% of teachers wanted to use computers more often but over 80% had either not used a computer regularly or at best had used a computer regularly for one or two years. Newhouse believed that despite significant access these teachers would need an additional two to three years of experience to become significant classroom users of computers.

The adoption of an innovation, like computer use within schools, is dependent upon the generation of a critical mass of computer-using teachers, the degree to which teachers use computers and their capacity to re-invent teaching practices (Christensen, 1998). In a study of elementary teacher’s integration of computers Christensen (1998) noted that the construction and delivery of a needs-based training program created a critical mass of computer using teachers. Furthermore, through targeted training teacher use of computers increased from an average of 2.7 hours per week to 5.5 hours within a ten-month period. No data were collected about changed teaching practice.

When computers are at least minimally available to teachers in schools, it appears that teacher motivation and disposition are important factors explaining whether computers are used in classrooms or not (Marcinkiewicz & Wittman, 1994). In such cases it appears that the progression
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from awareness, through interest, evaluation, trial and finally adoption of information technology for classroom use can be blocked (Marcinkiewicz & Grabowski, 1992). In particular, teachers' lack of experience hinders their capacity to further organise and elaborate upon their beliefs and attitudes about computers.

2.4.4 Teacher Utilisation of Computers

To explain why few teachers adopt computers when they are minimally available, Marcinkiewicz & Grabowski, (1992) used Expectancy Theory, which states that the adoption of an educational innovation by teachers is dependent upon three components of perception - valence, expectancy and instrumentality. Valence refers to a desired goal, expectancy to the prospect that one is capable of achieving the performance and instrumentality, the belief that the achieved performance actually results in acquiring the valued goal. For example, a teacher would be motivated to use computers in teaching if expending a modest amount of effort gaining experience (expectancy) resulted in competent use, and that using the computer was instrumental in achieving a valued goal (instrumentality), such as better teaching (valence).

Marcinkiewicz & Grabowski, (1992) hypothesised that teachers' computer competence, their commitment of time and effort to acquiring computer experience (expectancy), was dependent upon two factors, locus of control and self efficacy. Locus of control refers to personal beliefs about the outcomes of one's behaviour being contingent upon one's own actions rather than fate or luck. Self-efficacy refers to belief in one's capacity to attain a certain performance level. This tandem was chosen because studies of locus of control support the prediction of a person's future behaviour and their initiative in controlling their environment (Rotter, 1975 in Marcinkiewicz & Grabowski, 1992; Rose & Medway, 1982 in Marcinkiewicz & Wittman, 1994). Self-efficacy studies predict performance not predicted by locus of control studies (Taylor & Popma, 1990 in Marcinkiewicz & Grabowski, 1992).

Teachers' perception of classroom use of computers as a mechanism for achieving the valued goal of improved teaching and learning (instrumentality) was hypothesised as perceived relevance of computers. Teachers' feelings about their use of computers in the classroom were operationalised as self-competence. In terms of motivation, the pursuit of competence or mastery is a natural
disposition underlying self-directed behaviour (Piaget, 1952; Stipek, 1993; White, 1959; all cited in Marcinkiewicz & Wittman, 1994).

Marcinkiewicz & Grabowski, (1992) sampled 167 undergraduate students in their final year of training to become elementary school teachers. Respondents were classified into one of three categories, no use of computers, utilising computers in own learning, and capable of integrating computers into teaching and learning. The majority of students (84%) were classified at the utilisation level. About one in eight students (13%) were found to be at the integration level.

On the whole, the sample uniformly tended towards a perception of high relevance of computers to teaching (perceived relevance) and a perception of high likelihood of the ability to use computers competently for teaching (self-competence). Marcinkiewicz & Grabowski (1992) noted that perceptions of self-competence, perceptions of relevance of computers to teaching, teacher locus of control and innovativeness were influential variables that were responsive to intervention. On the other hand, age, gender and years of computer experience may still influence teacher’s computer use but could not be influenced by intervention. Knowledge of interactions between these characteristics is beneficial to staff training.

Marcinkiewicz (1994) also conducted a comparative study using the data from the 167 undergraduate students and data from another 170 practicing elementary teachers. It was found that just over 43% of the practicing teachers operated as non-users and another 48% were utilising computers. That is, while nearly half the sample did not use computers, nearly all those who did use computers in their teaching did so at a level where computer use was expendable - not really necessary for teaching to take place. As for the pre-service group, individuals were overwhelmingly placed in the utilisation category.

Using stepwise regression analysis, Marcinkiewicz (1994) established that expected levels of computer use were most closely identified with self-competence by practicing teachers and perceived relevance by pre-service teachers. Marcinkiewicz explained that because practicing teachers’ use of computers depended upon their perception of personal ability that this highlighted considerable under-utilisation of computers in schools. To expect those teachers to integrate computers would have required them to work beyond their professional expectations. The position for pre-service teachers though was somewhat different. For this group computer use was a relevant part of the teaching process, meaning there was an expectation that computers would be
used in practice, in “much the same way as a pilot trainee expects to fly or a sales trainee expects to work with people” (Marcinkiewicz, 1994, p.193).

In a follow-up to the 1992 study, Marcinkiewicz & Wittman (1994) were able to obtain further data from 100 of the original 167 undergraduate, final year students, a response rate of 60%. The greatest difference in the group after three years of teaching was that the percentage of students who reported that they did not use computers increased from 2.7% to 39%. Some 60% reported that they used computers at the utilisation level while only one teacher indicated computer use at the integration level. Comparisons of neophyte teachers’ classroom use of computers with that reported by the 170 practicing teachers involved in Marcinkiewicz’s 1994 comparative study revealed similar levels for non-use. However, neophyte teachers’ utilisation levels were well above those from the practicing teacher group. Such a difference might indicate an endurance of neophyte teachers’ perceptions of the relevance of computers. Marcinkiewicz & Wittman (1994) found it encouraging that after three years those teachers still retained a great deal of enthusiasm for computer technology. Such a view also supports the contention that teacher attitudes are fairly stable.

Marcinkiewicz (1993) says that administrators and staff developers should use measures of self-competence as indicators of teacher’s eventual computer use. For those teachers not appreciably demonstrative then intervention through staff development could be instigated. In the case of staff developers this knowledge could sensitise them to the characteristics of their audience as well as enabling them to better design activities to address these variables. Overall integration levels were very low across the groups studied by Marcinkiewicz, suggesting that teachers’ utilisation of computers may indeed be incremental.

2.4.5 Exemplary Computer Use by Teachers

Studies of teachers’ use of computers invariably come from the perspective that computers play a minimalist role in the schooling of most students. One study undertaken by Sheingold and Hadley (1990) deliberately set out to identify a group of teachers whose significant and visible classroom use of computers made them qualitatively different from their peers. The major findings of the study were:
i. Exemplary teachers used computers for 4 or more years. Those teachers were extremely comfortable with computers and on average used twice the number of applications as their peers,

ii. To learn how to use computers in their classrooms exemplary teachers had taken advantage of many different opportunities - attending in-service, conferences and workshops - often in their own time,

iii. In return for this motivation, exemplary teachers received significant amounts of support from their school and district,

iv. Exemplary teachers perceived computers as multipurpose tools useful in a variety of ways, some content specific, others more generic and tool-based,

v. The computer-based practices of exemplary teachers had shifted over time with a reduced emphasis upon programming and drill-and-practice software,

vi. Many exemplary teachers were interested in using technologies that were beyond their school’s current capacity, e.g. telecommunications and robotics,

vii. The most frequent use of software was to enable students to create their own products, often as part of project-based learning activities including several different applications,

viii. Using computers made many differences in exemplary teachers teaching. In particular;

   • Changed expectations to student work. More was expected such that students were grasping more difficult concepts and developing thinking skills,

   • Improved capacity to meet individual student needs. Computers permitted greater individualisation as well as more independent student work,

   • Integrating computers had turned teacher-centred classrooms into student-centred ones.

Sheingold and Hadley (1990).

The key incentive for exemplary computer-using teachers was the impact of computers upon student achievement and engagement. Nonetheless, exemplary teachers still experienced barriers which, in the main, related to hardware - too few computers; preparation time - insufficient to adequately prepare lessons; scheduling - insufficient time and space for more computer-based classes; and financial support.
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The resistive nature of the barriers drew Sheingold and Hadley to conclude that some of the schools involved in the survey were at a critical juncture from which further development would only be possible through organisational change. Sheingold and Hadley stressed that school structure and culture were critical elements in the encouragement of teachers to take a professional and experimental approach to their work.

Sheingold and Hadley provided a portrait of computer use other teachers might aspire to and ultimately attain, but the design of the study made it difficult to assess exactly how exemplary teachers came to use computers differently to other teachers (Becker, 1994). Becker (1994) argued that knowledge of the process would provide useful insight into how other teachers might be encouraged to become exemplary computer-using teachers and determine the ease with which barriers to classroom computer use could be removed.

Becker reworked U.S.A. data from the 1989 I.E.A. Comp-Ed survey of teachers' computer use in elementary and secondary schools. Becker’s analysis identified that nearly all work environment advantages - teaching with other teachers who used computers, access to relevant and broad-ranging staff development activities, access to computers in schools, time to use them personally and teaching smaller classes - enjoyed by exemplary computer-using teachers were extensible to other computer-using teachers.

On the other hand, Becker found exemplary computer-using teachers to be significantly more educationally well rounded than other teachers and disproportionately male. Being educationally well rounded meant that teachers had strong personal interest in computers (often highly correlated with gender), came from liberal arts backgrounds or were ardently committed to lifelong learning. Becker concluded that extending exemplary practice to teachers ‘who did not share those deep interests and backgrounds’ would be difficult.

Becker recommended two directions for future research. The first was to measure the relative cost-effectiveness of the alternatives to promulgate computer-based education. The second was to continue to examine the pedagogy that has been assumed to be consistent with exemplary classroom use of computers.
2.4.6 Teachers' Computer Competence

Debate has waged over the amount and structure of computer experience teachers ought to possess. There is consensus though that whatever the experience that teachers should hold, it must enable them to do something constructive with a computer, rather than be awareness based on what others have said (Lockard, et. al., 1994). However, beyond that point there is great conjecture.

The basis of the conjecture stems from there being no universally accepted definition of the term "computer literacy" (Okinaka, 1992). Early definitions of computer literacy stressed the importance of writing and interpreting computer programs (Luehrmann, 1994). Knowledge of programming is useful in appreciating how software actually works, but is no longer a survival skill in a world dominated by user friendly operating systems and elaborate multi-functional packages (M^2Keown, 1987; Okinaka, 1992). Rather, the focus has shifted from “What constitutes computer literacy and how do we help teachers become computer literate?” to “What knowledge do teachers need to utilise the computer in their classroom effectively, and what is the best way to provide that knowledge” (Overbaugh & Reed, 1994, p.211).

Despite the shift in emphasis many teachers still remain unprepared to incorporate computers into the curriculum (M^2Namara & Pedigo, 1995; Piotrowski, 1992; Stecher & Solorzano, 1987). The real problem is getting teachers to realise that they have to do more to expand their awareness of the computer's capabilities (Okinaka, 1992). This can be difficult when many teachers believe that post-initial training is an add-on to their workload rather than an intrinsic part of it (Lifelong Learning Associates, 1999).

Even teachers with favourable dispositions toward computer use do not necessarily use them in their classrooms (Turner, 1989). Recent United States data revealed that only 49.1% of teachers used computers at work (NCES, 1995). Thus, it would seem illogical to ask teachers lacking familiarity with computer based instructional methods to help students to become functionally computer literate (Stecher & Solorzano, 1987). If teachers are not literate in basic computer skills how can they even begin to consider the integration of computers into the classroom (M^2Namara & Pedigo, 1995)? According to the Office of Technology Assessment (U.S Congress, 1995) “helping teachers use technology well may be the most important step to helping students” (p.95).

Many reasons have been postulated to explain teachers' lack of computer competence. It is certainly true that few teachers have been effectively trained to integrate technology (Piotrowski,
1992). It is equally true that technology is not static but constantly changing and in order for teachers to remain knowledgeable about it and use it effectively they need continuous training (Becker, 1992; McNamara & Pedigo, 1995).

Galligan (1995) viewed teachers’ lack of computer competence more pragmatically and was of the opinion that personal and professional reasons impinge upon a teacher’s capacity to integrate information technology. In particular, Galligan saw aspects associated with career stage, demands of personal life, past experiences, schools’ computing culture and teachers’ pedagogical stance as potential barriers.

Career stage affected teacher preparedness in a number of ways. For those teachers nearing retirement there was little incentive (beyond professionalism) to adopt new approaches to teaching. Conversely, for teachers entering the profession without relevant undergraduate experiences there were real pressures to develop specific aspects of their teaching style in order to survive. For other teachers, priorities associated with other curriculum innovations saw those take precedence over integrating computers.

Teacher preparedness can be drained by the demands of personal life. Certainly female teachers with families are restricted in terms of their capacity to undertake computer skill development outside of work hours. Likewise, teachers who must care for aged parents talked of similar constraints.

Some teachers’ lack of computer competence was a function of their prior experiences (Galligan, 1995). If teachers had only ever seen simplistic or trivial use made of computer software then it was not unreasonable for them to develop deep reservations about the role of computers in education. For other teachers, their experiences lead them to form notions of the computer as a difficult, impersonal machine never to be mastered (Okinaka, 1992). In those circumstances it was teachers’ attitudes and lack of skills to implement instructional computing that made it difficult to effectively manage and implement computers in the classroom curriculum (Stevens, 1984).

Galligan (1995) also expressed concern over the effects of school computing culture on teacher preparedness. In this respect, so called ‘computer experts’ were actually promoting alienation among teacher colleagues rather than awareness. This was because the ‘experts’ were using deficit models of instruction, were over reliant upon jargon to explain concepts and focussed on doing rather than demonstrating how.
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Finally, Galligan (1995) noted that teachers' pedagogical stance influenced their approach to skill development. In particular, teachers' beliefs about how students best learn along with their personal understanding of what constitutes best practice influenced the way computers were used (or not used) in the classroom.

In the literature on teachers' work, there is widespread agreement that time constraints are a major reason why teachers are reluctant to develop experience with computers in education (Becker, 1994; Okinaka, 1992; Sheingold & Hadley, 1990; Zammit, 1992). In order to use computers effectively, teachers have to devote time to learning basic functions, mastering the intricacies needed to apply certain programs, reviewing and applying software packages as well as learning how to apply useful utility programs such as test constructors, word processors and spreadsheets (Okinaka, 1992). According to Hoffman (1997), teachers don't have the additional hours required to quickly become comfortable users of digital technology. Newhouse (1995) believes that Australian Secondary teachers need between three and five years of school-related computer experience before they might become significant classroom users of computers.

Chiero (1997) in a study spanning elementary, middle and high school teachers asked them to identify the frequency of 14 different uses for computers. Almost all used computers to prepare materials like tests and worksheets, while just over half indicated that they had used the computer to locate information for a particular subject. However, on twelve of the possible uses more than half of the teachers reported not using the computer at all. When asked about obstacles, 82% of teachers responded that time was the biggest obstacle to more computer use.

Thus, for most teachers, opportunities to learn remain limited so any learning undertaken is often done in informal settings and consequently what is accomplished is often highly specific (Maddux, 1991). As a consequence teachers often possess only splinter skills, that is, they know how to turn on a certain type of computer, start-up a given program and produce a fairly simple result. Maddux quite rightly points out that that even if teachers do acquire some expertise it quickly becomes outdated because of rapid developments in hardware and software.

Walker (1983) estimated that highly motivated teachers could learn the basics of computer use along with how to use computers with children in 180 hours, perhaps a little less with careful planning. Walker stressed that such a commitment was only the beginning for a teacher who wished to use computers professionally. Hoffman (1997) found that successful technology-using
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teachers continued to learn new skills through self-study, conferences and workshops, often in their own time.

Many teachers feel threatened by the prospect of having to learn about computers (Okinaka, 1992). For teachers the prospect of teaching a class having not mastered the computer would be intimidating (Turner, 1989). As professionals, teachers don’t want to feel uncomfortable teaching especially when their clients possess more ability and experience than they do!

Before teachers can become more comfortable and develop new skills in technology use they must be willing to engage in skill acquisition (Dusick, 1998). Some teachers, notably early adopters, readily accept such challenge. With respect to the integration of technology, George, Sleeth and Pearce (1996) defined four groups of teachers on the basis of their current patterns of information technology use: those unwilling to take risks, those who lacked knowledge, those who dabbled, and the experts. According to George, Sleeth and Pearce the unwilling and the unknowledgeable were often those teachers who also lacked tolerance for change, having no compelling reason to try teaching with technology.

Kay (1989) believed that among teachers, low levels of computer experience manifests itself as a lack of motivation. Low levels of experience caused teachers to display resistance, which according to Friedman (1985) is far more common than many would believe. Resistance that emanates from a lack of experience significantly reduces a teacher’s capacity to efficiently use computers as teaching and learning tools (Häkkinnen, 1994). Previous computer experience is often the basis for positive attitudes towards information technology (Häkkinnen, 1994). Unfortunately, over reliance upon past experience can limit personal awareness of the potential uses for computers. In particular, difficulties using computers combined with mediocre skills gives rise to a paradox of motivation and cognitive strategies (Häkkinnen, 1994).

The existence of this paradox is cause for concern. The paradox arises because the benefits people perceive in their computer experience are illusory. That is, people develop false expectations about their achievements and rather than adapt or adopt new ways they remain within their comfort zone. The paradox arises when those individuals attempt to interpret new situations based solely upon their previous knowledge. While valid similarities may be deduced, a heavy reliance upon such deductions can lead to one drawing wrong conclusions and not exploring possibilities far enough.
2.4.7 Computer Pedagogy

Teachers play a crucial role in determining the impact of computers on learning. It is teachers who choose how, when, where, why, and with whom computers will be used. The outcomes of classroom computer use are shaped to a large degree by the theoretical framework and beliefs of individual teachers, the range of their pedagogical repertoire and their sensitivity and responsiveness to the structure, potential and possible limitations of computer software in classrooms (Galligan, 1995). Successful integration of computers requires teachers to know how their use of technology relates to the curriculum. Knowing what to concentrate on improves intended learning and in some cases also incidental learning (Heller, 1990). Teachers need to know at what their use of technology is directed. Is it: to stimulate interest in a topic; to reinforce content; to elucidate questions and problems; to provide raw data for analysis; to provoke discussion; to develop student confidence in a given area; to provide open ended exploratory experiences and so on (Galligan, 1995)?

It is teachers with progressive beliefs about teaching who tend to be drawn towards using technology (Ritchie & Wiburg, 1994). Observations by Ritchie and Wiburg and by Newhouse (1995) indicate that as teachers incorporate information technology, their style of teaching increasingly takes on a student-centred active learning orientation.

Honey and Moeller (1990) observed distinct differences in pedagogical orientation and practice between groups of teachers they labelled as high and low level technology integrating teachers. Honey and Moeller found that as a group, highly integrative teachers were fairly homogeneous in their approach to teaching and learning, tending towards the instillation of a sense of curiosity and a desire to learn among their students. Those teachers embedded technology use within a process-oriented approach, which emphasised the development of critical thinking skills through inquiry-based tasks. Less class time was devoted to fact acquisition. High level technology integrating teachers believed that allowing students to explore and use desktop publishing, telecommunications and multimedia tools resulted in increased learning, as students enjoyed finding creative ways to master content objectives.

On the other hand, low-level technology implementation teachers were more heterogeneous in the approaches to teaching and learning. Teachers adhering to traditional practice were found to have very structured classrooms with high levels of discipline, and an emphasis upon content rather than process. Textbook and lecture were the dominant tools of teaching. The major reason offered
for not using computers was that they were too disruptive. When computers were used the major purposes were to reinforce basic skills, or to boost motivation, not curriculum enhancement.

Teachers who were more process oriented in their teaching but still low-level technology integrators, were said to belong to one of two groups by Honey and Moeller. The first group was associated with reluctant use of technology brought on by personal fear - computer anxiety - arising from either poor initial experiences with computers or belief that they personally, lacked ideas on how to appropriately incorporate computers into the curriculum. The other group of low-tech teachers identified hardware and software deficiencies in their schools as the major reason preventing use in the classroom.

Zimmer (1989) explored the link between teachers’ pedagogical stance and technology implementation. More recently, the Office of Technology Assessment (US Congress, 1995) concluded that if a teacher’s view of teaching were that they must control the learning environment, then their choice of technology tools would support their vision. If the teacher’s view were one of autonomy and cooperation in the learning environment, however, then technology tools would be chosen to complement that perspective.

When computers are used to promote autonomy and cooperation in learning, this act may have profound impact upon teachers’ personal and professional practice (Galligan, 1995). Russell (1988 cited in Galligan, 1995), in a study of teachers’ goals for using word processing, noted that less time was spent on classroom management issues. Russell found evidence of changed attitudes by teachers, especially regarding student independence, student and teacher roles, and with goals associated with specific learning tasks.

Newhouse (1995) however, was less than enthusiastic about changes in teacher pedagogy following a study of the implementation of a laptop program at a Perth private school. Newhouse reported increased use of computers but invariably the teachers simply substituted the computer for tasks normally completed by hand. Little thought was given to the totality of the task and no attempts were made to substitute tutorial, simulation or modelling software for traditional tasks. In most cases students expended time beautifying work rather than concentrating on the working nature of their documents. Newhouse also identified a group of teachers who almost never required students to use their computer either in class or at home and in many ways that group actively discouraged student use of computers. Becker (1991) linked such teacher behaviours to a lack of role models.
Newhouse gave three reasons for why few teachers at the school were ready to integrate computers. The greatest inhibitor to integration was the teachers' preferred pedagogy. Teachers found it difficult to adapt computers to their personal style of teaching and subject curriculum. There was an entrenched belief in instructivist pedagogy, with lessons dominated by teacher or text, requiring little use of computers as cognitive tools by students. Put simply, computers were perceived as non-essential supplementary items in classrooms. Compounding teachers' inability to adapt were their lack of experience and knowledge about how to use computers in classrooms and little or no time to experiment with the tool to build knowledge and expertise.

While the introduction of computers into the learning environment does not by itself produce changed pedagogies, there is some evidence that changes in teachers' pedagogy have occurred following the introduction of computers (Becker, 1991; Honey & Moeller, 1990; Sheingold & Hadley, 1991). The question is does technology impact upon teachers' beliefs and practices, or vice versa? This has led some researchers to ask whether technology use amplifies practice or transforms pedagogy (Miller & Olson, 1994). Niederhauser and Stoddart (1994) for instance, maintain that technology use reflects attitude and so is an extension of current beliefs. On the other hand, Vickers and Smalley (1995) point out that using technology in teaching "challenges teachers to reconstruct the practical theories they use for understanding the learning process" (p.280). Either way, Ragsdale (1992) was of the opinion that it was difficult to preserve one's teaching style if it were not conducive to computer use. As the Apple Classrooms of Tomorrow (ACOT) project found, "teachers who had regular access to computer technology in their classrooms over several years' time experienced significant changes in their instruction" (Dwyer, Ringstaff & Sandholtz, 1991, p.45).

As teachers become comfortable with the shift in classroom roles, they may start extending their idea of what it means to be a teacher. If they're supported, they may also change their approach to teaching and learning - from curriculum-centred to learner-centred, from individual tasks to collaborative work, and from passive learning to active learning.

Apple Computer, 1995, (p.15).

Sustainable shifts in pedagogy only proceed following changes in beliefs about what constitutes best practice (Sandholtz, Ringstaff & Dwyer, 1997). In the ACOT studies the researchers found that old teaching habits were only replaced over a long period and then only following repeated classroom success and recognition from colleagues and administrators. New beliefs are only ever forged reluctantly.
2.5 Teachers' Attitudes to the Use of Computers in Classrooms

2.5.1 Introduction

Attitudes have long been recognised as important predictors of individual differences in educational application, learning and achievement (Francis, 1993). However, research on teachers' attitudes toward computer use has not had a long tradition (Rosen & Thompson, 1990). As that tradition grows research will reveal more about teachers' interactions with information technology and its impact upon work practices. What follows is a discussion of the concept of teacher attitude, specifically attitudes toward information technology, how those attitudes have been measured and in particular the impact of computer anxiety.

2.5.2 The Nature of Attitudes

Attitude as a social psychological construct is a complex multi-dimensional concept (Breckler & Wiggins, 1989). It has been broadly defined as a 'posture of the mind' (Oskamp, 1977) and has been used to denote certain consistencies in a person's behaviour, statements and experience (The Open University, 1975).

Until recently, psychological research subscribed to the tripartite theory of attitude. This position holds that attitudes are comprised of affective, cognitive and behavioural components (Fishbein, 1967). In later reports, researchers have tended to omit behaviour from suggested models of attitude (Ajzen, 1989; Chaiken & Stangor, 1987; Tesser & Shaffer, 1990) because behaviour is proposed to be more of a consequence of attitude than a component of it, although this model too has been questioned (Duncan & Stenbeck, 1988). Not withstanding this, the weight of recent research would suggest that attitudes are comprised of cognitive and affective components that singularly or together lead to behavioural intentions, which may or may not result in actual behaviours towards attitude objects.

The cognitive component of attitudes is said to consist of responses that reflect what is known or perceived of attitude objects or events (Ajzen, 1996; Edwards, 1990; Oskamp, 1977). Attitude relevant cognition consists of judgements and thoughts that link attitude objects and events to
attributes. On the other hand, the affective component echoes a person's feelings, emotions, or drives associated with the attitude object or event (Edwards, 1990).

Importantly, attitudes are not dichotomous, in that they are neither purely cognitive nor purely affective. Rather, they contain both components to varying degrees. However, this is not to say that attitudes cannot be disproportionately made up of affective or cognitive elements. In the case of affective based attitudes, the attitude is formed with little (or no) cognitive appraisal. Attitudes primarily based on cognition are ones where affect plays little part and in many cases domain relevant information is used as the guide in the attitude formation (Edwards, 1990).

Since teachers are the keys to the success of any educational intervention, it follows that teacher attitudes are pivotal to any successful curriculum implementation. Since attitude is acknowledged as having both affective and cognitive components, it is vital to take into account what teachers think about any new initiative even if their opinion is not entirely based on fact and a sound judgement of the initiative (Fullan, 1991). In addition, attitude would seem to serve as an important influence upon behaviour. Williams (1979 cited in Homer & Kahle, 1988) reports that actual selections of behaviour result from concrete motivations in specific situations which are partly determined by prior beliefs and values. Teachers' prior beliefs and prejudices are a real and valid component of their attitudes and are, therefore, reflected in their reactions to curriculum initiatives. Thus, it seems reasonable to suspect that past efforts to integrate Educational Computing have not been successful because of an inability to create the circumstances under which teachers could change their attitudes.

2.5.3 Teacher Attitudes to Information Technology
With the infiltration of microcomputers into classrooms over the past two decades, much evidence has accrued on the changing nature of teachers' attitudes towards information technology (Robertson, Calder, Fung, Jones & O'Shea, 1995; Becker, 1992; Chin & Horton, 1993; Cobbs & Wilmoth, 1990; Davidson & Ritchie, 1994; Delcourt & Kinzie, 1993; Hickey, 1993; Novak & Knowles, 1991, Pina & Harris, 1993). This large body of evidence points to teachers becoming more enthusiastic about and expressing positive attitudes towards the implementation of microcomputers across the curriculum (Dupagne & Krendl 1992).
Positive attitudes manifest themselves in the ways individuals interact with attitude objects. Okinaka (1992) believed that teachers' more favourable attitudes towards the implementation of information technology in the classroom results from greater familiarity with computers. Bassler, Almeida and Van Voorst (1984) found that teachers who possessed more positive attitudes were more likely to own their own computer, a position re-affirmed more recently by Nash and Moroz (1997). Ownership of a microcomputer would be one means of providing the concentrated experiences with computers that Delcourt and Kinzie (1993) found to be critical in the formation of positive attitudes.

Strong personal beliefs are seen as a major factor in promoting computer use (Larner and Timberlake, 1995). Novak and Knowles (1994) in a study of first year teachers found their belief in the importance of developing computer skills in students as an important component in their use of computers. Similarly, Davidson and Ritchie (1994) found an overwhelming percentage of teachers who believed in the value of computer use to students possessed positive attitudes, which could be attributed to their successful integration of computers in their classrooms.

Stuckman and Knapke (1986, cited in Chin & Horton, 1993) noted that teachers who engage in computer training were found to have more positive attitudes towards computers. Furthermore, teachers who had experienced success with computers readily sought additional training to enhance their competencies. Stuckman and Knapke concluded that teachers' attitudes toward technology could be changed through proper staff development. These findings have considerable support (Chen, 1986; Green, Kluever, Lam, Staples & Hoffman, 1993; Madsen & Sebstiani, 1987; Okinaka, 1992; Woodrow, 1992).

Violato, Mariniz and Hunter (1989) agreed that teachers' attitudes were critical determinants of their success in feeling comfortable with classroom use of computers. Nash and Moroz (1997) found high intensity computer using teachers were significantly less anxious about computers, more confident users, liked computers more and judged computers to be useful tools more than teachers who were low intensity users. Christensen (1998) contends that the more teachers use computers, the more they feel confident and comfortable in using technology in their teaching.

The rate at which attitudes become more positive appears to vary according to the specific attitude. For example, Christensen (1998) found that anxiety levels dropped quickly, usually within three months of beginning an intervention. Perceptions of computer importance and enjoyment also changed quickly in a positive direction, usually within six months. As for other attributes like
confidence and acceptance those appeared to take a full academic year to show measurable change. Christensen noted that teacher knowledge of school administrator support for computer integration played a fundamental role in the process.

Despite this evidence, many teachers remain sceptical of the value computers have in education. Indeed, Chin and Horton (1993) have commented that "the level of feelings teachers have toward computer usage range from uncertainty to hostility, to fear to euphoria. Indeed, the link between teacher attitudes and teachers' use of computers may at best be tenuous" (p.84).

Dawson (1986) observed that as a result of negative experiences with computer technology, classroom teachers may label themselves as not the computer type and become outspoken opponents of the use of the technology in classrooms. Mahmood and Hirt (1992) found that teachers who saw computers as having limited roles in the classroom also viewed them as unhelpful technology at home. On the other hand, Mahmood and Hirt also established that if a teacher does own a computer, then provided one is available, they would use them at work.

2.5.4 Teacher Anxiety with Information Technology

The most critical factor in establishing a computer plan in a school is not the hardware or the software, but the HEADWARE. The headware, or positive mind set, can be achieved only when people find the microcomputer familiar and comfortable to work with, when exposure to computers is face-to-face, non-threatening, functional, and ongoing.

(Ehley, 1992, p10).

Fisher (1991) and Knowles (1990) believe that teachers' scepticism towards computers can be attributed to the impact of rapid technological change. This is because rapid technological change has produced the situation where major cultural changes have occurred within the lifespan of the average adult. Thus adults are faced with the fact that they were never taught about the fundamental aspects of the current technological society. Limited or incomplete procedural knowledge is a common cause of anxiety.

Anxiety may act as a barrier to people developing positive attitudes thereby diminishing their motivation to learn about technology and acquire the skills needed to use information technology. The infiltration of information technology into the workplace and its inclusion in the school
curriculum means that the problem must be confronted so that present staff can more purposefully engage themselves in their work.

Anxiety is recognised as a state of diffuse arousal, brought on by an individual's perception of a threat or alternatively unresolved fear (Epstein, 1972). Two types of anxiety, trait and state anxiety, are said to exist (Gordon, 1993). Trait anxiety is a general pervasive condition within a person that is dispositional and has to do with proneness. On the other hand, state anxiety is transitory (Gordon, 1993; Häkkinen, 1994). State anxiety is associated with the appearance of specific elements within recognisable situations that engender stress. Oetting (1983) characterises state anxiety as the anxiety you are experiencing right now. In this sense state anxiety is situational (Häkkinen, 1994) and therefore subject to modification or remediation.

The fear attached to interaction with computers is termed computer anxiety (Häkkinen, 1994; Oetting, 1983) or computerphobia (Fisher, 1991). Computerphobia manifests itself as negative emotional reactions to the use or anticipated use of computers, which are perceived as personally threatening to the user (Gardner, Discenza & Dukes, 1993). Mauer and Simonson (1984) defined computer anxiety as "the irrational fear or apprehension felt by an individual when using computers or when considering the possibility of computer utilisation" (p.XX). M'Inerney, M'Inerney and Sinclair (1994) add that "negative cognitions and attitudes toward computers may also accompany such feelings as anxiety and include worries about embarrassment, looking foolish, or even damaging computer equipment" (p.28). Howard (1986) describes this fear as disproportionate to the actual threat presented by the computer.

Computerphobia, like anxiety in general, is believed to exist at two levels, mild and chronic (Wilcox & Mason, 1990, in Fisher, 1991). Wilcox and Mason claim that mild computerphobia is widespread in the adult population, but that there is little evidence to suggest the same of chronic computerphobia. Given that this is the case, the greatest element of anxiety in computerphobia is of the state anxiety type and thus responsive to correction (Harrington, M'Elroy & Morrow, 1990).

A number of reasons have been postulated for why anxiety towards computers exists. Paramount among those reasons is the view that artefacts like computers are more valued than people (Häkkinen, 1994; Fisher 1991). This dehumanising view has arisen through the combined effect of rapid technological change and Western society's tendency to instil technical progress with the highest of values.
Jay (1981) is somewhat more specific suggesting that computerphobia is a symptom of one’s inability to keep pace with technological advances. Mason and Mitroff (1973) believed individuals who are less analytic in their cognitive style and more heuristic would be less comfortable with the logical discipline associated with technology and computers. Howard (1986) describes those individuals as external locus of control types, because they perceive computers as outside agents exercising control over them.

The inability of computerphobics to keep pace with change can be accentuated, according to Jay, by the effects of poor workplace planning for new technology along with a lack of incentives for individuals to keep pace with change. Such a situation would serve to reinforce the perceptions of the individual who displayed the characteristics of external locus of control.

Widmer and Parker (1991 cited in Larner & Timberlake, 1995) have shown that in spite of their better education, educators themselves are equally prone to fear technology. Research by Barker (1994), Pina and Harris (1993) and Chin and Horton (1993) clearly demonstrates that teachers who have high levels of anxiety are less likely to integrate computer technology into their curricula. Woodrow (1992) found that teachers who did not feel adequately prepared to use computers effectively in their classroom were more anxious and rarely used computers, if at all. What is encouraging though is that there is mounting evidence to indicate that the numbers of teachers who display computer anxiety diminishes with time (Larner & Timberlake, 1995).

Low levels of computer skill, lack of formal computer training (Kotrliek & Smith, 1988), and poor perceptions of mathematical ability (Gressard & Loyd, 1986; Kernan & Howard, 1990 cited in Harris & Grangenett, 1996; Rosen, Sears & Weil, 1987) contribute to high levels of computer anxiety among teachers. Larner and Timberlake (1995) were of the view that some computer anxiety stems from teachers’ beliefs that they need to be proficient at programming to use computers. Pina and Harris (1993) report that some teachers are “afraid of looking foolish, getting lost or pushing the wrong button and damaging the computer” (p3). Widmer and Parker (1991 cited in Larner & Timberlake, 1995) suggest that teachers back away from trying to explain computers rather than risking the embarrassment of being shown up by computer ‘whiz-kids’.

In a study of the effects of computer training on the levels of writing apprehension and computer anxiety in elementary teachers, Johnson (1987) found age to be positively correlated with computer anxiety. This position was not generally supported by other studies of computer anxiety at that time (Howard, Murphy & Thomas, 1987).
Howard (Howard, 1986; Howard, Murphy & Thomas, 1987) demonstrated a link between mathematical anxiety and computer anxiety. Fisher (1991) believed that the relationship between these two types of state anxiety was because computers are pieces of mathematical technology. From this perspective, a fear of computers is just an extension of a more general fear of mathematics. Howard on the other hand was of the opinion that while a mathematical link exists, computer anxiety was more likely a reflection of anxiety associated with technology in general. Rosen and Maguire (1990) in a meta-analysis were able to locate 10 studies reporting on mathematics anxiety and computer anxiety. In a synthesis of those studies a statistically significant positive correlation resulted. However, once again the variance was minimal and the effect slight. Rosen and Maguire concluded that mathematics anxiety and computer anxiety were quite distinct constructs.

Howard (Howard, 1986; Howard, Murphy & Thomas, 1987) was also able to establish a nexus between locus of control and computer anxiety. Locus of control refers to one's perceptions about whether or not the outcomes of a given behaviour - in this case computer use - are dependent upon one's own effort and ability, or are due to fate or luck (Marcinkiewicz & Wittman, 1994). People who displayed external locus of control were more likely than internal types to also exhibit computer anxiety (Dambrot, Watkins-Malek, Silling, Marshall & Garver, 1985). Howard stated the reason for this relationship stemmed from the external locus of control individuals believed that computers, as outside agents beyond their control, exercised over them. In 1985, such a conclusion would have been reasonable given the hardware and software of the era. Further evidence based on today's computing environment is required.

As computers become more prevalent it may be that computer anxiety will diminish over time without any corresponding increase in classroom computer use. In studies conducted by the Office of Technology Assessment (US Congress, 1995) some non-computer using teachers endorsed the necessity of students accessing information technology at school, however, many did not see why it should happen in their classroom. Those teachers believed that computer use had little to offer them in their pursuit of student outcomes. The broader acceptance of a role for computers in learning, provided it is removed from a personal experiential level was described by Norris and Lumsden (1984, cited in Christensen, 1998) as the application of Social Distance Theory. Christensen (1998) indicated that social distance has the potential to become a more accurate indicator of teacher attitudes towards classroom computer use.
2.5.5 Teacher Gender and Information Technology

Gender as a background variable has received considerable attention in computer-related research. In particular, this research has focussed on the causes of gender differences and how attitudes might be changed so individuals may reflect more positive views of information technology (Robertson, et. al, 1995). Lee (1997) noted that gender influences how computers are used, the kinds of socialising or informal training experiences undertaken, perceptions of the computing environment, and attitudes.

Probably the most telling fact to arise from gender effect studies of computer attitudes is that males show more positive attitudes towards the technology than do females (Robertson, et. al, 1995). Many reasons have been put forward as to why this gender gap exists. Of those reasons, most relate to differences in male-female socialisation or gender-role identity (Colley, Gale & Harris, 1994; Winkle & Matthews, 1982) and media gender stereotyping (Ware & Stuck, 1988). Differences in socialisation have been hypothesised as meaning that females hold more negative attitudes towards computers and so engage in fewer computer-related behaviours (Whitely, 1996).

According to Sian, Durndell, McLeod and Glissov (1988) the difference in positive attitudes between males and females reflects differences in motivational factors, with females showing interest in information technology only when there is clear pragmatic usefulness to do so. Gilliland (1990) found that females were more negative in their attitudes towards computers because they had lower expectations for computers and their usefulness than males. Lee (1997) states that while there may be a link between gender and commitment to computers it is weakened by the higher levels of motivation of women active in computing.

Loyd and Loyd (1985) established that computer experience was directly related to positive attitudes and, that since males had more experience with computers that explained why they tended to have more favourable attitudes, a position supported by Lee (1997) and Rotter (1975) (cited in Marcinkiewicz & Grabowski, 1992). Dambrot, Watkins-Malek, Silling, Marshall and Garver (1985) reported males' positive attitudes towards computers correlated significantly with their higher computer aptitude scores.

Dupagne and Krendl (1992) found few gender differences overall in computer attitudes. Statz, Shavelson and Statz (1985) found none in their study of teacher training and teachers' instructional use of computers. Kay (1992) argued that gender related research has consistently produced conflicting results. Kay identified 98 studies in which a gender effect on attitudes
towards computers was reported. Of those, 48 showed males to be more positive, 14 showed females to be more positive, while men and women shared similar attitudes in the remaining 36 studies. Rosen and Maguire (1990) concluded on the basis of a meta-analysis that gender differences in attitude were real, but small. Under the circumstances, it may be best to conclude that one gender exhibits a more positive attitude while the other has a less positive attitude.

Studies of the gender effect on computer use, however, reveal strong gender differences (Kay, 1992). Kay reports that of 38 studies recounting on gender and computer use, 30 studies showed that males used computers more than females, 4 showed that females used computers more than males and 4 showed an equal use of computers by the genders. According to Robertson, Calder, Fung, Jones and O’Shea (1995) this evidence supports the notion that males have more positive attitudes than females, a position that Kay does not support.

Lee (1997) considers there to be strong prima facie evidence of a masculine bias in computer use in high schools. Quoting data from Australian and British sources, Lee said that males invariably taught computing, while the majority of computer coordinators were males whose initial qualification was in mathematics or science and rarely if at all from the humanities. This bias towards male-dominated disciplines was institutionalised during the 1980s inferring that it may be the root of curriculum-based gender differences.

Males have greater personal involvement in computers wherever gaming and programming are the major uses (Lee, 1997). In classrooms where computers are used M’Kinnon and Nolan (1990) call teachers’ attention to this fact and urge them to remember that using a computer elicits positive attitudes and motivation and so it is necessary to create environments that nurture females and males equally. Lee says the same can be said for teachers.

In studies where computer use was not associated with programming, mathematics or science, few gender differences were found in usage patterns or attitudes towards computers (Sacks, Bellisimo & Mergendoller, 1993). Furthermore, in studies of word processing male and female attitudes towards computers have not differed significantly, although in those instances females have tended to be over represented when compared with males. Robertson, Calder, Fung, Jones and O’Shea (1995) considered that access to computers was an important reason why the gender gap remains with respect to computer use.

Conflicting findings suggest that the issue of gender and computer experience remains problematic. Studies by Krendl (Krendl, Broihier & Fleetwood 1989; Krendl, & Broihier, 1992)
found no gender differences before or after subjects had had computer experience. Gressard and Loyd (1984), on the other hand found that teachers on the whole had fairly positive attitudes toward computers, but that teachers with more experience were less anxious and that males as a group were less anxious than females. In a later study Loyd, Loyd and Gressard (1987) found the subjects' confidence increased after experience and this experience led to a decrease in previous gender differences.

Female teachers tend to rate their knowledge of computers and computing skills lower than male teachers (Lee, 1997). Citing time constraints as a limiting factor, Lee notes that teachers are often unable to fully develop their computing skills, which in turn limits their capacity to absorb those skills into their teaching practice. Of concern is that female teachers are more ready to admit to this lack of knowledge as a barrier only within the confines of an anonymous survey.

Whitely (1996) established the existence of a gender difference in computer anxiety between male and female undergraduates, but was unable to attribute the difference to experience with computers. However, controlling for gender in computer anxiety attenuated gender differences with respect to current behaviour. Whitely surmised that reducing gender differences in current behaviour might feedback as reduced computer anxiety among women.

Those findings were consistent with recently completed studies although inconsistent with a literature synthesis conducted by Mauer (1994 cited in Whitely, 1996). In an attempt to reconcile the difference, Whitely noted similarities in the way his and the consistent studies defined computer experience. Each study defined computer experience in terms of the quantity rather than the quality of the experience, that is, the number of computer courses completed as opposed to whether or not the experiences were positive or negative. Whitely suggests that research focusing on qualitative differences may reach other conclusions.

Anderson (1996) provides further insight into the complexity of the relationship between computer anxiety, computer experience and gender. A study of a first year undergraduate, business study cohort revealed that overall women were no more anxious about their computer experience than men, but that women were over-represented in higher anxiety groups when compared with men.
2.6 Overcoming Barriers to Educational Computing

2.6.1 Introduction

Studies of accomplished computer-using teachers have concluded that it was possible to cultivate competent educational computer users (Becker, 1994; Sheingold & Hadley 1990). In the quest to become a competent educational computer using teacher, teachers will face many subtle obstacles (Veen, 1995). As well as subtle obstacles, there will be many not so subtle ones and chief among those will be teachers’ own strong subject matter and pedagogy beliefs. Efforts to improve computing knowledge and skills in isolation of those strong beliefs will have little if any impact upon intentions to use computers as tools for teaching and learning (Veen, 1995).

If information technology integration is to be successful, the motivating potential of new tasks must be harnessed (Lee, 1997) as the means for overcoming the obstacles. Individuals though, will only confront new challenges when the likelihood of succeeding is reasonable because success is dependent upon one’s capacity to stretch one’s knowledge and skills to meet the challenges. To increase teachers’ chances of successfully confronting computing challenges – overcoming the barriers to becoming competent educational computer users – teachers may well have to be provided with many layers of support.

For those teacher support mechanisms to be successful, information technology will have to be repositioned within the context of education (Zhao, 1998), so as to acknowledge that teachers differ in how, when and why they may need to use computers (Lee, 1997). This acknowledgement is necessary because differences in computer use will give rise to different perceptions of barriers that must be overcome. For some, the barriers will be external - funding, hardware, access, physical space, suitability of software and human resource problems like no help, no collegiality and a lack of support by administrators. For others, the barriers will be personal - lack of knowledge, limited or no access to computers at home or simply the computer coordinator is too busy to help. Thus, how the barriers are reconciled is at issue.
2.6.2 Promoting Positive Attitudes

Attempts to promote positive attitudes towards curriculum innovation often fail. Chief among the reasons for the failure of curriculum innovation is that teachers are very conservative, a conservatism borne of their need to not disadvantage their students. Thus, before teachers are prepared to change their attitudes, they must be able to observe a positive and desirable change in the behaviour of the children they teach (Fullan 1985). Fullan found that any change in students’ skills takes time and practice and requires evaluation, feedback and further planned development. Change in teacher attitude is preceded with anxiety and uncertainty but breakthroughs begin to occur when teachers see that new ways really work better for their students. If this situation is true for students then it may also be true for teachers.

Perhaps the implementation of innovations like Educational Computing has to be evolutionary. This is because the most critical barriers to change in educational processes are personal ones (Kefford, 1983), which has implications for the professional development of teachers. Fullan (1992) argued that through systematic training programs that address teachers’ needs in a developmental way over an extended period of time, teachers will begin to develop the necessary expertise and hence the willingness to implement the innovation successfully.

Katz (1992) believed that there were certain personality attributes associated with teachers’ positive attitudes towards computers. Katz used an Eysenkian personality model to test that belief. Katz was able to identify significant relationships between positive extroversion (loudness, boisterousness and sociability), inverse neuroticism (calmness, flexibility, social adjustment, and self-confidence) and positive psychoticism (impulsiveness, craving for change, as well as stimulus and sensation-seeking) and teachers’ positive attitudes towards classroom use of computers. Given that personality attributes are usually stable over long periods of time, it could be that teachers will maintain their attitudes irrespective of how long computers have been used in their schools.

Given the stability of teacher attitudes towards computers, it makes sense to mould those attitudes as early as possible. Downes (1993) showed in a study of pre-service teachers that more positive attitudes towards computers develop if training combines computer experience in the classroom with good role models, in the form of teachers who use computers. Furthermore, under those circumstances student teachers were more likely to use computers in their own teaching, a position supported by Marcinkiewicz (Marcinkiewicz, 1994; Marcinkiewicz & Grabowski, 1992).
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Madsen and Sebastiani (1987) found high correlations between increased teacher training and significant improvement in knowledge of, and attitude towards, computers among high school teachers. Mahmood and Hirt (1992) concluded that teachers needed to acquire good training and a background in information technology if the integration process is to be successful.

The key issues to stimulating computer use among teachers appear to be education and exposure to computers in schools (Okinaka, 1992). Okinaka however, cautions policy makers to not execute policy on those finding alone. Heywood and Norman (1990, cited in Winnans & Sardo-Brown, 1992) believe that teachers will develop positive attitudes to computers in schools when there is a confluence of circumstances. Those circumstances will occur when teachers see a need and relevance from using computers, clarity in those uses, that it is possible to extend on those uses and that there is quality and practicality in the programs being used. Reed (1986) suggested that if a teacher does not value computers as an instructional device, they would not use computers even if they were available for instructional purposes.

2.6.3 New Pedagogy or Pedagogy Redefined

Olson (1991) states that acceptance of innovations like the integration of information technologies into teaching begins with teachers assigning meaning to new practices. If in assigning meaning to those practices teachers feel that the new approaches challenge fundamental beliefs, or diminish or remove influence, then concerns develop. Olson maintains that it is a reasonable expectation for some teachers to develop resistance to change if they believe they are protecting their influence over core elements of their work, such as curriculum coverage and maintaining their credibility.

Three models have been accepted as ways of addressing this issue. The first assumes teachers' existing conception of the teaching and learning process and their pedagogic role within it is flawed (Blease & Cohen 1990). If this is so, then there must be a set of 'superior forms of learning' (Means, 1994), forms of learning that teachers are generally not implementing. Using technology-based approaches would therefore support the integration of the superior forms of learning into teaching. In reality, this approach rests upon reforming curricula and instructional goals and then mobilising technology as a supportive tool (Means, 1994).
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The second remedy is to build ‘teacher-proof learning environments’ (Zhao, 1998). Teacher-proofing also implies the existence of a superior form of learning, however unlike the first remedy, the solution is to embed the specific learning principles into computer applications, which then deliberately and explicitly facilitate those principles regardless of teachers.

The practicality and effectiveness of these remedies has been questioned. Cuban (1986) noted that teachers’ beliefs and practices were very stable and extremely difficult to change. Loveless (1996) agreed and added that when teachers’ beliefs did change, change was incremental. Niederhauser and Stoddart (1994) maintained that the driving force behind teachers’ pedagogy was teachers’ personal perspectives, acquired through a lifetime of experiences. Thus, the pedagogical change required to enact superior forms of learning challenges too many teachers’ current educational philosophies:

If the past is any guide, educators will hardly flock to this message. In their various incarnations, progressive reformers have tried to fundamentally redefine the role of the teacher by emphasising child-centred practices and active learning. Technology experts and software designers now join this parade and, by enlisting computers in the progressive cause, embrace an educational philosophy that the vast majority of teachers have consistently rejected,


The third model does not prescribe a set of superior or inferior principles of learning (Zhao, 1998). Rather, it emphasises the application of information technologies to support a wide range of pedagogical beliefs, from traditional transmission models to constructivist approaches. In this way, teachers are not forced to change their ways to take advantage of the tools. However, teachers are expected to engage in reflective thought and action about their role within the teaching and learning process. By embedding technology within opportunities to learn and explore new ways of teaching, pedagogical change is neither imposed upon, nor shielded from, teachers. Instead, pedagogical change is fostered within the process in which teachers make use of the technology.
2.6.4 Staff Development - Reducing Computer Anxiety

Computer anxiety is a transient condition open to remediation. However, moderation is largely beyond the jurisdiction of the novice, simply because the novice lacks sufficient procedural knowledge (Anderson, 1996). Nonetheless, it is important to reduce computer anxiety because it interferes with learning and cognitive performance (Häkkenin, 1994). Before commencing remediation the reasons for the existence of the fears must first be clarified. This is because extrinsic factors are the basis of computer anxiety (Dusick, 1998) and therefore remediation through increased computer experience alone will not cure computerphobia (Rosen & Maguire, 1990). Knowing the source of the fear, be it perceptions of the equipment, the properties of the software, the situation, the environment or other users, is crucial to establishing the nature of the intervention and so hasten the formation of positive attitudes (Häkkenin, 1994).

Knowles (1990) believed that the main elements to be considered when attempting to correct computer anxiety in adults were self-concept, experience, readiness to learn and time. For Knowles, self-concept was important because it represented the individual’s brush with failure; experience was consequential because of its interrelationship with self-image; readiness was critical because it defined one’s willingness to learn and accept new ideas; while time was threatening because adults believe they need to get it right now. For those undertaking to reduce their computer anxiety, success would depend upon maintaining a high level of self-motivation and a significant degree of independence.

Jay (1981) however, was also of the opinion that group learning would be more likely to reduce computer anxiety. Fisher (1991) regarded group learning superior because of the capacity of the teacher to structure the learning environment and thereby scaffold learning to maintain high levels of self-motivation. According to Fisher, group learning approaches that were humanistic in principle would enable individuals to overcome their computerphobia. In particular, those approaches must enable learners to control their own learning, choose their own goals, accept responsibility for what happened and use teachers as facilitators.

Studies associated with the reduction of computer anxiety in teachers have emphasised both the skills of the trainer and the type of learning environment constructed. Novice teachers feel less intimidated by computer training when trainers maintain a friendly and comfortable atmosphere (Stecher & Solorzano, 1987) and are able to display patience and understanding toward them (Piotrowski, 1992). Furthermore, intimidation declined further when training was undertaken.
voluntarily. Teachers required to undergo training were also positive about the experience, but less so than those who undertook it voluntarily (Stecher & Solorzano, 1987).

Appropriately designed courses reduce computer anxiety and promote positive attitudes towards information technology (Häkkinen, 1994). Of concern to Overbaugh and Reed (1994) was whether or not course content alone or exposure to course content over an extended period promoted a reduction in computer anxiety. In a study of 101 education students completing an eleven-week course, Maurer and Simonson (1993) found computer anxiety actually increased during the first few weeks but reduced substantially in the second half of the course. Maurer and Simonson noted that while the rise was not significant statistically and therefore could have been a random event, it nonetheless questions the effectiveness of short courses in reducing computer anxiety. Maurer and Simonson suggest that such courses may indeed harm the goal of reducing computer anxiety.

Maurer and Simonson also found that achievement was most strongly related to the level of computer anxiety that remained after students completed a course. Given that computer anxiety can be remediated through planned intervention it seems that past feelings are relatively unimportant suggesting that if treated properly the problem of computer anxiety goes away. Furthermore, it appears that hands-on experience is no more a remedy for computer anxiety than one that is more theoretically based. This led Maurer and Simonson to conclude “a lack of knowledge causes higher anxiety, which inhibits hands-on interaction with the computer and in turn reduces the acquisition of knowledge about computers” (p.215).

2.6.5 Staff Development: Limitations

Without ongoing support and training, teachers will employ 21st century technology to 19th century education practices.

Dwyer, 1995

There is little doubt that the education community has been generous in purchasing information technology, but it has generally not been as willing to devote the necessary funding to provide computer training for teachers or to hire computer resource teachers (Barker, 1994; Maddux, 1991; Zammitt, 1992). This is despite the obvious and well-recorded fact that the acquisition of hardware and software is no guarantee that it will be used (Zammitt, 1992; Zhao, 1998). Indeed
the lack of effective training is the single most important reason technology’s potential remains largely unexploited in schools (Maddux, 1991). Throughout the literature the recurring solution for the integration of computers into the classroom is teacher education (Burkholder, 1995; Christensen, 1998; Dupagne & Krendl, 1992; Kearsley & Lynch, 1994; Shermis, 1990; Stoddart & Niederhauser, 1993). In schools where a fair amount of money has been committed to staff development and support, technology is being more effectively integrated (Becker, 1992).

Classroom computer use will not receive a positive reception in schools until teacher preparation improves (Barker, 1994; Woodrow, 1992). Despite this significant numbers of teachers attend few if any computer-based training courses (Zammit, 1992). Often, this is despite calls for more training (Zammit, 1992). This anomaly has to do with teachers undertaking professional development in their own time and consequently could explain why male teachers have a better record for attending computer in-service (Zammit, 1992).

It is possible that the model used to deliver in-service computer training is flawed (Stecher & Solorzano, 1987). This is because the number of committed days are limited and all too often dispersed across the school year. Furthermore, when groups of teachers are involved those groups are generally too large and too heterogeneous to possibly meet different skill and comfort levels. Invariably, teachers are taught about technology and not about how technology connects to their teaching and student learning (Zhao, 1998). Training for teachers with prior computer experience becomes ‘boring’, while those teachers with no prior computer experience complain of being ‘overwhelmed’. Finally, when teachers return to their classrooms, rarely are they offered a chance to practice what they have learnt further predating against teachers making the connection between technology and its educational use.

It is little wonder then that teachers lack self-efficacy with regard to computer expertise derived from formal training experiences (Winnans & Sardo-Brown, 1992). Data collected by Winnans and Sardo-Brown showed teachers ranked in-service lowest from a list of ways to promote teachers’ classroom computer use. Exposure to computers through in-service training does not appear to guarantee the confidence required of teachers to use computers effectively.

Ritchie and Wiburg (1994) provide three reasons why the in-service workshop model promotes teachers’ failure or inability to implement into classrooms what they are exposed to during in-service. These include; “(a) failure to conduct a needs analysis to identify knowledge required by users; (b) presentations limited to factual knowledge which omit higher level thinking strategies;
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and (c) failure to incorporate activities which are relevant to the audience in a collaborative, problem solving approach” (p.148).

Zammitt (1992) believes that many teachers are unwilling to engage in training because they are aware of the time required to become proficient computer users. For those teachers it is a matter of priorities among competing demands. Lee (1997) has recognised that time constraints are usually more severe for women. Fullan, Miles and Anderson (1987) state that the time obstacle is one of the most difficult organisational problems to overcome in the practical implementation of computers.

Issa and Lorentz (1990) argued that attempts at computer integration should not be made on a short-term basis, noting that the link between exposure to computers and diminished teacher anxiety was greatest when teachers had adequate time to overcome their negative attitudinal perceptions. M‘Keown (1990) also recognised the importance of time. When talking of early adopters of technology, M‘Keown noted that these leading edge teachers found the personal time to learn how to use computers. With respect to those that follow, those teachers less excited or even frightened by the technology, M‘Keown believed they needed school time to explore, to become comfortable with and to talk about technology with colleagues. School time, however, is a very expensive commodity as it requires the employment of additional teachers. If such efforts were to succeed in reducing computer anxiety and promoting self-efficacy, one might reasonably expect that the need to allocate school time to promoting computer integration may diminish.

Valdez (1989) has called for a qualitative shift in technology staff development for technology use in education to reach its full potential. Valdez stated that any remodelling must move away from the general one time event, in which little thought was given to ongoing support, to more systematic and integrated activities aimed at developing competence and confidence with the goal of accelerating use. Any remodelling though has to recognise that teachers need long term professional development (Zammitt, 1992). However, the impact of long term programs will depend upon the degree of support teachers receive once they have returned to the classroom (Ingvarson & McKenzie, 1987, cited in Zammitt, 1992). As part of the qualitative shift it is essential to include follow-up support and not leave this to chance.
2.6.6 Staff Development: A Re-conceptualisation

Teachers are the main gatekeepers in allowing educational innovations to diffuse into the classroom. Therefore one of the key factors for effecting an integration of computers in the school curriculum is adequate training of teachers in handling and managing these new tools in their daily practices.


At the heart of the remodelling of technology staff development is strategic planning (Valdez, 1989). For quality to be built into programs a long range perspective must be taken so that the purpose of professional development may thoughtfully evolve. Valdez emphasised the need to consider how and what human and educational factors could be improved through participation in the program.

Strategic planning calls upon designers to fit the program to the participant. By tailoring training to individual need, teachers’ limited time resources are better directed to areas of value and interest to them (Jordan 1993; Lee, 1997; Ritchie & Wiburg, 1994; US Congress, 1995; Zhao, 1998). To achieve this goal the program should begin with an assessment of participants’ stages of concern, learning styles and levels of understanding so as to ensure the total program is targeted at the right level of participant need (Valdez 1989).

An appropriate tool for this purpose is the Concerns-Based Adoption Model by Hall, George and Rutherford (1979, cited in Christensen, 1998). Christensen noted that when teachers engaged in appropriate staff development they advanced on average one full stage toward full technology integration. Furthermore, as a result of that exposure teachers exhibited more positive attitudes towards computers than teachers who received no training.

Once the nature of the participants is known training should be undertaken at a number of levels. Ehley (1992) proposed that teachers acquired computer skills in stages and so another crucial issue in planning was to ensure the sequence was followed in training sessions. The acquisition process according to Ehley is shown in Figure 2.1. Training undertaken in stages caters for teachers at different levels of understanding.
Ehley's five-stage model builds from basic to more complex skills. Ehley too, suggests that an assessment be done to determine the beginning level of each teacher. This provides the trainer with a reasonable starting point, while providing teachers with some say in planning their inservice sessions. Through training, each teacher is assisted to move to a higher level of learning.

Teachers want to know how training will help them personally and professionally (Stecher & Solorzano, 1987). In particular, teachers want to know how integrating computers helps their students (Piotrowski, 1992). In planning programs training should focus on teachers' subject area and grade level (Novak & Knowles, 1991; Stecher & Solorzano, 1987). To maximise classroom computer use teachers need specific classroom implementation strategies and curricular skills. Jordan (1993) recommends that each training session should introduce software applications within instructional contexts, to offer ideas that have immediate applicability to the classroom. Furthermore, that training should occur in situ providing teachers with experience working with school computer equipment.

Jordan (1993) emphasised the imperative of building in teacher comfort. Thus, fellow teachers expert in their field, rather than outsiders unfamiliar with classroom applications, should conduct the training. Such approaches would support the creation of a network of computer using teachers (Becker, 1992). Stecher and Solorzano (1987) experienced considerable success in their study by using teachers to train teachers. On the matter of teacher comfort, Madsen and Sebastiani (1987)
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recommended hands-on training to effectively increase teachers' knowledge of computers, a position supported by Barker (1994). Stecher and Solorzano (1987) noted the provision of written materials during training sessions as a helpful measure. Providing such resources scaffolds for the trainee, freeing them from extensive note taking and allowing more time for exploration.

It may not be possible, however, to engage in one to one training. Planners must be cognisant therefore of the potential limitations of group diversity and group size (Stecher & Solorzano, 1987). Groups have to be small and as homogeneous as possible to make training responsive to the needs of teachers on differing levels, and thereby improve the overall quality of the training. By improving the efficiency of training teachers who already have limited time would see computer-based staff development as a good investment of that scarce resource.

As a guide for planners, Valdez (1989) proposed a three-stage model through which teachers could acquire competencies that would enable them to use technology for educational improvement. During the first stage of awareness building, teachers would tinker and play with software packages within the subject area they were teaching. Heavy messages about curriculum integration and pedagogy are inappropriate at this stage and remain so until participants feel more comfortable with the software and hardware. This is because those teachers most likely to need awareness raising tend to be either sceptical of the value of technology in student learning or lack an understanding of the capability of technology. Trainers need to be comfortable with the chosen software packages and be able to give assistance while valuing participant exploration.

In the second stage, concern switches to adoption, implementation and integration (Valdez, 1989) with participants more concerned with curriculum, instructional design, research findings, and resource availability. Valdez recommends using content personnel who are knowledgeable about how the technology can be integrated into the curriculum during this phase. This is because participants would want trainers who could answer questions on actual issues of implementation dealing with resources, space, time, and acceptable substitutions for existing expectations.

The final phase of the model is concerned with refinement, adaptation and new vision. Valdez (1989) suggests exemplary teachers, instructional designers and visionary people capable of inspiring and stretching participants beyond existing software to exploit their own creativity would be most beneficial. The focus at this stage is upon participants recognising and modifying their own practices to “exploit the potential of technology to enhance knowledge, learning and teaching” (p.38).
Ehley (1992) also proposed a three stage-training model - see Figure 2.2.

![Stages of Training Diagram]

Fig 2.2  A Model of Computer Training Stages

In the ‘Awareness’ stage, the focus is on basic knowledge about computers. In the second stage (‘Development of Skills’), the focus is on the basic operation of the equipment and on the use of applications. Finally, in the last stage (‘Application of Knowledge’), the focus turns to the integration of computers into the content areas (Ehley, 1992). Ehley, in following through her model, reported overall computer use increased, computer anxiety decreased, and the integration of computers into traditional subject areas occurred.

The Ehley (1992) and Valdez (1989) models promote teachers’ acquisition of computer knowledge and skill because training is undertaken over multiple sessions to meet the complex training needs of individuals (Jordan, 1993). By espousing a long-term perspective teachers are able to return to their classrooms to practice before the next training session where they can address problems and then move on to the stage of instruction (Stecher & Solorzano, 1987). To be truly effective, teachers need more practice time to process what they have learned. Follow-up is a crucial aspect in the success of any training model (Jordan, 1993).
2.6.7 School Information Technology Environment

Effective integration of technology in schools is as dependent upon teachers’ actions as it is upon the actions of those who administer schools and the technology within them (Becker, 1993; Ritchie & Wiburg, 1994). For teachers to succeed in their task they must believe that administrators support their efforts. Thus teachers’ perceptions of the commitment to classroom computing within the overall organisational climate of a school is important.

The role of positive leadership in classroom computing across the curriculum has been afforded a high value (Chin & Horton, 1993; Larner & Timberlake, 1995; Mahmood & Hirt, 1992; Ritchie & Wiburg, 1994). Put simply, “principals play a key role in the implementation of microcomputers in school” (Dupagne & Krendl, 1992, p.422). Principals who promote teacher professionalism instilled into teachers the desire to be committed and successful (Chin & Horton, 1993).

Positive leadership is often expressed within a school ethos. McMahon (1990 cited in Mahmood & Hirt, 1992) concluded that general school mentality might be the most prominent factor in determining the implementation of computers in schools. McGee (1987, cited in Mahmood & Hirt, 1992) found the implementation of classroom computing was successful when those responsible for it understood the social context of the school. This proposition was supported by Larner and Timberlake (1995) who commented:

It is how the administrators, exemplary computer knowledge teachers, and other support personnel at the school encourage the rest of the teachers to utilise the equipment they have at their disposal

(p.11.)

The formation of close relationships between administrators, users, experts and new users is fundamental to the successful integration of computers into schools (Becker, 1993; Mahmood & Hirt, 1992). Successful implementation of classroom computing becomes a reality when shared decision making is institutionalised in the life of the school (Ritchie & Wiburg, 1994). Van Dusen and Worthen (1992) concluded that many teachers felt no commitment to the successful integration of technology because as little as 3% of them were likely to be involved in purchase decisions and fewer than 10% ever played a major role in implementation.

There is a need for both top-down and bottom-up commitment for successful technology integration to occur (Ritchie & Wiburg, 1994). In fact, it is only when teachers see their
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administrators using technology that they feel a need to learn themselves (Barker, 1990, cited in Ritchie & Wiburg, 1994). For integration to be successful, administration must:

- Provide and sell a vision to teachers and the school community,
- Obtain resources such as time, knowledge, materials and facilities,
- Provide recognition and encouragement for teachers making the transition to teach with technology, and
- Monitor the reform effort by regularly meeting with teachers.


Within information systems literature it is well recognised that successful implementation of projects is dependent upon careful planning and there is no reason to suspect that this statement does not equally apply to computer integration in schools (Mahmood & Hirt, 1992). Research and practice in schools has shown that technology plans are ineffective unless those plans are tied to school-wide efforts for educational improvement (Ritchie & Wiburg, 1993). Key features of effective plans are centralised planning and decentralised decision making (Martin, 1988, cited in Mahmood & Hirt, 1992).

A well-developed plan provides a powerful support for the effective use of technology (Ritchie & Wiburg, 1993). Plans should address why existing technology has not been utilised; how learning resource management could be improved; who would be responsible for what aspects of the plan in the future; and how the school could evaluate their progress toward technology integration. To convince teachers to adopt a positive attitude and thereby implement the plan requires strategies like: more resources for training and equipment, improved access to resources, encouraging teacher use of computers in and out of school, rewarding and recognising teacher effort, employing computer specialists, establishing goals and objectives, and generally eliminating ‘red tape’.
2.7 Summary

Over the past quarter of a century significant efforts have been undertaken to promote the use of computers in schools. To provide guidance for those efforts the Commonwealth and New South Wales government educational bureaucracies have developed and refined policies to improve access to hardware, promote curriculum development and train and encourage teachers to use computers in teaching and learning. Those policies have led to greater use of information and communications technology across the secondary school curriculum. At issue is whether or not computers are servicing the curriculum at levels that can truly be defined as integration.

Policy development has provided a framework within which integration can take place. Nonetheless, teacher uptake has remained modest. The research on teachers’ use of technology consistently reports under utilisation of computers by teachers. Under utilisation manifests itself in high and low computer using teachers. This would indicate that there are still major barriers to be overcome.

Effort has been expended on describing the differences in teachers’ use of technology as a means of characterising potential barriers. Differences in teachers’ computing experience have been identified as a major characteristic. This is a logical link and in the past significant professional development resources were committed to improving knowledge and skill levels among teachers. However, the link between teachers’ use of technology and teachers’ computing experience is not simply linear.

To develop a more encompassing perspective other teacher aspects have been examined. Those aspects converge upon teacher attitudes and dispositions as underlying teacher intentions to use information technology. From this perspective researchers have been able to identify the nexus between the holding of positive attitudes toward computers, teachers’ preferred pedagogy and classroom use of computers.

Of relevance to this position is the understanding that attitudes are amenable to intervention. This has led some researchers to propose new staff development models aimed at reshaping teacher attitudes to information technology while building knowledge and skill levels. Fundamental to the success of those initiatives is the creation of a school environment that empowers teachers across a spectrum of issues that include information technology.
The success of this improved understanding is yet to be fully tested. What is clear is that teachers have not yet come to grips with the rapidity of change and its impact upon their most scarce resource: time. It is apparent that many teachers wish to remain masters of the knowledge base, an increasingly untenable situation. Hopefully, in encouraging teachers to become lifelong learners, a critical mass will emerge with a perspective that is sympathetic to a paradigm shift based on the integrative classroom use of computers.
Chapter 3

Conduct of Study
CONDUCT OF STUDY

3.1 Introduction

The study sought a quantitative understanding of teachers' intentions to use information technologies across the secondary school curriculum. The purpose for collecting the data was threefold: to identify baseline information about teacher characteristics and dispositions that were considered important determinants of computer use; to explain how those characteristics and dispositions relate to each other and impact upon teachers' classroom usage patterns and; to establish an explanatory model useful in future research.

The methodological process relevant to the study follows. For clarity, the approach taken was divided in four sections.

Section 3.2 explains how the study was conceived. Five sets of factors identified as influencing teachers' intentions to use information technology within a single site case study were chosen as a starting point from which to build a more in-depth exploration of teachers' attitudes toward computers.

Section 3.3 outlines the research design. A model of the methodological approach is provided, firstly to identify each of the five phases and then to itemise each.

Section 3.4 details the conduct of the study. Activity undertaken within each of the five phases is stated along with the outcomes. Important outcomes listed in this section include the key attitudinal constructs, the selection of the sample from the total population, the construction of the survey instrument, the processes associated with data collection and finally an explanation of how the data were to be analysed and the causal model developed.

Section 3.5 explores a range of issues that arose following data collection and before data analysis was undertaken. Three issues that had the potential to impact upon the generalisability of the study are presented. Those issues are response rate, the representativeness of the sample and stratification. The researcher's response to each of the issues is also found in this section.
3.2 How the Study was Conceived

This study utilised previous research conducted by Yakub (1994). In exploring the incentives and barriers to the integration of information technology across the curriculum in one comprehensive Department of School Education secondary school in Western Sydney, Yakub identified five sets of factors believed to be influencing teachers' intentions to use information technology in their teaching within that school. Those factors were:

1. Teacher experiences, motivation, and perceptions of information technology;
2. Teachers' current pedagogical practices;
3. Training, support and collegiality;
4. The centralisation of facilities; and
5. The formulation of policy from an administrative rather than an educative perspective.

Yakub's study concluded that it was generally left to teacher initiative to acquire computing expertise and skills. For most teachers, self-training was often the only path available to knowledge and skill acquisition. As a consequence, high levels of computer anxiety were reported by a majority of teachers.

Compounding this problem was a lack of teachers who could be considered role models for the use of computers in classroom contexts. Apart from those teachers actively engaged in the delivery of Computing Studies and the newly introduced Design and Technology subject, few teachers reported using computers in meaningful ways with students. This was despite the fact that faculty generally believed that the use of computers promoted student learning. Teachers were aware of and accepted that increased use of computers would lead to changes in the teaching learning process, but were critical of the lack of computing resources necessary to institute change. The existence of these barriers was considered to be the primary result of an administration that had not shifted its focus from learning about computers to using computers for learning.

Yakub's case study reinforced other literature, suggesting that a complex interplay of incentives and barriers determine whether or not teachers use computers. Insomuch as the study provided a descriptive picture of the 'how', 'why' and 'what' of teachers' use of computers within one school, the real test remained whether or not the findings could be generalised. The present study sought to explore the generalisability of the findings by using a more extensive sample as well as seeking an in-depth understanding of teachers' intentions to use of information technologies.
3.3 Research Design

3.3.1 Initial Research Issues
Yakub employed a single site Observational Case Study methodology to explore the integration of computers. Implicit within that study was that the site was not noticeably different from typical Department of School Education secondary schools throughout Western Sydney. However such an assumption highlights a major limitation of the case study approach, in that there is no way of knowing how typical the selected case really is, making it rather hazardous to draw any general conclusions or to engage in widespread transfer of the findings.

Yin (1998) recommended several replications of the single site case study to overcome this problem. However, it was considered prohibitive to replicate Yakub’s case study across Western Sydney secondary schools, given the complexity of observational case studies, the concomitant demand for resources and time required to do it. Nonetheless, Stake (1978) regarded single site case studies as having the potential to aid the development of theory and empirically testable hypotheses. It was from this perspective that the current research proceeded.

3.3.2 Conceptualising the Study
A five-phase process was identified as appropriate to seeking information on teachers’ intentions to use information technology in their teaching. Phases one to three set out to ground the factors identified by Yakub in the research literature, and then validate their application in other Western Sydney Department of School Education secondary schools. Phase four focused on data collection, while phase five involved analysis and model development to explain the relationship between teacher characteristics on the one hand and teachers’ intentions to use information technology on the other. Figures 3.1 and 3.2 outline the conceptualisation of the present study.
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Fig 3.1  An Outline of the Methodological Approach
Fig3.2 A Detailed Conceptualisation of the Methodological Approach Taken
3.4 Conduct of the Study

3.4.1 Phase One - Conceptual Grounding

In an attempt to ground the conceptualisation provided by Yakub’s case study and to provide scope for explanation and prediction, a detailed analysis of the literature was undertaken. From that analysis a more global understanding emerged of the form and structure of incentives and barriers that affect teachers’ intentions to use information technology.

The factor Yakub defined as teacher experiences, motivation and perceptions (factor one as listed in 3.2) did not possess a distinct conceptualisation within the literature. Reading suggested that teacher experiences, motivation and perceptions related to computer use were a mixture of attitudes and personal judgment in one’s capacity to use the technology. Thus it was considered judicious to include in the present study measures for attitude and for personal belief in lieu of Yakub’s ‘factor one’.

The literature on teachers’ attitudes towards information technology also presented this construct as somewhat nebulous. In a review of the literature on teachers’ attitudes towards computers, Dupagne and Krendl (1992) identified 20 aspects affecting a teacher’s intention to use computers as part of teaching and learning strategies. To provide focus, Yakub’s conclusion that despite being highly anxious, teachers felt that computer use promoted student learning was taken as a reference point. Thus two separate attitude measures, namely variables related to computer anxiety and relevance of computers as tools for learning were conceptualised and these factors were operationally defined and included in the study.

To sufficiently differentiate a variable for teachers’ judgment of their capacity to use technology, it was considered prudent to focus on an outcome based construct of the notion. To retain the initial context, the variable was operationally defined to focus on the teaching learning process and named computer competence.

Support emerged from the literature for the inclusion of current pedagogical practices, training, support and collegiality; centralisation of facilities; and the formulation of policy from administrative perspectives (factors 2, 3, 4 and 5 as listed in 3.2) as factors influencing teachers’ intentions to use information technology. Yakub’s designations, however, reflected practice in a single school rather than the more generic descriptions of the literature. Hence, it was considered more appropriate to use and define expansive terms like pedagogical practices, staff development,
access to resources, and policy formulation within the present study. The pedagogical practices variable was also conceived to be an outcome-based construct and it too was operationally defined to focus on the teaching-learning process. In total, then, the present study used seven constructs - three attitude variables and four perceptions of practice. Each construct is listed and defined in Table 3.1.

Table 3.1: Definitions of Key Constructs affecting Teachers' Intentions to Use Information Technology

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Anxiety</td>
<td>A measure of a teacher's apprehension towards computers.</td>
</tr>
<tr>
<td>Computer Competence</td>
<td>An assessment by teachers of their capacity to use a computer.</td>
</tr>
<tr>
<td>Relevance of Computers</td>
<td>A measure of teacher mindfulness of the suitability of computers as tools for learning.</td>
</tr>
<tr>
<td>Pedagogical Practices</td>
<td>An assessment of the extent to which teachers used, or were disposed to use computers in their classrooms.</td>
</tr>
<tr>
<td>Staff Development</td>
<td>A reflection of teachers’ commitment to engage in formal and informal computer related training.</td>
</tr>
<tr>
<td>Access to Resources</td>
<td>An appraisal by teachers of their beliefs in the investment necessary to operate computers across the curriculum.</td>
</tr>
<tr>
<td>Policy Formulation</td>
<td>An appraisal by teachers of their understanding of the organisational environment for integrating computers across the curriculum.</td>
</tr>
</tbody>
</table>

3.4.2 Phase Two - The Sample

The Target Population

The focal group for the study comprised teachers in Department of School Education secondary schools located in Western Sydney. The boundaries of the geographical construct of Western Sydney are depicted in Figure 3.3.
Figure 3.3  The locality of Western Sydney

Western Sydney is a part of Greater Sydney. It stretches from the city of Parramatta in the east to the city of Penrith and the foothills of the Blue Mountains in the west and from the hamlet of Wiseman’s Ferry on the Hawkesbury River in the northwest to the satellite city of Campbelltown in the southwest. It is a diverse area in which most of Sydney’s post 1970s growth has taken place, a trend likely to continue. Because of this diversity, it was the researcher’s assumption that a sample of secondary schools from this part of the state would provide a fairly representative picture of the majority of NSW Department of School Education secondary schools.

The decision to focus on secondary teachers in Western Sydney was made largely on instrumental grounds. Firstly, the University of Western Sydney, Nepean, services this area of Sydney: the researcher’s place of employment. By limiting schools in this manner, the practical constraints of
time and travel associated with establishing contact, arranging meetings, administering the instrument and collecting completed surveys could be kept manageable and within the resources available. There was the additional benefit that some recommendations arising from the study could inform the University's own initiatives in teacher education.

Secondly, at the time access to teachers was sought from the employer, the Department of School Education was divided into ten administrative regions. Two of those regions, Metropolitan West (Met. West) and Metropolitan South West (Met. South West), were responsible for secondary schools in Western Sydney. Met. West Region administered schools in the area from Auburn, just east of Parramatta, west to the township of Katoomba, located in the Blue Mountains, and to the north west of Parramatta towards the hamlet of Wiseman's Ferry. Met. South West Region administered schools in the area from Bankstown to Fairfield, and then south through Liverpool to Campbelltown. Met. West schools were targeted to facilitate the researcher's gaining of ethical and administrative approval to conduct the study within a reasonable time frame.

A Stratified Sample
Secondary schools operated by the Department of School Education have been designated either Comprehensive or Selective over the period dating back to the introduction of the Wyndham Scheme in the early 1960s. As part of a commitment to greater diversity, a third tier of secondary school, labelled generically as the Specialist High School, was introduced in 1990. Among the list of comprehensive high schools transformed into specialist high schools in 1990 were 24 schools designated Technology High Schools, set up specifically to support student-centred learning in technology rich environments (NSW Ministry of Education and Youth Affairs, 1989).

When planning for the study began, Comprehensive, Selective and Technology High Schools had entered their sixth year of operation under the reforms implemented in 1990. Six years in the operation of a secondary school in NSW represents a generation of students. It would therefore seem reasonable that all the curriculum changes necessary to implement the aims of Technology High Schools would have been operational. It was decided that the present study needed to include Comprehensive, Selective and Technology High Schools within the sample to examine whether or not school type in any way affected the use and integration of computers in schools.
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With an emphasis on contrasting school types, the sample was drawn to include examples of each type of school - Technology High Schools, Selective High Schools, and Comprehensive High Schools. The stratification could be maintained by selecting equal numbers of schools from the three pools, although it was recognised that any attempt to generalise to the population of secondary schools would need weighting in proportion to strata size. However, more interest centred on the contrasts across school types.

The introduction of the stratification concept did impose a limitation upon the sample, in that the Met. West Region population of Selective High Schools and Technology High Schools was (and remains) eight, four of each. By setting the sample at six schools (a reasonable number given the intention was to survey all teachers within the schools), it was possible to include two Selective High Schools and two Technology High Schools without exhausting the Met. West Region population, and hence allow for replacement should a school decline to participate.

Targeted Schools

All 54 Met. West, Department of School Education secondary schools were identified and pooled according to status as Comprehensive, Selective or Technology High Schools. Six schools, two from each pool, were selected at random. Selected schools were located on a map of Western Sydney and found to reflect geographic and socio-economic diversity in Western Sydney.

Unfortunately, the Principal of one of the selective high schools declined the invitation to participate. This necessitated the selection of a replacement, which was chosen randomly from the remaining schools in the pool.

The socio-economic status of the localities in which the randomly selected schools are situated was noted, to account for the regional diversity of Western Sydney. Regional diversity may have been a limiting factor on the generalisability of this study. Information on socio-economic status is arranged in Table 3.2.
Table 3.2  Sample Schools’ Locality and Socio Economic Status

<table>
<thead>
<tr>
<th>School Number</th>
<th>School Type</th>
<th>Locality within Met West Region</th>
<th>Socio Economic Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Comprehensive</td>
<td>West</td>
<td>Upper Mixed</td>
</tr>
<tr>
<td>2</td>
<td>Comprehensive</td>
<td>Centre West</td>
<td>Lower</td>
</tr>
<tr>
<td>3</td>
<td>Technology</td>
<td>Centre West</td>
<td>Lower Mixed</td>
</tr>
<tr>
<td>4</td>
<td>Technology</td>
<td>East</td>
<td>Mixed</td>
</tr>
<tr>
<td>5</td>
<td>Selective</td>
<td>West</td>
<td>Mixed</td>
</tr>
<tr>
<td>6</td>
<td>Selective</td>
<td>Nth Nth West</td>
<td>Upper</td>
</tr>
</tbody>
</table>

3.4.3 Phase Three - Survey Instrument

Item Selection and Construction

A cross sectional survey was chosen as the most appropriate type of instrument for the collection of data about how teachers were or intended to integrate computers into teaching and learning (Borg & Gall, 1989). This type of instrument was favoured for five reasons. Firstly, a cross sectional survey enables standardised information to be collected from a predetermined population. Secondly, that information is collected at one point in time. Thirdly, many more questions may be asked in the allotted time. Fourthly, respondents remain anonymous and hopefully more honest in their responses. Finally, analysis is open to a variety of methods (Borg & Gall, 1989; Larner & Timberlake, 1995).

The literature on the integration of computers in education contains many examples of questionnaires as a means of data collection (Gardner, Discenza & Dukes, 1993; Kluever, Lam, Hoffman, Green & Swearingen, 1994; Massoud, 1991; Robertson, Calder, Fung, Jones & O’Shea, 1995; Winnans & Sardo-Brown, 1992; Woodrow, 1991). Selected items from the literature provided a pool from which the researcher operationally defined the seven scales (see Table 3.1), which formed the conceptual basis of the study.

To add meaning to some of those items, wording was altered to reflect circumstances within Western Sydney. Where no suitable item could be identified in the literature, a new item was constructed. In this way, the questionnaire was designed to ensure content validity for the dimensions as defined above.
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In summary, the questionnaire was divided into two sections. Section one sought information about gender, age, teaching experience, key learning area of teaching, teaching status, computing skill, computer availability, major use of computers and the teacher’s training. These background variables served two functions. In the first place, they allowed detailed description of the sample. Secondly, where teacher opinions, attitudes or intentions differed markedly, the background variables offered scope to “explain” such differences.

Section two sought information on teachers’ intentions to use information technology across the curriculum in Western Sydney high schools. As noted earlier, seven global constructs, grounded in the literature, were identified as influencing teachers’ intentions to use computers and those seven variables were to form the key predictor areas in the study. Section two contained questions related to the seven global scales, subdivided into:

- Computer Anxiety (10 questions);
- Computer Competence (9 questions);
- Relevance of Computers (10 questions);
- Pedagogical Practices (15 questions);
- Staff Development (10 questions);
- Access to Resources (11 questions); and
- Policy Formulation (15 questions).

Each question required a response on a four-point Likert scale (1 = strongly disagree to 4 = strongly agree). A four-point Likert scale was chosen because the spread across four potential responses was considered sufficient for people to make a judgment. For those unable to make a valid judgment a separate fifth not relevant response was included.

Pretest of Survey

Fifteen practising teachers enrolled in their first year of a Master of Education program in Educational Computing and taught by the researcher were invited to complete the instrument and comment upon it. The group of predominantly secondary teachers were themselves teachers in Western Sydney Department of School Education schools.
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Each member of the group was given a copy of the survey printed on one half of an A4 page with the other half blank for comment. Written comments identified for the researcher a number of grammatical errors. Those errors were corrected.

3.4.4 Phase Four - Data Collection Process
A letter of introduction (Appendix 1) was sent to each Principal of the randomly selected schools. The letter stated that the researcher had ethical approval from the University of Western Sydney, and the Department of School Education to conduct the study and that the purpose of the correspondence was to seek permission to undertake data collection within the school. The ethics clearance letters were included. The letter of introduction also contained a rationale for conducting the research, which was presented in a way which contextualised the study for the reader. The letter concluded by indicating that a follow up telephone call would be made. Telephone contact was made, at which point a commitment to participate was obtained from each Principal.

Approval was also sought for the researcher to work with a liaison person in the school. In each instance, the Principal nominated the school’s Computing Coordinator and contact was made to solicit assistance in administering the survey. All coordinators indicated they were willing to act on behalf of the researcher and arrangements were made to visit each site to discuss requirements.

Discussions with each coordinator began with negotiations for a suitable time for the researcher to speak to staff. Schools 1, 3 and 4 (see Table 3.2) were able to provide some time during a staff meeting for this to happen. The remaining three schools had conducted a staff meeting prior to the researcher making contact and had no plans to schedule another. Hence it was decided to forego meeting staff personally in those schools.

Each coordinator agreed to distribute surveys through the school’s Computer Education Committee. This meant that instead of personally having to circulate approximately 70 surveys, the coordinator could delegate this responsibility across a group. It was agreed that teachers would be given one week to complete and return surveys with committee members acting as distribution and collection points. Completed surveys were collected one week after the agreed time so that if late responses were received, these could be included. Information relating to response rates to the questionnaire is presented in Section 3.5.
3.4.5 Phase 5 - Analysis and Model Development

The current study aimed, in the first instance, to investigate the form and structure of incentives and barriers that influence the intentions of teachers to use information technology in teaching and learning. To this end, teachers from a range of schools implementing to varying degrees the integration of computers in their classrooms were studied ex post facto using a questionnaire designed by the researcher, but incorporating many items developed and tested in previous research. According to Borg and Gall (1989), the principal advantage of this form of research is that it provides information on the degree of relationship between the variables being studied.

Simple relationships based on causal comparative and correlation techniques have limitations with respect to the establishment of causality. To overcome those limitations the key variables were analysed using multivariate analysis with the aim of developing a predictive model to explain how incentives and barriers determined teachers' use or intended use of information technology.

Stage 1 Initial Analysis – Identifying Relationships

The survey instrument was designed to be number coded. Data were initially entered into a Microsoft Excel 5.0a for Power Macintosh spreadsheet as a check on the accuracy of the data entry process before export to the statistical package SPSS 6.1 for Power Macintosh.

Both positively and negatively stated items were included in Section 2 of the instrument to minimise the possibility of response bias being introduced into the study (Borg & Gall, 1989). By including both positively and negatively stated items, respondents do not feel that the researcher is attempting to unduly influence their perceptions. The inclusion of positively and negatively stated items also reduces the effect of a scale discriminating simply through response set where some respondents consistently tick all high or low options. Negatively stated items were re-coded to reflect positive statements and this was done using the computer software package, SPSS.

Prior to examining for relationships, data reduction techniques were applied to item sets used to measure the seven global constructs, operationally defined as influences upon teachers' intentions to use information technology – see Table 3.1. Of particular concern was whether or not selected item sets used to generate scales could be shown to measure the hypothetical constructs that each ostensibly represented (Borg & Gall, 1989). To this end, the determination of construct validity became a necessary prior condition to relationship identification.
Initially, all items based on the researcher’s conceptualisation of each global construct were entered into correlation matrices. Correlation matrices were computed to illustrate the strength of relationship between every possible pair of variables within each set. Items that correlated poorly with other items in the set were excluded from further analysis thereby simplifying the application of other data reduction processes.

The remaining items in each set were then subjected to factor analytic techniques. Factor analysis provides an empirical basis for testing the construct validity of combining moderately or highly correlated items into a single factor to express a common element cutting across the combined variables (Borg & Gall, 1989). Principal components analysis was undertaken to determine whether or not more than one set of items in the remaining pool could be shown to measure specific aspects of the operationally defined constructs.

Principal component analysis was guided by the application of three criteria. The first criterion involved the application of the Kaiser-Guttman rule that “the number of factors to be extracted should equal the number of factors having an eigenvalue (variance) greater than 1.0” (ACITS, 1995, p4). The Kaiser-Guttman rule provides insight into the maximum number of factors that can be extracted from a pool of items using factor analytic techniques. Secondly, when applicable, a variimax rotation model was applied. Varimax rotation simplifies the interpretation of latent variables by minimising the effect of split loadings, should they emerge. Varimax rotation produces an orthogonal solution to delineate “pure factors” or non-overlapping constructs. The choice of an orthogonal solution made the application of the final criterion “theoretical meaningfulness” much easier, for whatever factors are extracted, ultimately each factor extracted must be open to valid and defensible interpretation.

Finally, before accepting aggregated items as factors, the internal consistency reliability of the derived variable was determined. Internal consistency reliability in the form of Cronbach’s Coefficient Alpha (α) is the type reported in this thesis. Cronbach’s Coefficient Alpha is used whenever data contains non-dichotomous elements (Borg & Gall, 1989; Tuckman, 1988).

Internal consistency reliability refers to the ability of a set of questions to accurately measure a construct. Internal consistency reliabilities vary from a low of 0 to a high of 1.0 and represent the proportion of the variance in the respondents’ scores that are attributable to true differences on the psychological construct (DeVellis, 1991). Guidelines for acceptable reliabilities for research instrument scales, proposed by DeVellis were used in this thesis and are displayed in Table 3.3.
Table 3.3 Guidelines for Internal Consistency Reliabilities for Research Instrument Scales

<table>
<thead>
<tr>
<th>Cronbach's Alpha Coefficient</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>below .60</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>between .60 and .65</td>
<td>Undesirable</td>
</tr>
<tr>
<td>between .65 and .70</td>
<td>Minimally acceptable</td>
</tr>
<tr>
<td>between .70 and .80</td>
<td>Respectable</td>
</tr>
<tr>
<td>between .80 and .95</td>
<td>Very Good</td>
</tr>
<tr>
<td>above .95</td>
<td>Consider shortening the scale</td>
</tr>
</tbody>
</table>

(after DeVellis, 1991, p.85)

SPSS was then used to calculate frequency distributions, measures of central tendency and measures of dispersion. The value of such statistics is in their capacity to summarise the data set (Borg & Gall, 1989). This information allowed an examination of the representativeness of the sample as well as providing a description of the attitudes, opinions and intentions of teachers.

Stage 2 Multivariate Analysis - The Causal Model

To overcome the inherent limitations of relationship studies, multivariate path analysis was considered an appropriate means for testing the causal links between the scales as initially conceived and teachers' intended use of computers in classrooms. Path analysis was chosen before other predictive multivariate models of analysis because it was considered to be more powerful.

A number of hypotheses were developed following the initial analysis, drawing together the relationships identified in Stage one. Data relevant to the hypotheses and coded in SPSS were exported to the statistical package Eqs 5.1 for Macintosh for further analysis.

The hypotheses developed for testing treated attitudes that were outcomes based as predilections for use. This meant that relationships between attitudes toward computers and the predilections - pedagogical practices and computer competence - were relevant intermediate steps requiring analysis.

The hypotheses, the causal model and discussion of the model are contained in Chapter 6.
3.5 Issues Arising from Data Analysis

3.5.1 Response Rates

An overall response rate of 37% was achieved across the sample, with 150 of the 407 surveys distributed being returned. Tables 3.4 and 3.5 provide details of the response rates for each school and each school type respectively.

Table 3.4 Response Rates Across the Six Schools

<table>
<thead>
<tr>
<th>School Number</th>
<th>Responses</th>
<th>Teachers Surveyed</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26</td>
<td>82</td>
<td>31.7%</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>75</td>
<td>52.0%</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>65</td>
<td>44.6%</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>52</td>
<td>19.2%</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>61</td>
<td>24.6%</td>
</tr>
<tr>
<td>6</td>
<td>28</td>
<td>72</td>
<td>38.9%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>150</td>
<td>407</td>
<td>36.9%</td>
</tr>
</tbody>
</table>

Table 3.5 Response Rates by School Type

<table>
<thead>
<tr>
<th>School Type</th>
<th>Responses</th>
<th>Teachers Surveyed</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive</td>
<td>65</td>
<td>157</td>
<td>41.4%</td>
</tr>
<tr>
<td>Technology</td>
<td>39</td>
<td>117</td>
<td>33.3%</td>
</tr>
<tr>
<td>Selective</td>
<td>43</td>
<td>133</td>
<td>32.3%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>150</td>
<td>407</td>
<td>36.9%</td>
</tr>
</tbody>
</table>

The response rate of 37% was lower than expected. However, Dinham and Scott (1996) reported a similar response rate (38%), when studying teacher motivation, satisfaction and health issues across Western Sydney. In that study, undertaken just prior to the current study, the researchers noted their response rate was within a range (30% to 40%) that appeared to be the norm for response rates from teachers working in Western Sydney schools.

Even so, two aspects of the study appeared to have contributed to lower than expected response rates. Firstly, devolution of responsibility for the distribution and collection of surveys meant that
the Computing Coordinator and the Computer Committee in each school, given the other demands on their time, may not have been as diligent in their efforts to retrieve questionnaires as the researcher would have himself. It was felt at the time that this method of coordination would spread the load and only marginally add to the already busy schedule of most teachers. However, it did unnecessarily fragment the distribution and collection process and could therefore have had a detrimental impact on response rates.

Secondly, the provision of an extended completion period may have been counter-productive. The extended period (one week) over which the survey could be completed was provided on the assumption that late in the school year, teachers were busy and so may have difficulty finding time to complete a survey. In reality, extra time to complete and return the survey provided teachers with time in which the survey could be lost, misplaced, or accorded a lower priority.

Those aspects appeared to have had the greatest impact on schools 4 and 5. In discussions with Computing Coordinators indicated that teachers were heavily committed to activities peculiar to the time the survey was issued. Those discussions revealed that neither Coordinator utilised the computer committee to aid the distribution and collection process. A cursory glance of the 10 surveys from school 4 identified three that contained the comment, "what computer committee" beneath question 6 of the Policy Formulation section. With this information in mind, the Coordinator at school 5 was also asked about the role of the Computer Committee. Both Coordinators explained that their school's Computer Committee was at best ad hoc, and rarely met. In their opinion, to ask members to perform additional functions would have been impossible, thereby leaving them with the full responsibility for the distribution and collection of surveys.

In the case of school 4, an additional aspect contributed to the low response rate, the lowest of all six schools. Prior to permission being granted by the Principal, school 4 was involved in a rather lengthy Quality Assurance Audit. The researcher was unaware of this until meeting with teachers. At that meeting, a number of teachers expressed concern that their colleagues were exhausted due to their commitment to the audit and for them the survey was another imposition on top of what had been an intensive process for many.

An important question for the study was whether the low response rate in some schools introduced bias to the sample. Might the returned questionnaires have come from particular faculties or from staff with a higher commitment to the use of computers in schools? Hence it was decided to extend the sample to a seventh school, this time with active researcher involvement in data...
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collection, to see if a higher response rate could be obtained, and then to compare the data from
the additional school with those from the previous six.

As data collection was finalised at the end of the 1995 school year, nothing could be done until
1996. Approval to extend coverage to other schools was initiated. However, restructuring within
the Department of School Education posed a problem. Early in 1996, the 10 regions were
abolished, along with the Regional Research Committee. Interim rules were established with the
effect that research approval to work in more than one school had to be obtained from a central
research committee, while research within one school was at the discretion of the school principal.
After consultation, it was stated that access to schools in the former Met. West Region would
require central research committee approval, but a school outside of the region would be deemed
research within a single site. Therefore, it was considered expedient to select at random one
additional school, this time within the former Met. South West Region.

The appropriate steps of phases two and four were repeated. Schools in the former Met. South
West Region were identified and one selected at random. School 7 was selected and the Principal
approached for approval, which was gained. School 7 can be described as a comprehensive high
school that services one rapidly growing area of the satellite city of Campbelltown (see Figure
3.1). The school was in its 12th year of operation at the time of the survey. Following approval,
the researcher liaised closely with both the Computing Coordinator and the School’s Leading
Teacher to ensure a higher response rate, as depicted in Table 3.6.

<table>
<thead>
<tr>
<th></th>
<th>No. of Responses</th>
<th>No. of Teachers</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools 1 - 6</td>
<td>150</td>
<td>407</td>
<td>36.9%</td>
</tr>
<tr>
<td>School  7</td>
<td>61</td>
<td>74</td>
<td>82.4%</td>
</tr>
<tr>
<td>Total all 7 Schools</td>
<td>211</td>
<td>481</td>
<td>43.9%</td>
</tr>
<tr>
<td>Total useable</td>
<td>206</td>
<td>481</td>
<td>42.8%</td>
</tr>
</tbody>
</table>

An analysis of respondents completed surveys from school 7 revealed that five ignored or were
unable to finish a significant proportion of items in Section 2. Data from those teachers were not
used in the study. Thus the final count of useable surveys was 206 or 42.8% of the surveys
distributed.
3.5.2 The Representativeness of the Sample

The lower than expected response rate necessitated a check on the representativeness of respondents compared with information already known about the population of teachers in Department of School Education secondary schools in Western Sydney. That process is reported on below.

Teacher Gender

Teachers at each of the seven schools were asked to indicate their gender. Of the 206 teachers who responded, 204 stated their gender. The sample comprised 53% female teachers with the range across the schools varying from 69% to 33%. This compares closely with the state wide teaching population in Department of School Education secondary schools for 1994 in which the percentage of female teachers was 51% (Baumgart, 1995).

Teacher Age

Teachers were asked to report their age across seven bands. In the Staffing Review of New South Wales Public Schools, Baumgart (1995) described the average age of Department of School Education school teachers (K-12) as being '44 years of age and statistically getting ten months older each year' (p7). The modal category (41-45yrs) in the present study is consistent with Baumgart's statement and hence on this variable the sample is fairly representative of the population.

Figure 3.4 displays the age distribution of the sample. It is evident from the data that female teachers were somewhat younger than are their male colleagues, a situation consistent with data collected by Dinham and Scott (1996) in their study of teachers in Western Sydney. Furthermore, the distribution of female teachers was bimodal, perhaps reflecting a pattern of leave consistent with family commitments.
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![Age Distribution of Teachers by Gender](image)

Figure 3.4 Age Distribution of Teachers by Gender

The sample was over represented by younger females and under represented by older females, when compared with statewide data. To clarify the situation, the researcher again spoke with Computing Coordinators. In schools 2, 3 and 7 there were more female than male teachers and this was reflected in response rates. As to why females were younger in these schools, Coordinators stated that their school had higher than average staff turnover with few teachers (willingly) transferring in. Being large schools, high turnover rates translated into more vacancies, filled by first appointment teachers who more and more were young women.

On the other hand, in schools 1, 4, 5 and 6 male teachers slightly outnumbered female teachers and this too, was reflected in response rates. However, the females who responded tended to be older than was the case for schools 2, 3 and 7. Computing Coordinators agreed that their school had higher staff retention rates, and this was reflected in teachers’ age in those schools. When vacancies arose, those vacancy were invariably filled by transfer rather than first appointment.

It would seem that in those parts of Western Sydney experiencing population growth or servicing lower socio-economic communities, there is greater opportunity for younger people, especially women, to gain employment as teachers. On the other hand, in those areas where the population is drawn from higher socio-economic groups or the school possesses unique characteristics, there is a tendency for schools to retain teachers and in particular males and older females.
Teaching Experience

Data on teaching experience within the sample is shown in Table 3.7. On average, teachers had between 11 and 15 years of teaching experience. Data from Dinham and Scott (1996) established that Western Sydney teachers had a mean length of service of 14.5 years, a figure consistent with the data collected. Some 73 percent of teachers in the current study reported they had been teaching no more than 20 years. In fact, 40 percent of the total sample of teachers had fewer than 10 years teaching experience.

Table 3.7 The Experience of Teachers by School Type

<table>
<thead>
<tr>
<th>Teaching Experience in Years</th>
<th>Comp. (%)</th>
<th>School Type</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tech. (%)</td>
<td>Selective (%)</td>
<td></td>
</tr>
<tr>
<td>≤ 5 yrs</td>
<td>31 (25)</td>
<td>10 (26)</td>
<td>6 (14)</td>
</tr>
<tr>
<td>6-10 yrs</td>
<td>28 (23)</td>
<td>4 (10)</td>
<td>3 (7)</td>
</tr>
<tr>
<td>11-15 yrs</td>
<td>20 (16)</td>
<td>8 (21)</td>
<td>5 (12)</td>
</tr>
<tr>
<td>16-20 yrs</td>
<td>18 (15)</td>
<td>5 (13)</td>
<td>11 (26)</td>
</tr>
<tr>
<td>21-25 yrs</td>
<td>15 (12)</td>
<td>5 (13)</td>
<td>7 (16)</td>
</tr>
<tr>
<td>&gt; 25 yrs</td>
<td>10 (8)</td>
<td>7 (18)</td>
<td>11 (26)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>122</td>
<td>39</td>
<td>43</td>
</tr>
</tbody>
</table>

A breakdown of teaching experience by school type indicates comprehensive schools are characterised by a younger teaching force, while there was a strong tendency for more experienced teachers to be located in selective schools and to a lesser extent in technology high schools ($\chi^2=19.7; df=10; p=0.03$). Given intra-regional differences this pattern would not be unexpected.
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Key Learning Area

Teachers from all KLAs responded to the survey. In the case of Special Education teachers, no specific category was provided in the survey because it was assumed those teachers would opt for a core area. Interestingly, those teachers took the opportunity to indicate that Special Education was their major teaching responsibility. Responses are summarised in Table 3.8.

Table 3.8: Key Learning Area by Teaching Position

<table>
<thead>
<tr>
<th>KLA / Area of Responsibility</th>
<th>Classroom Teacher</th>
<th>Executive Teacher</th>
<th>Total Frequency</th>
<th>Total Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>25</td>
<td>4</td>
<td>29</td>
<td>14.5</td>
</tr>
<tr>
<td>Mathematics</td>
<td>24</td>
<td>3</td>
<td>27</td>
<td>13.5</td>
</tr>
<tr>
<td>Science</td>
<td>21</td>
<td>5</td>
<td>26</td>
<td>13.0</td>
</tr>
<tr>
<td>HSIE</td>
<td>20</td>
<td>6</td>
<td>26</td>
<td>13.0</td>
</tr>
<tr>
<td>LOTE</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>3.5</td>
</tr>
<tr>
<td>PDHPE</td>
<td>10</td>
<td>4</td>
<td>14</td>
<td>7.0</td>
</tr>
<tr>
<td>TAS</td>
<td>33</td>
<td>8</td>
<td>41</td>
<td>20.5</td>
</tr>
<tr>
<td>C &amp; PA</td>
<td>12</td>
<td>6</td>
<td>18</td>
<td>9.0</td>
</tr>
<tr>
<td>Special Ed</td>
<td>10</td>
<td>2</td>
<td>12</td>
<td>6.0</td>
</tr>
<tr>
<td>Not Specified</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>168</strong></td>
<td><strong>38</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The high numbers of teachers who labelled their KLA as English, Mathematics, Science or HSIE (Human Society & Its Environment) is indicative of the predominance of subjects taught from those KLAs within secondary schools. Similarly, the lower numbers for LOTE (Languages Other Than English), PDHPE (Personal Development, Health & Physical Education) and C&PA (Creative & Performing Arts) are characteristic of lower teacher numbers in secondary schools across those KLAs. Two of the five teachers who did not respond to this question were Librarians.

The solid participation (20.5% or 41 teachers) of Technological and Applied Studies (TAS) teachers within the study was not anticipated. If numbers reflected the population, TAS teachers would account for a proportion of responses between those for the HSIE and C&PA KLAs. The comparative over representation of TAS teachers however does not appear to be accidental, but rather the result of three discrete, yet interrelated events.
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Firstly, the focus of the study, the integration of computers across the secondary school curriculum, intersected with the responsibility of the TAS KLA for the delivery of Computing subjects. A study that considers the role of computers within the secondary school curriculum is more likely to attract those teachers with a professional involvement with computers. This professional involvement includes the delivery of Computing Studies as well as the mandated 50 hours of computing within the compulsory 200 hour Design and Technology subject.

Secondly, the introduction of KLAs saw teachers who previously taught Home Economics, Industrial Arts, and Agriculture now formed the TAS KLA. In addition, teachers who previously would have labelled themselves by initial training as Mathematics or Science teachers, but who now taught significant loads in Computing Studies are also part of this KLA. Thus the number of teachers who may potentially be labelled as TAS was somewhat larger than initially thought.

Finally, in each of the seven schools, the Principal assigned the Computing Coordinator as a contact person. Through informal discussions with these people, the researcher was able to identify six of the seven as a TAS teacher. It would be a reasonable assumption that this situation also prompted a greater response from teachers within the TAS KLA.

Overall, the sample did exhibit the major characteristics of the population of teachers in Department of School Education secondary schools in Western Sydney with the exception that teachers from the TAS KLA were somewhat over represented. This aspect needs to be considered when findings are interpreted.

Teaching Position
The majority of surveyed teachers were classroom teaching (75%, N=206). Ten responded (5%) to the other category indicating they were a Year Coordinator or an Advanced Skills Teacher (AST). While important, these positions carry financial incentive to complete administrative tasks with no reduction in face to face teaching load. Hence it would not be unreasonable for this group to be added to the pool that identified classroom teaching as their major responsibility. Thus, eight out of ten teachers in the sample could be considered to be classroom teachers, and the ratio of eight to two would be fairly indicative of the average relationship between classroom teachers and members of school executive across all Department of School Education secondary schools.
3.5.3 Stratification

An original goal of the study was to examine differences in the integration of computers across diverse school types. Lower than expected response rates from teachers working within one Technology high school and one Selective high school reduced the sample size within those school types limiting the potential for meaningful outcomes. Given the overall magnitude of the data collected this aspect of the study was not pursued.

3.6 Concluding Comment

The study sought a quantitative understanding of teachers’ intentions to use information technologies across the secondary school curriculum. Factors considered as influences upon teachers’ intentions to use information technologies were identified and these formed the conceptual basis for the development of a survey instrument.

A stratified sample of six Western Sydney, New South Wales Department of School Education secondary schools was identified and data were collected from teachers in those schools. However, initial response rates were considered poor and so a further site was selected and with greater researcher involvement additional data were collected. An examination of the representativeness of all data collected was undertaken. From that analysis three issues were noted. Firstly, the numbers of female teachers who responded matched closely the gender balance in statewide data though more younger and fewer older female teachers were represented in the sample than was the case in statewide data. Secondly, more Technological and Applied Studies teachers responded than was initially expected. Reasons for greater TAS teacher involvement were discussed. Finally, with lower than expected response rates from teachers in Technology and Selective high schools stratification was not pursued.
Chapter 4

Scale Construction
4.1. Introduction

Chapter Four contains a detailed examination of the process used to extract attitude and outcomes scales from the data collected. Those scales formed a major component of the study.

The study sought a quantitative explanation of teachers’ intentions to use information technology across the secondary school curriculum. Five factors, identified in a single site case study by Yakub (1994), were chosen as a starting point. Following a conceptual grounding of those factors, seven global constructs emerged from a literature review. Those global constructs were operationally defined and clusters of questions based on dimensions within the constructs were included in a survey instrument. Data were then collected, to which a two-part data reduction process, outlined in Section 3.4.5, was applied to each of the global constructs. Some thirteen factors or scales were identified.

As factors emerged in the data reduction process, discussion of the meaning of each was included in an effort to provide both empirical and theoretical support for the scales.

4.2. Computer Anxiety

Computer anxiety was operationally defined as a ‘measure of a teacher’s apprehension towards computers’ - see Table 3.1. Respondents were asked to consider ten assertions as a basis for determining anxiety associated with computers. The ten statements were drawn from a larger pool, consisting of items identified in the literature as reflecting an individual’s apprehension towards computers - see Appendix 4 for the ten assertions. The dimensions included a fear of the unknown, the ability to conceptualise uses and adequacy when interacting with computers.

The chosen set represented the researcher’s initial conception of the operational definition of computer anxiety. To test the construct validity of this interpretation, data were subjected to the two-part data reduction process outlined in Section 3.4.5. Table 4.1 displays the correlation matrix used to screen computer anxiety items for inclusion in a factor analysis.
Table 4.1 Computer Anxiety Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Computer Anxiety Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>.36*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.10</td>
<td>.40*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.06</td>
<td>.26*</td>
<td>.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.38*</td>
<td>.49*</td>
<td>.35*</td>
<td>.26*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.31*</td>
<td>.26*</td>
<td>.23*</td>
<td>.16</td>
<td>.49*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.33*</td>
<td>.42*</td>
<td>.47*</td>
<td>.14</td>
<td>.55*</td>
<td>.50*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.34*</td>
<td>.36*</td>
<td>.26*</td>
<td>.25*</td>
<td>.38*</td>
<td>.32*</td>
<td>.36*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.33*</td>
<td>.40*</td>
<td>.38*</td>
<td>.12</td>
<td>.33*</td>
<td>.26*</td>
<td>.52*</td>
<td>.43*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>.16</td>
<td>.27*</td>
<td>.11</td>
<td>.26*</td>
<td>.18*</td>
<td>.06</td>
<td>.18</td>
<td>.28*</td>
<td>.28*</td>
<td></td>
</tr>
</tbody>
</table>

* p<0.001

Computer anxiety items four and ten correlated least with other pool items and were rejected - see Table 4.1. Item four related to interaction with computers, while item ten reflected an aspect of fear of the unknown. Principal Components Analysis including a varimax rotation of the eight remaining computer anxiety pool items was undertaken. Details of the analysis are contained in Tables 4.2 and 4.3.

Table 4.2 Computer Anxiety Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigenvalue</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3.95</td>
<td>49.4</td>
<td>49.4</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.01</td>
<td>12.7</td>
<td>62.1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>.80</td>
<td>10.0</td>
<td>72.1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>.65</td>
<td>8.2</td>
<td>80.2</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>.54</td>
<td>6.7</td>
<td>87.0</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>.43</td>
<td>5.4</td>
<td>92.4</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>.33</td>
<td>4.2</td>
<td>96.6</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>.28</td>
<td>3.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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Table 4.2 contains a summary of the Principal Components Analysis. Two latent factors with eigenvalues exceeding the Kaiser-Guttman rule – see Section 3.4.5, were identified. Together, the eight computer anxiety items reduced to latent factors, explained some sixty percent (62.1%) of the variance amongst the pool.

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.78</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.61</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.57</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>.89</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>.63</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>.61</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>.60</td>
</tr>
</tbody>
</table>

The varimax solution in Table 4.3 identified the clusters of computer anxiety items that loaded most onto each latent factor. Moderate to strong correlation coefficients were exhibited within the clusters aggregating to form latent factors. For latent factor one (1, 5, 6 and 8) items denoting apprehension were associated principally with “adequacy when interacting with computers”. Phrases such as ‘in control’, ‘by hand’, ‘use if not expected’ and ‘seem to enjoy’ are indicative of one’s feelings of adequacy.

In the case of latent factor two strong to very strong coefficients were evident. Those items loading on latent factor two (2, 3, 7 and 9) were characterised by “fear of the unknown”. Key statements like ‘uncomfortable’, ‘making work fit’, ‘avoid’, ‘unfamiliar’ and ‘feel stupid’ in the main reflect elements of fear.

As both computer anxiety latent factors covered single dimensions, it was considered appropriate to test the internal consistency reliabilities of both – see Tables 4.4 and 4.5.
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Table 4.4 Indices of Internal Consistency Reliabilities for Computer Anxiety Latent Factor – Adequacy when Interacting with Computers

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I feel that I control computers rather than computers control me.</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I’d rather do things by hand than use a computer.</td>
<td>.56</td>
<td>.70</td>
</tr>
<tr>
<td>6.</td>
<td>I would use a computer even if it were not expected of me.</td>
<td>.50</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>I don’t understand how people can spend so much time working with computers and seem to enjoy it.</td>
<td>.44</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5 Indices of Internal Consistency Reliabilities for Computer Anxiety Latent Factor – Fear of the Unknown

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>I would feel uncomfortable using computers as tools for learning.</td>
<td>.52</td>
<td>.75</td>
</tr>
<tr>
<td>3.</td>
<td>I usually have to make my work fit the computer rather than the computer fit my work.</td>
<td>.52</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I have avoided using computers because they are unfamiliar to me.</td>
<td>.61</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>I feel stupid when others talk about computers.</td>
<td>.54</td>
<td></td>
</tr>
</tbody>
</table>

Tables 4.4 and 4.5 illustrate the correlation between each item and the total for each of the computer anxiety latent factors (or, more accurately, the total with the contribution of that item omitted). DeVellis (1995) protocols - see Section 3.4.5 - indicate respectable Cronbach’s Alpha Coefficients (α = .70 for adequacy; α = .75 for fear of the unknown) for both computer anxiety latent factors. There is justification both empirically and theoretically to aggregate items. Thus items 1, 5, 6 and 8 forming latent factor one were aggregated to ostensibly form a scale Computer Anxiety – adequacy when interacting with computers while items 2, 3, 7 and 9 forming latent factor two, were aggregated to form another scale Computer Anxiety - fear of the unknown.
4.3. Computer Competence

Computer competence was operationally defined as ‘an assessment by teachers of their capacity to use a computer’ - see Table 3.1. For this concept, nine statements focussing on the dimensions of willingness to choose and participate in computer activities, expectations of success, and capacity to actualise computer-related outcomes were used - see Appendix 4.

The construct validity of the initial conception of the operational definition for computer competence was then tested using the two-part data reduction process outlined in Section 3.5.4. Table 4.6 displays the correlation matrix used to screen computer competence items for inclusion in a factor analysis.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>.50*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.34*</td>
<td>.46*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.44*</td>
<td>.57*</td>
<td>.51*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.47*</td>
<td>.52*</td>
<td>.36*</td>
<td>.61*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.24*</td>
<td>.23*</td>
<td>.27*</td>
<td>.38*</td>
<td>.24*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.04</td>
<td>.02</td>
<td>-.01</td>
<td>-.05</td>
<td>-.03</td>
<td>.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.35*</td>
<td>.38*</td>
<td>.41*</td>
<td>.35*</td>
<td>.33*</td>
<td>.45*</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.21*</td>
<td>.35*</td>
<td>.40*</td>
<td>.37*</td>
<td>.26*</td>
<td>.36*</td>
<td>.03</td>
<td>.35*</td>
</tr>
</tbody>
</table>

* p<0.01

Table 4.6 highlights many useful correlation coefficients among computer competence items. Some weak and insignificant relationships were also noted, in particular involving item seven. Based on these indicators, item seven was rejected and excluded from further analysis. Principal Components Analysis including varimax rotation using the remaining eight computer competence items was then undertaken. Details of the analysis are contained in Tables 4.7 and 4.8.
Teachers’ Intentions to Use Information Technologies:
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Table 4.7  Computer Competence Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigenvalue</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3.71</td>
<td>46.3</td>
<td>46.3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.06</td>
<td>13.3</td>
<td>59.6</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.78</td>
<td>9.8</td>
<td>69.4</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.65</td>
<td>8.1</td>
<td>77.4</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0.57</td>
<td>7.1</td>
<td>84.5</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>0.50</td>
<td>6.2</td>
<td>90.7</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>0.42</td>
<td>5.3</td>
<td>96.0</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>0.32</td>
<td>4.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The outcomes of the computer competence Principal Component Analysis are shown in Table 4.6. The analysis revealed two latent factors with eigenvalues greater than one. The combinations of computer competence items reduced to factors were capable of explaining almost sixty percent (59.6%) of the variance among the pool items.

Table 4.8  Computer Competence Rotated Factor Solution

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factor Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
</tr>
<tr>
<td>2</td>
<td>.78</td>
</tr>
<tr>
<td>5</td>
<td>.78</td>
</tr>
<tr>
<td>1</td>
<td>.76</td>
</tr>
<tr>
<td>4</td>
<td>.71</td>
</tr>
<tr>
<td>3</td>
<td>.51</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

The varimax solution illustrated in Table 4.7, displays moderate to strong correlation amongst the aggregated computer competence items. However, the split-loaded moderate correlation coefficients recorded for item three “I will be able to keep up with the important technological advances of computers” indicate that orthogonal rotation was unable to allocate the item entirely to one latent factor. Where then, should the item rest?
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The cluster loading onto latent factor one minus item 3 (items 1, 2, 4 and 5), emphasises the "personal expectations of success" associated with being a competent computer user. That is, the positives 'feeling confident about using' 'showing others' and negatives "might damage" 'make tense' associated with participating in computer activities. As for the array forming latent factor two minus item 3 (items 6, 8 and 9), it records teachers' assessment of their "capacity to actualise computer-related outcomes". Towards this end, this includes statements like, 'have my own computer' 'can learn computer skills' and 'solve problems does not appeal'. The reference to 'keeping up' within item three is supportive of the outcomes based nature of the operational definition. In so much, item 3 represents a bond between the dimensions loading as latent factors.

If item three were a bond between the dimensions loading as latent factors, then calculating internal consistency reliabilities may be considered an appropriate empirical test of that theoretical perspective. That is, if acceptable or better coefficients of internal consistency reliability are generated, then there is a basis to accept that both latent variables could contribute to an understanding of the nature of computer competence amongst teachers. Item to total correlation and scale reliability scores are shown in Tables 4.9 and 4.10.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>If given the opportunity to use a computer I’m afraid I might damage it in some way.</td>
<td>.55</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>The idea of working with computers makes me tense.</td>
<td>.66</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>I will be able to keep up with the important technological advances of computers.</td>
<td>.52</td>
<td>.82</td>
</tr>
<tr>
<td>4.</td>
<td>I feel confident about using the computer as a learning tool in my classroom.</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I sometimes show other people how to use a computer.</td>
<td>.63</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.10  Indices of Internal Consistency Reliabilities for Computer Competence Latent Factor – Capacity to Actualise Outcomes

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>I will be able to keep up with the important technological advances of computers.</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Having my own computer would help me in my professional role.</td>
<td>.45</td>
<td>.67</td>
</tr>
<tr>
<td>8.</td>
<td>I am confident I can learn computer skills.</td>
<td>.51</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>The challenge of solving problems with a computer does not appeal to me.</td>
<td>.48</td>
<td></td>
</tr>
</tbody>
</table>

Item to total correlation in Table 4.9 indicate moderate to strong relationships between items clustering to form factor one “expectations of success”. Cronbach’s Coefficient Alpha (α=0.82) for that latent factor was very good according to DeVellis (1995) protocols. For latent factor two about teachers’ “capacity to actualise computer-related outcomes”, only moderate item to total correlation were recorded – see Table 4.10. While Cronbach’s Coefficient Alpha (α=0.67) for latent factor two was lower, it was nonetheless (minimally) acceptable.

The various results provide empirical justification to accept the perspective that there are two, separate but related, computer competence factors within the data. Those factors were labelled *Computer Competence – expectations of success*, based on items 1, 2, 3, 4 and 5 and *Computer Competence – capacity to actualise computer-related outcomes*, based on items 3, 6, 8 and 9.
4.4. Relevance of Computers

Teacher perspectives of the relevance of computers was confined to ‘mindfulness of the suitability of computers as tools for learning’ when the concept was operationally defined - see Table 3.1. Respondent’s attitude towards the applicability of computers as tools for learning was confirmed using ten assertions – see Appendix 4. The ten statements were drawn from a larger pool of items with regard to computers as facilitators of student learning identified in the literature. In selecting assertions preference was given to the connection of computers with learning and upon the organisation of learning environments.

The set of assertions presented the operational definition to teachers in a positive sense. The construct validity of this interpretation was tested against the data collected using data reduction (factor analysis) techniques - outlined in Section 3.4.5. Table 4.11 displays the correlation matrix used to screen relevance of computer items as part of that data reduction process.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>.63*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.63*</td>
<td>.61*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.67*</td>
<td>.70*</td>
<td>.77*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.40*</td>
<td>.45*</td>
<td>.37*</td>
<td>.41*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.33*</td>
<td>.41*</td>
<td>.38*</td>
<td>.41*</td>
<td>.58*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.33*</td>
<td>.40*</td>
<td>.30*</td>
<td>.39*</td>
<td>.31*</td>
<td>.37*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.43*</td>
<td>.42*</td>
<td>.43*</td>
<td>.44*</td>
<td>.45*</td>
<td>.45*</td>
<td>.53*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.29*</td>
<td>.51*</td>
<td>.29*</td>
<td>.43*</td>
<td>.45*</td>
<td>.42*</td>
<td>.39*</td>
<td>.50*</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>.33*</td>
<td>.49*</td>
<td>.30*</td>
<td>.36*</td>
<td>.44*</td>
<td>.38*</td>
<td>.23*</td>
<td>.42*</td>
<td>.65*</td>
</tr>
</tbody>
</table>

* p<0.001

The computations summarised in Table 4.11 identify significant correlation between all ten relevance of computers items. In the main, those coefficients denote moderate levels of relationship between all items. All relevance of computers items were considered appropriate for inclusion in the Principal Components Analysis. Details of that analysis are contained in Tables 4.12 and 4.13.
Table 4.12 Relevance of Computers Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigenvalue</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>4.96</td>
<td>49.6</td>
<td>49.6</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.19</td>
<td>11.9</td>
<td>61.5</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>.91</td>
<td>9.1</td>
<td>70.7</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>.80</td>
<td>8.0</td>
<td>78.6</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>.51</td>
<td>5.1</td>
<td>83.7</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>.46</td>
<td>4.6</td>
<td>88.3</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>.37</td>
<td>3.7</td>
<td>92.0</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>.32</td>
<td>3.2</td>
<td>95.2</td>
</tr>
<tr>
<td>9</td>
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<td>.28</td>
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</tr>
<tr>
<td>10</td>
<td></td>
<td>.20</td>
<td>2.0</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.13 Relevance of Computers Rotated Factor Solution

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factor Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
</tr>
<tr>
<td>3</td>
<td>.86</td>
</tr>
<tr>
<td>4</td>
<td>.84</td>
</tr>
<tr>
<td>1</td>
<td>.83</td>
</tr>
<tr>
<td>2</td>
<td>.70</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.12 provides a synopsis of the Principal Component Analysis of relevance of computers data and reveals two latent factors with eigenvalues exceeding the Kaiser-Guttman rule. Together relevance of computers items, reduced to two latent factors explain just over sixty percent of the variance (61.5%) within the pool items.
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The varimax solution in Table 4.13 illustrates the clusters of relevance of computers items loading to form latent factors. The orthogonal rotation separated items (1) “Computers can motivate uninterested students”, (2) “Computers can empower students to learn”, (3) “Computers help students to feel good about themselves” and (4) “Computers have a positive influence on students’ attitudes towards school” as one latent factor. This factor was characterised by very strong correlation, denoting quite close relationships among the items.

From a theoretical perspective, latent factor one reflects teachers’ consideration of the propensity of computers to “affect students as learners”. It focuses on teacher understanding of the intersection of the learner with computers. Irrespective of whether that intersection occurs within the learning environment organised by the teacher, the feelings expressed by teachers relate to the capacity of the computer to offer to students a means to exercise control over their learning.

The remaining six relevance of computers items formed a second latent factor. Items nine and ten contribute very strongly to this factor, while items five, six, seven and eight are moderate contributors. From a theoretical perspective, latent factor two expresses teachers’ standpoint on the propensity of computers to “affect teacher-created learning environments”. This is illustrated through statements like “in my class”, “learn skills”, “acquire”, “accommodate ability levels” and “cater for different learning styles”. Latent factor two stresses teachers’ understanding of the intersection of the learner with computers within the learning environments they create. It is an expression of the possibilities available to teachers to implement computers as tools for learning.

Tests to determine internal consistency reliability were then conducted. Details of item to total correlation and the reliability score for each factor are shown in Tables 4.14 and 4.15.

Table 4.14 Indices of Internal Consistency Reliabilities for Relevance of Computers Latent Factor – Students as Learners

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Computers will motivate uninterested students.</td>
<td>.72</td>
<td>.89</td>
</tr>
<tr>
<td>2.</td>
<td>Computers can empower students to learn.</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Computers help students to feel good about themselves.</td>
<td>.76</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Computers have a positive influence on students’ attitudes towards school.</td>
<td>.82</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.15 Indices of Internal Consistency Reliabilities for Relevance of Computers Latent Factor – Teacher-Created Learning Environments

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Computers are one means of developing cooperative social structures in my class.</td>
<td>.61</td>
<td>.82</td>
</tr>
<tr>
<td>6.</td>
<td>Computers make it possible for students to learn oral and written communication skills.</td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Computers help students learn to research and report on a topic.</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Computers help students acquire problem-solving skills.</td>
<td>.64</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Computers enable teachers to accommodate different ability levels.</td>
<td>.66</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Computers enable teachers to cater for different learning styles.</td>
<td>.57</td>
<td></td>
</tr>
</tbody>
</table>

Item to total correlation in Table 4.14 support previous evidence of a close relationship among items forming the relevance of computers latent factor “affects upon students as learners”. Internal consistency reliability measured using Cronbach’s Coefficient Alpha (α=0.89), provides evidence of a very good stability. For latent factor two “affects within teacher-created learning environments”, item to total correlation were moderate to strong – see Table 4.15. As was the case for latent factor one, internal consistency reliability (α=0.82) was also very good.

Thus, there was sufficient justification both empirically and theoretically for relevance of computers items to be aggregated to clearly form two measures for further analysis within the study. Those measures were named relevance of computers – affects upon students as learners and relevance of computers – affects within teacher-created learning environments, respectively.
4.5. Pedagogical Practices

Some teachers use information technology regularly in their classrooms, others do not. To determine the potential of information technologies to influence the instructional process it was essential to also identify those teachers who, while not using computers per se, were nonetheless predisposed to do so. For this reason, the global construct pedagogical practices was conceived as being an outcome variable and operationally defined as 'the extent to which teachers used, or were disposed to use computers in their classrooms' - see Table 3.1.

Respondent's positions were resolved through the application of fifteen assertions. The assertions were drawn from a pool of items identified in the literature as focussing upon the instructional process – see Appendix 4. The statements emphasised teachers' capacity to assimilate computers into their teaching style, the effect of computer integration on prescribed learning outcomes and the tasks engaged in by teachers when preparing lessons.

Assertions were chosen by the researcher to form a set of items that operationally defined pedagogical practices. The construct validity of the chosen set was then tested against the data collected using the two-part data reduction process outlined in Section 3.4.5. Table 4.16 displays the correlation matrix used to screen pedagogical practices items as part of the data reduction process.
### Table 4.16: Pedagogical Practices Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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</tbody>
</table>

*p < 0.01
In Table 4.16 a majority of pedagogical practices items are related, however little if any relationship was noted between items seven and ten and the pool. Those items expanded the "tasks teachers engage in when preparing lessons" dimension. Item seven queried booking facilities, while item ten focused on time. As neither item possessed cohesiveness with the pool, they were rejected.

When devising the pedagogical practices construct, item six "preparing lessons involving computers takes more time than traditional lessons" was conceived as a component of the lesson preparation dimension. Rejecting items seven and ten diminished this dimension, thus it was decided to also delete item six, thereby removing the lesson preparation dimension completely. Twelve of the original fifteen pedagogical practices items were available for Principal Components Analysis – see Tables 4.17 and 4.18.

Table 4.17 Pedagogical Practices Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigenvalue</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
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</thead>
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<td>.61</td>
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<td>9</td>
<td></td>
<td>.56</td>
<td>4.7</td>
<td>82.4</td>
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<td></td>
<td>.54</td>
<td>4.5</td>
<td>86.8</td>
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<td>90.7</td>
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</table>

Following Principal Component Analysis of the pedagogical practices data it became apparent that the remaining pool items could be explained by two latent factors (eigenvalues for both latent factors exceeded the Kaiser-Guttman rule) – see Table 4.17. Together the pedagogical practices clusters, reduced to latent factors explained just over half (53.9%) of the variance within the pool items.
Table 4.18 contains the factor loadings derived from the varimax rotation of the pedagogical practices pool. Within factor one, items 3, 8, 9, 11, 14 and 15 manifest moderate to very strong correlation and reflect the dimension of pedagogical practices associated with teachers' "assimilation of computers into their teaching style". This dimension is highlighted by references to teachers being able to use computers to 'individualise learning', 'innovate in subject delivery' and have 'control over teaching'.

Among items 1, 2, 4, 6, 12 and 13 combining to form latent factor two, there was strong correlation. This correlation denotes the effect of computer integration on 'prescribed learning outcomes' a more broadly based dimension of pedagogical practices. Reference to questions about 'outcomes', 'syllabus requirements' and 'approaches to teaching' highlight this dimension.

Finally, tests to determine the internal consistency reliability of each of the pedagogical practices latent factors were conducted. Details of item to total correlation and the reliability score for each factor are shown in Tables 4.19 and 4.20.
### Table 4.19  
Indices of Internal Consistency Reliabilities for Pedagogical Practices Latent Factor – Assimilation of Computers

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item ( \times ) Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Computers would enable me to individualise instruction.</td>
<td>.57</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>The computer offers me some variety in lesson presentation</td>
<td>.50</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Using technology stimulates me to innovate in the way I deliver my subjects.</td>
<td>.63</td>
<td>.82</td>
</tr>
<tr>
<td>9.</td>
<td>Using computers means I have more control over my work.</td>
<td>.64</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Using computers provides time to engage students in higher levels of thinking.</td>
<td>.58</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Having a computer available in my classroom would improve my productivity.</td>
<td>.58</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4.20  
Indices of Internal Consistency Reliabilities for Pedagogical Practices Latent Factor – Prescribed Learning Outcomes

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item ( \times ) Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Achieving desired outcomes is made more difficult by using computers.</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I would only use computers if it were a syllabus / program requirement.</td>
<td>.65</td>
<td>.82</td>
</tr>
<tr>
<td>4.</td>
<td>My teaching style could never be altered to fit computers.</td>
<td>.59</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Traditional resources are more relevant to the way I teach.</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Using computers requires management strategies that I am not familiar with.</td>
<td>.55</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I will do as little with computers as possible.</td>
<td>.63</td>
<td></td>
</tr>
</tbody>
</table>
Item total correlation in Tables 4.19 and Table 4.20 register moderate to strong degrees of relationship between items for each of the pedagogical practices latent factors. This consistency within the clusters suggests a very reasonable level of stability within the factors. Indeed, both factors record quite high values for Cronbach’s Coefficient Alpha (α=0.82) that indicate very good reliabilities (DeVellis, 1995).

There was justification to endorse the aggregation of pedagogical practices clusters for further analysis within the study. The measure named pedagogical practices – assimilation of computers was based on established relationships associated with teaching style, while the measure pedagogical practices – prescribed learning outcomes was founded on principals linking computer integration with assigned goals.

4.6. Staff Development

As demands to use computers in schools increase, it would be reasonable to expect all teachers to have some, though differing, need for training. The staff development construct explored teachers’ commitment to engage in formal or informal computer related training - see Table 3.1. Thus, the major foci were personal awareness of training alternatives and the availability of those options in and out of school contexts. Respondents were asked to consider ten assertions that in the main mixed general ideas with specific examples but concentrating on the context of training – see Appendix 4. One statement considered teachers using school resources at home to further personal training goals.

The construct validity of the staff development set was then tested against the data collected using the two-part data reduction process outlined in Section 3.4.5. Table 4.21 displays the correlation matrix used to screen staff development items as part of that process.
Teachers' Intentions to Use Information Technologies:
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Table 4.21

Staff Development Correlation Matrix

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<td>-.01</td>
<td>.15</td>
<td>.12</td>
<td>-.05</td>
</tr>
</tbody>
</table>

*p ≤ 0.001

Table 4.21 clearly delineated those staff development items that correlate with others from those that don’t. In particular, items five, using school resources at home to further personal training goals; eight, specific information processing skills; and ten, the necessity for all teachers to be able to manage computer resources; correlate least with other pool items. Those items were rejected.

The rejection of staff development items did not exhaust the supply of questions within any one dimension. However, the deletion of item eight did remove the limited link with engagement in staff development at home. Data explained elsewhere gives weight to the opinion that teachers are in the main, already well served with appropriate technology at home – see Section 5.2.

The final part of the data reduction process was then completed using the remaining seven staff development items. Details of the Principal Components Analysis are contained in Tables 4.22 and 4.23.
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Table 4.22  Staff Development Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigenvalue</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
</tr>
</thead>
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<td>94.3</td>
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<td>9</td>
<td></td>
<td>.40</td>
<td>5.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Two latent factors with eigenvalues exceeding the Kaiser-Guttman rule are evident within the Principal Component Analysis digest of staff development data in Table 4.22. The combinations of staff development items clustering to form those factors are capable of explaining almost sixty percent (57.7%) of the variance within the pool.

Table 4.23  Staff Development Rotated Factor Solution

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factor Matrix</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
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<td>.80</td>
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<tr>
<td>4</td>
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<td>6</td>
<td>.80</td>
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<tr>
<td>9</td>
<td>.73</td>
</tr>
</tbody>
</table>

The rotated solution illustrated in Table 4.23 displays moderate to strong correlation amongst staff development items. The varimax method of rotation however, split item seven "I'd use computers more in teaching and learning if there was in school training available", over both factors. Where then, does the item rest?
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The five staff development items loading on latent factor one effectively illustrate teachers’ overall concerns about their access to training with reference to regional inservice, library and school training within the items. Also within those items was reference to inservice in my KLA, specific training and varying classroom practice, which focus upon using computers to facilitate learning. The combination of overall concerns about access and a focus on learning give rise to latent factor one being concerned with ‘general engagement in training’.

In latent factor two, teachers’ concerns about access to training are confined to school contexts with only item seven containing references to the locality of training. The other two items, items six and nine, were concerned with types of training, specifically entry level skills and classroom management strategies associated with classroom computer use. Both ideas relate well to the local context of item seven and together the three items give rise to latent factor two being concerned with ‘school-based training’.

A valid argument can be put that item seven adds understanding to both latent factors. It would seem appropriate then, to test the internal consistency reliability of both staff development latent factors before making any further decisions – see Tables 4.24 and 4.25.

Table 4.24 Indices of Internal Consistency Reliabilities for Staff Development Latent Factor – General Engagement in Training

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach's Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I would use computers more if I had access to regional in service for computers in my KLA.</td>
<td>.57</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I would use computers more if there were information on potential uses available in the library.</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>I would use computers more if I had specific training in the use of simulation games and database exploration.</td>
<td>.55</td>
<td>.76</td>
</tr>
<tr>
<td>4.</td>
<td>I want to learn more about how technology enables me to vary my classroom practices.</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I’d use computers more in teaching and learning if in school training were available.</td>
<td>.46</td>
<td></td>
</tr>
</tbody>
</table>
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Item to total correlation in Table 4.24 indicate a moderate relationship among items forming the staff development latent factor one. For latent factor one, "general engagement in training", Cronbach’s Coefficient Alpha (α=0.76) indicates a respectable internal consistency reliability (DeVellis, 1995). Thus, justification was established for the aggregation of items 1, 2, 3, 4 and 7 to form the scale staff development – general engagement in training within the study.

Table 4.25  Indices of Internal Consistency Reliabilities for Staff Development Latent Factor – School-based Training

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>I need training that provides entry level skills.</td>
<td>.50</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I’d use computers more in teaching and learning if in school training were available.</td>
<td>.47</td>
<td>.66</td>
</tr>
<tr>
<td>9.</td>
<td>I need to know how to manage classes when they use computers.</td>
<td>.45</td>
<td></td>
</tr>
</tbody>
</table>

Item to total correlation for the staff development factor school-based training, – see Table 4.25, like those for general engagement in training, indicate moderate relationships between items and scale scores. However, for school-based training a smaller Cronbach’s Coefficient Alpha (α=0.66) was recorded. Although the alpha value was within those defined as minimally acceptable by DeVellis (1995), the factor possessed a distinct conceptual basis and so it was decided to perservere with it in the study.

4.7. Access to Resources

Any integration of information technology across the curriculum implies a resource need. Access to resources was another global construct included in the study. This construct was operationally defined as a perception variable based on ‘teacher beliefs of the investment necessary to operate computers across the curriculum’ - see Table 3.1.

In defining this set, assertions were drawn from a pool of eclectic statements about teacher insight into the resources required and resource issues to be overcome if computers were to be integrated
across the curriculum. To this end, dimensions included were related to models of organisation, software and hardware availability and the locality of resources to best promote learning outcomes.

The researcher’s initial conception of the operational definition of access to resources contained 11 items - see Appendix 4. The construct validity of this definition was then tested against the data collected using the two-part data reduction process outlined in Section 3.4.5. Table 4.26 displays the correlation matrix used to screen access to resources items for inclusion in a factor analysis.

Table 4.26 Access to Resources Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>10</th>
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<tbody>
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<td></td>
<td>.32*</td>
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<tr>
<td>4</td>
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<td>.10</td>
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<td></td>
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<td>-.05</td>
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<td>-.05</td>
<td>-.32*</td>
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<td>.24*</td>
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<td>8</td>
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<td>.09</td>
<td>.28*</td>
<td>-.09</td>
<td>.28*</td>
<td>.39*</td>
<td>.40*</td>
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<td>.34*</td>
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<td>.06</td>
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<td>.38*</td>
<td>.15</td>
<td>.29*</td>
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<td>11</td>
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<td>.10</td>
<td>.29*</td>
<td>.28*</td>
<td>.46*</td>
</tr>
</tbody>
</table>

* p ≤ 0.001

In Table 4.26, the first five items were poor correlates and so were rejected. Items one and two related to models of organisation, item three to equity, while items four and five considered software as a resource. A Principal Components Analysis using a varimax rotation of the six remaining items was then undertaken. Details of the analysis are contained in Tables 4.27 and 4.28.
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Table 4.27  Access to Resources Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigen-value</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
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<td>2.54</td>
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<td>42.3</td>
</tr>
<tr>
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<td>2</td>
<td>1.04</td>
<td>17.4</td>
<td>59.7</td>
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<td>8</td>
<td></td>
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<td>13.3</td>
<td>73.1</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>.61</td>
<td>10.1</td>
<td>83.2</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>.56</td>
<td>9.3</td>
<td>92.5</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>.45</td>
<td>7.5</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.28  Access to Resources Rotated Factor Solution

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.81</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>.73</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>.72</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>.70</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>.70</td>
</tr>
</tbody>
</table>

The outcomes of Principal Component Analysis, illustrated in Table 4.27, revealed two latent factors with eigenvalues exceeding the Kaiser-Guttman rule within the access to resources items. The combinations of access to resources items clustering to form those factors are capable of explaining almost sixty percent (59.7%) of the variance within the pool.

The factor loadings in Table 4.28 reveal two items reducing to form one factor and four forming another. The items loading on latent factor one, items (6) “I would use computers more if they were located in or close by to my room” and (7) “With computers in my classroom linked to the library, my students would be better prepared to learn” are described as a ‘doublet’ factor (ACITS, 1995). Doublet factors are problematic, and rarely reduce them to a single reliable factor. For instrumental reasons latent factor one was excluded from further analysis.
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Upon reflection, it could be that excluding items 1 and 2 affected the capacity of items 6 and 7 to reduce to a discrete factor. It was thought to be appropriate to keep items 6 and 7 within the analysis given the correlation with items 10 and 11 – see Table 4.26.

As for latent factor two, items 8, 9, 10 and 11 display teachers’ perceptions of (some of) the software and hardware barriers that have to be overcome for computers to be integrated across the curriculum. This factor was then tested for internal consistency reliability. The outcomes of that test are depicted in Table 4.29.

Table 4.29 Indices of Internal Consistency for Access to Resources Latent Factor – Software and Hardware Barriers

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>There is not enough time spent letting staff know about the latest software.</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>We need printers, scanners, modems and other devices if we are to teach students useful skills relevant to their future.</td>
<td>.44</td>
<td>.68</td>
</tr>
<tr>
<td>10.</td>
<td>How can I be expected to use computers when there just aren’t enough to go round as it is.</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>It’s one thing to have computers in the school, it’s another thing to have enough software to justify using them.</td>
<td>.48</td>
<td></td>
</tr>
</tbody>
</table>

Item total correlation in Table 4.29, indicates only a moderate degree of relationship between items and scale scores, with Cronbach’s Coefficient Alpha (α=0.68) is on the higher side of those deemed minimally acceptable. While the alpha value was within those defined as minimally acceptable (DeVellis, 1995), the factor access to resources – software and hardware barriers possessed a distinct conceptual basis and so it was decided to persevered with it in the study.

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4.8. Policy Formulation

For the integration of information technology across the curriculum to be anything other than piecemeal, schools should engage in planning processes that lead to supportive policies. It was from this perspective that the policy formulation global construct was operationally defined as 'an appraisal of teacher understanding of the organisational environment for integrating computers across the curriculum' - see Table 3.1. The key dimensional concepts upon which assertion statements were selected were effective leadership, empowerment and policy issues - see Appendix 4.

The researcher's initial conception of the operational definition of policy formulation contained 15 assertions. The construct validity of the construct was tested against the data collected using the two-part data reduction process outlined in Section 3.4.5. Table 4.30 displays the correlation matrix used to screen policy formulation items for inclusion in a factor analysis.
### Table 4.30  Access to Policy Formulation Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>.58*</td>
<td>.38*</td>
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<td>.19</td>
<td>.58*</td>
<td>.38*</td>
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<td>-.02</td>
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<td>-.06</td>
</tr>
</tbody>
</table>

* p<0.01
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Five items were identified in Table 4.30 as poor correlates and so were rejected. Items three and fifteen expanded the dimensions of empowerment, while the remaining excluded items focused on policy associated with technology integration. Principal Components Analysis and varimax rotation of the remaining nine items was then undertaken – see Tables 4.31 and 4.32.

Table 4.31 Policy Formulation Principal Components Analysis

<table>
<thead>
<tr>
<th>Item No</th>
<th>Factors Extracted</th>
<th>Eigenvalue</th>
<th>Explained Variance</th>
<th>Cumulative Explained Variance</th>
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</thead>
<tbody>
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<td>81.7</td>
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<td>96.3</td>
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Table 4.32 Policy Formulation Rotated Factor Solution

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Factor Matrix</th>
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<tbody>
<tr>
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<td>.67</td>
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<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Two latent policy formulation factors were revealed through Principal Component Analysis. Together the variables, reduced to two latent factors explained sixty percent (61%) of the variance within the pool items. Varimax rotation separated items 1, 2, 5 and 6 as a latent factor, with strong to very strong correlation among the items. Key concepts included vision, commitment and support, highlighting the dimension of effective leadership. Items 4, 9 and 10 formed a second latent factor displaying strong correlation. The thrust of that factor was empowerment of teachers.

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within the decision making process. Items 4 and 10 concerned perceptions of teacher involvement, while item 9 introduced the concept of equity within the decision making process. Each factor was then tested to determine internal consistency reliability. Details of item to total correlation and the reliability score for each factor are shown in Tables 4.33 and 4.34.

Table 4.33 Indices of Internal Consistency for Policy Formulation Latent Factor – Effective Leadership

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The school possesses a definite vision for the place of technology in the classroom.</td>
<td>.73</td>
<td>.79</td>
</tr>
<tr>
<td>2.</td>
<td>The executive is committed to implementing a specific vision for technology in the classroom.</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>The principal is supportive of the use of technology in the classroom.</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>There is a strong commitment from within the computer committee to support teachers using technology in the classroom.</td>
<td>.54</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.34 Indices of Internal Consistency for Policy Formulation Latent Factor – Empowerment of Teachers

<table>
<thead>
<tr>
<th>Item No</th>
<th>Item Description</th>
<th>Item v Total Scale Correlation</th>
<th>Cronbach’s Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>I have a say in the purchase of hardware and software used in the school.</td>
<td>.49</td>
<td>.69</td>
</tr>
<tr>
<td>9.</td>
<td>Equity is a high priority in determining school policy.</td>
<td>.45</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Decisions about where computers are located are made by all staff.</td>
<td>.42</td>
<td></td>
</tr>
</tbody>
</table>

Item total correlation for the policy formulation latent factor effective leadership, as shown in Table 4.33, indicates moderate to strong relationship between items and scale scores. Cronbach’s Coefficient Alpha (α=0.79) for latent factor one is on the high side of respectable (DeVellis, 1995). There was sufficient justification to aggregate the policy formulation items 1, 2, 5 and 6 to form a measure for effective leadership.
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For the policy formulation factor empowerment of teachers, item total correlation revealed only moderate relationship between items – see Table 4.34. Cronbach's Coefficient Alpha (α=0.69) was only minimally acceptable, though closer to a respectable than undesirable score (DeVellis, 1995). Thus, there was reason to aggregate the policy formulation items 4, 9 and 10 to form a scale for further analysis.

4.9. Concluding Comment

Emerging from the empirical analysis of the seven global constructs were thirteen specific factors. This expansion illustrates the importance of close examination of collected data. Each of the derived factors helps to explain a specific component of the more expansive global constructs and thereby potentially expands the clarity of the examination of the phenomena hypothesised as influencing teachers' intentions to use information technology.
Chapter 5

Results and Discussion
5.1 Introduction

Teachers were asked, in total, 96 questions. For analytical purposes, the questions were grouped. The largest group contained 80 questions, which were related to teacher attitudes. For this group, seven global constructs were operationally defined and short titled, Computer Anxiety, Computer Competence, Perceived Relevance, Pedagogical Practices, Staff Development, Access to Resources and Policy Formulation. The global constructs were subject to a two-part data reduction process, from which thirteen scales were derived. The formation of the scales and discussion of their validity and reliability were presented in Chapter Four.

The remaining sixteen questions were also grouped and titled, Teacher Use of Computers (6 questions), Teacher Self-rated Computing Skill (1 question), Teacher’s Knowledge Base with respect to Computing and Computers as Tools for Learning (4 questions) and Teacher Demographics (5 questions).

Each set generated data that were used to explore the research areas, issues and dimensions outlined in Chapter One. The remainder of this chapter presents the results of the study and discusses findings for the research questions stated in Chapter One.
5.2 Are there Differences in the Pattern of Teachers' Use of Computers?

5.2.1 Teachers’ Use of Computers at School

Teachers were asked four questions about their access to and use of computers at school. The first two questions concerned school access. At school 94.6% (N=206) of teachers stated that computers were available in the staff study to administer the teaching process. Eleven teachers reported no computer in their staff study, though ten of them indicated a computer was available elsewhere. When Computing Coordinators were asked, they reported that computers were available in all staff studies.

Why would eleven teachers report no computer when one was readily available? Could it be that access does not equate with availability? In staff studies when often there are many more teachers than available computers, it may be easier to find alternatives elsewhere or complete computer tasks at home. Only two of the eleven teachers could not access a computer at home. One of the two indicated that she would never use a computer for administration or teaching and learning.

Two further questions focussed on teacher’s school use of computers for preparing, delivering and administrating student learning. Both questions used a five-point categorical scale – daily, more than once per week, weekly, once per month or never – to identify how often computers were used in those contexts. How often teachers used computers for lesson preparation and record-keeping is displayed in Table 5.1, while more general teaching and learning use is displayed in Table 5.2.

<table>
<thead>
<tr>
<th>Pattern of Computer Use</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>38</td>
<td>18.7</td>
</tr>
<tr>
<td>More than once per week</td>
<td>59</td>
<td>29.1</td>
</tr>
<tr>
<td>Weekly</td>
<td>39</td>
<td>19.2</td>
</tr>
<tr>
<td>Once per Monthly</td>
<td>44</td>
<td>21.7</td>
</tr>
<tr>
<td>Never</td>
<td>23</td>
<td>11.3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>203</td>
<td>100</td>
</tr>
</tbody>
</table>
Two of every three teachers regularly used computers in lesson preparation and record-keeping (67% – daily, more than once per week and weekly). Nearly nine of every ten teachers used computers at least monthly, reflecting amongst other things an increasing reliance upon electronic recording of assessment in schools. This pattern of usage would be consistent with the ubiquity of computers in schools for preparing and administrating student learning.

Table 5.2  Teaching / Learning Use of Computers

<table>
<thead>
<tr>
<th>Pattern of Computer Use</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>36</td>
<td>18.4</td>
</tr>
<tr>
<td>More than once per week</td>
<td>39</td>
<td>19.9</td>
</tr>
<tr>
<td>Weekly</td>
<td>23</td>
<td>11.7</td>
</tr>
<tr>
<td>Once per Monthly</td>
<td>58</td>
<td>29.6</td>
</tr>
<tr>
<td>Never</td>
<td>40</td>
<td>20.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>196</td>
<td>100</td>
</tr>
</tbody>
</table>

Teachers reported lower levels of teaching and learning use of computers, indicating a greater reluctance to use computers as tools for student learning. Even so, higher than expected regular teaching and learning use of computers was recorded, with half of the respondents indicating that they purportedly used a computer at least once each week in a classroom situation.

5.2.2 Teachers’ Use of Computers and Access to Computers at Home

The final two questions about teachers’ use of computers concerned use at home. The first question established that seven out of ten teachers (69.8%) were able to access a computer at home, a figure double the national average for all households (34.0%) and one and a half times greater than that of white collar workers generally (45%) (Apple Computer Australia, 1996).

Teachers were asked about the purpose to which they put computers. Responses are illustrated in Table 5.3. Seven out of ten teachers (69.6%, N=134) who used a computer at home used it as an aid in lesson preparation. The ubiquity of school based computers coupled with a substantial rate of home access points to most teachers using computers in some way to complete tasks associated with the job.
Table 5.3 Teachers’ Use of Computers at Home

<table>
<thead>
<tr>
<th>Purpose of Use</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson Prep.</td>
<td>96</td>
<td>69.6</td>
</tr>
<tr>
<td>Entertainment</td>
<td>9</td>
<td>6.5</td>
</tr>
<tr>
<td>Home Related</td>
<td>12</td>
<td>8.7</td>
</tr>
<tr>
<td>Business</td>
<td>9</td>
<td>6.5</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>8.7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>138</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Chi-square analysis was performed to determine if teachers’ lesson preparation and record-keeping use of computers was independent of home access – see Table 5.4. Analysis revealed a significant difference ($\chi^2=37.9; df=4; p<0.00001$) in use of computers for lesson preparation and record-keeping between those teachers with access to a computer at home and those without access. One could reasonably conclude that teachers with home access to a computer were very likely to be using that tool for lesson preparation and record-keeping purposes.

Table 5.4 Teachers’ Lesson Preparation and Record-keeping Use of Computers and Home Access

<table>
<thead>
<tr>
<th>Pattern of Use</th>
<th>Home Access to a Computer</th>
<th>Total N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes N (%)</td>
<td>No N (%)</td>
</tr>
<tr>
<td>Daily</td>
<td>35 24.8</td>
<td>3 4.9</td>
</tr>
<tr>
<td>More than once per week</td>
<td>41 29.1</td>
<td>17 27.9</td>
</tr>
<tr>
<td>Weekly</td>
<td>35 24.8</td>
<td>4 6.6</td>
</tr>
<tr>
<td>Once per month</td>
<td>22 15.6</td>
<td>22 36.1</td>
</tr>
<tr>
<td>Never</td>
<td>8 5.7</td>
<td>15 24.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>141 (100)</strong></td>
<td><strong>61 (100)</strong></td>
</tr>
</tbody>
</table>
5.2.3 Teacher Gender and Access to Computers at Home

The pattern of home access to computers based on teacher gender was also explored using a chi-square test. Table 5.5 shows the contingency table used in the analysis. Of the 60 teachers with no home access to computers, two thirds were female ($\chi^2=6.2; df=1; p=0.01$). Thus, the data points to a difference in the pattern of home access to computers between female and male teachers. A possible contributing factor to this outcome may be the relative proportions of younger and older female teachers within the sample. Caution should be exercised when generalising from this pattern of home access to computers based on gender.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Home Access to a Computer</th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes N(%)</td>
<td>No N(%)</td>
<td>N(%)</td>
</tr>
<tr>
<td>Male</td>
<td>75 (52)</td>
<td>20 (33)</td>
<td>95 (47)</td>
</tr>
<tr>
<td>Female</td>
<td>68 (48)</td>
<td>40 (67)</td>
<td>108 (53)</td>
</tr>
<tr>
<td>Total</td>
<td>143 (100)</td>
<td>60 (100)</td>
<td>108 (100)</td>
</tr>
</tbody>
</table>

For this sample of Western Sydney secondary teachers, what if gender differences in home access to computers were to carry over into teachers’ school use of computers? May there be some advantage for students in being taught by male teachers, especially if male teachers used computers more? No support could be established for the notion that computers are used more by one gender and less by the other at school. It would seem that males and females equally use, or for that matter equally do not use computers, in either lesson preparation and record-keeping ($\chi^2=3.26; df=4; p=0.52$) or more generally in the classroom ($\chi^2=0.47; df=4; p=0.98$).

Speculation about gender usage patterns should be treated with caution. However, three potential scenarios may be worth pursuing in future research. Firstly, female teachers have developed more effective mechanisms that enable them to overcome barriers to school computer use than their male counterparts. Secondly, males and females face barriers to the use of computers, but different sets. Finally, the set of barriers faced by all teachers, regardless of gender is so powerful that it negates any advantage that males may gained through better home access.
5.2.4 Teachers' School Use of Computers and Teaching Position

There is a general expectation for executive teachers to model appropriate administrative and pedagogical practices to those teachers they supervise. Would it not therefore be a reasonable proposition to expect executive teachers to model best practice with respect to computers? Such an expectation should translate into executive teachers utilising computers more to aid lesson preparation and record-keeping as well as using them as tools for learning. Chi-square analysis was used to test those expectations.

In the case of lesson preparation and record-keeping use of computers, executive teachers did use computers more often than classroom teachers ($\chi^2=14.32; df=4; p=0.006$) – see Table 5.6. This difference in usage probably reflects differences in workload between classroom teachers and executive teachers.

### Table 5.6 Teachers’ Teaching Position and Lesson Preparation and Record-keeping Use of Computers

<table>
<thead>
<tr>
<th>Pattern of Use</th>
<th>Teaching Executive N (%)</th>
<th>Position Classroom N (%)</th>
<th>Total N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>15 (39.5)</td>
<td>23 (13.9)</td>
<td>38 (18.7)</td>
</tr>
<tr>
<td>More than once per week</td>
<td>9 (23.7)</td>
<td>50 (30.3)</td>
<td>59 (29.1)</td>
</tr>
<tr>
<td>Weekly</td>
<td>7 (18.4)</td>
<td>32 (19.4)</td>
<td>39 (19.2)</td>
</tr>
<tr>
<td>Once per month</td>
<td>5 (13.2)</td>
<td>39 (23.6)</td>
<td>44 (21.7)</td>
</tr>
<tr>
<td>Never</td>
<td>2 (5.3)</td>
<td>21 (12.7)</td>
<td>23 (11.3)</td>
</tr>
<tr>
<td>Total</td>
<td>38 (100)</td>
<td>165 (100)</td>
<td>203 (100)</td>
</tr>
</tbody>
</table>

It would appear though that this pattern of usage did not translate into the use of computers as tools for teaching ($\chi^2=3.64; df=4; p=0.46$) – see Table 5.7. That is, while executive teachers may use computers more for out of class activities, they are just as likely (or not likely) to use computers in classrooms as the teachers they supervise.
### Table 5.7  Teachers’ Teaching Position and General Classroom Use of Computers

<table>
<thead>
<tr>
<th>Pattern of Use</th>
<th>Teaching Executive N (%)</th>
<th>Position Classroom N (%)</th>
<th>Total N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>9 (25.0)</td>
<td>27 (16.9)</td>
<td>36 (18.4)</td>
</tr>
<tr>
<td>More than once per week</td>
<td>9 (25.0)</td>
<td>30 (18.8)</td>
<td>39 (19.9)</td>
</tr>
<tr>
<td>Weekly</td>
<td>5 (13.9)</td>
<td>18 (11.3)</td>
<td>23 (11.7)</td>
</tr>
<tr>
<td>Once per month</td>
<td>7 (19.4)</td>
<td>51 (31.9)</td>
<td>58 (29.6)</td>
</tr>
<tr>
<td>Never</td>
<td>6 (16.7)</td>
<td>34 (21.3)</td>
<td>40 (20.4)</td>
</tr>
<tr>
<td>Total</td>
<td>36 (100)</td>
<td>160 (100)</td>
<td>196 (100)</td>
</tr>
</tbody>
</table>
5.3 Are there Differences in Computing Skill amongst Teachers?

5.3.1 Teachers’ Self-rated Computing Skill

Teachers self-rated computing skill into one of five categories, assessing self-perceptions of skill rather than the skills themselves. While perceptual measures may be subject to more error than comparable objective measures, research has demonstrated a significant, positive correlation between subjective and objective measurement of skill (Karsten & Roth, 1998).

The distribution of teachers’ responses is shown graphically in Figure 5.1. Figure 5.1 shows a modal group of teachers in a middle category and a distribution with a slight, positive skew of teachers’ perceptions of their own skills. While this positive skew is quite small, it would require a markedly negatively skewed distribution (teachers showing self-assurance in their skills), to assure one that computers were being integrated into schools with relative ease.

![Figure 5.1: Teacher Self-rated Computing Skill](image)

To further illustrate this point, 24.4% of the teachers surveyed (Technology schools 28.2%; Comprehensive schools 26.0%; Selective schools 16.3%) self-rated themselves above average or higher. It may well be that in the current study, low levels of expertise among secondary teachers in Western Sydney indicate that teachers are generally lacking the basic computing skills to effectively integrate computers across the curriculum.

In a similar study, Winnans and Sardo-Brown (1992) reported that 21% of respondents rated their computer expertise above average or higher. Based on these data, the authors concluded...
that there was little self-efficacy with regard to computer expertise, that is, teachers were not so much lacking training, but lacking extensive and continuing training in using computers.

Will initiatives like the Department of Education and Training's TILT program have any impact upon computing skills among teachers like those established in this study who believe their skills to be below average or lower? Targeting the lowest computing skilled teachers (the one-third who self-rated Low or Below Average) is indeed admirable, but what if Winnans and Sardo-Brown (1992) were correct in their interpretation of low computing skill levels among teachers? What then is the likely long-term effect of a thirty-hour course like TILT? The answer is probably limited, for without a significant commitment to ongoing training within schools the problems one associates with a lack of self-efficacy will not disappear.

Similar modal patterns to those displayed in Figure 5.1 were evident within each of the specific school types. Teachers' responses based on school type are shown in Figure 5.2.

![Bar chart showing teacher self-rated computing skill by school type]

**Figure 5.2** Teacher Self-rated Computing Skill by School Type

A visual comparison using Figure 5.2 suggests those teachers in Technology High Schools and Comprehensive High Schools rated their computing skills more highly than did teachers in Selective High Schools. This neat conclusion could lead one to believe that efforts to promote teachers' computing skills may be more problematic for Selective High Schools thus, even with meaningful training the task of integrating computers across the curriculum would have to be more difficult for Selective High Schools. A Kruskal-Wallis one-way ANOVA based on ranks did not yield support for this assertion ($\chi^2=4.89; df=2; p=0.09$).
Nonetheless, conjecture remains as to the educational impact of between school type difference in self-rated computing skill. Alford (1993) provided evidence for Western Sydney secondary schools that technology integration was clearly influenced by levels of teachers’ computing skills.

5.3.2 Teachers' Self-rated Computing Skill and Gender

Previous studies of teachers’ use of computers have reported gender differences in computer expertise (Robertson, et. al., 1995). Table 5.8 displays teachers’ recognition of their computing skill according to gender.

Table 5.8 Teacher Self-rated Computing Skill by Gender

<table>
<thead>
<tr>
<th>Rating of Skills</th>
<th>Teacher Gender</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female N (%)</td>
<td>Male N (%)</td>
<td>Total N (%)</td>
</tr>
<tr>
<td>Low</td>
<td>16 (15)</td>
<td>13 (14)</td>
<td>29 (14)</td>
</tr>
<tr>
<td>Below Ave</td>
<td>28 (26)</td>
<td>11 (12)</td>
<td>39 (19)</td>
</tr>
<tr>
<td>Ave</td>
<td>48 (44)</td>
<td>38 (40)</td>
<td>86 (42)</td>
</tr>
<tr>
<td>Above Ave</td>
<td>14 (13)</td>
<td>17 (18)</td>
<td>31 (15)</td>
</tr>
<tr>
<td>High</td>
<td>2 (0)</td>
<td>16 (17)</td>
<td>18 (9)</td>
</tr>
<tr>
<td>Total</td>
<td>108 (100)</td>
<td>95 (100)</td>
<td>203 (100)</td>
</tr>
</tbody>
</table>

Female teachers in the study self-rated their computing skills lower than male teachers. Only 15% of female teachers rated their skills as “high” or “above average” compared with a corresponding figure of 35% for males, while fewer males (26%) self-rated their skills as “below average” or “low” when compared with females (41%). The differences in self-rated computing skill between males and females illustrated in Table 5.8, were found to be significant ($\chi^2=19.31; \text{ df}=4; p=0.0007$). It is clear that female teachers believed their computing skills to be lower than their masculine peers did. If male teachers are indeed more highly skilled then efforts have to be directed at redressing the imbalance, given the comparable percentages of female and male teachers in Department of Education and Training.
secondary schools and the school system in general. In addition, if higher skill levels transfer to greater use of computers in the curriculum by male teachers, then this may signal to girls that computing is a male domain.

5.3.3 Teachers’ Self-rated Computing Skill and Use of Computers

Teachers’ use of computers (Section 5.2) carried no surprises, and when factored against teachers’ computing skills expected relationships emerge. Simple rank order correlation (used in preference to Pearson product moment since self-rated computing skill was measured on an ordinal scale) explored the relationship between self-rated computing skill and teachers’ use of computers. The analysis revealed teachers’ lesson preparation and record-keeping use of computers was moderately correlated with teachers’ self-rated computing skill ($r_{ho}=0.57; df=202; p<0.001$).

A common approach to promoting teacher computing skill has been to encourage the use of computers as personal productivity tools within lesson preparation and record-keeping tasks – writing teaching and learning programs, developing teaching units, creating lesson plans, producing resources, storing and manipulating raw marks, obtaining student data etc. Indeed, it is most likely that as new personal productivity tools like electronic mail and web browsers become the norm, they too will be seen as promoters of computing skill.

It would be difficult to accept further improvement in teachers’ computing skill could arise from their use of school-based computers as personal productivity tools, now that 94.6% of teachers ($N=206$) - see Section 5.2.1 have immediate access to computers at school for administrative purposes. Such change would more than likely have to be based upon some qualitative change in teachers’ administrative interactions with computers rather than improved access alone.

Teachers’ general teaching and learning use of computers also moderately correlated with teachers’ self-rated computing skill ($r_{ho}=0.49; df=195; p<0.001$). This says computing skill and classroom use of computers are linked however, which computing skill(s) is as problematic as is causality. No effort was made to distinguish between generalist computing skills - how to use a word processor - and pedagogic computer skills - how to use a word processor to promote literacy or other outcomes. It is quite feasible that some transfer from
generalist to pedagogic situations occurs, though an over reliance upon transference would be an inefficient way to promote pedagogic computer use by teachers.

There were differences in self-rated computing skills between teachers who were able to access a computer at home and those who could not ($\chi^2=25.34; df=4; p=0.00004$), suggesting access may well be important in the development of computing skill. Simply, access to a computer (home or elsewhere) provides an opportunity to develop long-term interaction patterns that serve to promote computing skill. Probably as important and something not measured in this context, are the qualitative issues associated with that access. This point was canvassed earlier.

As difficult as it was to foresee further improvement in teachers' computing skill through school-based interactions, it too would be difficult to foresee differences in self-rated computing skill arising from differential home access dissipating with time. Teachers already enjoy elevated levels of home access to computers, when compared with the rest of the community – see Section 5.2.2. It is highly probable that a major contributor to the differences in self-rated computing skill based on home access, has been teachers actively bringing computers into their homes. This is an area that deserves further consideration.

On the other hand, minimising gender differences in home access to computers may lead to some improvements in self-rated computing skill, at least across this sample of teachers – see Section 5.2.3. Already some private schools offer all teachers (male and female) portable computers as part of their employment package. Within the Department of Education and Training there are similar options available through a salary sacrifice scheme. To reiterate, improved access should not be considered the only way to guarantee improved teacher computing skill even though computing skills are most probably a function of actively using computers.

Thus, for teachers' computing skill (generalist or pedagogic) to improve, paradigm shifts may be necessary to effect transformations in teachers' interactions with information technology. That is, improving access to computers alone may be insufficient. Incentives (or requirements for that matter) that promote a qualitative shift in the intersection of a teachers' performance of their job and their use of information technology in teacher tasks may be a reasonable first step of any shift.
5.3.4 Teachers’ Self-rated Computing Skill and K L A

Table 5.9 displays a breakdown of teachers’ self-rated computing skills by Key Learning Area (KLA). Except for the LOTE and PDHPE KLAs, the modal category in which teachers in each KLA self-rated their computing skill was ‘average’. In line with the general trend, there was a slight positive skew within each KLA except for TAS and Science. The negative skew within TAS and Science reflects the common location of teachers delivering computing based subjects in the curriculum. See section 5.4.5.

Table 5.9 Teachers’ Self-rated Computing Skill by Key Learning Area

<table>
<thead>
<tr>
<th>Key Learning Area</th>
<th>Low (1)</th>
<th>Below Ave (2)</th>
<th>Ave (3)</th>
<th>Above Ave (4)</th>
<th>High (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Maths</td>
<td>6</td>
<td>2</td>
<td>12</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Science</td>
<td>1</td>
<td>5</td>
<td>11</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>HSIE</td>
<td>6</td>
<td>2</td>
<td>16</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LOTE</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PDHPE</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>TAS</td>
<td>3</td>
<td>7</td>
<td>15</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>C&amp;PA</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Sp. Ed.</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

According to McNamara and Pedigo (1995) a lack of perceived skill translates into a lack of preparedness to incorporate computers into the classroom. Table 5.5 shows lack of perceived skill and, by implication, a lack of preparedness to incorporate computers into the classroom by teachers across the secondary school curriculum. In a majority of KLAs more teachers reported that they perceived their computing skills to be below average or lower than do report their computing skills to be above average or higher.

In the TAS and Science KLAs more teachers perceived their computing skills to be above average or higher than below average or lower - see Table 5.9. Thus, teachers of TAS and Science who perceive their computing skills to be average or lower, appear to be in a better position to improve those skills through peer mentor relationship with a KLA colleague. Even so, on average there are two teachers in need of assistance in those KLAs for every teacher who may be capable of providing it. As for the other KLAs, the ratio is much closer to seven
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to one. Furthermore, the situation would be compounded if adjustments were made for the number of schools within the sample.

Consider the case of Special Education teachers – Table 5.9. As a group, the ratio of Special Educators who may be capable of mentoring to those who require support was two to one (this was the case in the TAS and Science KLAs), with the pool of above average or higher computer skilled teachers across the sample at four. However, factoring in that all schools in the sample employed Special Education teachers, on average, there would be only one potential Special Education mentor per two schools. If Special Education teachers wished to enter a peer mentor relationship as a way of improving their computing skill they would most likely have to do this with a teacher from another KLA.

Generic computing skills alone are insufficient to support integration (Newhouse, 1995). In addition, teachers must identify significant tasks within the curriculum to which computers can be applied. Thus, the potential for the integration of computers within a KLA is somewhat dependent upon teachers possessing computing skill and the pedagogical understanding to utilise that capacity.

A simple interpretation of the data in Table 5.9 would suggest that efforts should be directed to lifting teachers’ individual computing skill levels. However, there is a more urgent need to make teachers aware that they need both computing skills and pedagogical understanding if computers are to be successfully integrated across the secondary school curriculum. This has to be the basis of any effort aimed at increasing classroom use of information technology across the curriculum.

NSW Department of Education and Training initiatives (TILT) identified in Chapter 2 have provided a springboard for raising teacher’s awareness of the complementarity between computing skills and pedagogic skill. No doubt new training initiatives will continue this perspective. However, if initiatives continue to be delivered away from school contexts, what guarantees are there that teachers will have appropriate backup and support when they return to their schools?

Can schools sustain a ‘grassroots’ program to build upon central training initiatives (as this was a priority that respondents wanted from their training – see Section 5.4.5)? The answer is a qualified yes, but both the bureaucracy and the schools will have to realise that backup and support are required after the formal training has finished in order to transform the benefits into sustainable practice.
5.4 Are there Differences in Computing Knowledge amongst Teachers?

5.4.1 Teachers’ Formal Computing Training

Teachers were asked four questions about their knowledge of computing and computers as tools for learning. The questions focussed on formal study, how much additional knowledge teachers believed they required and how they would like to acquire that knowledge.

Table 5.10 displays information about teachers’ formal training in computing and/or computers as tools for learning. In total, 31.2% of teachers reported that they had undertaken some formal study with respect to computers, with training at the postgraduate level (10.2%) the most common form. Based on the percentage data for the Postgraduate category many teachers have undertaken formal computing training after completing their initial teacher training.

Table 5.10 Teachers’ Formal Training in Computing and/or Computers as Tools for Learning

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate Degree</td>
<td>19</td>
<td>9.3</td>
</tr>
<tr>
<td>Postgraduate Coursework</td>
<td>21</td>
<td>10.2</td>
</tr>
<tr>
<td>TAFE Course</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>Other*</td>
<td>20</td>
<td>9.8</td>
</tr>
<tr>
<td>No Formal Training</td>
<td>141</td>
<td>68.8</td>
</tr>
<tr>
<td>Total</td>
<td>205</td>
<td>100</td>
</tr>
</tbody>
</table>


When teachers were asked about additional knowledge of computers as tools for learning, 99% stated they would like to hold additional knowledge – see Question 15, Appendix 4. Teachers, regardless of whether or not they had formal training, willingly acknowledged the need for additional training to effectively promote the integration of computers across the secondary school curriculum.

Teachers were also asked to identify sources from which additional knowledge about the uses of computers as tools for learning could be sought. Almost eight out of ten teachers (78.5%) indicated one source, while one in ten (11.2%) indicated two sources. Teacher responses are summarised in Table 5.11.
Table 5.11 Teachers’ Preferred Sources of Additional Computing Knowledge

<table>
<thead>
<tr>
<th>Source of Learning</th>
<th>Number of Responses</th>
<th>Responses as a percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>School based Inservice</td>
<td>115</td>
<td>38.6</td>
</tr>
<tr>
<td>A school colleague</td>
<td>56</td>
<td>18.8</td>
</tr>
<tr>
<td>Self teaching</td>
<td>49</td>
<td>16.4</td>
</tr>
<tr>
<td>Inservice outside of school</td>
<td>36</td>
<td>12.1</td>
</tr>
<tr>
<td>Consultant</td>
<td>30</td>
<td>10.1</td>
</tr>
<tr>
<td>University</td>
<td>12</td>
<td>4.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>298</td>
<td>100</td>
</tr>
</tbody>
</table>

It is fair to say that teachers want computer training to be undertaken within their school. More than a third of responses (38.6%) preferred school-based inservice as the method for acquiring the knowledge necessary to integrate computers. Furthermore, almost one in five responses assumed a school colleague or mentor could be an essential support mechanism. As for external sources, teachers were less interested in pursuing additional knowledge delivered away from school contexts (Inservice outside of school – 12.1%; University – 4.0%), or by individuals removed from the school (Consultants – 10.1%).

For some, the disposition toward school-based solutions is recognition that learning how to integrate computers is best undertaken in the environment where integration is to occur. For others, school-based solutions offer opportunities to manage time effectively, while for still others, support for self-teaching could reflect a belief in lifelong learning to maintain professional status. Finally, lower responses for knowledge sources removed from school contexts could be characteristic of a greater concern for practical and pragmatic (simple) solutions over more theoretically based pedagogical interpretations.

Further analysis of teachers’ formal computing training was undertaken at two levels. The first tier sought to identify between group differences. That is, were there differences between those teachers who undertook formal computing training and those that did not? The second tier used only the responses from teachers who had indicated that they had undertaken formal computing training. The purpose was to examine the nature of the formal training experience.
5.4.2 Teachers' Formal Computing Training and Gender

Teachers' formal computing training was examined for gender differences from two perspectives. Firstly, was one gender of teacher more or less likely to engage in formal training than the other? Secondly, how comparable was the training experience of male and female teachers?

Table 5.12 illustrates the distribution of males and females between formal and no formal training. Unlike computing skill, where there was a noticeable difference in favour of males, it was found that neither gender was more or less predisposed to formal training ($\chi^2 = 1.7; df = 1; p = 0.2$).

Table 5.12 Teachers' Formal Computing Training and Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Total</td>
</tr>
<tr>
<td>Formal</td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
</tr>
<tr>
<td>Training</td>
<td>30 (27.5)</td>
<td>34 (36.2)</td>
<td>64 (31.5)</td>
</tr>
<tr>
<td>No Formal Training</td>
<td>79 (72.5)</td>
<td>60 (63.8)</td>
<td>139 (68.5)</td>
</tr>
<tr>
<td>Total</td>
<td>109 (100)</td>
<td>94 (100)</td>
<td>202 (100)</td>
</tr>
</tbody>
</table>

Table 5.13 displays the distribution of males and females between various types of formal computer-based training. Note: The previously identified Formal Training category of TAFE was collapsed into Other Types of Formal Training to minimise distortion in the chi-square ($\chi^2$) statistic caused by expected cell frequencies being less than 5 (Tuckman, 1988).

Table 5.13 Type of Formal Computing Training and Teacher Gender

<table>
<thead>
<tr>
<th>Formal Training</th>
<th>Gender</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>6 (20.0)</td>
<td>13 (38.2)</td>
<td>19 (29.7)</td>
<td></td>
</tr>
<tr>
<td>Postgraduate</td>
<td>8 (26.7)</td>
<td>13 (38.2)</td>
<td>21 (32.8)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>16 (53.3)</td>
<td>8 (23.5)</td>
<td>24 (37.5)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30 (100)</td>
<td>34 (100)</td>
<td>64 (100)</td>
<td></td>
</tr>
</tbody>
</table>
Accordingly, when female and male teachers engaged in formal training there was a difference in the type of training undertaken (χ²=6.2; df=2; p=0.04). In a majority of cases in this sample, female teachers preferred to formalise their computing knowledge through non-university sources, male teachers chose to formalise their knowledge base through university study. Caution should be shown if interpreting this result generally.

5.4.3 Teachers’ Formal Computing Training and Use of Computers

Do teachers with formal computing training use computers more often in teaching and learning than their colleagues without formal computer training? To test these assertions Mann-Whitney U tests were conducted. The outcomes are contained in Table 5.14.

Table 5.14  Mann-Whitney U Tests on Formal Computing Training and Use of Computers

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Formal Training</th>
<th>No Formal Training</th>
<th>Formal Training</th>
<th>No Formal Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>64</td>
<td>139</td>
<td>61</td>
<td>135</td>
</tr>
<tr>
<td>R</td>
<td>88.02</td>
<td>108.44</td>
<td>88.18</td>
<td>103.16</td>
</tr>
<tr>
<td>U</td>
<td>3553.5</td>
<td>5633.5</td>
<td>3488.0</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>5379.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z₀</td>
<td>-2.36</td>
<td></td>
<td>-1.76</td>
<td></td>
</tr>
<tr>
<td>p (2-tail)</td>
<td>0.02</td>
<td></td>
<td>0.08</td>
<td></td>
</tr>
</tbody>
</table>

The Mann-Whitney U Test would appear to support the notion that teachers’ preparation and record-keeping use of computers is influenced by whether or not formal training has been undertaken (U=3553.5; Z₀=-2.36; p=0.02). However, the value of U reported by SPSS was with corrections for ties, which increases the calculated value of U and so tends to make a result more significant than it would be without ties. Thus, given the 2-tail value of p it also would be wise to take a more conservative approach to the interpretation of this result.

Teachers’ general use of computers in teaching and learning was not found to be influenced by formal training (U=3488; Z₀=-1.76; p=0.08). It would appear that there is no difference in
general classroom computer use between formally trained teachers and those teachers without formal training. Could it be that differences exist only between a sub-group of the formally trained and the untrained? To test this position a Kruskal-Wallis one-way ANOVA based on ranks was performed. This analysis revealed that there were significant differences for general classroom use of computers among the sub-groups ($\chi^2=11.57; df=3; p=0.009$).

The Kruskal-Wallis test however, does not reveal which groups are significantly different. Further nonparametric analyses using the Mann-Whitney U test identified where the significant differences lie. In this instance, that difference was between teachers with postgraduate computing qualifications and teachers with no formal qualifications ($U=768.5; Z=-3.39; p=0.0007$) and with teachers holding other formal qualifications ($U=116; Z=-2.87; p=0.004$). Such a finding supports the view that the type of training provided in postgraduate educational computing programs fills the (computing) pedagogical knowledge gap.

5.4.4 Teachers' Formal Computing Training and K L A

Table 5.15 illustrates teachers' level of formal computing training with respect to Key Learning Area. In all Key Learning Areas the number of teachers without formal computing training exceeds the number of teachers with formal training. In the majority of KLAs, the ratio of teachers with no formal training to those with formal training exceeds two to one.

Table 5.15 Teachers' Level of Formal Computing Training by Key Learning Areas

<table>
<thead>
<tr>
<th>Key Learning Area</th>
<th>Formal Training</th>
<th>Other</th>
<th>Training</th>
<th>No Formal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undergrad</td>
<td>Post grad</td>
<td>Formal</td>
<td>No Formal</td>
<td>Total</td>
</tr>
<tr>
<td>English</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>Maths</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Science</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>HSIE</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>LOTE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>PDHPE</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>TAS</td>
<td>4</td>
<td>10</td>
<td>4</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>C&amp;PA</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Sp. Ed.</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>20</td>
<td>24</td>
<td>63</td>
<td>136</td>
</tr>
</tbody>
</table>
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The greatest number of teachers with undergraduate qualifications corresponds with the Pure and Applied Science domains – Mathematics, Science, TAS and PDHPE. As would be expected, the TAS KLA has the lowest proportion of no formal computer trained to formal computer trained teachers. Almost half of the TAS respondents (45.0%) indicated that they have undertaken some formal computer-based training.

Teachers from the TAS KLA also possessed the most postgraduate qualifications in which computing-based training was undertaken. This is indicative of the response by TAS teachers to syllabus changes and the regrouping of subjects that followed the creation of Key Learning Areas in 1990.

Of particular interest is the Special Education group of teachers. As reported earlier, this group identified themselves separate from the KLAs. Data indicate that 41.7% of this group profess to have some formal qualification in computing, which may indicate a belief within the group that computers are tools that support students’ learning.
5.5 Teachers’ Attitude Towards Computers - The Scales

5.5.1 Introduction

Data on teacher attitudes toward computer use were collected and scrutinised. Initially, five aspects of teachers’ attitudes toward computers were identified within a case study of one Western Sydney Government Secondary School (Yakub, 1994). Grounding of those dispositions within the broader literature revealed support for seven constructs, which were operationally defined for a wider study analysing teachers’ intentions to use information technology. Data collected were subjected to a two-stage data reduction process – see Section 3.4.5, from which emerged thirteen scales – see Chapter 4. Those scales form the basis for discussion in this section.

Consideration of the thirteen scales was undertaken with respect to five other variables – Computer Use, Computer Skill, Computer-related Knowledge, Computer Access and Teacher Gender – identified in the literature and explored previously in Sections 5.2, 5.3 and 5.4. Attention was paid to the potential for type I error, reflecting the number of (potential) relationships that could be explored. Thus, only those relationships based on very conservative alpha levels are reported ($p = 0.002$).

Tables 5.16 and 5.17 summarise the outcomes of various t and ANOVA tests used to explore relationships between the mean scores of twelve of the scales and the independent variables. When statistically significant differences were detected using ANOVA techniques, the Student-Newman-Kuels (S-N-K) multiple range test was used to determine which group means differed significantly (Tuckman, 1988). The thirteenth scale, Access to Resources, presented a special instance of teachers’ responses that was best summarised through reference to measures of central tendency.

Nonetheless, the picture to emerge was that underlying attitudes helped to explain the uptake of computers by teachers in this sample of secondary schools.
### Table 5.16: A Summary of Relationships between Teachers’ Attitudes, Self-rated Computer Skill and Use of Computers.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Computer Lesson Prep</th>
<th>Use General Classroom</th>
<th>Self-rated Computer Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Anxiety – Adequacy when interacting with computers</td>
<td>$F = 20.64^*$</td>
<td>$F = 8.16^*$</td>
<td>$F = 45.07^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,126$</td>
<td>$df = 4,126$</td>
<td>$df = 4,126$</td>
</tr>
<tr>
<td></td>
<td>$p &lt; 0.0001$</td>
<td>$p &lt; 0.0001$</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>Computer Anxiety – Fear of the Unknown</td>
<td>$F = 26.17^*$</td>
<td>$F = 11.88^*$</td>
<td>$F = 41.84^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,124$</td>
<td>$df = 4,124$</td>
<td>$df = 4,124$</td>
</tr>
<tr>
<td></td>
<td>$p &lt; 0.0001$</td>
<td>$p &lt; 0.0001$</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>Computer Competence – Expectations of Success</td>
<td>$F = 26.04^*$</td>
<td>$F = 15.04^*$</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>$df = 4,114$</td>
<td>$df = 4,114$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p &lt; 0.0001$</td>
<td>$p &lt; 0.0001$</td>
<td></td>
</tr>
<tr>
<td>Computer Competence – Capacity to Actualise Outcomes</td>
<td>$F = 6.44^*$</td>
<td>$F = 6.27^*$</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>$df = 4,117$</td>
<td>$df = 4,117$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p = 0.0001$</td>
<td>$p = 0.0001$</td>
<td></td>
</tr>
<tr>
<td>Relevance of Computers – upon Students as Learners</td>
<td>NA</td>
<td>NA</td>
<td>$F = 1.92$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,120$</td>
<td>$df = 4,120$</td>
<td>$p = 0.11$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.099$</td>
<td>$p = 0.099$</td>
<td></td>
</tr>
<tr>
<td>Relevance of Computers – within Teacher-Created Learning Environments</td>
<td>NA</td>
<td>NA</td>
<td>$F = 2.24$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,119$</td>
<td>$df = 4,119$</td>
<td>$p = 0.07$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.008$</td>
<td>$p = 0.008$</td>
<td></td>
</tr>
<tr>
<td>Pedagogical Practices – Assimilation of Computers</td>
<td>NA</td>
<td>NA</td>
<td>$F = 7.19^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,100$</td>
<td>$df = 4,100$</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.0002$</td>
<td>$p = 0.0002$</td>
<td></td>
</tr>
<tr>
<td>Pedagogical Practices – Prescribed Learning Outcomes</td>
<td>NA</td>
<td>NA</td>
<td>$F = 22.55^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,99$</td>
<td>$df = 4,99$</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td></td>
<td>$p &lt; 0.0001$</td>
<td>$p &lt; 0.0001$</td>
<td></td>
</tr>
<tr>
<td>Staff Development – General Engagement in Training</td>
<td>$F = 1.62$</td>
<td>$F = 0.62$</td>
<td>$F = 6.21^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,118$</td>
<td>$df = 4,118$</td>
<td>$df = 4,118$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.17$</td>
<td>$p = 0.65$</td>
<td>$p = 0.0001$</td>
</tr>
<tr>
<td>Staff Development – School-based Training</td>
<td>$F = 10.18^*$</td>
<td>$F = 2.34$</td>
<td>$F = 18.52^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,121$</td>
<td>$df = 4,121$</td>
<td>$df = 4,121$</td>
</tr>
<tr>
<td></td>
<td>$p &lt; 0.0001$</td>
<td>$p = 0.06$</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>Policy Formulation – Effective Leadership</td>
<td>$F = 2.57$</td>
<td>$F = 4.54^*$</td>
<td>$F = 0.71$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,116$</td>
<td>$df = 4,116$</td>
<td>$df = 4,116$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.04$</td>
<td>$p = 0.001$</td>
<td>$p = 0.59$</td>
</tr>
<tr>
<td>Policy Formulation – Teacher Involvement</td>
<td>$F = 3.58$</td>
<td>$F = 2.94$</td>
<td>$F = 2.37$</td>
</tr>
<tr>
<td></td>
<td>$df = 4,115$</td>
<td>$df = 4,115$</td>
<td>$df = 4,115$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.008$</td>
<td>$p = 0.02$</td>
<td>$p = 0.05$</td>
</tr>
</tbody>
</table>

$p \leq 0.002$ Bonferroni corrected significant value

* Significant difference

NA Analysis Not Applicable
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#### Table 5.17

A Summary of Relationships between Teachers’ Attitudes, Gender, Formal Computer Training and Home Access to Computers.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Formal Training</th>
<th>Home Access</th>
<th>Gender</th>
</tr>
</thead>
</table>
| **Computer Anxiety – Adequacy when interacting with computers** | \( t = -2.47 \)  
\( df = 126 \)  
\( p = 0.02 \) | \( t = -4.36^* \)  
\( df = 126 \)  
\( p < 0.001 \) | \( t = 1.05 \)  
\( df = 126 \)  
\( p = 0.30 \) |
| **Computer Anxiety – Fear of the Unknown**           | \( t = -4.76^* \)  
\( df = 124 \)  
\( p < 0.001 \) | \( t = -4.47^* \)  
\( df = 124 \)  
\( p < 0.001 \) | \( t = 2.39 \)  
\( df = 124 \)  
\( p = 0.02 \) |
| **Computer Competence – Expectations of Success**    | \( t = 2.84 \)  
\( df = 114 \)  
\( p = 0.005 \) | \( t = 5.00^* \)  
\( df = 114 \)  
\( p < 0.001 \) | \( t = -2.30 \)  
\( df = 114 \)  
\( p = 0.02 \) |
| **Computer Competence – Capacity to Actualise Outcomes** | \( t = 1.98 \)  
\( df = 117 \)  
\( p = 0.05 \) | \( t = -3.29^* \)  
\( df = 117 \)  
\( p < 0.001 \) | \( t = 2.21 \)  
\( df = 117 \)  
\( p = 0.03 \) |
| **Relevance of Computers – upon Students as Learners** | \( t = 2.18 \)  
\( df = 120 \)  
\( p = 0.03 \) | \( t = 1.94 \)  
\( df = 120 \)  
\( p = 0.05 \) |                   |
| **Relevance of Computers – within Teacher-Created Learning Environments** | \( t = 2.16 \)  
\( df = 119 \)  
\( p = 0.03 \) | \( t = 1.18 \)  
\( df = 119 \)  
\( p = 0.24 \) |                   |
| **Pedagogical Practices – Assimilation of Computers** | \( t = -1.94 \)  
\( df = 100 \)  
\( p = 0.05 \) | \( t = 0.63 \)  
\( df = 100 \)  
\( p = 0.53 \) |                   |
| **Pedagogical Practices – Prescribed Learning Outcomes** | \( t = 4.56^* \)  
\( df = 99 \)  
\( p < 0.001 \) | \( t = -0.61 \)  
\( df = 99 \)  
\( p = 0.55 \) |                   |
| **Staff Development – General Engagement in Training** | \( t = -1.38 \)  
\( df = 118 \)  
\( p = 0.17 \) | \( t = -1.81 \)  
\( df = 118 \)  
\( p = 0.07 \) | \( t = 2.90 \)  
\( df = 118 \)  
\( p = 0.004 \) |
| **Staff Development – School-based Training**        | \( t = -4.30^* \)  
\( df = 121 \)  
\( p < 0.001 \) | \( t = -3.63^* \)  
\( df = 121 \)  
\( p < 0.001 \) | \( t = 3.40^* \)  
\( df = 121 \)  
\( p = 0.001 \) |
| **Policy Formulation – Effective Leadership**         | \( t = 1.10 \)  
\( df = 116 \)  
\( p = 0.27 \) | \( t = 0.26 \)  
\( df = 116 \)  
\( p = 0.80 \) |                   |
| **Policy Formulation – Teacher Involvement**         | \( t = 1.65 \)  
\( df = 115 \)  
\( p = 0.10 \) | \( t = 0.38 \)  
\( df = 115 \)  
\( p = 0.70 \) |                   |

\( p \leq 0.002 \)  
Bonferroni corrected significant value

* Significant difference

NA Analysis Not Applicable

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**Chapter 5**  
Results and Discussion  
Page 155
5.5.2 Teachers' Computer Anxiety

An extensive review of the literature identified apprehension towards computer use as a major influence upon teachers' intentions to use information technologies. From data collected about teachers' computer anxiety, two factors, adequacy when interacting with computers and fear of the unknown, were extracted using data reduction techniques – see Chapter 4. Within the factors identified, greater scores were indicative of higher levels of computer anxiety, which in practice would normally prompt lower levels of teacher engagement with information technologies. Tables 5.16 and 5.17 detailed the outcomes of a number of causal comparative tests using background variables as a means of differentiating the degree of computer anxiety among teachers in the sample. Those findings are explained in more detail below.

Teachers' Computer Anxiety and Use of Computers

Adequacy when Interacting with Computers

A comparison of mean adequacy when interacting with computers scores across groups of teachers based on their lesson preparation and record-keeping use of computers was undertaken using a one-way ANOVA. The computed $F$ for adequacy when interacting with computers reported in Table 5.16 was significant ($F=20.64; df=4,126; p<0.0001$). Post hoc comparisons using the Student-Newman-Keuls (S-N-K) technique (Popham & Sirotnik, 1992) were then applied to determine between group variations in mean scores – see Table 5.18.

### Table 5.18: S-N-K Multiple Range Test for Adequacy when Interacting with Computers and Teachers' Lesson Preparation and Record-keeping Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.72</td>
<td>Daily</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.27</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.89</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>11.16</td>
<td>Monthly</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.05</td>
<td>Never</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p <.05$
Post hoc analysis clearly differentiated teachers' feelings of adequacy when interacting with computers based on their lesson preparation and record-keeping use of computers. The mean adequacy score across teachers who used computers daily was 6.72. As a group, daily computer using teachers felt more in control, were more prepared to use computers as a first choice even if they were not expected to and found using computers enjoyable. On the other hand, the mean score for teachers who stated they never used computers in lesson preparation and record-keeping was more than double that of daily computer using teachers, reflecting their lack of control and hence strong feelings of inadequacy.

Thus, as teachers' interaction with computers increases their computer anxiety, arising from feelings of inadequacy decreases. Furthermore, there appear to be distinct stages through which teachers pass as their feelings of inadequacy diminish. The matrix in Table 5.18 did not reveal any difference between teachers who used computers weekly and those who used them more than weekly, suggesting that there may be four stages of anxiety associated with daily, regular, rare and no (never) use of computers for administrating learning.

A similar comparison of mean scores was then undertaken, based on teachers' general classroom use of computers. Again, the F for adequacy when interacting with computers was significant ($F=8.16; df=4,126; p<0.0001$). Results of post hoc S-N-K comparisons are shown in Table 5.19.

Table 5.19 S-N-K Multiple Range Test of Adequacy when Interacting with Computers and Teachers' General Classroom Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.43</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.71</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.24</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.57</td>
<td>Monthly</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>11.32</td>
<td>Never</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p<0.05$

S-N-K analysis of teachers' adequacy when interacting with computers based on general classroom use identified a different pattern of mean differences to that for lesson preparation and record keeping use. Gone was the highly differentiated pattern, instead there was contrast only between the very regular general classroom users of computers (using them daily or multiple times per week) and infrequent classroom users (using them monthly or never). In
this regard, using computers on a very regular basis in classroom contexts does appear to contribute to teachers feeling more adequate about using them.

There was no difference in mean scores between the weekly classroom user group and either of the very regular classroom user groups or the infrequent classroom user groups. Could it be that there is some threshold of classroom use of computers that, until teachers are regularly beyond it, their feelings of inadequacy about interacting in those contexts remain as a significant barrier? This question deserves further study.

Fear of the Unknown

A one-way ANOVA contrasting teachers’ lesson preparation and record-keeping use of computers with their mean scores for the computer anxiety factor fear of the unknown, indicated that $F$ was significant ($F=26.17; df=4,124; p<0.0001$) – see Table 5.16. Post hoc comparison of mean scores using S-N-K analysis are reported in Table 5.20.

Table 5.20

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.08</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.39</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.93</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.32</td>
<td>Monthly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.52</td>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p <.05$

Post hoc comparisons revealed another well-differentiated pattern. Daily users were the least fearful about using computers for lesson preparation and record-keeping. They felt that this type of computer use fitted their work well and as a consequence, they did not have to avoid it or feel uncomfortable around those who did or who talked about computers. Again, there is one group of regular lesson preparation and record-keeping users rather than separate multiple weekly and weekly users. It would also seem that when teachers’ fear of the unknown is taken into account, that there is no difference between monthly users and those who profess to never using as a computer as was the case with the factor adequacy when interacting with computers.
ANOVA techniques were used to compare mean fear of the unknown scores across teachers' general classroom use of computers. The computed F score was significant ($F=11.88; df=4,124; p<0.0001$) – see Table 5.16. S-N-K comparisons of mean fear of the unknown scores against teachers' general classroom use of computers are shown in Table 5.21.

Table 5.21 S-N-K Multiple Range Test for Fear of the Unknown and Teachers' General Classroom Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.21</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.82</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.00</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.02</td>
<td>Monthly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.08</td>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < 0.05$

Significant differences in teachers' mean fear of the unknown scores based on general classroom use were found between the daily, multiple weekly and weekly user groups and the monthly and never user groups. No significant mean score differences were found within the daily, multiple weekly and weekly user groups, nor within the monthly and never user groups. This would suggest two subsets of computer using teachers based on the factor fear of the unknown. Thus, using computers on a regular, probably timetabled basis in classroom contexts does appear to contribute to a reduction in teachers' fear of the unknown.

Overall, teachers' lower mean computer anxiety scores, be they adequacy when interacting with computers scores or fear of the unknown scores, were associated with higher degrees of engagement with computers. However, while regular (at least once per week) classroom use of computers diminished teachers' fear of the unknown, for teachers to feel more adequate about those interactions they required multiple classroom interactions per week.
Teachers' Intentions to Use Information Technologies:
A Study of Western Sydney Secondary Teachers

Teachers' Computer Anxiety and Self-rated Computing Skill

Adequacy when Interacting with Computers

A one-way ANOVA comparing mean adequacy when interacting with computers scores across groups of teachers based on their self-rated computing skill returned an $F$ score that was significant ($F=45.07$; $df=4,126$; $p<0.0001$). Analysis of group variations in mean scores (S-N-K comparisons), produced a pattern that strongly reflects varying levels of apprehension associated with teachers’ self-rated computing skill – see Table 5.22.

Table 5.22 S-N-K Multiple Range Test for Adequacy when Interacting with Computers and Teachers’ Self-rated Computing Skill

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Skill Level</th>
<th>High</th>
<th>Above Ave</th>
<th>Ave</th>
<th>Below Ave</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.23</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.65</td>
<td>Above Ave</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.53</td>
<td>Ave</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.14</td>
<td>Below Ave</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>14.30</td>
<td>Low</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < .05$

In Table 5.22 the mean scores for the high skill and above average skill groups were not sufficiently different. Nonetheless, the low-mean scores of these groups is recognition by those teachers of their perceived adequacy when interacting with computers when compared with the other self-rated computing skill groups of teachers. Indeed, the many between group differences clearly delineate the nature of this relationship, such that as teachers increase their interaction with computers and with other computer-using teachers both perceptions of adequacy when interacting with computers and self-rating of skill increase.

Fear of the Unknown

Inferential comparisons of mean fear of the unknown scores based on distinct self-rated computing skill groups returned a computed $F$ score that was significant ($F=41.84$; $df=4,124$; $p=0.0001$) – see Table 5.16. Post hoc S-N-K contrasts project the delineation in mean fear of the unknown scores – see Table 5.23.
The pattern of computer anxiety based on teachers’ self-rated computing skill was highly differentiated. In this instance between group differences were identified across all five categories of self-rated computing skill. The mean fear of the unknown score across teachers who self-rated their computing skill as high was 5.22 suggesting that as a group those teachers were comfortable using computers as tools for learning and were most probably actively integrating information technology into work tasks. On the other hand, the mean score of teachers self-rating their computing skill as low was triple that of those who self-rated high, reflecting a greater propensity by low-skilled teachers for avoiding interaction with computers.

Overall, the results comparing teachers’ self-rated computing skill with the computer anxiety factors adequacy when interacting with computers and fear of the unknown are a fairly conclusive indication that as teachers’ perceptions of their personal computing skill improves their apprehension towards computers diminishes.

Teachers’ Computer Anxiety and Formalised Computing Training

Fear of the Unknown

Teachers who had undertaken some kind of formal training in computing (X=7.61; s=3.33) displayed lower levels of fear of the unknown than did teachers who reported no formal training at all (X=10.48; s=4.20). A t-test for independent samples registered a significant difference between the fear anxiety state of the two groups of teachers (t=-4.76; df=124; p<0.001). Thus formal computing training would be an essential element in diminishing the fear some teachers attach to using computers. Appropriately designed formal computer training courses have been found to reduce fear and promote positive attitudes towards information technology (Häkkenin, 1994).
Teachers' Intentions to Use Information Technologies:
A Study of Western Sydney Secondary Teachers

Teachers' Computer Anxiety and Home Access

Adequacy when Interacting with Computers
Teachers with access to a computer at home \((X=8.58; \ s=3.74)\) perceived themselves to be more adequate when interacting with computers than did teachers who do not have home access to a computer \((X=11.26; \ s=3.99)\). A \(t\) test for independent samples supported this proposition \((t=-4.56; \ df=124; \ p<0.001)\). This kind of access provides teachers with an opportunity to develop more positive perceptions about their interactions with computers.

Fear of the Unknown
Another \(t\) test for independent samples \((t=-4.47; \ df=124; \ p<0.001)\) revealed that teachers with access to a computer at home \((X=8.76; \ s=3.77)\) also displayed significantly lower levels of fear of the unknown than did teachers who reported no home access to a computer \((X=11.51; \ s=4.36)\).

Together, the results inform us that using a home-based computer to engage in school-related tasks could be another component of a strategic approach to minimising computer anxiety. However, success in correcting computer anxiety outside of a formal-group computer-training environment would require teachers to maintain high levels of self-motivation (Knowles 1990). Thus, a relevant issue is whether using a computer for school related tasks at home supplements formal training or replaces it. If people with computerphobia are incapable of overcoming their fears without formal intervention then perhaps home access to a computer should be considered supplemental. This finding is especially important as two-thirds of the teachers who reported no access to a computer at home were women.
5.5.3 Teachers' Computer Self-Competence

Teachers' assessment of their capacity to use a computer was operationalised as a definition for computer self-competence. Following the application of data reduction techniques to teacher responses based on the operational definition, two factors expectations of success and capacity to actualise outcomes were extracted – see Chapter 4. Together, both factors provide insight into teachers' participation in school-related computer activities. For both factors, higher scores were indicative of greater optimism among teachers of their computer self-competence. This optimism would in practice be associated with higher levels of teacher engagement in school-related computer activities. Tables 5.16 and 5.17 detail the outcomes of a number of causal comparative tests using background variables as a means of differentiating levels of computer self-competence among teachers in the sample. Those findings are explained in more detail below.

Teachers' Computer Self-Competence and Use of Computers

EXPECTATIONS OF SUCCESS

A comparison of mean expectations of success scores across groups of teachers based on their lesson preparation and record-keeping use of computers was undertaken using a one-way ANOVA. The $F$ statistic reported in Table 5.16 was significant ($F=26.04; d.f=4,114; p<0.0001$). Post hoc comparisons using S-N-K techniques were undertaken to determine between group variations in mean scores. This analysis is summarised in Table 5.24.

Table 5.24 S-N-K Multiple Range Test for Expectations of Success and Teachers' Lesson Preparation and Record-keeping Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.58</td>
<td>Daily</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.82</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.61</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.80</td>
<td>Monthly</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.19</td>
<td>Never</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – p < .05
Post hoc analysis differentiated teachers’ expectations of success based on their lesson preparation and record-keeping use of computers. The mean expectations of success score across teachers who used computers daily was 17.58. As a group, daily computer using teachers felt at ease, knowing that they would not damage the computers, and believing that they were capable of keeping up with technology advances. Consequently, this group were the most confident about helping others use computers and above all, they were most prepared to use computers as tools for learning. On the other hand, the mean score for teachers who stated they never used computers in lesson preparation and record-keeping was almost half that of daily computer using teachers, reflecting their significantly lower expectations about successful computer interactions.

As teachers’ lesson preparation and record-keeping interaction with computers increases so to do their expectations of successful outcomes. Furthermore, this heightening of expectation would be indicative of a self-fulfilling prophecy. The matrix in Table 5.24 however, did not reveal any difference in expectations between teachers who used computers weekly and those who used computers more than weekly. Thus, it could be that there are four threshold levels of expectations of successful outcomes, with each level associated with either daily, regular, rare and no (never) use of computers for administrating learning.

A similar comparison of mean scores was then undertaken, this time based on teachers’ general classroom use of computers. Again, the computed F score for expectations of successful outcomes was found to be significant ($F=15.04; df=4,114; p<0.0001$) – see Table 5.16. The results of post hoc S-N-K comparisons are shown in Table 5.25.

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.86</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.82</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.60</td>
<td>Weekly</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.71</td>
<td>Monthly</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>11.94</td>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < .05$
Post hoc analysis of mean scores revealed that teachers who are regular classroom users of computers maintained higher expectations, supporting the view that there is a self-fulfilling aspect associated with regular use of computers in classroom contexts. That is, as teachers engage in more classroom computer use it is likely to lead to those teachers to engage in further classroom computer use believing that their practice will be successful.

Capacity to Actualise Outcomes

A one-way ANOVA contrasting teachers' lesson preparation and record-keeping use of computers with their mean scores for the computer competence factor capacity to actualise outcomes returned an F score that was significant ($F=6.44; df=4,117; p=0.0001$) – see Table 5.16. Further analysis using S-N-K post hoc comparisons of mean scores was completed – see Table 5.26.

Table 5.26 S-N-K Multiple Range Test for Capacity to Actualise Outcomes and Teachers’ Lesson Preparation and Record-keeping Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.89</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.94</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.78</td>
<td>Weekly</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.06</td>
<td>Monthly</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>10.22</td>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < .05$

The mean capacity to actualise outcomes score of teachers who used computers daily in lesson preparation and record-keeping was 13.89. Teachers who use computers daily do so because they are of the opinion that their level of computer self-competence is such that they will actualise outcomes when compared with the computer use of other groups of teachers. On the other hand, teachers who never use computers for lesson preparation and record keeping are of the opinion that their level of computer competence would be unlikely to lead to them to actualise outcomes when compared with teachers who are regular users of computers.

ANOVA techniques were again used to compare mean capacity to actualise outcomes scores across groups of teachers, this time based on their general classroom use of computers. The $F$
value reported in Table 5.16 was significant ($F=6.27; \, df=4.117; \, p=0.0001$). S-N-K comparisons were used to determine between group variations in mean scores — see Table 5.27.

Table 5.27  S-N-K Multiple Range Test for Capacity to Actualise Outcomes and Teachers’ General Classroom Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.82</td>
<td>Daily</td>
<td>⬤</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.18</td>
<td>&gt; Weekly</td>
<td>⬤</td>
<td>⬤</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.86</td>
<td>Weekly</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.82</td>
<td>Monthly</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>11.76</td>
<td>Never</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference — $p < .05$

S-N-K analysis revealed few between group variations in teachers’ capacity to actualise outcomes. However, the group variations that were identified through S-N-K analysis were between daily general classroom users of computers and teachers who used computers in classrooms less often (weekly or monthly) or not at all. Could it be that teachers require daily classroom contact with computers to produce within themselves levels of optimism sufficient for them to believe that they are indeed capable of effective classroom technology use?

**Teachers’ Computer Self-Competence and Formalised Computing Training**

**Expectations of Success**

A comparison of mean computer competence scores revealed teachers who had undertaken some kind of formal training in computing ($X=15.89; \, s=3.66$) held higher expectations of success than those teachers who reported no formal training at all ($X=14.26; \, s=3.84$). A $t$-test for independent samples registered a difference between the reported competence levels of the two groups of teachers ($t=2.84; \, df=114; \, p=0.005$), but it was not considered to be significant.

Rejection of the $t$ value of 2.84 however, presents the view that any relationship between teachers’ formalised computing training and expectations of success would be no more than a chance occurrence. This view arises because the study adopted a highly conservative alpha,
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designed to minimise the occurrence of Type I errors given the number of statistical tests undertaken. Type I errors involve accepting a relationship between variables under examination, when in reality no relationship exists between the variables. However, reducing the risk of a Type I error does increase the risk of committing a Type II error. Type II errors involve rejecting a relationship between variables as a chance occurrence when indeed a relationship does exist.

Having said that, it would seem somewhat incongruent for teachers to engage in formalised computing training if that training was not to have some potential to influence a teacher’s optimism towards computer use being successful, be it related to lesson preparation and record-keeping or general classroom use. Rather than rejecting the relationship outright and therefore inferring that formalised computing training does not affect teachers’ beliefs about their computer competence, it may be prudent to accept that for this sample of teachers formalised computing training was not essential for improving all teachers’ expectations of success. Could it be that formalised computing training is but one of many elements in generating teachers’ optimism about their expectations of success in specific circumstances? If that is the case then the area warrants further examination.

Teachers’ Computer Self-Competence and Home Access

Expectations of Success
Teachers with access to a computer at home (X=15.62, s=3.49) held higher expectations for successful interaction with computers than did teachers who did not have home access to a computer (X=12.88; s=3.99). A t-test for independent samples (t=5.00; df=117; p<0.001) revealed that this difference in teachers’ mean scores was significant.

Capacity to Actualise Outcomes
Another t-test for independent samples (t=3.29; df=117; p=0.001) revealed that teachers who have access to a computer at home (X=12.88, s=2.38) were also more optimistic about their capacity to actualise outcomes than teachers without home access to a computer (X=11.66; s=2.50).
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With a computer based at home away from the stresses and strains of day to day teaching, there is an opportunity for teachers to invest discretionary time to interact with computers. Through regular contact with computers, teachers increase their chances of experiencing successful interactions with computers. It is this experience that is so important to the development of optimism about one's expectations of success and capacity to actualise outcomes. This is one reason why many private schools are providing computers to teachers as part of their package.

Teachers' optimism about their expectations of success and capacity to actualise outcomes comes from them building a repertoire of useful skills while engaging in task relevant activities. Using skills to satisfactorily complete tasks is a powerful reinforcer for positive attitudes. While this may be so in this instance, how this interaction can be translated into classroom practice remains problematic. Nonetheless, it does illustrate the potential for planners to construct circumstances that have the potential to lead to desired outcomes for using computers in education.

5.5.4 Teachers' Perceived Relevance of Computers
The suitability of computers as tools for learning is predicated on the belief that computer-based learning environments make a difference. Thus, teachers' feelings of the suitability of computers as tools for learning was considered to have a major bearing on (potential) interactions with information technology at school. Teachers' perceived relevance of computers was analysed and data reduction techniques identified two factors as influential – the relevance of computers upon students as learners and within teacher created learning environments – see Chapter 4. Teachers perceiving computers to be relevant tools for learning would score more highly on both factors and be expected to be interacting with computers at school. Tables 5.16 and 5.17 provide a summary of a number of tests exploring links between perceptions of relevance and background variables. For fairly obvious reasons some background variables were not tested against either factor. Only one test produced an alpha less than the level set.
Teachers' Perceived Relevance and Use of Computers

Teacher Created Learning Environments

A comparison of mean teacher created learning environments scores across groups of teachers based on their general classroom use of computers was undertaken using a one-way ANOVA. The computed $F$ reported in Table 5.16 was significant ($F=4.94; \text{df}=4.119; p=0.0008$). Post hoc S-N-K comparisons are summarised in Table 5.28.

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Wkly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.45</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.22</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15.78</td>
<td>Weekly</td>
<td></td>
<td></td>
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<tr>
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</tr>
<tr>
<td>14.29</td>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < .05$

Only two between group variations in mean teacher created learning environment scores based on teachers' general classroom use of computers were found to be significant. Post hoc analysis brought to light differences between the scores of teachers who used computers in their classrooms very regularly (daily $X=16.45$ and more than weekly $X=16.22$), and teachers who never used computers in classroom contexts ($X=14.29$). Very regular classroom computer using teachers perceived a greater role for computers in supporting cooperative social structures, catering for different abilities and learning styles as well as supporting students' attainment of communication, research and problem solving skills than did teachers who never use a computer in classrooms.

The use of a highly conservative alpha to determine the acceptance or rejection of a computed statistic has limited the capacity of other background variables as operationalised in this study, to explain fully teachers’ perceptions of the relevance of computers. Further research is therefore necessary before a more complete picture of teachers’ perceptions of the relevance of computers becomes available. For example, this research could examine the formal computing training experience of teachers in other ways. By identifying specific elements of that experience, schools could use that knowledge to encourage teachers to share a common set of beliefs about the relevancy of computers upon students as learners, and thereby intensify the
potency and permanence of the perception within teacher-created learning environments. Similarly, qualitative assessment could explain the subtly in computer using teachers beliefs about teacher-created learning environments as well as the basis for perceptions of the relevance of computers upon students as learners that was not possible in this study.

5.5.5 Teachers' Pedagogical Practices
Some teachers regularly use computers in their classroom and others do not. Among the group of non-regular users there are teachers predisposed to greater classroom computer use but because of various barriers they are yet to use technology more regularly. The aspects of pedagogical practice relevant to the study relate to the assimilation of computers into teachers’ teaching style and the impact of assimilation upon prescribed learning outcomes – see Chapter 4. For the factor assimilation of computers, teachers with higher scores had either assimilated or possessed the potential to assimilate computers into the practice more readily than teachers with lower scores. On the other hand, for the factor prescribed learning outcomes, higher scores were indicative of teachers who were least likely to willingly use a computer, that is this group of teachers would only use computers in learning if use was a course requirement. Tables 5.16 and 5.17 detail a number of significant relationships between teachers’ disposition towards pedagogical practices involving computers and (some of) the background variables operationalised in this study.

Teachers' Pedagogical Practices and Use of Computers
Assimilation of Computers
A one-way ANOVA contrasting teachers’ general classroom use of computers with their mean score for the pedagogical practices factor assimilation of computers indicated that $F$ was significant ($F=5.69; df=4,100; p=0.0002$) – see Table 5.16. Further analysis to determine between group variations in mean scores using S-N-K techniques is contained in Table 5.29.
Table 5.29  S-N-K Multiple Range Test for Pedagogical Practices
Factor Assimilation of Computers and Teachers’ General Classroom Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.47</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.27</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.59</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.82</td>
<td>Monthly</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.61</td>
<td>Never</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – p < .05

S-N-K techniques identified significant differences between the mean assimilation of computers scores of teachers who were very regular classroom users of computers (daily X=18.47 or more than weekly X=18.27) and teachers who were irregular classroom users of computers (monthly X=15.82 or never X=15.61). The difference in those scores reflects both differing perceptions of the value of using computers in classroom contexts and differing practices.

Very regular classroom users of computers were the most successful in assimilating computers into their practice. As a group, these teachers believed that this type of computer use gave them greater control over their work, providing opportunities for them to innovate and add variety to the lessons they presented. In this manner, those teachers believed they were able to individualise instruction.

On the other hand, the perceptions of irregular classroom computer-using teachers were that this type of computer use did not offer them the same control over their work patterns. Consequently, if this group of teachers were to innovate and introduce variety into lessons as well as individualise instruction they had to find and use other means. Irregular classroom computer using teachers were least successful in assimilating computers into their practice and for some there was a strong belief that computers would not enhance student learning.

Thus, there is a dichotomy in pedagogical belief and practice, similar to one described by Honey and Moeller (1990). Honey and Moeller believed the dichotomy distinguished ‘low-tech’ teachers from ‘high-tech’ teachers. With the focus in this study upon the assimilation of computers into teachers’ style of teaching, it appears that irregular users or ‘low-tech’ teachers either use other innovative approaches to teaching that have more to offer them or less innovative approaches are within their comfort zones. According to Honey and Moeller, those
'low-tech' teachers who used computers least were also the most likely of teachers to engage in more traditional pedagogical practices, perceiving computers to be a threat to their control of student learning and to the completion of work. 'Low-tech' teachers who engaged in more traditional pedagogical practices, always had reasons for minimising computer use.

Prescribed Learning Outcomes
A comparison of mean scores for the pedagogical practices factor prescribed learning outcomes across groups of teachers based on their general classroom use of computers was undertaken using a one-way ANOVA. The outcome reported in Table 5.16 indicated that $F$ was significant ($F=14.54; df=4.99; p<0.0001$). Post hoc S-N-K comparisons to determine between group variations in mean scores were then completed – see Table 5.30.

Table 5.30 S-N-K Multiple Range Test for Pedagogical Practices Factor Prescribed Learning Outcomes and Teachers' General Classroom Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Never</th>
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<tr>
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<td>Daily</td>
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</tr>
<tr>
<td>12.11</td>
<td>&gt; Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.26</td>
<td>Weekly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.79</td>
<td>Monthly</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.81</td>
<td>Never</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < 0.05$

Significant differences in teachers’ mean prescribed learning outcomes scores based on general classroom computing use were found between daily ($X=10.8$), multiple weekly ($X=12.11$) and weekly ($X=13.26$) user groups and the monthly (15.79) and never (17.81) user groups. As well, there was a significant difference between monthly and never user groups. The difference in mean scores between daily, multiple weekly and weekly user groups was not considered significant. This would suggest differences in beliefs about prescribed learning outcomes across three groups of classroom computer-using teachers.

Altogether, this knowledge provides more information of pedagogical discord between 'low-tech' and high-tech' teachers. As a group, regular classroom computer-using teachers were more or less inclined to use computers when possible, were able to adapt management
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strategies to fit computer use by students and saw computer use as relevant or more relevant than other teaching resources to the way they taught. These teachers were less likely to use computers just because computer use was prescribed and using computers in their opinion made achieving learning outcomes no more difficult for them.

As for teachers who never used computers, there was a strong perception that their teaching style could not be altered to fit computers and reasons for why they would have as little to do with computers as possible are quite clear. As a group, these teachers were more likely to state that traditional resources were more relevant to their way of teaching and as a consequence would only use computers if prescribed by syllabuses. In their opinion, using computers would make achieving desired outcomes more difficult.

The difference in beliefs about prescribed outcomes between not so regular classroom computer-using teachers (monthly) and teachers who never use computers in classrooms, is indicative of the transforming effect of computer use upon pedagogy (Miller & Olson, 1994). The difference between not so regular classroom computer-using teachers (monthly) and regular classroom computer-using teachers (daily, multiple weekly and weekly), reflects an amplification of practice. Thus, teachers do not have to use computers daily with their students for that use to transform and possibly amplify their practice. In the first instance teachers must simply be prepared to use computers. For greater pedagogical impact computer use must be regular and probably timetabled.

Teachers’ Pedagogical Practices and Self-rated Computing Skill

Assimilation of Computers

A one-way ANOVA comparing mean assimilation of computers scores across groups of teachers based on their self-rated computing skill returned an F score that was significant ($F=7.19; \; df=4,100; \; p<0.0001$). Analysis of group variations in mean scores (S-N-K comparisons), produced a pattern that reflected variations in pedagogical practices associated with teachers’ self-rated computing skill – see Table 5.32.
Differences in mean assimilation of computers scores were detected between groups of teachers who self-rated their computing skill as high, above average or average and groups of teachers who self-rated their computing skill as below average or low. No differences were detected between groups who self-rated their computing skill as high, above average or average or between groups of teachers who self-rated their computing skill as below average or low. Thus, teachers who self-rated their computing skill as below average or lower perceived themselves as more likely to be deficient in the skills needed to assimilate computers in their pedagogy, while groups of teachers who self-rated their computing skill as average or better believed they were better equipped in that regard.

Prescribed Learning Outcomes
Inferential comparisons of mean prescribed learning outcomes scores based on distinct self-rated computing skill groups returned a computed F score that was significant ($F=22.55; df=4.99; p<0.0001$) – see Table 5.16. Post hoc S-N-K contrasts project the delineation in mean prescribed learning outcomes scores – see Table 5.23.
Clear differences emerged in the pattern of mean *prescribed learning outcomes* scores. The mean *prescribed learning outcomes* score for each self-rated computing skill group was significantly different from each of the other groups, except for the mean scores of the above average and average self-rated group. In particular, the mean score of the lowest self-rated group of teachers (X=19.61) was more than double that of the highest (X=9.56). As a group, the highest self-rated group teachers were the most likely to be experiencing the confluence of computing and pedagogical skills associated with the integration of computers into classroom contexts. Progressively, that likelihood appeared to diminish, with the lowest self-rated group of teachers the most likely to be lacking either computing or pedagogical skills or both.

**Teachers’ Pedagogical Practices and Formalised Computing Training**

**Prescribed Learning Outcomes**

The mean *prescribed learning outcomes* scores of teachers who had not undertaken some kind of formal training in computing (X=15.24; s=5.08) was higher than the mean score teachers who reported formal computing training (X=11.84; s=4.48). A t-test for independent samples registered the difference between the reported pedagogical stance of the two groups of teachers as significant (t=-4.56; df=99; p<0.0001). This result indicates that teachers without formal training tend to focus more on the relative difficulties associated with integrating computers, while those teachers with formal training tend to look more to the relative merits of integrating computers. Thus, formalised computing training helps teachers bridge the understanding gap. Through focused tasks, typical of formal training events, teachers
experience information technologies in ways that enable them to build different perspectives of the pedagogy required to integrate computers, thereby widening the choice of available pedagogical tools and creating circumstances more favourable to using computers as tools for learning.

5.5.6 Teachers’ Awareness of Staff Development Needs
As expectations for computer use in classrooms grow, teachers will need to articulate their individual training needs. Staff development activities are an essential ingredient of any coordinated policy that aims to support innovation and meet growing expectations. An understanding of teachers’ reflections on their commitment to engage in training can help schools to better target efforts. This study identified two factors as reflective of teachers’ awareness of staff development needs – the need for general engagement in training and the need for school-based training. Teachers believing there was a greater need for them to engage in the types of training and localities listed would possess higher scores on both of the staff development factors. Tables 5.16 and 5.17 detail a number of significant relationships between teachers’ awareness of their staff development needs and their use of computers, self-rated computing skill, involvement in formal training, home access to computers, and teacher gender.

Awareness of Staff Development Needs and Teachers’ Use of Computers

School-Based Training
A causal comparative examination of teachers’ mean school-based training scores was undertaken with respect to lesson preparation and record keeping use of computers. A one-way ANOVA returned an F value that was significant (F=10.18; df=4,121; p<0.0001) see Table 5.16. S-N-K comparisons determining where group variation in mean score lay are shown in Table 5.34.
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Table 5.34  S-N-K Multiple Range Test for the Staff Development Factor School-Based Training and Teachers' Lesson Preparation and Record-keeping Use of Computers

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Computer Use</th>
<th>Daily</th>
<th>&gt; Wkly</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.29</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.94</td>
<td>&gt; Weekly</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7.72</td>
<td>Weekly</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.89</td>
<td>Monthly</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>9.34</td>
<td>Never</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – p <.05

A number of differences in mean school-based training scores were registered in the post hoc analysis. Those differences are reflected within two general groups of lesson preparation and record-keeping computer users, frequent and infrequent users. As a group, frequent users were inclined to believe they had less of a need to engage in further training, certainly at the entry skills level and with respect to managing classes using computers. There was heterogeneity across the frequent user group though, with those teachers who used computers only once per week perceiving significantly different needs with respect to entry level skills and classroom management strategies than teachers using computers daily. Infrequent users were somewhat more homogeneous in their belief that they should engage in more school-based entry skills level training along with developing knowledge of managing classes using computers.

ANOVA techniques were also used to examine teachers' mean school-based training scores with respect to their general classroom use of computers. The computed F value was not significant – see Table 5.16. Similar examinations of teachers' use of computers were undertaken with respect to general engagement in training. Again, no differences were found to exist. Could it be that teachers see information technology integration as an incremental process, firstly in terms of gaining useful skills away from the classroom, developing them and at some later stage beginning to experiment with classroom use? This would be a worthwhile direction to pursue in future research.
Awareness of Staff Development Needs and Self-rated Computing Skill

General Engagement in Training

A one-way ANOVA comparing mean general engagement in training scores across groups of teachers based on their self-rated computing skill returned an F score that was significant \( (F=6.21; \ d.f=4,118; \ p=0.0001) \). Analysis of group variations in mean scores (S-N-K comparisons) provided a more detailed understanding of teachers' awareness of staff development needs – see Table 5.35.

Table 5.35  S-N-K Multiple Range Test for the Staff Development Factor Engagement in Training and Teachers' Self-rated Computing Skill

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Skill Level</th>
<th>High</th>
<th>Above Ave</th>
<th>Low</th>
<th>Ave</th>
<th>Below Ave</th>
</tr>
</thead>
<tbody>
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<td>12.33</td>
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<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.58</td>
<td>Ave</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.04</td>
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<td>*</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

(*) Indicates a between group difference – \( p < .05 \)

Differences in awareness of the need to engage in training, across self-rated computing skill groups exist between those teachers reporting well-developed skills (high and above average ratings) and those reporting developing (average rating) and less developed (below average rating only) computing skills. Interestingly, the mean general engagement in training score for the least developed (low rating) computer-skilled teachers differed significantly only from the mean score of the most developed (high rating) computer-skilled teachers.

Not surprisingly, teachers with well-developed computer skills were on the whole less amenable to further training, when compared with their colleagues whose skills were self-rated average or below. Those teachers with developing and less developed skills perceived that they would benefit from further training in and out of school of how computers related to their Key Learning Areas. In particular, those teachers were interested in knowledge of how computers could be used to vary classroom practice.

A reasonable explanation for only a difference between teachers who self-rated their computing skill lowest and those who self-rated their computer skill the highest was that
within the low self-rated group there was a small but noticeable subgroup of teachers not wanting to engage in computer training. That is, there was a subgroup of teachers self-rating their computing skill low believing training was necessary to overcome their deficit and so better place them to integrate information technology. As well, there was a subgroup that acknowledged a deficit but for varying reasons had no desire to overcome it through the options listed in the questions.

School-Based Training

ANOVA techniques comparing teachers’ mean school-based training scores across self-rated computing skill groups reported an $F$ score that was significant ($F=18.52; df=4,121; p<0.0001$) – see Table 5.16. Analysis of group variations in mean score is shown in Table 5.36.

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Skill Level</th>
<th>High</th>
<th>Above Ave</th>
<th>Ave</th>
<th>Below Ave</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.50</td>
<td>Ave</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.99</td>
<td>Below Ave</td>
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<td></td>
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</tr>
</tbody>
</table>

(*) Indicates a between group difference – $p < .05$

Post hoc analysis identified a number of differences in school-based training across self-rated computing skill groups. Those variations differentiate training needs at three broad levels of self-rated skill – well developed; developing and less developed. As was the case with general engagement in training, differences in school-based training reflect perceptual variation between groups as to the degree of training required. However, the factor school-based training was more specific in type of training and where that training was to be delivered than was the factor general engagement in training. As a result, the pattern of between group mean score differences was in line with what was expected. It would appear that those teachers who self-rated their computing skill lowest but felt that the
training alternatives and localities forming the factor general engagement in training were not so acceptable, believed the training alternatives and delivery of that training in school contexts to be more acceptable. It is difficult to ascertain from this data set the exact reason why one form of training is more or less acceptable. Could it be that some teachers are just not willing to undertake any training away from school? Put another way, are those teachers in tune with the need to provide a contextual base to computer training as a means to support the integration of information technologies across the curriculum?

Awareness of Staff Development Needs and Formalised Computing Training

School-Based Training

The mean school-based training score for teachers who had undertaken some kind of formal training in computing (X=7.54; s=2.63) was less than those for teachers who reported no formal training at all (X=9.3; s=2.63). A t-test for independent samples registered a significant difference between the reported training needs of the two groups of teachers (t=4.30; df=121; p<0.001). Based on this result it would appear that teachers who have already undertaken formal training in computing were less inclined to believe they needed further staff development opportunities in this area.

It is possible that highly engaged computer-using teachers found two of the three issues canvassed by the factor school-based training—entry level training and classroom management strategies—as inappropriate to their needs. If that was the case then serious thought must be given to considering how to continue the development of highly engaged computer-using teachers, particularly in the teaching and learning use of computers. Thus, training that explores new and varied pedagogical practices or alternate models of organising computer interactions may be of interest to that group.

It was pleasing to see that teachers without formalised computing knowledge recognise the need to engage in further training. For this group, training needs to be quite specific and the examples provided in the survey are most likely to be typical of what is required.
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Awareness of Staff Development Needs and Home Access

School-Based Training
The mean school-based training score for teachers who have access to a computer at home (X=7.35; s=2.5) was lower than for teachers who reported no access to a computer at home (X=8.72; s=2.23). A t-test for independent samples registered a significant difference between the reported access to home computers by the two groups of teachers (t=-3.63; df=121; p<0.001). This finding supports the notion that teachers need sustained access to computers if they are to benefit from staff development activities. Being able to go home and recreate, apply or simply practice provides an ideal opportunity to continue the learning process. Immediacy is an important factor in motivating people to continue with a particular course of action. This finding is especially important as two-thirds of the teachers who reported no access to a computer at home were women.

Awareness of Staff Development Needs and Teacher Gender

School-Based Training
A similar comparison between male and female teachers was undertaken this time using mean school-based training scores. Once again male teachers recorded lower scores (X=7.15; s=2.48) than their female colleagues (X=8.33; s=2.39). This time, the reported difference in mean school-based training scores between male and female teachers was found to be significant (t=-3.40; df=121; p=0.001). The difference highlights female teachers' perceptions that they may not be as well prepared to implement computers across the curriculum as are their male colleagues. It appears that female teachers are acutely aware of their need for specific entry-level training as well as particular training in classroom management strategies.
5.5.7 Teachers’ Understanding of Policy Formulation

Policy formulation was operationally defined as an appraisal of teacher understanding of the organisational environment for integrating computers across the curriculum. From data collected, data reduction techniques extracted policy formulation factors effective leadership and empowerment of teachers – see Chapter 4. Teachers perceiving that school policies were conducive to the integration of computers across the curriculum would score more highly on both factors. Tables 5.16 and 5.17 provide a summary of a number of causal comparative tests using background variables to differentiate teachers’ understanding of policy formulation. Of the ten tests completed, only one test produced an alpha less than the level set. The result of that test is reported in detail below.

Teachers’ Understanding of Policy Formulation and Use of Computers

EFFECTIVE LEADERSHIP

A comparison of mean effective leadership scores across groups of teachers based on their general classroom use of computers was undertaken using a one-way ANOVA. The computed F reported in Table 5.16 was significant \( F=4.54; df=4,116; p=0.001 \). Post hoc S-N-K comparisons using the were applied to determine between group variations in mean scores – see Table 5.37.

Table 5.37  S-N-K Multiple Range Test for Pedagogical Practices Factor Assimilation of Computers and Teachers’ Lesson Preparation and Record-keeping Use of Computers

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<th>Mean Score</th>
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<th>Monthly</th>
<th>Never</th>
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</table>

(*) Indicates a between group difference – p < .05

S-N-K techniques identified significant differences between the mean effective leadership scores of teachers. Those teachers who were very regular classroom users of computers (daily \( X=13.35 \) or more than weekly \( X=13.22 \)) were more inclined to believed that leadership was
effective than teachers who were less regular (weekly X=11.34) or irregular classroom users of computers (monthly X=11.73 or never X=11.64). The differences in mean effective leadership scores between less regular and irregular classroom users of computers were not significant, though it is interesting to note that the mean effective leadership score for the group of less regular classroom users of computers was the lowest.

Very regular classroom users of computers perceived leadership to be the most effective. As a group, these teachers believed the principal was supportive of classroom technology use, that the school possessed a definite vision for the place of technology in the classroom and that the executive and school computer committee were committed to implementing that vision. On the other hand, all other groups of classroom computer-using teachers were less inclined to hold that perception as truth. Could this difference reflect a dichotomy between the ‘true believers’ and the ‘non-believers’?

As it stands, the relationship would be consistent with an ‘insider’s perspective’. A teacher who regularly uses computers, be they executive teacher or classroom teacher, would more likely be closer to the decision making process than one who does not have a vested interest. As a result, high computer engaging teachers would more likely hold and express views associated with computer policy within a school - definite vision, principal, executive and computer committee support and committed to technology in the classroom. As an outsider, low computer engaging teachers may lack information and therefore the inclination to participate. Unfortunately, this is the very situation that may result in an ineffectual technology implementation plan.
5.5.8 Access to Resources

Twelve of the thirteen factors identified through data reduction techniques in Chapter 4 provided opportunities to explain teachers' intentions to use information technology with reference to the background variables of the study. Pertinent results were illustrated in Tables 5.16 and 5.17. The thirteenth factor, software and hardware barriers presented a special instance where the spread of scores for the factor was sufficiently distinctive to warrant explanation without reference to the background variables of the study.

Educational computing is a resource intensive form of teaching. Schools interested in implementing computers across the curriculum would benefit from an understanding of teachers' beliefs about software and hardware barriers. The factor software and hardware barriers refers to teacher perceptions of insufficient time to find out about software, lack of specific hardware items to teach students useful skills, insufficient computer numbers and a general lack of available software titles. For this factor the higher the score the more the teacher believes in the existence of barriers.

The distribution of aggregated teacher scores for the factor software and hardware barriers is shown graphically in Figure 5.3. Figure 5.3 shows a distribution with a strong negative skew (N=102; X=12.97; s=2.50; skewness=-0.83).

![Figure 5.3 Distribution of Aggregated Teacher Access to Resources Scores](image-url)

The strong negative skew of scores shown in Figure 5.3 clearly illustrates a consistency in teachers' attitudes toward software and hardware barriers. By categorising teachers' responses
into subgroups some understanding of this consistency may arise. Subgroup boundaries could exist where aggregated response scores correspond with teachers generally disagreeing with the assertions (aggregate score of eight or less; labelled no or minimal barriers), agreeing with some assertions and disagreeing with others (aggregate score between nine and twelve; labelled some barriers) and generally agreeing with all assertions (aggregate score thirteen or greater; labelled major barriers). Using those subgroups, less than six percent of teachers would be categorised as believing there were no barriers or that barriers to use were minimal. Another thirty percent would be categorised as believing there were some software and hardware barriers. Overall though, two of every three teachers (63.7 percent) would be of the opinion that there were major software and hardware barriers to overcome before computers could be effectively integrated across the curriculum.

This strong belief in software and hardware barriers was not a unique perception to any one group of teachers and it is this ubiquity across teachers that makes it difficult to counteract in the short term. Nonetheless, the many differences in the nature of relationships identified earlier will provide opportunities to indirectly redress the beliefs that software and hardware barriers preclude the spread of information technology across the secondary school curriculum.
5.6 Addressing the Issues

The present study stated that it would address four questions – see Chapter 1. Two questions (one and two) provided a framework for the study. A third question (three) was addressed in Chapter 5 and a summary follows. The final question (four) will be addressed in Chapter 6 and builds upon the summary below as part of the model building process that was outlined in Chapter 3.

As a group, the teachers surveyed felt that there was a tangible need for greater access to educational computing resources. No noticeable differences though were found in teachers' perception of that need, highlighting uniformity in attitude among all that essentially more resources were necessary if they were to successfully integrate computers across the curriculum. Becker (1992) noted that access to resources was among the most important variables affecting teachers' intentions to use computers. On the other hand, others have since stated that access to hardware and software alone are insufficient to promote teacher use of computers (Newhouse, 1995; NBEET, 1996; Zammit, 1992; Zhao, 1998).

Noticeable differences however, were recorded between twelve dispositional factors and teachers' use of computers, prompting the conclusion that teacher attitudes are significant influences upon teacher engagement with computers. Two aspects of teachers' use of computers were noted in the study, lesson preparation and record-keeping use, and general teaching and learning use in classrooms. For four of the twelve measures of teacher disposition, adequacy when interacting with computers, fear of the unknown, expectations of success and capacity to actualise outcomes differences were noted with both aspects of teacher computer use. The disposition measures perceived relevance of computers within teacher-created learning environments, assimilation of computers, prescribed learning outcomes and effective leadership were pertinent to classroom use, while a relationship was identified between the disposition measure school-based training and teachers' administrating use of computers.

Causal comparative analysis further differentiated teachers' use of computers. In the main teachers' lesson preparation and record-keeping use of computers was characterised by multiple levels of engagement, while teachers' teaching and learning use tended to be either very regular or irregular bordering on no use. Teachers who used computers in their day to day activities expressed the view that they did so because they were in control, they did not avoid computers, nor colleagues who also used computers or who regularly discussed such issues. Those same teachers found computer use enjoyable probably because they were able to fit the computer to their work. Indeed, there was a self-fulfilling aspect associated with this use.
It would appear though, that teachers need almost daily contact with computers to develop such optimism. From a classroom teaching perspective this type of exposure did affect teachers' perceptions of the relevance of computers. Through such contact those teachers were able to assimilate information technologies into their pedagogical stance and as a consequence they were able to look beyond what syllabuses and programs mandate as computer use.

The impact of this immersion would appear to be greatest when classroom-computing opportunities are timetabled, however the process may not be that simple. Not only must those entrusted with promoting computer integration account for computer anxiety and other negative perspectives, it appears that they must also contend with the effectiveness of their leadership. It is quite possible that all of the positives so far identified may simply fail to penetrate beyond the ‘true believers’.

To improve understanding of the relationship between teacher use of computers and teacher disposition reference to teacher characteristics may be necessary. Relationships between dispositions and teacher characteristics identify potential areas for intervention. This study initially sought to explore the impact of eight teacher characteristics, however only four computing skill, involvement in formal training, home access to a computer and gender, provided interpretable results.

It is not surprising that teacher perceptions of computing skill influence dispositions toward computers. Teachers in the sample generally rated their skill level average or lower. In fact, teachers who self-rated their skills the lowest were most likely to feel inadequate and fearful about using a computer. Those same teachers found assimilating computers into their teaching so difficult that they expressed the view that they would only do so only if required.

At issue is how do teachers improve computing skill. Research clearly indicates that computer anxiety (Häkkenin, 1994; Maurer & Simonson, 1993; Overbaugh & Reed, 1994), computer competence and perceptions of relevance (Marcinkiewicz, 1994) are all subject to intervention. Some answers to the question how do teachers improve computing skill are contained in the data collected for the study. Relationships were noted between involvement in formal training and the dispositional factors fear of the unknown, prescribed learning outcomes and school-based training. That is, teachers with formal training in using computers while less likely to want to engage in further training, were more likely to display less anxiety toward computers and believe that computers could have a role in classrooms beyond what was prescribed by syllabuses. Thus, involvement in formal training had provided those teachers with useful knowledge upon which to build more positive attitudes toward computers which in turn influenced their intentions to use computers.
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Even so, the outcomes of involvement in formal training upon teachers' use of computers remain problematic. Within the data collected there was qualified support acknowledging that formal training improves the opportunity for a teacher to use computers in lesson preparation and record-keeping, but nothing clearly directs one to the same conclusion about classroom use of computers. This means that many teachers feel comfortable about producing worksheets, searching for subject-based information and so on but are less comfortable with students using computers. Closer analysis of the data on the type of training undertaken by teachers did provide an answer and one that was able to highlight the importance of embedding pedagogic principles into the training event. As for meeting teacher need through staff development events, it should be noted that teachers were aware of the need to engage in training to improve computing skills. However, the translation of that awareness into a willingness to engage in training events was conditional for a small group of teachers who perceived a lack appropriate of skills. This group was not prepared to engage in training activities beyond what their school may provide.

There was also conjecture as to whether or not there was a relationship between formal training and teachers' expectations of success. It would seem logical for such a positive link to exist given that reference was made to one in the literature. However, the data collected for this study were analysed very cautiously and so there was insufficient evidence from among this sample of teachers to support the existence of such a relationship. It would be expected that future research would not ignore this issue.

A second set of relationships useful to promoting teachers' computing skill was derived from the study. Relationships were noted between home access to a computer and dispositional measures of computer anxiety, computer self-competence and awareness of staff development needs. Based on those relationships teachers could benefit from owning or being able to use a computer at home. This finding was consistent with others identified in the literature review. It is important however, to note that a relationship existed only between home access to a computer and teachers lesson preparation and record-keeping use of computers. It is worth qualifying that position based of the relationship between home access and the staff development dispositional measure. It is possible that through formal training home access to a computer could have pedagogical implications if that access enabled teachers to practice in some way in the comfort of their own home.

Finally, it is worth noting that some gender differences were identified within the study. In the main, female teachers were more likely to self-rate computing skill lower than male teachers. While neither female nor male teachers were more or less likely to engage in training, when
female teachers did engage in formal training they preferred non university sources. Furthermore, female teachers were acutely aware of their need for entry level training, particularly if it were school-based. Female teachers were also found to have restricted home access compared with their male colleagues, a position consistent with that reported by Robertson, Calder, Fung, Jones & O'Shea (1995).

Female teachers would have most to gain from improved home access to a computer, but this development alone would be insufficient to remove all gender differences. Solutions to the problem need to consider other dispositional differences between females and males. Identification of such differences was beyond the scope of the original study however, Lee (1997) has reported that differences in socialisation make women more pragmatic about the benefits of computer use, which is consistent with statements made by Fullan (1982) about the acceptance of change without fully knowing the benefits. Differences in socialisation result in women's perceptions of the computing environment being more negative and this is quite often reinforced through informal learning experiences as well as an over-supply of masculine computer users.

The path secondary teachers need to traverse to develop the knowledge and skill base necessary to implement computers across the curriculum is becoming clearer. The process of adjusting teacher dispositions so that they are more amenable to classroom computer use cannot achieve instant success. Underlying the path is time, which is required for both interaction with computers and for reflection.
Chapter 6

The Causal Model
THE CAUSAL MODEL

6.1. Introduction

Earlier, the researcher developed a model outlining potential factors influencing teachers' intentions to use computers to guide the conceptualisation stage of the study. The model was displayed in Figure 1.1 of Chapter 1. The basic proposition contained in that model was that teacher factors were important determinants of computer use outcomes. After a review of relevant literature a survey instrument was designed and applied to a sample of secondary teachers in Western Sydney Department of School Education secondary schools. The analysis of the data collected revealed a number of variables that were contained within the model illustrated in Chapter 1.

To test the validity of the revised model multivariate Path Analysis was undertaken. Path Analysis was chosen for two reasons.

i. The variables studied were in the main interval variables and open to analysis using parametric correlational techniques. Correlational techniques can identify a relationship between variables, however causal inferences or the direction of relationship cannot be ascertained with certainty.

ii. As a multivariate model, the sole purpose of Path Analysis is to test theories about hypothesised causal links. While there are a number of multivariate models, such as multiple regression, that subscribe to the same purpose, Path Analysis was chosen over the other methods because it is considered to be a more powerful predictor of causal relationships.

6.2 The Causal Links

Of interest to the researcher was an explanation of why do some teachers use information technology more than other teachers do? Thus, the basic premise guiding the search for explanatory variables was that by overcoming barriers to the use of computers teachers would be able to make greater use of Information Technology, which in turn would promote integration across the curriculum.

Barriers to computer use were considered to be dispositional. Data to describe teachers' dispositions toward computers, their patterns of computer usage and specific characteristics, were collected using a questionnaire. The procedures used to identify and operationalise relevant variables were outlined in sections 2 and 3 of Chapter 3. To aid understanding of the complexity of teacher attitudes toward computers, the dispositions that were operationally
defined as outcomes in section 4 of Chapter 3 were considered within the model building process to be dependent and thus influenced by other dispositions.

Based on a correlational analysis of the variables and described in Chapter 4, a number of theoretical statements were formulated in order to better explain the causal links within the generalised model of teachers’ intentions to use computers that is displayed in Figure 1.1 of Chapter 1. The theoretical statements were:

1. Teachers use computers for two purposes:
   a. Lesson preparation and record keeping and
   b. As tools for teaching and learning.

2. Teachers’ predilection to use computers is a reflection of their:
   a. Pedagogical practices and
   b. Computer competence.

3. Teachers’ use of computers and their predilection to use computers alters as their disposition changes. Greater use of computers is consistent with:
   a. Lower levels of computer anxiety;
   b. Improved understanding of the relevance of computers;
   c. Engagement in staff development;
   d. Heightened awareness of resource requirements and;
   e. Greater involvement in policy formulation.

4. Teachers display more positive attitudes toward computer use with improvement in computer skill.

5. Improvement in teachers’ computing skill is associated with teachers’:
   a. Involvement in formal training and
   b. Access to computers
6.3 Results

Correlations among variables presumed to have causal links are presented in Table 6.1. Relationships that were statistically significant are indicated. Explanations of pertinent relationships were stated in Chapter 5. Relationships identified using causal comparative techniques in Chapter 4 have been recalculated using correlational techniques for the purpose of path analysis.

Formulae based on the theories were generated as part of a path analysis using EQS 5.1 for the Macintosh (Bentler, 1993). EQS is a statistical program that tests the fit between a sample covariance matrix and a hypothesised matrix. Paths with a single headed arrow represent relationships between observed variables. Paths are reported as standardised coefficients that would result if other variables in the model were held constant. A fit index for the model was provided and for the present model the comparative fit index - CFI (Bentler, 1993) was used. Maximum likelihood was the method of estimation used in the model.

Each of the described variables central to the theories was tried in the model. The model was not modified nor were additional paths tested as the final model, shown in figure 6.1, proved to fit the data well ($\chi^2=43.0; df=16; CFI=0.97$). No special problems or out of bounds parameter estimates were encountered. All paths in the model were significant based on the $z$-values of the unstandardised coefficients. The broad finding of the analysis was that the theories identified did in fact describe significant causal paths between the identified variables.
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* indicates p < .01
Fig 6.1 The Causal Model

The data collected and scrutinised in part one of this study, when examined using path analysis, did not fit exactly the initial conception outlined in Chapter 1. A number of differences were noted and the most probable explanation for those differences was the identification of thirteen dispositional factors – see Chapter 4 – embedded in the seven constructs originally conceptualised as the basis for this study – see Chapter 3. Of the thirteen factors only six proved reliable in the prediction of teachers’ use of computers. In addition to those six dispositional factors, three other variables were found to be reliable. Thus the model derived reflects the uses of computers and attitudes toward computers of the teachers drawn from a sample of Western Sydney secondary schools.

Teachers’ school-relevant use of computers was characterised in Figure 6.1 as consisting of two broad sets of practices; those that related to the administration of learning – lesson preparation and record-keeping; and those that related to classroom use in teaching and learning. Teachers’ school-relevant use of computers was attributed to their attitudes toward computers, though different attitudes were found to be more influential with respect to each broad set of school computer practices. For administrative uses of computers, teachers’ level of computer anxiety as measured by the factors adequacy when interacting with computers and fear of the unknown and their disposition toward school-based training were found to be paramount. For classroom computer use teachers’ computer anxiety as measured by the factors
adequacy when interacting with computers, teachers' computer self-competence defined as expectations of success and their pedagogical practice perspective toward prescribed learning outcomes along with the policy formulation disposition effective leadership were considered to be the dominant dispositions. For teachers' administrative use of computers access to a home computer was also a relevant consideration. Teacher attitudes toward computers were variously affected by perceptions of computing skill and involvement in formal training.

The model illustrated the importance of three of the original constructs within teacher attitudes toward computers, computer anxiety, computer self-competence and pedagogical practices. Teachers' level of computer anxiety was a major determinant of computer use in school-relevant tasks, a position well supported in the literature review – see Chapter 2. In this instance apprehension derived from feelings of inadequacy and to a lesser extent fear of the unknown diminished teacher interaction. Underpinning diminished interaction were varying beliefs about the control each teacher could exert over their work when computers are involved. Providing teachers with different levels of understanding associated with how computers fit their work regimen is a logical step and one that is well supported in the literature review – see Chapter 2. This kind of knowledge would enable those teachers most anxious about computers to begin using them without feeling that control over work was sacrificed for the sake of using the computer.

Given that feelings of adequacy influence all school-relevant computer interactions it is essential that computer understandings provided to teachers and designed to reduce apprehension match the range of work tasks closely. While the model does contain a direct link between computer anxiety and pedagogical understanding of computers, it is reasonable to surmise that feelings of inadequacy associated with computer interaction would be limiting in this respect. Thus, confining illustrations to teachers of the benefits of computers to how to use a word processor to generate worksheets or use email to respond to a request for information, ignores classroom uses and so may ignore completely teachers' apprehension associated with classroom computer use. The Department of Education and Training has restructured professional development to emphasise classroom computer use, though the literature notes that acquiring understanding of classroom computer use is a medium term goal and in general cannot be shortened (Becker 1994; Sheingold & Hadley, 1990).

The model defines computer self-competence and pedagogical practices constructs as bearing directly on classroom use of computers. When considered against endeavours to reduce apprehension towards among teachers, the intertwined nature of expectations of success and teacher perceptions of the role of computers in achieving learning outcomes becomes clearer. As previously stated, matching understandings to classroom and teacher needs was fundamental to reducing feelings of inadequacy. When teachers become aware of the capacity of computers and feel that using them does not diminish their potential to achieve desired learning outcomes, teachers will begin to put them to use (in varying degrees) in their classrooms with (varying levels of) success. As teachers experience success, this success can
provide the impetus for further innovation. This self-fulfilling quality of success encourages some teachers to employ other teaching strategies that are conducive to computer use, which aids though does not assure, the transition to computers being embedded in day to day classroom practices.

Teacher administrative use of computers was also predicted by their disposition towards *school-based training*. The relationship between teacher disposition towards *school-based training* and administrative use of computers was an interesting one. Firstly, the relationship was an inverse one, that is less desire for school-based training was matched by more use of computers in administrating learning. Secondly, the themes underlying the factor were meant to have a pedagogical rather than an administrative bias. It may be that teachers picked up on the proposition's entry level training and school contexts as important to their acquisition of administrative computing skills. If this is so, then it may help explain why there is greater variation amongst teachers' administrative use of computers than amongst classroom use.

Access to computers away from school was no less an important predictor of teachers' administrative use of computers than were the dispositional factors. It would appear that many teachers have quite deliberately incorporated computers into activities they perform at home in support of their day to day teaching. Nonetheless, there are teachers less predisposed to using computers who have not incorporated them into their work at home routine and a significant proportion of those teachers were female.

No predictive link was established between home access and computing skill in the model, though one was discussed in Chapter 5. Similarly, home access and teacher classroom use of computers were not linked, though the literature does suggest that benefits may arise through the introduction of portable computers. Data supplied by Newhouse (1995) supports the view that such a program, at least in its infancy, would have little classroom impact without teachers being encouraged to consider pedagogical issues. Newhouse did speculate about the development of exemplary computer using teachers once schools using portables were able to create programs that considered pedagogical issues.

The *policy formulation* factor *effective leadership* was confined to predicting teachers' classroom use of computers. Attitudes toward effective leadership impact upon teachers' perceptions of how schools set the computer policy agenda. Issues associated with setting the computer policy agenda include the establishment of a vision for classroom computing use and the mechanisms to be used to implement and support that vision. When schools have an established and agreed upon set of principles for classroom use of computers it is often that those principles have been arrived at through effective leadership. When this is the case, effective leadership has played a role increasing the propensity for classroom computing.

Unfortunately, *effective leadership* was not determined within the model through reference to other dispositions or influences, consequently no explanation is provided of how schools implement *effective leadership* resulting in a greater propensity for classroom computing. However, insight into the more generalised process of *effective leadership* is provided in the
literature (Fullan, 1985, 1992; Kefford, 1983). Fullan and others closely associate effective leadership with the diffusion of innovation and acceptance by teachers of a common set of beliefs about children benefitting from the innovation, in this case classroom-relevant computing.

In the present study the process of sharing common goals appeared incomplete. As stated in Chapter 5, the dominant view among respondent teachers using computers in classrooms was that leadership was indeed effective a view not yet shared by all teachers. Thus, without realising it, the conviction of those using computers in classrooms regularly could very well be inhibiting the integration of computers and so serving to perpetuate the very barriers to the spread of classroom computing. It is therefore no surprise to see that the Department of Education and Training taking greater responsibility for permeating educational computing policy.

Discussion so far has focussed on the major dispositions identified as directly influencing teachers' school-relevant use of computers. The path analytic model provides some insight into how individual teachers' school-relevant use of computers could be promoted. Promotion of teachers' school-relevant use of computers could occur at two points, either through improvements in computer skill, or through involvement in formal training.

Data on teachers' computer skill were initially collected on the basis of a rating, which assumed that those who rated highly would possess a diverse array of technology skills akin to what was described in the literature as being computer literate. As well, there was an expectation that those computing skills would include understandings associated with the use of information technologies within learning environments.

The model highlights the importance of teachers' computer skill as a predictor of attitude towards computers, with five of the six dispositional measures predicted by teacher rating of their computing skill. Of those five dispositional measures four relate inversely to computer skill, which suggests that improving the array of computing skills available to teacher will minimise the impact of perceptual barriers and lead to increased school-relevant computing.

The role of formal training was defined also within the model however, as a predictor formal training linked only to teacher expectations of success and teacher beliefs about the nature of learning outcomes. No link existed between teacher perceptions of their computing skill and formal training, suggesting that teachers need not engage in structured learning tasks to improve their computing skill. Engaging in formal computing training though does create circumstances in which teachers feel comfortable to raise their personal expectations about interactions with computer being successful. Similarly, through formal training teachers are exposed to new and varied practices that can be the catalysts for them to alter their beliefs about how computer use can impact upon student learning outcomes. Causal comparative analysis reported in Chapter 5 clearly illustrates that it is the nature of the training that counts. If teachers are to acquire attitudes conducive to classroom-relevant computing then engagement in training is a means for that outcome to be achieved. Approaches that both tier
training to meet the individual needs of teachers and embed pedagogy within the training would provide the best opportunities for teachers.

Finally, it is important to recognise that a proportion of the variance in the outcome variables was left unexplained by the constructs of the model. Clearly teachers’ use of computers and their predilection to computer use is dependent upon other factors that were not incorporated into the present conceptualisation. This points to the fact that predicting outcomes such as computer use is a complex business and the present study contributes to the field by clarifying the role of teacher attitudes as predispositions to teachers’ use of computers.

6.4 Concluding Remarks

The model developed from data collected in the study begins to unravel the complexity of the factors affecting teachers’ intentions to use information technology. The analysis has shown that there is a relationship between teachers’ level of formal computer training, access to computers away from school, computer skill and the interplay of attitude toward computers. As an initial analysis the linkages have been assumed to be one way, holding constant the impact of feedback.

It is important to recognise that a potential outcome for the model building process is the incorporation into a technology plan of a multi-faceted approach to teachers’ integration of technology across the curriculum. The model identifies three points – Teachers’ Level of Computing Skill, Formal Training, and Access to Computers – where policy makers have the potential to influence teachers’ computer use either directly or indirectly through influencing teacher attitudes toward computers. In addition, the model highlights the importance of Effective Leadership as an environmental factor in influencing the integration of computer into classroom activity by teachers.

Finally, future research directions can be identified. Firstly, the model is incomplete, in the sense that not all relationships have been defined fully. Further exploration of teacher attitudes toward computers should be undertaken to refine the model.

Secondly, there is sufficient information identified through the model to warrant its application within a school. Use of the model to generate intervention strategies should be considered. Evaluation data collected in such circumstances would also benefit the refinement of the model.

Finally, the literature review identified many factors that impact upon each of the components of the model. In this regard, further analysis of specific linkages would enlighten our understanding of teachers’ intentions to use information technology.
Appendix I

Principal’s Letter
Dear Colleague,

My name is Allan Morton. I am a lecturer in Educational Computing within the Faculty of Education at the University of Western Sydney, Nepean. As part of my research activities I am examining the Integration of Computers across the Curriculum within Secondary Schools. I am writing to seek permission to conduct part of my study within your school.

The project is a multi-site attempt to develop a profile of incentives and barriers to the integration of computers across the curriculum. Once the profile is developed, it will serve as a database to provide schools with informed options to enable them to better integrate computers into all KLAs.

Should you grant permission, I would like to discuss the project with the staff and leave them with a copy of a survey designed to identify teachers' attitudes towards computers. The research literature identifies five aspects that influence the ability of schools to effectively implement computers across the curriculum. The five areas are

i. Teacher experience, motivation and perceptions of Information Technology, measured primarily by computer anxiety, computer competence and perceived relevance;

ii. Current Pedagogical Practices;

iii. Training, Support and Collegiality;

iv. Access to Information Technology and

v. Formulation of Policy.

Background data will also be collected to correlate against the above aspects. A copy of the research instrument is enclosed.
Teachers' Intentions to Use Information Technologies:
A Study of Western Sydney Secondary Teachers

In addition, access to the school Computer Coordinator / Head Teacher Computing or another nominated person is part of the research design. It would be my intention to liaise with this person as part of the process of validating the data collected by the questionnaire. Prior to any discussions taking place I would contact the Computer Coordinator / Head Teacher Computing / Nominated person seeking their permission to be involved in the process.

Thank you for taking the time to read my letter and consider my proposal. I will be contacting you by telephone within the next week to confirm whether or not you grant permission for the research to be undertaken in your school. I have sought and gained approval for the project from the University of Western Sydney, Nepean Human Ethics Research Committee and the Metropolitan West Department of School Education Research Committee.

Yours faithfully

Allan Morton
Lecturer
University of Western Sydney, Nepean
Appendix 2
Information Sheet
1. AIMS
The project aims:

- to identify potential incentives and barriers to the integration of computers across the Secondary School Curriculum.
- to determine the existence of specific incentives and barriers within the context of individual schools.
- to correlate the pattern of incentives and barriers across different schools.
- to provide some policy alternatives to promote the integration of computers across the curriculum.
- contribute to a growing body of Australian knowledge on computer integration that will complement and extend an understanding of this issue that is developing across the world.

2. PARTICIPATION
This questionnaire seeks information about your attitudes to using computers in teaching and learning. We would be grateful if you would agree to take part in our study by answering all questions and returning the questionnaire to (PLACE TO BE DETERMINED IN CONSULTATION WITH PRINCIPAL) where it will be collected in one week’s time.

You RETAIN the right to refuse to answer any or all of the questions.
3. CONFIDENTIALITY
Any answers you provide remain confidential. Your name will not be recorded. Any identifying data that is collected for the purposes of matching your responses and the questionnaire will remain confidential and will not be published.

4. AVAILABILITY OF RESULTS
A summary of the collated data for your school and a summary of the collated data from the six participating schools will be made available to your principal.

If you have any comments or queries please direct them to:

Mr. Allan Morton
Dept of Professional Studies
Faculty of Education
P.O. Box 10 Kingswood
N.S.W. 2747
(p) 047 36 0257 (f) 047 36 040
e-mail a.morton@nepean.uws.edu.au
Appendix 3

Consent Form
I ........................................ (participant's name) agree to participate in the research project Case Studies of the Integration of Computers Across the Secondary School Curriculum in Western Sydney High Schools being conducted by Allan Morton from the Dept. of Professional Studies, Faculty of Education, P.O. Box 10 Kingswood, N.S.W. 2747, telephone 047 360 257 of the University of Western Sydney Nepean.

I understand that the purpose of this study is identify the incentives and barriers to the integration of computers across the curriculum within Western Sydney High Schools and to use the data generated to provide schools with some policy alternatives to promote integration.

I understand that my participation in this research will involve a questionnaire of approximately 20 minutes duration.

I am aware that I am at liberty to contact Allan Morton if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, and without giving a reason.

I agree that Allan Morton has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

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

Signed by

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

Witnessed by

NOTE: The University of Western Sydney Nepean's Human Ethics Review Committee has approved this study. If you have any complaints or reservations about your participation in this research, you may contact the Ethics Committee through the Human Ethics Officer (tel: 047 360 169). Any complaint you make will be treated in confidence and investigated fully, and you will be informed of the outcome.
Appendix 4
Research Instrument
USING COMPUTERS IN THE

KEY LEARNING AREAS

Questionnaire for Teaching Staff

The purpose of this questionnaire is to find out how
schools have and are using computers in the curriculum.

Please complete the following questionnaire as honestly
as possible.

The questionnaire will take approximately 20 minutes to
complete.

Your responses are anonymous and you are NOT
required to your name on this form.
BACKGROUND INFORMATION

Answer this set of questions about yourself by placing a tick in the most appropriate box.

1. What is your gender?
   - female 1 ☐
   - male 2 ☐

2. How old are you?
   - under 25 years 1 ☐
   - 26-30 years 2 ☐
   - 31-35 years 3 ☐
   - 36-40 years 4 ☐
   - 41-45 years 5 ☐
   - 46-50 years 6 ☐
   - over 50 years 7 ☐

3. How many years have you been a teacher?
   - under 5 years 1 ☐
   - 6-10 years 2 ☐
   - 11-15 years 3 ☐
   - 16-20 years 4 ☐
   - 21-25 years 5 ☐
   - over 25 years 6 ☐

4. In which KLA is most of your teaching load?
   - English 1 ☐
   - Mathematics 2 ☐
   - Science 3 ☐
   - Human Society & Its Environment 4 ☐
   - Languages Other Than English 5 ☐
   - Personal Development Health Physical Education 6 ☐
   - Technological & Applied Studies 7 ☐
   - Creative & Performing Arts 8 ☐
   - Special Education / Support 9 ☐
   - Other 10 ☐

   please specify ____________________________
5. Are you a

- Member of the School Executive
- (Head Teacher, Deputy Principal, Leading Teacher etc)
- Classroom Teacher
- Librarian
- Other
- please specify _____________

6. How do you rate your computer skills?

- Low
- Below Average
- Average
- Above Average
- High

7. Do you have access to a microcomputer at home?

- Yes
- No

8. What is the major purpose for which you use this computer?

- Lesson preparation and record keeping
- Entertainment
- Home related record keeping and letter writing
- Running a business
- Other
- please specify _____________

9. Is there a computer in your staff study?

- Yes
- No

10. Do you have access to a computer elsewhere within the school?

- Yes
- No
11. Overall, how would you describe your lesson preparation and record keeping use of computers?
   Daily 1 □
   More than once per week 2 □
   Weekly 3 □
   Once a month 4 □
   Never 5 □

12. Overall, how would you describe your teaching / learning use of computers?
   Daily 1 □
   More than once per week 2 □
   Weekly 3 □
   Once a month 4 □
   Never 5 □

13. Have you done or are you currently undertaking any studies in computer use?
   Yes 1 □
   No 2 □
   go to question 15

14. Level
   Undergraduate Preservice (Degree / Diploma) 1 □
   Graduate (Dip Ed / M Teaching) 2 □
   Postgraduate Coursework 3 □
   Postgraduate Research 4 □
   TAFE 5 □
   Other 6 □
   please specify __________________________

15. How much more knowledge of the uses of computers as tools for learning would you like to have?
   None 1 □
   Some 2 □
   Moderate 3 □
   A Lot 4 □
   A Great Deal 5 □
16. Where would you prefer to seek help to learn of the uses of computers as tools for learning? (You may have more than one preference).

- School based In service
- Regional KLA based In service
- A Colleague in my school
- An outside consultant
- University
- My own experiences

ATTITUDES ABOUT COMPUTERS

Computer Anxiety

1. I feel that I control computers rather than computers control me. 1 2 3 4 5
2. I would feel uncomfortable using computers as tools for learning. 1 2 3 4 5
3. I usually have to make my work fit the computer rather than the computer fit my work. 1 2 3 4 5
4. Working with computers cuts you off from the people around you. 1 2 3 4 5
5. I’d rather do things by hand than use a computer. 1 2 3 4 5
6. I would use a computer even if it were not expected of me. 1 2 3 4 5
7. I have avoided using computers because they are unfamiliar to me. 1 2 3 4 5
8. I don’t understand how some people can spend so much time working with computers and seem to enjoy it. 1 2 3 4 5
9. I feel stupid when others talk about computers. 1 2 3 4 5
10. Computers are changing the world too rapidly. 1 2 3 4 5
Computer Competence

1. If given the opportunity to use a computer I'm afraid I might damage it in some way.
   1 2 3 4 5

2. The idea of working with computers makes me tense.
   1 2 3 4 5

3. I will be able to keep up with the important technological advances of computers.
   1 2 3 4 5

4. I feel confident about using the computer as a learning tool in my classroom.
   1 2 3 4 5

5. Electronic machines such as videos are really hard to use.
   1 2 3 4 5

6. I sometimes show other people how to use a computer.
   1 2 3 4 5

7. Having my own computer would help me in my professional role.
   1 2 3 4 5

8. Computers will never replace the teacher in classrooms.
   1 2 3 4 5

9. I am confident that I can learn computer skills.
   1 2 3 4 5

10. The challenge of solving problems with a computer does not appeal to me.
    1 2 3 4 5

Perceived Relevance

1. Computers will motivate uninterested students.
   1 2 3 4 5

2. Computers can empower students to learn
   1 2 3 4 5

3. Computers help students to feel good about themselves.
   1 2 3 4 5

4. Computers have a positive influence on students' attitudes towards school.
   1 2 3 4 5

5. Computers are one means of developing cooperative social structures in my class.
   1 2 3 4 5

6. Computers make it possible for students to learn oral and written communication skills.
   1 2 3 4 5

7. Computers help students learn to research and report on a topic.
   1 2 3 4 5

8. Computers help students acquire problem-solving skills.
   1 2 3 4 5

9. Computers enable teachers to accommodate different ability levels.
   1 2 3 4 5

10. Computers enable teachers to cater for different learning styles.
    1 2 3 4 5
## Pedagogical Practices

<table>
<thead>
<tr>
<th>1. Achieving desired outcomes is made more difficult by using computers.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. I would only use computers if it were a syllabus/program requirement.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Computers would enable me to individualise instruction</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. My teaching style could never be altered to fit computers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. The computer offers me some variety in lesson presentation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Preparing lessons involving computers takes more time than traditional lessons.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I don’t use computers because I have to book the computer lab.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Using technology stimulates me to innovate in the way I deliver my subjects</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Using computers means I have more control over my work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Using computers means I work longer hours.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. Using computers provides time to engage students in higher levels of thinking</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. Traditional resources are more relevant to the way I teach.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. Using computers requires management strategies that I am not familiar with.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I will do as little with computers as possible.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. Having a computer available in my classroom would improve my productivity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

## Staff Development

| 1. I would use computers more if I had access to regional in service for computers in my KLA. | 1 | 2 | 3 | 4 | 5 |
| 2. I would use computers more if there was information on potential uses available in the library. | 1 | 2 | 3 | 4 | 5 |
| 3. I would use computers more if I had specific training in the use of simulation games and databases exploration. | 1 | 2 | 3 | 4 | 5 |
| 4. I want to learn more about how technology enables me to vary my classroom practices. | 1 | 2 | 3 | 4 | 5 |
Staff Development

5. I am encouraged to take computers home to enable me to be comfortable with them.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

6. I need training that provides entry-level skills.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

7. I'd use computers more in teaching and learning if there was in school training available.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

8. I know how to access, retrieve, handle and evaluate information using a computer.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

9. I need to know how to manage classes when they use computers.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

10. All teachers need to know how to manage computer resources.
    - Slightly Disagree: 1
    - Disagree: 2
    - Undecided: 3
    - Agree: 4
    - Strongly Agree: 5

Access to Resources

1. The best way to use computers with students is in a computer laboratory.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

2. Flexible timetables are necessary to improve access to computers.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

3. Computing resources are monopolised by specialist classes.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

4. Scarce funds are better spent on more traditional resources like textbooks.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

5. We need to see software before we can buy it.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

6. I would use computers more if they were located in or close by to my classroom.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

7. With computers in my classroom linked to the library, my students would be better prepared to learn.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

8. There is not enough time spent letting staff know about the latest software.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

9. We need printers, scanners, modems and other devices if we are to teach students useful skills, relevant to their future.
   - Slightly Disagree: 1
   - Disagree: 2
   - Undecided: 3
   - Agree: 4
   - Strongly Agree: 5

10. How can I be expected to use computers when there just aren't enough to go round as it is.
    - Slightly Disagree: 1
    - Disagree: 2
    - Undecided: 3
    - Agree: 4
    - Strongly Agree: 5

11. It's one thing to have computers in the school, its another thing to have enough software to justify using them.
    - Slightly Disagree: 1
    - Disagree: 2
    - Undecided: 3
    - Agree: 4
    - Strongly Agree: 5
### Policy Formulation

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Slightly Disagree</th>
<th>I'm Undecided</th>
<th>Slightly Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The school possesses a definite vision for the place of technology in the classroom.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>The executive is committed to implementing a specific vision for technology in the classroom.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>As a classroom teacher I am in the best position to determine my classes' computing needs.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>I have a say in the purchase of hardware and software used in the school.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>The principal is supportive of the use of technology in the classroom.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>There is a strong commitment from within the computer committee to support teachers using technology in the classroom</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Implementing a computers across the curriculum program for teachers is a wise choice of spending school funds.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>The school should have a policy that calls for prescribed computer experiences in all subjects in all years.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Equity of access is a high priority in the school's policy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Decisions about where computers are to be located are made by all staff.</td>
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<td>Implementing computers across the curriculum won't require any modifications to classrooms.</td>
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<td>12</td>
<td>The school should be committed to replacing its stock of hardware every three years.</td>
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<td>I'm willing to learn how to use computers; there just aren't enough staff development funds available.</td>
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There are no more questions.

Thank you for your cooperation.
The answers you have supplied will be most helpful
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TEACHERS’ INTENTIONS TO USE INFORMATION TECHNOLOGIES:
A STUDY OF WESTERN SYDNEY SECONDARY TEACHERS

by

Allan D. Morton BEc. G.DipEd. M.Ed

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Education (Hons)

University of Western Sydney, Nepean

1999
PLEASE NOTE

The greatest amount of care has been taken while scanning this thesis,

and the best possible result has been obtained.
Certificate of Originality

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree.

I certify that any help received in preparing this project, and all sources used, have been acknowledged in this thesis.

[Signature]

Allan Morton
University of Western Sydney, Nepean

Abstract

TEACHERS’ INTENTIONS TO USE INFORMATION TECHNOLOGIES: A STUDY OF WESTERN SYDNEY SECONDARY TEACHERS

by Allan Morton

Chairperson of the Supervisory Committee:
Dr Steven Wilson
School of Lifelong Learning and Educational Change

The object of this study was to answer four major research questions dealing with the intentions of teachers to use information technologies. These questions were: 1) What are the teacher characteristics and dispositions that impact upon teacher intentions to use computers in teaching and learning; 2) How do teacher characteristics and dispositions impact upon teacher intentions to use computers in teaching and learning; 3) How do teacher characteristics and dispositions that impact upon teacher intentions to use computers in teaching and learning relate to each other; and 4) Can the pattern of relationship between teacher characteristics and dispositions explain conceptually the processes by which teachers' uptake computers into teaching and learning situations?

Teachers were sampled from seven Department of School Education secondary schools located in Western Sydney. Subjects were provided with a questionnaire containing items pertaining to educational, professional and computing backgrounds, and attitudes toward computers. Statistical analysis was undertaken and appropriate data descriptive and inferential techniques such as Correlation, Chi Square, t-test and ANOVA were used.

Results of the study show teachers' use of computers to be influenced by attitudes toward computers as well as background factors such as teachers' computer skill, their involvement in formal training, and their access to computers outside of school. Gender issues were examined and while some effect was found, the effect was not consistent across all variables.

The results of the inferential analysis were used to formulate a causal model using path analysis techniques. The purpose of the model was to explain further the relationship between teachers' attitudes toward computers and computer use.
For Jane
Without your understanding and support this thesis would have remained incomplete
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